POST OFFICE

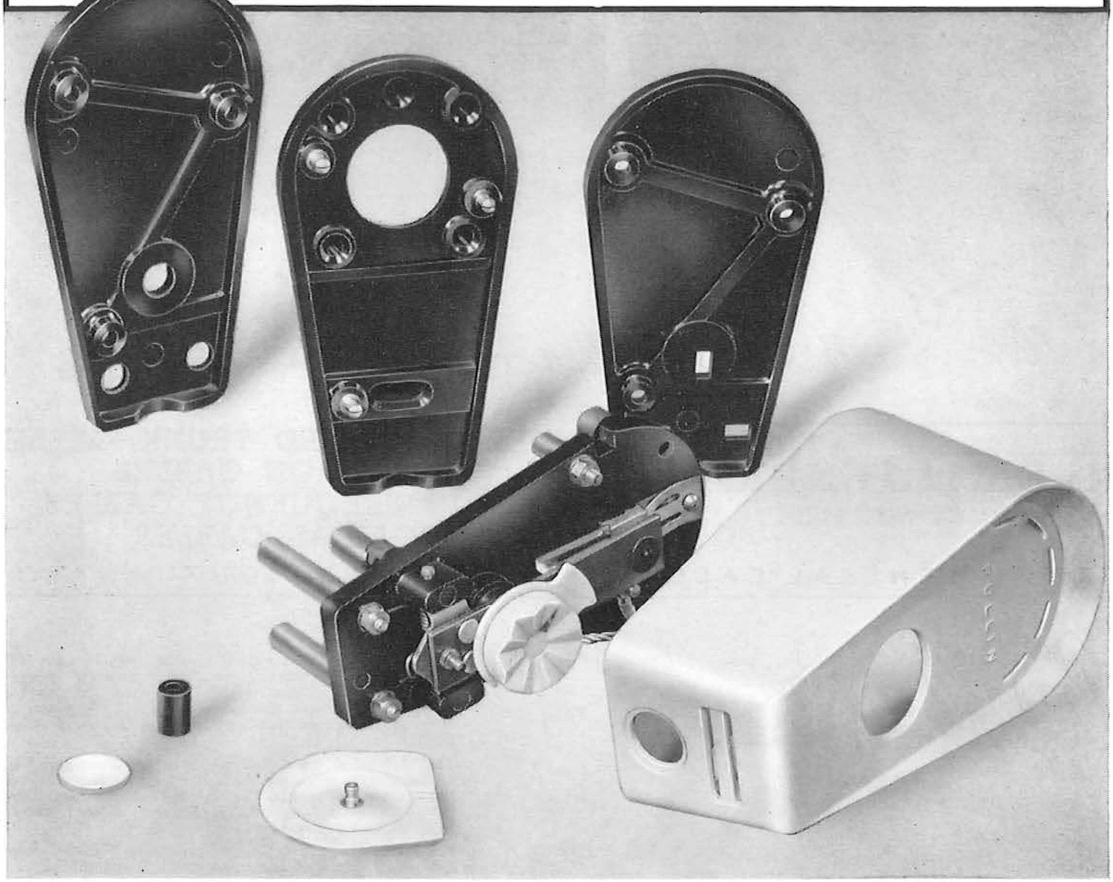
telecommunications

JOURNAL

ONE SHILLING AND SIXPENCE

SPRING 1961

Metropolitan Plastics Limited

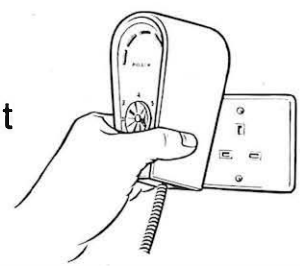


METROPOLITAN EXCEL IN SPECIALISED MOULDINGS FOR ELECTRICAL EQUIPMENT

More and more manufacturers of electrical equipment are coming to Metropolitan Plastics for highly specialised jobs in Thermo-setting Plastics, like the 11 components we have made for the Pullin Plug-Stat. They know that however complex the design, Metropolitan Plastics will carry it out with supreme precision and right on time.

Metropolitan Plastics Limited

The Pullin Plug-Stat



the plug with the built-in thermostat, is playing an important part in cutting electricity costs. The components of the Plug-Stat represent the type of specialised work in which Metropolitan Plastics are unsurpassed.

Faraday Way, St. Mary Cray, Kent   Telephone Orpington 31631   *The Technical Moulding Specialists*

Post Office Telecommunications Journal

Published by the Post Office of the United Kingdom to promote and extend knowledge of the operation and management of telecommunications

Contents

*

Vol. 13 *Spring* 1961 *No.* 2

Fleet Building

THE new telecommunications centre for London, Fleet Building, will be opened in April; a building that has cost just under £2 million in which automatic telex for London has been working since December 12, and which will soon contain, as we have previously shown, many other facilities for London customers.

