AUSTRALIAN POST OFFICE

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TECHNICAL TRAINING PUBLICATION

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INTRODUCTION TO TELEGRAPHY

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1. INTRODUCTION.

1.1 Telegraphy as a means of communication has many applications, all of which serve a common purpose of providing a means of transmitting printed rather than verbal information from one point to another. The word "telegraph" originates from the Greek words "tele" meaning far, and "graphein" to write.

Throughout history many forms of telegraphy have existed but it was electricity that gave Man his seven league boots and enabled the electric telegraph to span continent and ocean.

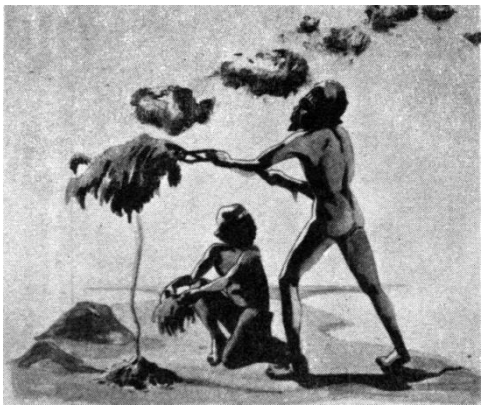
1.2 Australia opened its first telegraph line from Williamstown to Melbourne in 1854, only nine years after Samuel Morse opened his first commercial circuit. With the completion of the Overland Telegraph line to Darwin in 1872, all capitals except Perth were connected to London over the extended England – Java cable.

1.3 The telephone system provides a most convenient system of communication, but has some disadvantages. There is no record of the communication, and difficulty arises in transferring important information, especially if there is a significant amount of coded numeric content.

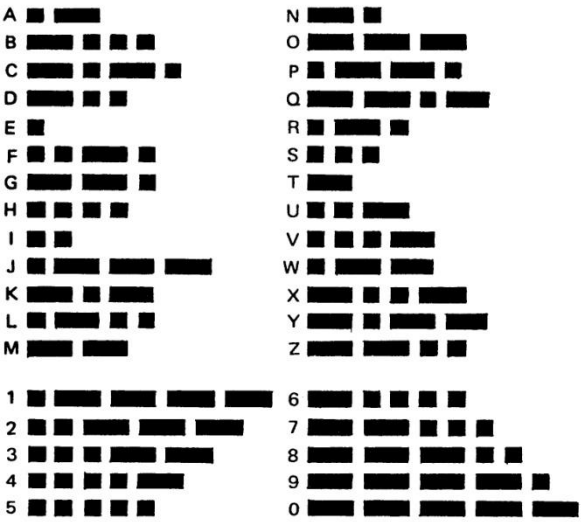
Telegraphy offers the advantages of a typed or tape copy at each end of the circuit, and rapid and accurate transmission of information. It also meets the specialised requirements of commerce, industry, defence etc. that cannot be provided by other forms of communication.

INTRODUCTION TO TELEGRAPHY

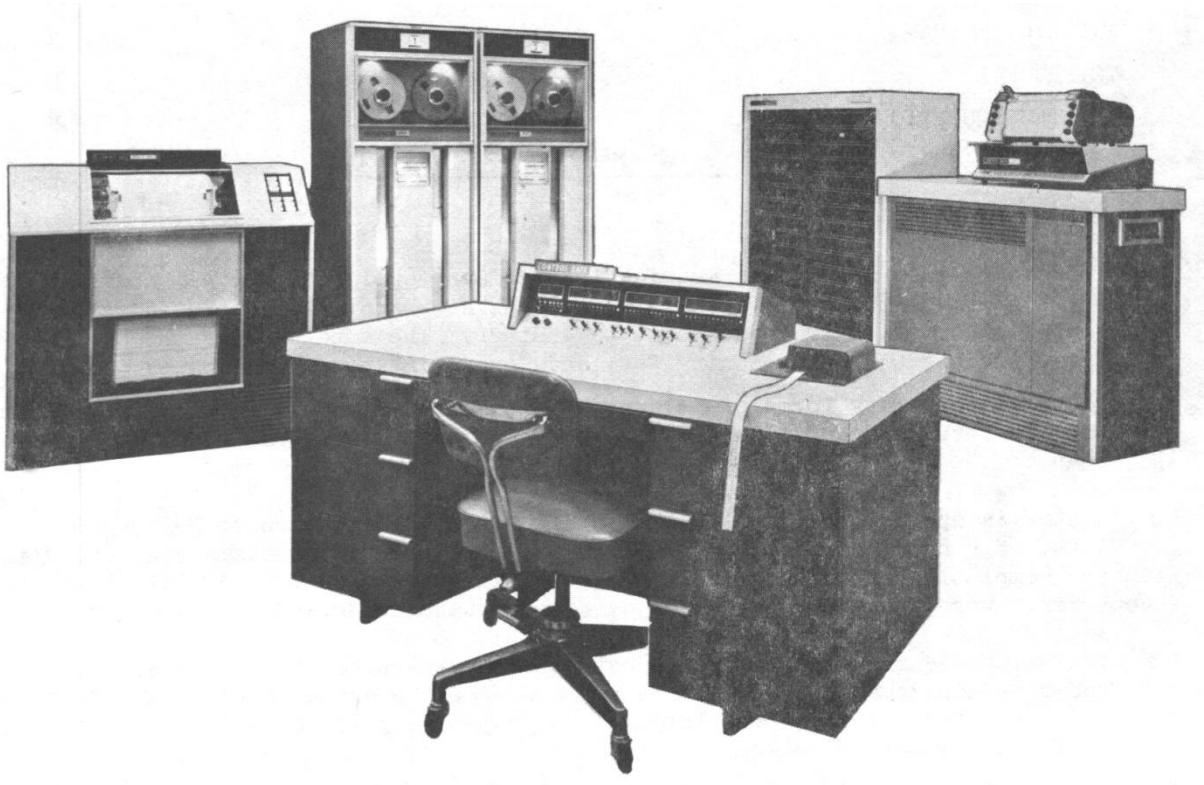
1.4 From the days of using smoke signals, jungle drums, cannons, bells and Morse code, through to the use of the five unit code and data transmission for computers, the same type of signalling has prevailed. This consists of combinations of two distinct elements. They may be smoke – no smoke, dot – dash, mark – space, or the one – naught of computer terminology. (Fig. 1).



(a) Aborigine "keying" smoke.



(b) Morse code.



(c) Computer.

FIG. 1. TELEGRAPHIC PROGRESS.

1.5 With the introduction of printing telegraphy a new form of code was required having code combinations of uniform length. Several codes were developed and used but Donald Murray, an Australian newspaper man, developed his own five unit code assignments, and this code with minor changes was eventually adopted by the International Telegraph and Telephone Consultative Committee and became the C.C.I.T.T. Number 2 Telegraph Alphabet used throughout the world today. This code is explained in detail in Section 2.5.

2. TELEGRAPH SIGNALLING.

2.1 GENERAL. Telegraph signalling involves the transmission and reception of electrical impulses called signal elements, the equivalent of the smoke - no smoke signals of the Aborigine. One of two electrical conditions can apply. One condition is called "mark", the other "Space". A representation of this is shown in Fig. 2.

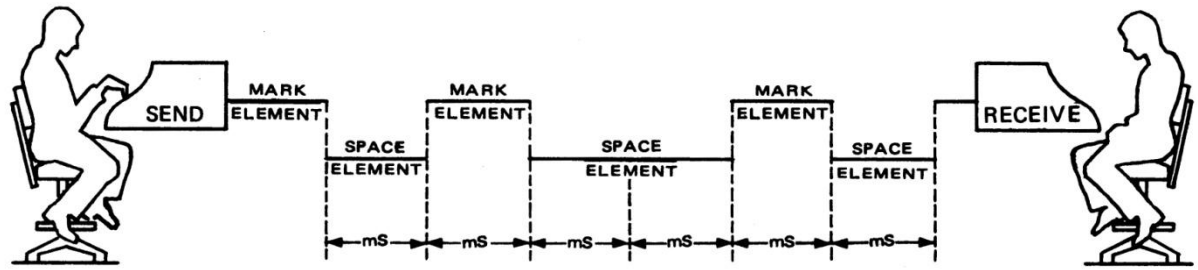


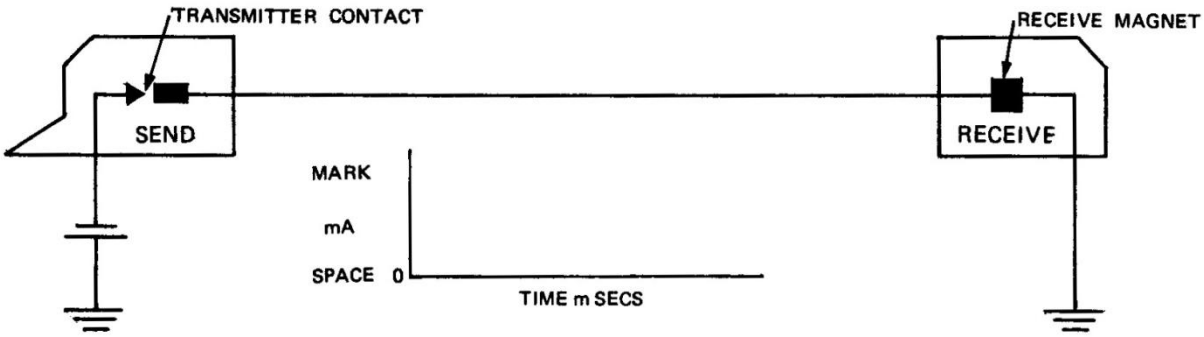
FIG. 2. SIGNAL ELEMENTS.

There are two main methods of telegraph signalling used by the Australian Post Office, known as:

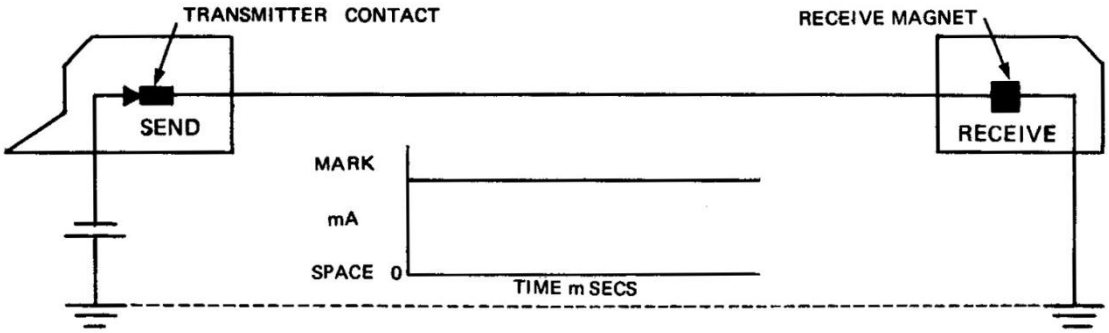
- Single-Current (sometimes called Neutral signalling).
- Double-Current (sometimes called Polar signalling).

2.2 SINGLE-CURRENT (NEUTRAL) SIGNALLING. (Fig. 3). As indicated above, two different electrical circuit conditions called mark and space are applied to the equipment. In this method of signalling, current flows during only one of these conditions. It is for this reason that this method is called Single-Current signalling. The alternative term Neutral signalling is derived from the fact that neutral or non-polarised relays are used for the reception of signals of this nature.

- TRANSMISSION. The transmitting mechanism of single-current machines is a simple "make-break" contact assembly. Current flows through the circuit when the contacts close or "make" (Fig. 3a), and ceases to flow when the contacts open or "break" (Fig. 3b).
- RECEPTION. When current flows, the receiving magnet armature is attracted, while the cessation of current allows the armature to return to its unoperated position under the influence of a mechanical restoring force (usually a spring).



(a) Contacts Open - Space (No current flows).



(b) Contacts Closed - Mark (Current flows).

FIG. 3. SINGLE-CURRENT SIGNALLING.

In practice most circuits are operated on a send-receive basis, the machines on either end being capable of sending or receiving, as shown in Fig. 4. This means that the sending machine prints a "home record" of information identical to that received on the distant machine because both magnets are in the same circuit and respond identically to the signals.

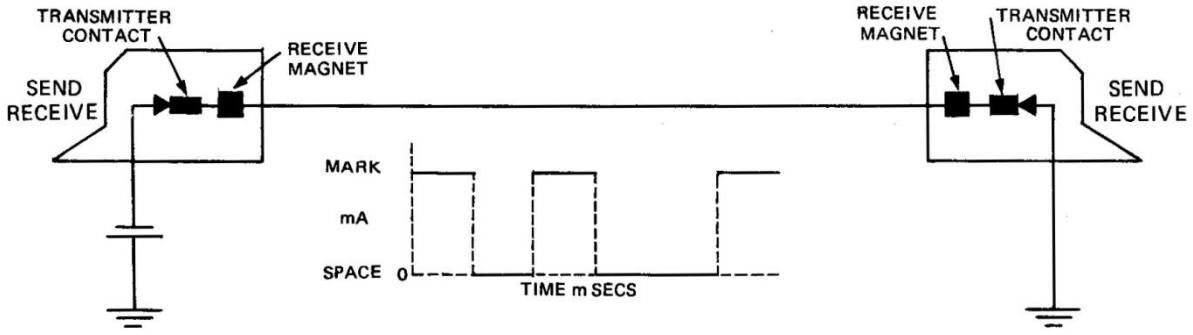


FIG. 4. SEND RECEIVE SINGLE CURRENT CIRCUIT.

2.3 DOUBLE-CURRENT (POLAR) SIGNALLING also uses the principle of two different electrical conditions being applied to the equipment, but in this case current flows during both conditions. It is the direction of the current that is important in this case, as the current flows in one direction for one condition, and in the opposite direction for the other condition.

- **TRANSMISSION.** By the inclusion of another power supply of opposite potential connected to an additional transmitter contact, as shown in Fig. 5, Double-Current transmission is achieved by the movement of the centre contact, or as it is usually called, the transmitter tongue. The position of the transmitter tongue determines the polarity of the voltage and therefore the direction of current flow.

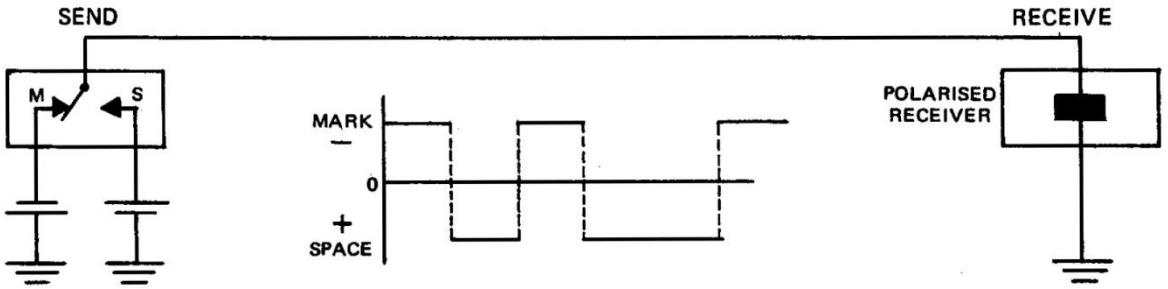


FIG. 5. DOUBLE CURRENT SIGNALLING.

- **RECEPTION.** During Single-Current reception the receiving magnet responds according to whether current is flowing in the circuit or not; but in the case of Double-Current reception, where current flows during both of the signalling conditions, a receiving magnet which will respond to the different directions of current is necessary. A polarised relay (see para. 2.7) is used for this purpose. Current in one direction operates the receiving magnet armature to one position; a reversal of the direction of current operates the armature to the other position.

2.4 STANDARD LINE CONDITIONS. The electrical condition of the circuit is often referred to as Marking or Spacing, and is determined by the prevailing current condition in the circuit at a particular instant. The normal at-rest condition in most circuits is Marking.

Generally, for Single-Current signalling, current flows over the line for the Marking condition, and no current flows over the line for the spacing condition.

In the Double-Current case, negative battery potential is applied to the line for the Mark signal and positive for the Space signal.

2.5 THE FIVE UNIT CODE. We normally convey intelligence by using the alphabet and numbers with suitable punctuation. To transmit this form of information by telegraph signalling it is necessary to convert the letters, figures and punctuation into a code. This code, called the Five Unit Code, consists of the two signalling elements of Mark and Space, grouped together in units of five to form each code combination. When using five units, each made up of two different elements, a total of 32 combinations is possible ($2^5 = 32$).

Only 26 combinations are used for the alphabet, the remaining 6 combinations being used to control "functions" of machines.

The term "function" covers those operations of the machine associated mainly with paper control (combinations 27 to 31) as distinct from printing.