It was appropriate that the first operational section should be for automatic telex, since it combines the principal advantages of all our telecommunication services; as the Postmaster General said in December, it offers businessmen "the speed of the telephone, the authority of the written word and the security of the cable", and is "the fastest means of communication, providing a complete office-to-office service". Inland automatic telex "paves the way to international customer-dialling. From next May customer-dialling of telex calls to Europe will start through a new exchange which will be installed in this building; by the end of (1961) customers will be able to dial 90 per cent. of their telex calls to the Continent for themselves".

The Postmaster General pointed out that the value of the telex system depends on how well it is used and he urged business people to use it more. At present the average user employs it for sending only about six calls a day. Many of our customers take up telex for a special purpose and forget that it can be used for other purposes as well. There can be few subscribers who cannot find some of their suppliers and customers at the end of one of the 6,700 inland lines or 100,000 oversea lines.

The Post Office has provided the lines; we hope the City of London will make the best use of them.

Subscriber Trunk Dialling in London

T. W. Mansfield

The successful introduction of Subscriber Trunk Dialling in the United Kingdom was discussed in this Journal, Summer 1959. Other articles have dealt with National Telephone Numbers (Spring 1959), Register-Translators for STD (Summer 1959) and Charging for STD Calls (Winter 1959). In this—the eighth article in our STD series—the author describes the problems in London arising from the changeover to STD, making particular reference to the methods to be used for routing calls through the trunk network.

THE introduction of Subscriber Trunk Dialling to and from London creates particular problems largely because of the size of the project. The area and density of Metropolitan London makes any change from the present system of operator-controlled trunk calls an operation which must be carefully planned and phased to fit both Post Office economy and the supply of new items of communications equipment. In consequence, the changeover to STD in London will be gradual, the more important phases being completed this year and in 1962.

For telephone administrative purposes, London and its immediate environs form the London Telecommunications Region. Because of differences in the method of handling telephone traffic, the LTR is divided into two broad territories; the first, the Director Area, approximately 12½ miles radius about Oxford Circus; the second, the Non-Director Area, extending from the Director Area to a radius of approximately 20 miles about Oxford Circus. Switching telephone traffic between these two areas and the rest of the United Kingdom is a complex matter which will in no way be simplified by STD and, as there are to be differences in the techniques to be used in the Director and Non-Director Areas, it will perhaps make for clarity if the Director Area is considered first.

By its nature, the director system enables subscribers within the Area to dial each other, using the first three letters of the exchange name followed by four numerical digits; for example, WAT 5240 for Waterloo 5240. They can also dial local calls to nearly 100 exchanges in the Non-Director Area. All trunk traffic is handled by operators at the local exchange, or at a Trunk Control Centre, where the operator completes the calls by dialling special numerical routing codes into the Kingsway, Faraday or Toll "A" trunk switching units in central London. A small residue of calls requiring manual handling at the distant end remains, but these are scheduled to be mechanized within the next 10 years.

By 1970, it is also expected that the present 210 exchanges in the Director Area will have increased to 260 and the present 1.2 million exchange lines to 1.7 millions. In terms of traffic quantity, they already account for 60 million trunk calls a year although, because of the extensive area covered by local calls, this figure is only 16 per cent. of the national total. More than half of the Director Area trunk traffic originates from telephones within three miles of Oxford Circus; this has led to locating the trunk switching units within a small area and developing an intensive cable network radiating from the centre of London.

STD into the Director Area

Because so much preparatory work is involved, STD from exchanges in the Director Area will not be available until the Autumn of 1961. Its introduction at a large number of provincial exchanges in advance means that, for the time being, London must play a passive rôle limited to accepting STD from other areas. Without the facility of dialling into central London, the value of STD at many provincial exchanges would be greatly reduced, as the remainder of their trunk traffic is widely dispersed. The continued high rate of growth of trunk traffic, now about 12-15 per cent. a year, has exceeded the most optimistic estimates and is leading to overloading trunk switchboards, particularly in the larger towns. Difficulties in recruiting operating staff in areas where light industry is a major competitor for labour are also reaching serious proportions; much therefore depends on the early exploitation of STD into London.

Processing of STD calls

The register-translator equipment[1] to be used for processing subscriber-dialled trunk calls, is designed to operate within a national numbering scheme[2] which requires that all subscribers on automatic exchanges in the London Director Area be identified by a combination of letters and figures containing four essential parts:—

(i) the STD prefix "O", to obtain connexion to the controlling register translators

(ii) the figure "1", to identify the London Director Area. ((i) and (ii) forming the London "number group" code)

(iii) the first three letters of the director exchange name

(iv) the local number of the subscriber ((i), (ii), (iii) and (iv) forming the "national number")

for example:—01 WAT 5240, for London Waterloo 5240.