A.P.O. START STOP MACHINE ALPHABET									
CODE COMBINATION No.	LETTERS	FIGURES	NUMBER OF IMPULSES						
			START	1	2	3	4	5	STOP
1	A	—	S	M	M	S	S	S	M
2	B	?	S	M	S	S	M	M	M
3	C	:	S	S	M	M	M	S	M
4	D	NOTE 1	S	M	S	S	M	S	M
5	E	3	S	M	S	S	S	S	M
6	F	%	S	M	S	M	M	S	M
7	G	$	S	S	M	S	M	M	M
8	H		S	S	S	M	S	M	M
9	I	8	S	S	M	M	S	S	M
10	J	BELL	S	M	M	S	M	S	M
11	K	(	S	M	M	M	M	S	M
12	L	)	S	S	M	S	S	M	M
13	M	.	S	S	S	M	M	M	M
14	N	,	S	S	S	M	M	S	M
15	O	9	S	S	S	S	M	M	M
16	P	0	S	S	M	M	S	M	M
17	Q	1	S	M	M	M	S	M	M
18	R	4	S	S	M	S	M	S	M
19	S	‘	S	M	S	M	S	S	M
20	T	5	S	S	S	S	S	M	M
21	U	7	S	M	M	M	S	S	M
22	V	=	S	S	M	M	M	M	M
23	W	2	S	M	M	S	S	M	M
24	X	/	S	M	S	M	M	M	M
25	Y	6	S	M	S	M	S	M	M
26	Z	+	S	M	S	S	S	M	M
27	CARRIAGE RETURN		S	S	S	S	M	S	M
28	LINE FEED		S	S	M	S	S	S	M
29	LETTERS SHIFT		S	M	M	M	M	M	M
30	FIGURES SHIFT		S	M	M	S	M	M	M
31	WORD SPACE		S	S	S	M	S	S	M
32	BLANK		S	S	S	S	S	S	M
NOTE: M = MARKING SIGNAL S = SPACING SIGNAL									

NOTE 1: "Answer Back" facility, if fitted.

FIG. 6. A.P.O. START-STOP MACHINE ALPHABET (FIVE UNIT CODE).

A mechanism controlled by the "Letters" and "Figures" combinations (Nos. 29 & 30) extends the number of available character selections to 52. The preselection of the "Letters" combination mechanically conditions the machine so that the 26 alphabetical characters are available for selection, while the same 26 combinations may be used to print figures and punctuation symbols if the "Figures" combination is transmitted before them.

Each group or combination of five code elements is preceded by a spacing "start" element and followed by a marking "stop" element. These additional two elements are necessary for the correct functioning of the machines.

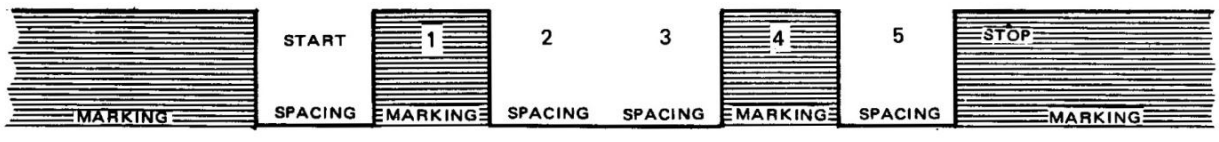


FIG. 7. TRANSMITTING THE LETTER "D" IN FIVE-UNIT CODE.

2.6 SIGNALLING SPEED. The Australian Post Office uses internationally agreed standard signalling speeds. The most common speed used has each signalling element of the five-unit code or 20 milliseconds (ms) time duration. This is equivalent to a signalling speed of 50 bauds.

The "Baud" is an international unit of signalling speed (named after one of the pioneers of Telegraphy, Baudot) and represents the number of shortest signal elements in one second. i.e. With a signal element of 20 ms length divided into 1 second, the signalling speed of 50 bauds results.

- **Characters per Minute** is another way of expressing signalling speed and can be calculated as follows. Allowing 20 ms for the "start" signal and 30 ms for the "stop" signal, the total time taken for the transmission of one five-unit start-stop code character is therefore 150 ms. Dividing this time into one minute ($\frac{60 \times 1000}{150}$), a signalling speed of 400 characters per minute results.

Words per Minute is the usual way of designating typing speeds. Taking the average length of word as being 5 characters plus a word space, the maximum transmission speed of a continuously operated start-stop machine is 400÷6 = 67 words a minutes. Because of various factors encountered in manual operation this figure cannot be attained. Normal keyboard operation is about 50 words per minute. With tape transmission the full speed of 67 words per minute is maintained.

The limit to the maximum signalling speed obtainable over a circuit is governed by several factors, the main ones being:

- The maximum speed at which the receiving apparatus can receive and tranlate the signals.
- The type of telegraph channels used.
- The speed and method of handling the traffic.

In practice, the main deciding factor is the speed at which the receiving apparatus operates.

2.7 POLARISED REALYS. Relays, when used on machine telegraph systems, may be operating continuously for long periods, and could operate a million times in a few days. They must, therefore, be robust, capable of operating at high speeds for long periods with low operating current, and capable of repeating signals without adding distortion. Distortion of a signal is said to have taken place if the received signal shape is altered in any way from that which was sent.

Modern telegraph machines have a large theoretical tolerance to distortion, but some of this tolerance has been allocated to the distortion which takes place on the telegraph line or channel, and some allocated to distortion caused by wear of the machine parts. The less tolerance, therefore, that has to be allowed for relays, the more there is for other demands.

Factors contributing to the repetition accuracy of a relay include -

- The ability to respond to very small current variations,
- Low hysteresis - low magnetic resistance,
- Short transit time - the time for the tongue of the relay to move between contacts - and a complete absence of contact rebound.

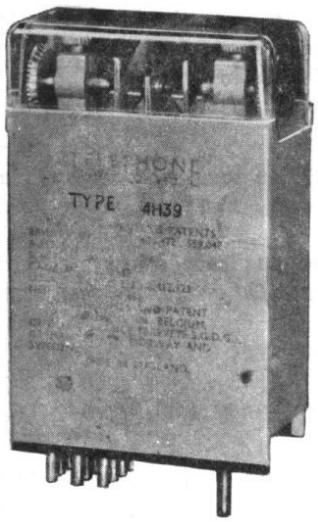
In addition, it is desirable that the relay should possess the following features: ease of adjustment, long operational life between readjustments, high contact pressure, absence of pivots, immunity from the effects of mechanical vibration, absence of positional error in that the relay can be mounted in any direction of horizontal or vertical, immunity from the effects of external fields, compactness of size, and for some applications, shortness of operating time.

When not in a circuit the relay should be free of "bias", that is its tongue should not show any tendency to stay on one contact in preference to the other.

The best currently available relays designed to achieve these requirements are polarised telegraph relays. These are relays in which the direction of the armature depends on the direction of the current through the coils, as opposed to non-polarised relays where the armature movement is independent of the direction of the coil current.

Two examples of polarised telegraph relays used by the A.P.O. are shown in Fig. 8. Solid state relays are currently being introduced into telegraph circuits.

(a) Clare Relay



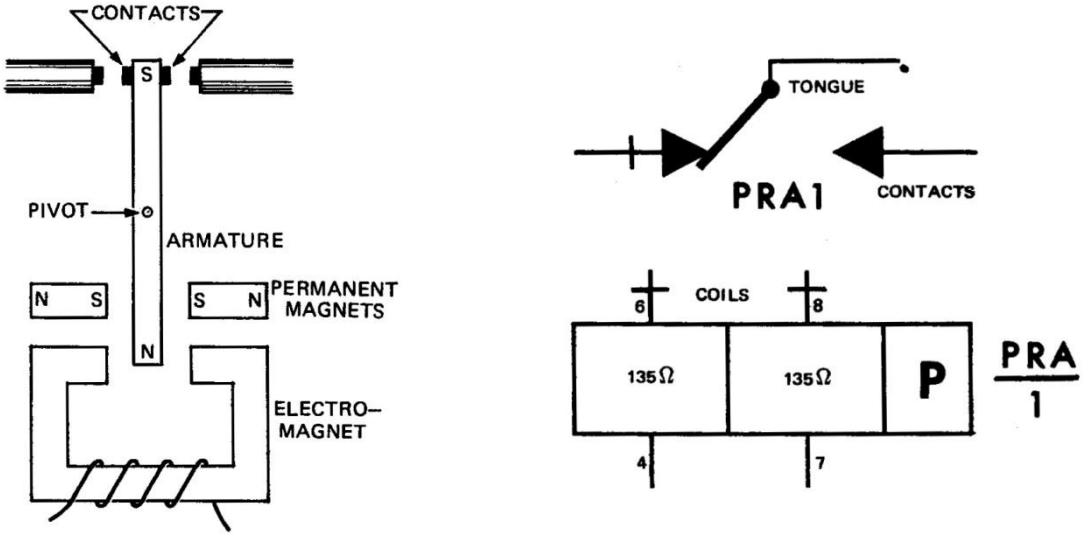
(b) Type 4 Carpenter Relay

FIG. 8. TYPICAL POLARISED TELEGRAPH RELAYS.

2.8 PRINCIPLE OF OPERATION. (Fig. 9a). An armature, pivoted near its centre, has contacts fitted at one end which move between two fixed contacts. An electromagnet is placed so that the other end of the armature moves in the air-gap between the pole pieces. Permanent magnets either side of the armature induce magnetism into the armature.

Assume that the polarity of the induced magnetism in the armature is indicated by the symbols N and S. When current flows through the coil of the electromagnet in such a direction as to make the left-hand pole piece north and the right-hand pole piece south, the lower end of the armature is replied by the left-hand pole piece and attracted by the right-hand pole piece. The armature, therefore, moves in a counter-clockwise direction until electrical connection is made with the left-hand contact, and further movement stopped.

When the current in the coil is reversed, the magnetic poles produced by the coil are also reversed, and the armature moves in a clockwise direction, thus making electrical connection between the armature and the right-hand contact.



(a) Principle of Operation. (b) Circuit Symbol.

FIG. 9. POLARISED TELEGRAPH RELAY.

2.9 COIL DESIGNATION. The coil and contact connections are brought out on the base of the relay and designated. Relays have two or more coils to control the electromagnet. As the direction of movement of the armature or tongue between the mark and space contacts depends on the direction of the resultant magnetic field, which in turn is determined by the direction and value of currents through the relay coils, it is necessary when reading telegraph circuit diagrams to know not only the direction and value of the currents through the coils, but also the way in which the currents affect the armature movement.

The method of indicating this on circuit diagrams, and the standard symbols used to represent polarised relays having two or more windings, are shown in Fig. 9b.

When the relay coil connection designated by a stroke is positive with respect to the other coil connection, the tongue tends to move to the contact designated by a stroke.

2.10 CARE OF RELAYS. To ensure that the relay will give reliable service the cover should be kept in place and not removed unless absolutely necessary. Iron dust is the chief enemy, as the smallest particle in the magnetic gaps will cause irregularity of working.

The magnets must not be allowed to come into contact with other magnets or any magnetic materials, not handled with iron or steel pliers. Failure to observe these precautions will result in a reduction of pole strength. The magnets are carefully matched during manufacture and must not be separated or replaced by odd pairs.

2.11 CIRCUIT APPLICATIONS OF POLARISED RELAYS. The following paragraphs describe some simple circuits using polarised telegraph relays. The principles outlined are those in general telegraph use, and advanced applications are dealt with in other papers dealing with telegraph circuits. The relay contact connections to the controlled circuit have been shown for double-current signal output, but by variation of these connections single-current signal output can be obtained.

A simple circuit application of a polarised relay is that of the repetition of double-current signals (Fig. 10). The relay is operated by reversals of current through one or more coils connected either in series or parallel, as shown in Fig. 11 and 12. (Although a relay may have many coils only those connected in a circuit are drawn).

When the signal from the controlling circuit is negative the relay terminal designated with a stroke is more positive and the tongue of the relay moves to the contact designated by the stroke. With a reversal of potential from the controlling circuit the stroke side of the coil is more negative than the controlling side and the tongue moves to the opposite contact.

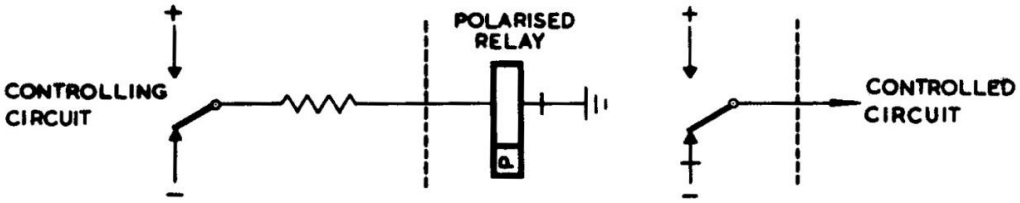


FIG. 10. DOUBLE-CURRENT OPERATION – SINGLE COIL.

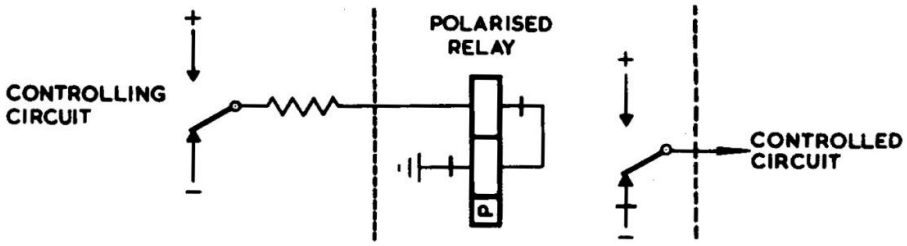


FIG. 11. DOUBLE-CURRENT OPERATION – 2 COILS IN SERIES.

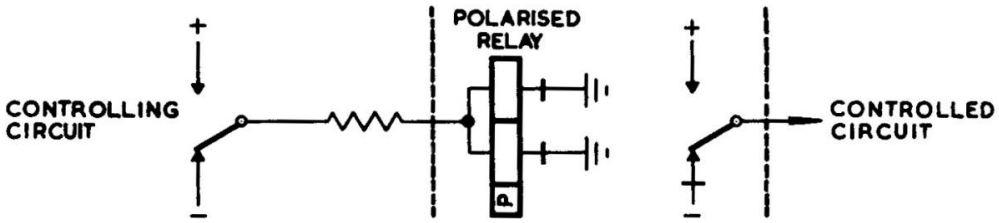


FIG. 12. DOUBLE-CURRENT OPERATION – 2 COILS IN PARALLEL.

Single-current signals control the operation of the polarised relay shown in Fig. 13. The current flowing in winding "a" during the current condition is adjusted to be twice the value of the current in winding "b", and in the opposite direction. As the relay windings are differential, the resultant magnetic effect is that due to the stronger current. In the mark or current condition the armature operates to the contact under the influence of the greater current in winding "a". When the single-current signal from the controlling contacts is in the "no current" or spacing condition, the "biasing" current in "b" operates the armature to the other contact.

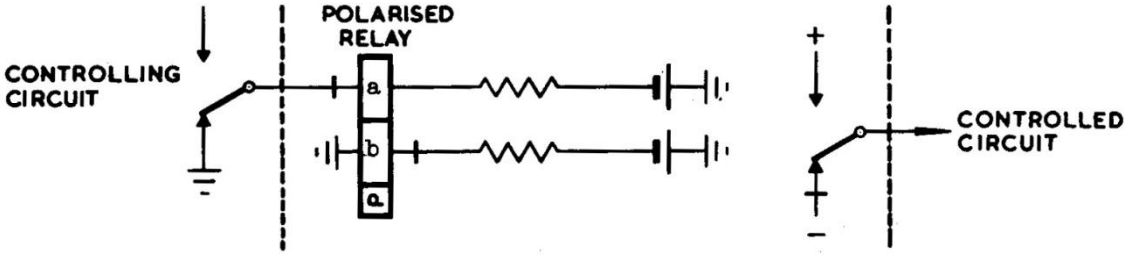


FIG. 13. SINGLE-CURRENT OPERATION.

3. TYPES OF MACHINES.

3.1 The Australian Post Office has, over a number of years, purchased different types of telegraph machines. As earlier machines were superseded or new facilities were required, appropriate machines were purchased. However many of the earlier machines are still in service.

All machines conform to the basic fundamental functions of:

Coding of messages into suitable form for-
Transmission of signals over the line, followed by
Reception of these signals for decoding, and
Translation into readable form at the destination.

Likewise all machines conform to the standards laid down by C.C.I.T.T. so that international communication is possible.

The normal "at rest" condition of these machines is marking and the signals may be single-current or double current depending on the design of the machine.

The machines can be divided into two basic categories, page machines and tape machines.

3.2 **PAGE MACHINES.** (Fig. 14 & 18) are in many ways similar to an electric typewriter but print the characters on a continuous 8½" wide roll of paper instead of individual pages. *Coding* is performed by the keyboard which has an almost standard typewriter format. *Transmission* takes place automatically from the transmitter associated with the keyboard. Reception of signals is under the control of an electromagnetic mechanism which stores incoming signal elements until a whole code combination is received so that *Translation* can take place as the character is printed.

When transmitting a message, the whole process from coding to translation takes place within the originating machine providing a printed "home record" of the message, while at the distant machine only the receive section of the machine is actuated to receive and print.

Page printers are provided with several 'functions' which are associated with the control of the page with respect to the position of the type. The function of Carriage Return brings the type back to the start of a line. The function of line Feed feeds the paper upward putting the last line of typed message one line above the type. The functions of Letters and Figure shifts the relationship of the paper and typeface so that the appropriate selection of type faces are available for printing.

Some page printers are provided with a Answerback facility. This mechanism recognises a specific incoming code signal and as a result transmits an identification sequence from the transmitter. This enables accurate identification of a subscriber on a switching network even when the machine is unattended. This is invaluable when working overseas countries on a different standard of time.

3.3 **TAPE MACHINES** are basically the same as page machines but use 11/16" wide paper tape on which each letter or character of the message is represented by varying arrangements of a series of holes perforated across the tape. The holes represent marking elements of the Five Unit Code.

Machines using these tapes provide a convenient method of storing messages and have been designed to perform the following operations:

- *Tape Perforation* - achieved by manipulation of a Keyboard Perforator (Fig. 15), the tape being perforated and automatically stepped after each operation.

- *Tape Transmission.* By using a Transmitter Distributor (Fig. 16), into which previously perforated tape has been placed, five unit code signals are automatically transmitted to line in accordance with the performance on the tape.

- *Tape Reperforation.* On receipt of five unit code signals, a Reperforator automatically perforates a tape according to the signals received (*receiving perforator*). Some reperforators not only perforate the tape but also print the message on the tape. The use of these Typing Reperorators (Fig. 17) assists unskilled operators to process the tapes.

3.4 Some machines perform only one operation while others are designed to provide a combination of these operations.

The following figures show typical examples of telegraph machines.

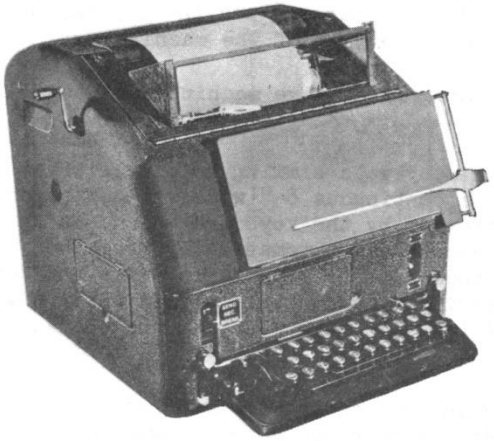


FIG. 14.
PAGE PRINTER
Send – Receive

TELETYPE M15

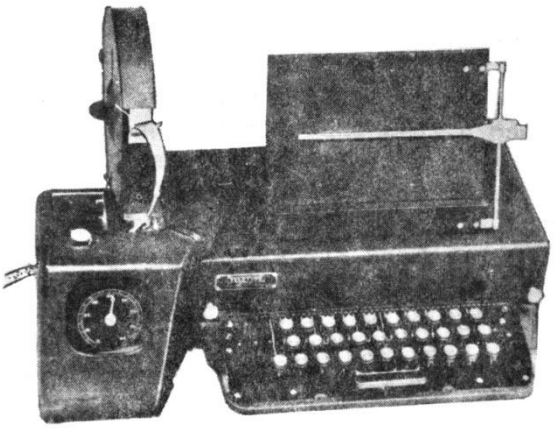


FIG. 15.
KEYBOARD PERFORATOR
TELETYPE.

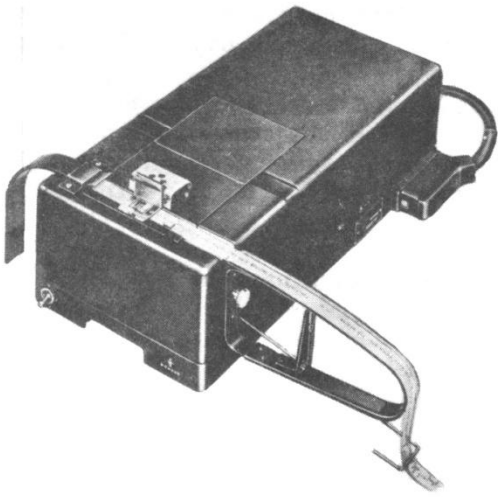


FIG. 16.
TRANSMITTER DISTRIBUTOR
(Tape Transmitter)
SIEMENS T Send 77

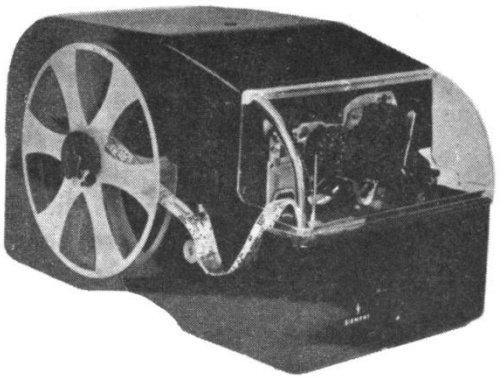


FIG. 17.
TYPING REPERFORATOR
SIEMENS T Loch 15.

Two examples of composite machines follow:

FIG. 18.
KEYBOARD
TRANSMITTER
PAGE PRINTER
TAPE REPERFORATOR
TAPE TRANSMITTER
SIEMENS M 100

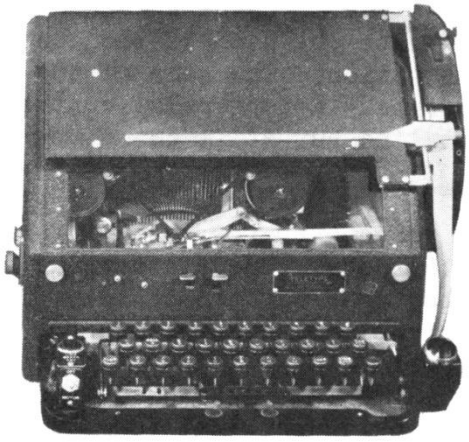


FIG. 19.
KEYBOARD TYPING REPERFORATOR
KEYBOARD TRANSMITTER
TYPING REPERFORATOR
TELTYPE M14

4. TELEGRAPH SERVICES.

4.1 The Telegraph Section provides many services for public use. Most of these services are provided specifically for commercial and industrial organisations and range from two machines connected by a line to a whole switching network with hundreds of terminals. The following paragraphs introduce the names of the services with a short description of each. A fuller coverage of each service is provided in following sections of this paper.

4.2 TRESS. People wishing to send telegrams usually fill in a form at the local Post Office and hand it over the counter to be sent to its destination. The telegraph network over which these telegrams are sent is called TRESS. The name is derived from the initials of 'Teleprinter REperforator Switching System'.

4.3 TELEX. Business houses of all kinds find that the telephone has limitations in regard to the recording of contracts and orders, and the rapid and accurate exchange of written material. The Telex service provides a similar service to the telephone service with communication taking place over a Telex network and the subscribers using telegraph machines instead of telephones.

4.4 DATEL. Although the commercial use of computers is becoming commonplace, business houses and institutions find it more economical to have access to centrally placed computers. This can be done using the telephone network with Datel equipment installed in association with the subscriber's telephone. This allows the transfer of data (information) in telegraph form over the telephone network. DATEL is derived from 'Data on TELephone'.

4.5 C.U.D.N. With the growth in the number and types of computer being used and the application of these computers to different functions by different subscribers, a need was found for a separate network for the high speed transmission and switching of data. The switching of the C.U.D.N. network is itself computer controlled for maximum flexibility and speed. C.U.D.N. is derived from the initials of Common User Data Network.

4.6 PRIVATE WIRE. When telegraph subscribers wish to have a permanent connection between two or more points a Private Wire service is provided. This consists of the cable connections between subscribers premises but includes no A.P.O. switching. The terminal equipment does not have to be rented from the A.P.O. but must be approved by the A.P.O.

4.7 TAPE RELAY CENTRES. Some subscribers with Private Wire facilities have a large network requiring switching functions of some kind at a central point. A simple way of handling messages is to store the information on tape which is then circulated by hand in the control centre to a circuit where it will be relayed to its destination. The name of the service is derived from the function that the centre performs – a tape relay centre. Many complex networks have been designed and installed but still carry the same general title.

4.8 PICTUREGRAM. News services rely heavily on telegraph equipment for the movement of written information. They also have a need for the transmission of photographs. The Picturegram service provides for the transmission and reception of photographs between States. The Overseas Telecommunication Commission provides all international connections for Picturegrams.

4.9 BUSFAX. Business houses often have the need to transfer documentary material in its original form. The Busfax machines provide this service on a Private Wire basis, and because of the simplicity of operation, no skilled operators are required. Any balck and white document can be transmitted and the receive machine provides a facsimile (exact copy) of the original. BUSFAX is an adaption of 'BUSiness FACsimile'.

5. TRESS (Teleprinter Reperforator Switching System).

5.1 TRESS is an automatic switching network (Fig. 20) provided to enable the general public to send telegrams.

5.2 The most common method of using the service is to hand in a message at a Post Office where an operator types the telegram into the system. Telephone subscribers can send telegrams by telephoning the Phonogram section and dictating the message. The Phonogram operator types out the message and passes it to operators working on the TRESS network. Where a message is handed in to a small Post Office which does not handle enough messages to warrant a machine connection, the message is phoned into the nearest Phonogram centre. Telex subscribers can call the Printergram section on their machines and type out their telegram. The printed copy is torn off the Printergram machine and passed to a TRESS operator for transmission into the system.

5.3 All messages sent into the network are prefixed by a three letter switching code, the first letter indicating the State and the next two the Post Office of destination. These letters are recognised by electro-mechanical logic circuits at the Chief Telegraph Office (C.T.O) which route the messages to the correct destination.

There is no direct connection between the sending and receiving offices like a telephone call. All messages into the system are stored on perforated tape at the C.T.O. and forwarded when equipment and traffic is clear. Interstate messages pass directly between the two C.T.O's concerned, switching taking place at each centre (Fig. 20).

5.4 Elaborate safeguards are inbuilt to ensure that no messages are lost and the system provides priority for urgent interstate messages. Delivery is effected according to the address provided, that is, by messenger for an addressed telegram, by Phonogram if a telephone number is included, or by Printergram if a Telex number forms part of the message address.

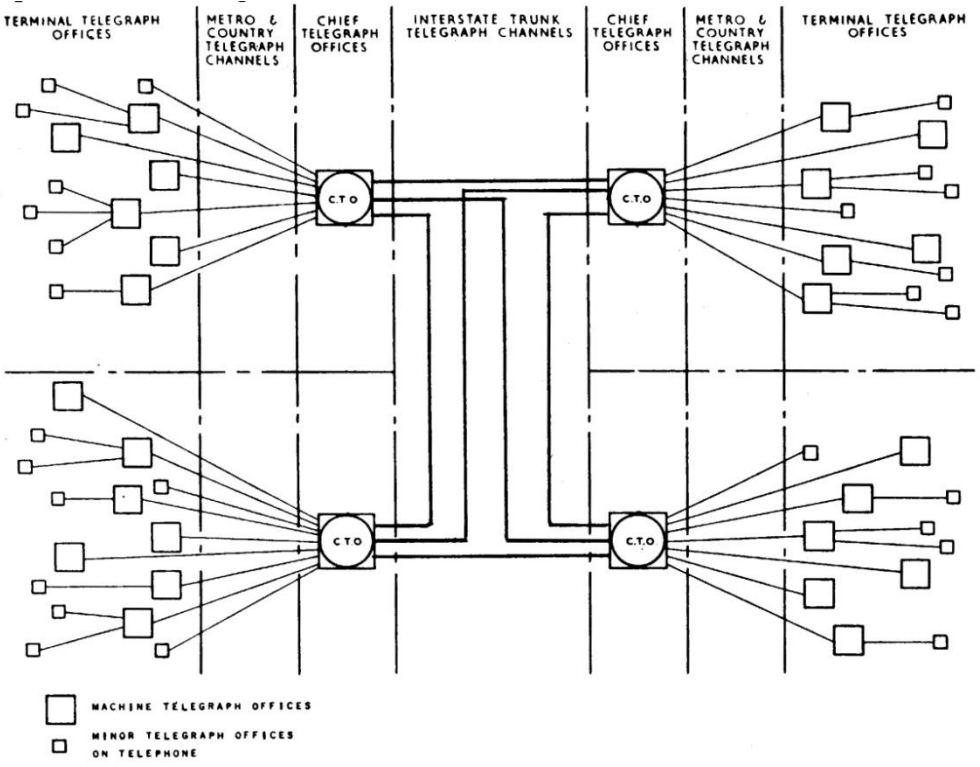


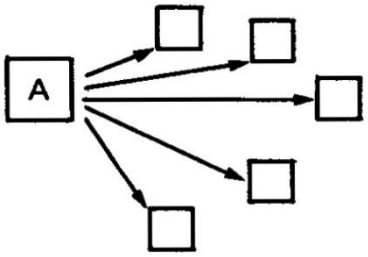
FIG. 20. TRESS NETWORK.

6. TELEX.

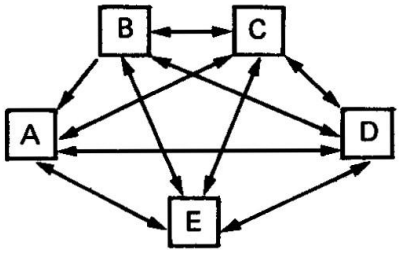
6.1 Telex, like the telephone service, is a subscriber operated service and uses a similar network, with the added advantage of having all transactions documented at both transmitting and receiving terminals on teleprinters. The service operates on a 24 hour basis with unattended operation made possible by the use of automatic "answerback" units in the teleprinters. The answerback unit being activated from the other end of a circuit to transmit the subscriber's number.

Each subscriber has an individual number consisting of five digits. The subscribers and their numbers are listed in a Telex directory facilitating calls intrastate, interstate, or overseas via O.T.C.

6.2 SERVICE CENTRES. All subscribers have access to a Service Centre where operators can give assistance in the form of directory enquiries, connection of Broadcast or Conference facilities, or connection of Part Time services. Broadcast and conference calls are illustrated in Fig. 21a and 21b respectively. Part Time telex subscribers are connected for a set period of time on a manual basis and are charged accordingly.



(a) Broadcast Call.
(From one subscriber – one way)



(b) Conference Call.
(Both ways between all subscribers – one at a time)

FIG. 21.

6.3 SUBSCRIBER CATEGORIES. Subscribers are classified into categories, so that certain categories of subscribers can be denied access to all or part of the telex network or to subscribers in other categories.

One example of this is the part time subscriber who does not have access to the telex network except through the Service Centre. Another example is a Conference circuit which can only be connected by the Service Centre.

6.4 SERVICE CODES. Successful telephone operation by subscribers depends upon a knowledge of the service tones e.g. dial tone, busy tone etc. The telex service has similar service codes which are indicated by two or three letter groupings typed on the subscriber's teleprinter. Some examples with explanations are:

GA Go Ahead – equivalent to dial tone

NA Access to subscriber Not Admitted (wrong category)

OCC Called sub OCCupied – busy tone.

7. DATEL.

7.1 Computers are being used by an ever increasing number of business houses and institutions. These computers perform a wide range of functions and have an equally wide range of sizes and prices.

The basic function of all computers is to handle information, whether it be details of transaction for a bank. Stock movement for a warehouse, or details of personnel in a large organisation. The information is stored in some coded form as "data" until required. Because of the capability of computers to handle calls within a fraction of a second and the high cost of individual installations, centralised computer installations have become an economic necessity.

7.2 MODEMS. With the establishment of a centralised computer, provision must be made to connect the computer with the people wishing to use it. The Datel service provides this switching service over the existing telephone network. (Fig. 22) A subscriber wishing to transfer data from one place to another or to interrogate a computer makes communication with the appropriate telephone number by dialling. When voice connection is established with the attendant at the distant terminal, a key is operated on the telephone which substitutes a Data Modem in the circuit in place of the phone.

This Modem is a modulator and demodulator combined in one unit. The modulator changes the binary direct current signals from the data transmitter (a keyboard or tape transmitter) into voice frequency tones for transmission over the telephone network. A the telephone terminal near the computer, a similar Modem's demodulator restores the signals to polar impulses ready for the computer.

Information from the computer is sent via the modulator over the telephone link to the demodulator at the subscriber's Modem. There it is converted to signals which will operate, in many cases, a teleprinter or similar printout device.

7.3 SIGNALLING SPEED. The telephone network is capable of data transmission speeds of up to 1200 bauds, using existing switching plant. This allows for a speedy provision of services as only the terminals need converting to make a straight telephone service into a Datel service.

A private wire service with special line compensation has to be provided if a subscriber wishes to operate a data link at speeds of 2400 bauds and upwards.

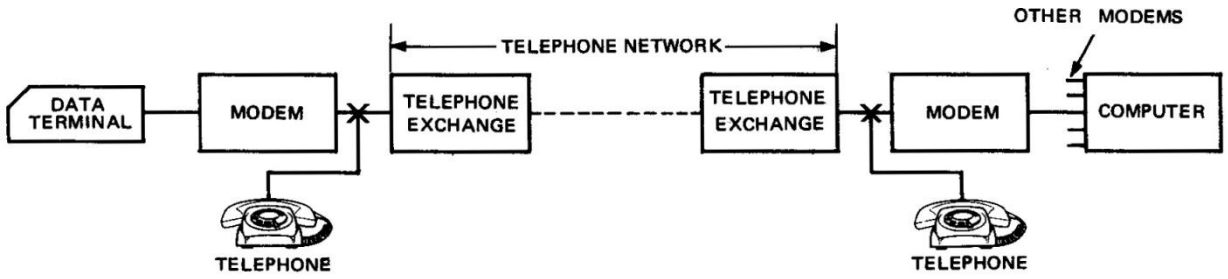


FIG. 22. DATEL SERVICE.

8. C.U.D.N. (Common User Data Network).

8.1 Although line switching services such as Telex and Datel provide useful services, these have certain limitations for handling data. Such things as the time wasted in establishing a connection, no priority for urgent over routine messages, separate transmission required for each multi-address message, and a need for compatibility in signalling rates and character codes throughout the network.

8.2 The CUDN is a computer controlled data switching network which provides a customer with the facilities of a private store and forward network with shared network economy. The store and forward principle (also used in TRESS) allows for the transmission of data to the CUDN before a path to the destination is established. By sharing the network with other organisations a considerable saving is achieved in the provision of equipment and trunks. Compatibility is only required between the CUDN and the terminals, and provides entry and exit points throughout the Commonwealth via centres located in each state (Fig. 23).

8.3 The CUDN does not engage in general data processing but provides only communications for a customer's data. This can take one of two basic forms, either as a message switching network or as a computer communications interface.

8.4 COMPUTER COMMUNICATIONS INTERFACE. Interface equipment does for equipment. What an interpreter does for people, in allowing the exchange of information between different forms of language. The CUDN can provide communications between a customer's central computing unit (CCU) and remote terminals. With a single link to the CCU the CUDN can interface a variety of terminals in different geographic locations. This allows for the collection and distribution of data over the network between the CCU and terminals, and the interrogation of a CCU by a terminal which then generates a response to that terminal.

The passage of this interrogation or response across the network takes only a few seconds.

8.5 MESSAGE SWITCHING. A message received in the CUDN from a terminal is sent to its destination, determined by the analysis of the address in the heading of the message. The transmission back to a terminal is at the appropriate speed and in the suitable code form for that terminal. The CUDN can provide multi-addressing and group addressing if required.

8.6 Sub networks may be derived on the CUDN for individual customers. These function effectively as private networks with intrusion by other customers barred. CUDN interfaces with the TRESS and Telex networks and other interfaces may be arranged. The main feature of the CUDN is the flexibility brought about by its computer control. There is no inherent limitation on the type of customer which can join the CUDN. The design allows for the accommodation of new customers and new functions as required.

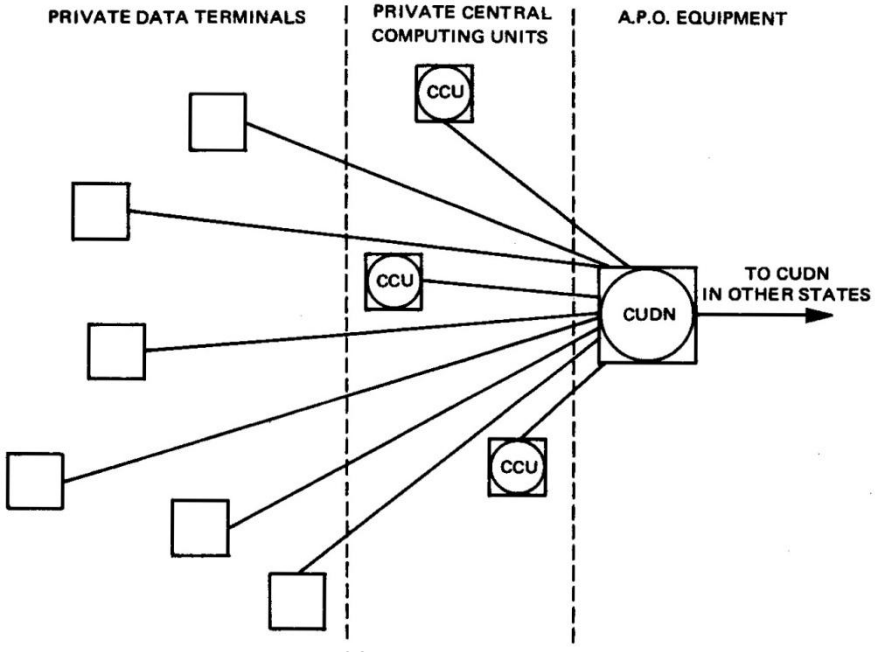


FIG. 23. CUDN NETWORK.

9. PRIVATE WIRE.

9.1 Any telegraph service where the line and perhaps the subscriber's equipment is leased for sole use of the customer, whether it is a point-to-point service or a complete network, can be considered a Private Wire service. For example a connection between the sales department and warehouse of a company with locations in different districts or a news service network feeding news items to newspapers throughout the Commonwealth.

9.2 PART TIME Services may be connected as required by Traffic Officers on the Trunk Test Board. Race meeting services are often connected this way. Another method is to terminate the subscribers as special category Telex terminals which are cross-connected by the Service Centre.

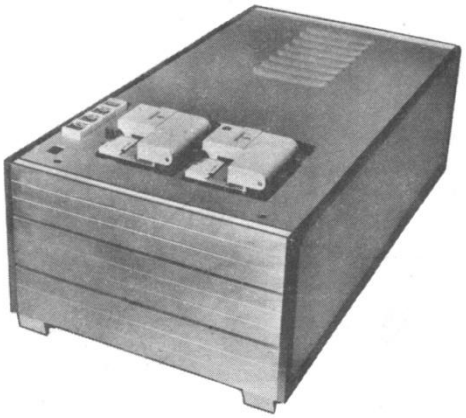
9.3 NETWORKS may be completely isolated or form part of a larger common service depending on the facilities required. By using a separate category, a customer may have a network on Telex, which although using the common switching equipment and interstate channels, is not available to any other subscriber. The same sort of facility is provided by the CUDN.

9.4 SUBSCRIBERS EQUIPMENT. May be leased from the APO and consist of any of the standard items provided, whether it be a teleprinter or a facsimile unit. Some subscribers lease privately or purchase equipment to suit their own requirements, which they then operate on leased Departmental lines. Under this arrangement the equipment must be "type approved" by the APO. An alternative arrangement is a composite service such as the high speed Datel circuits where the APO provides the lines and Modem equipment and the subscriber arranges for the supply of "type approved" data equipment.

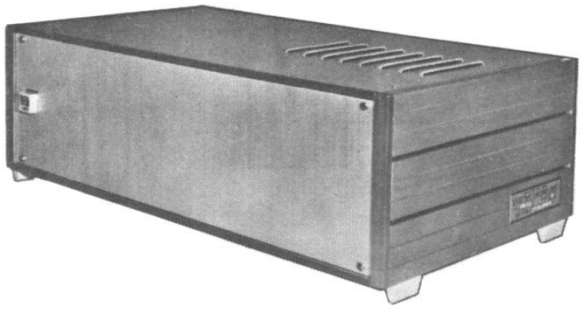
10. TAPE RELAY CENTRES.

10.1 Tape Relay Centres are a particular form of private wire network. In its simplest form such a network consists of a group of lines terminating on Reperforators and Tape Transmitters. Information incoming to the control office is received as perforated tape. This tape is torn off the machine and conveyed by operator to the transmitter of the destination circuit. This manual handling of all messages becomes cumbersome in a large network.

10.2 More sophisticated systems are in use with a variety of methods of handling the routing of traffic through the control centre. The less the handling of tape is involved, the more efficient the system and the fewer operators required.



(a) T108 Tape Transmitter.



(b) Selective Calling Unit

FIG. 24.

10.3 The terminal equipment associated with these networks is usually a teleprinter, with or without tape facilities. With the advent of more complex computer based switching systems a new A.P.O. designed Tape Transmitter was introduced which incorporates a Siemens Tape Reader 108. This Tape Transmitter T108 (Fig. 24a) utilises solid state circuitry and allows for wide flexibility in its operating mode, the most striking feature being the automatic numbering of all messages sent from the transmitter. Associated with this unit is a companion Selective Calling Unit (Fig. 24b) on the receive circuit. This unit is capable of recognising the particular code address for its associated teleprinter and will only allow the printing of such addressed messages. This allows for several outstations on the one circuit, each with its own code address.

11. PICTUREGRAM.

11.1 The object in facsimile telegraphy is to reproduce (remotely) a faithful copy of an original document, whether written, printed, or pictorial. Picturegram equipment is designed for the transmission of pictures having all shades from white through to black as in photographs, or black and white documents as in line drawings. Picturegram equipment is located in each C.T.O. and is used mainly in association with press photographs. The charge for each transmission is based on the area of the picture.

11.2 Telephone carrier channels are normally used for transmission between States and all overseas communication is via the Overseas Telecommunications Commission, Melbourne.

11.3 Trained operating personnel are required to control the manual lining-up procedure prior to transmission, and the photographic dark-room operations associated with receiving.

11.4 The picture to be transmitted is clipped around a drum which is then rotated at a constant speed. A phasing signal from transmitter to receiver ensures correct drum relationships, and when transmission commences, the drums are stepped sideways with each rotation.

11.5 A small area of the picture surface is brightly illuminated and the light reflected from it is proportional to the shade of the particular spot or picture element being scanned (Fig. 25).

11.6 An electronic device converts this reflected light into electric signals which are then amplified. The signals are then shifted into a range of frequencies suitable for transmission over a telephone circuit.

11.7 The receiver converts the incoming signal to a varying direct current and uses this to control the action of a mirror (Fig. 26). The mirror deflects in accordance with the incoming signal strength and by focussing a light on the mirror, the amount of reflected light is varied as it is focussed on to the receive drum.

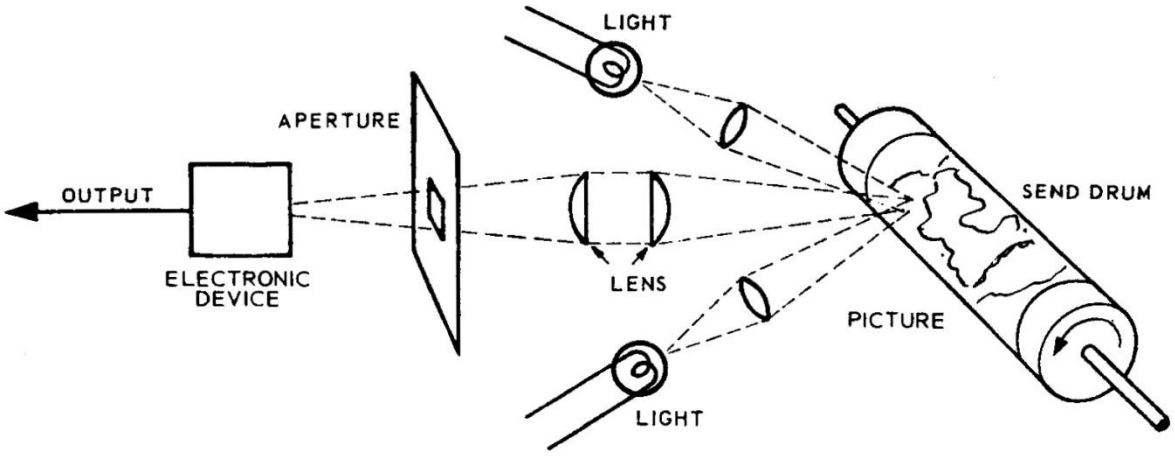


FIG. 25. PRINCIPLE OF OPERATION OF PICTUREGRAM TRANSMITTER.

11.8 A piece of film is clipped to the receiver drum mechanism which is similar to that of the transmitter. The transmitter and receiver drum rotate in direct relationship and the picture is built up from one to the other.

11.9 Photographic processing of the exposed film in a dark-room completes the operation.

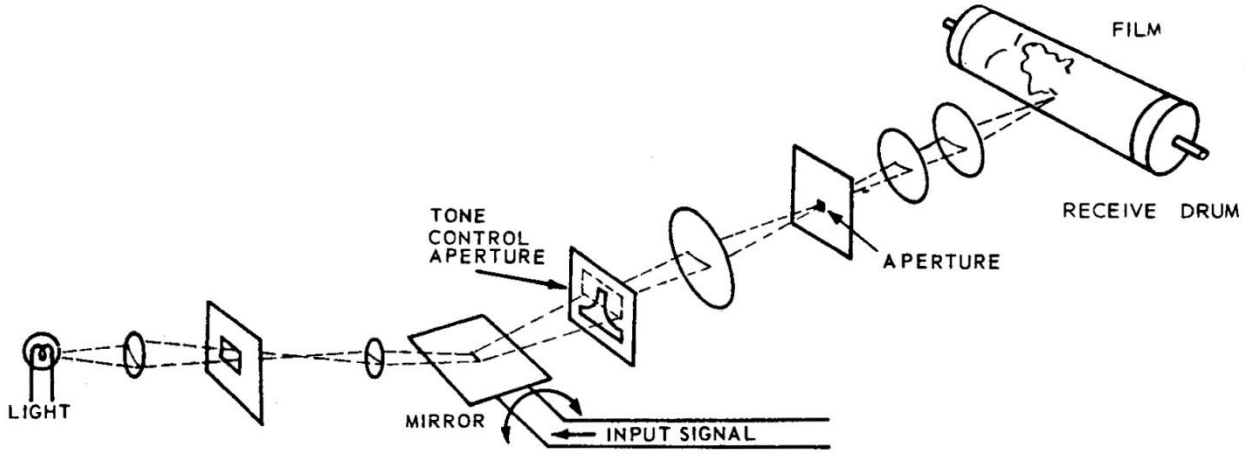
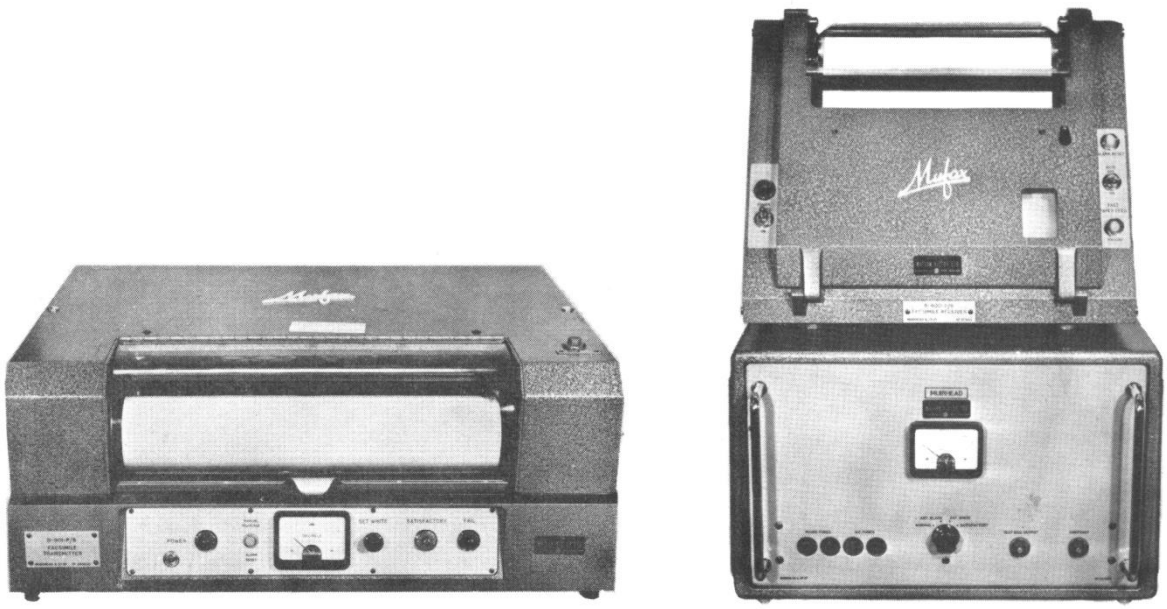


FIG. 26. PRINCIPLE OF OPERATION OF PICTUREGRAM RECEIVER.

12. BUSFAX (Business Facsimile).

12.1 Business facsimile equipment is designed for automatic transmission and reception of documents over a circuit similar to a telephone channel. The service operates on a private wire basis and may be point-to-point or on some form of network. The documents transmitted may be handwritten messages or sketches, or typewritten.



(a) Transmitter. (b) Receiver.

FIG. 27. BUSFAX EQUIPMENT.

12.2 The transmitter (Fig. 27a) does not need the attention of a skilled operator, and the receiver performs its functions automatically. The messages are received in an immediately usable permanent form without the risk of error, because the received copy is a facsimile of the original.

12.3 At the transmitter, the document to be transmitted is wrapped around the drum by the simple method of pulling out a device like a roller blind, placing the document on the blind and the blind when released wraps the document onto the send drum.

12.4 Transmission and reception are performed in a similar method to that used for the Picturegram service, except for the actual recording on the receiver.

12.5 A roll of sensitised paper at the receiver provides the received copy. The incoming signals are passed through the paper and the strength of the signal controls the density of the chemical stain marked on the paper. At the end of the reception the piece of recorded paper is torn off the receiver.

13. TEST QUESTIONS.

1. *What are the names of the two signalling elements?*
2. *Names two types of telegraph signalling.*
3. *What are the circuit conditions which apply during each type of signalling above?*
4. *What is the normal rest condition of a telegraph circuit?*
5. *How many possible combinations are there in the five unit code?*
6. *How can the number of characters available for printing exceed the number of code combinations?*
7. *What is meant by a "function" when applied to a telegraph machine?*
8. *What is a Baud?*
9. *How is the signalling speed of a machine calculated in words per minute?*
10. *List the characteristics of a polarised relay.*
11. *What is meant by relay bias?*
12. *Draw the circuit symbol of a polarised relay.*
13. *How can the direction of operation of a relay tongue be determined from a circuit drawing?*
14. *Sketch a circuit showing a polarised relay being used to convert Polar signals to Neutral signals.*
15. *What are the four basic operations of any telegraph machine?*
16. *What are the basic differences between Page and Tape machines?*
17. *What signalling element does the hole in a tape represent?*
18. *What are two ways to send a telegram?*
19. *Which telegraph service would be involved in sending a telegram?*
20. *What similarities are there between Telex and the telephone service?*
21. *What type of information is sent on the Datel service?*
22. *What are the basic functions of the Modem unit?*
23. *What switching network does the Datel service use?*
24. *Why was the CUDN service introduced?*
25. *What is meant by the term "Private Wire"?*
26. *What is the function of a Tape Relay Centre?*
27. *What type of information is sent over the Picturegram service?*
28. *What type of information is sent over the Busfax service?*
29. *What is the difference in operating skill required for the two facsimile services above?*
30. *Which of these two services gives a direct record?*

END OF PAPER.

Commonwealth Printing Unit, Melbourne.