The controlling register-translators to be installed in many provincial exchanges can provide up to 180 translations, or routing codes, to control the routing of calls through the trunk network. They are, however, designed to recognize the London Director Area as a single number group and, to identify individual director exchanges, a further stage of translation is required; this is to be achieved initially by using the existing facilities of London Trunk Director Exchange.

Trunk Director was originally provided to permit trunk operators in the larger provincial cities to dial into London using the first three letters of the director exchange name followed by the local number. The director equipment translates the exchange name code into a new code of from two to five digits determined by the subsequent routing of the call through the director network. It will be used to an increasing extent for STD into the Director Area (Fig. 1a) and must take the brunt of this type of traffic until additional translating facilities are provided in Faraday Trunk Exchange.

Faraday Trunk Exchange was also provided to permit operator dialling into London but extended the facility to smaller provincial centres. In contrast to Trunk Director, an operator using the Faraday unit must dial numerical codes of two or three figures to obtain the desired director exchange, so avoiding the cost and delay of translation. Such a system is unsuitable for STD and incoming register-translators will be provided in Faraday Trunk Exchange during this year to augment Trunk Director. They will be used at first for subscriber-dialled traffic only but ultimately will provide distant operators with director code dialling over the same routes. One operational feature associated with incoming register-translators, and not provided in the older director equipment, will enable the operator to discard the translating process by first dialling the figure "1". Any subsequent digits will be treated as though the operator were using the present system of number code dialling and will permit access to manual exchanges and special services in London, not available to the subscriber using STD.

STD from the Director Area

As in other areas, the successful changeover to STD in London requires breaking down subscribers' old telephone habits and substituting new ones. The introduction of Group Charging[3] in January 1958 was a big step in this direction inasmuch as subscribers on Director Area exchanges were given extended dialling facilities for untimed calls to most exchanges within 20 miles of Oxford Circus. Subsequently, the assistance code "O" was replaced by "100", this change being completed well in advance of STD to minimize the amount of false "O" code traffic likely to continue after the change. As a result, within a short period about 30,000 coin-box dials in the London call offices had to be modified to permit dialling of the "100" code without inserting coins. Other preparations for introducing STD present a more formidable task as many of the older automatic exchanges require partial re-equipping. Some of these lie within central London where, to avoid unfavourable reaction by

1. *Register Translators for STD.* Telecommunications Journal, *Summer* 1959

2. *National Telephone Numbers.* Telecommunications Journal, *Spring* 1959

3. *Simplified Charges.* Telecommunications Journal, *Winter* 1958

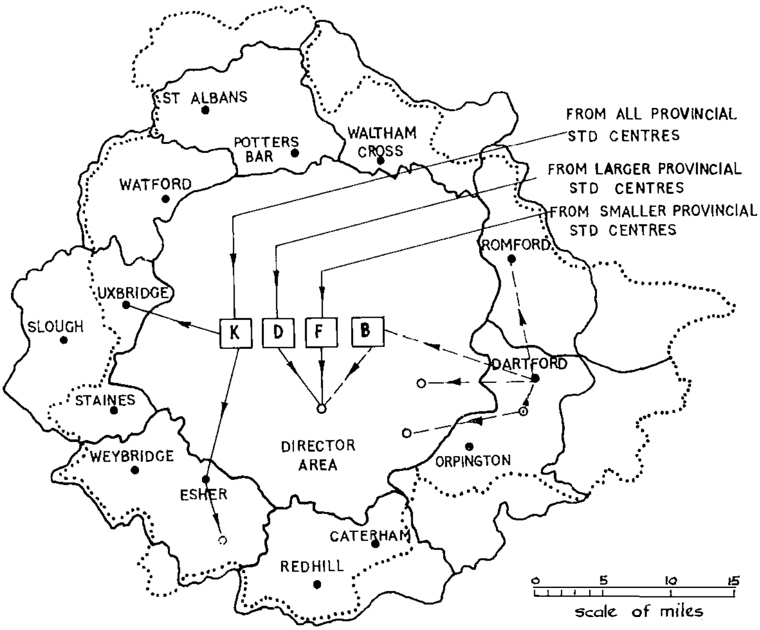


Fig. 1a: Routing of subscriber dialled calls *to* the London Director Area and adjacent charging groups (See Fig. 1b opposite for legend)

subscribers, STD should be introduced at all exchanges within as short a period as possible.

Citadel

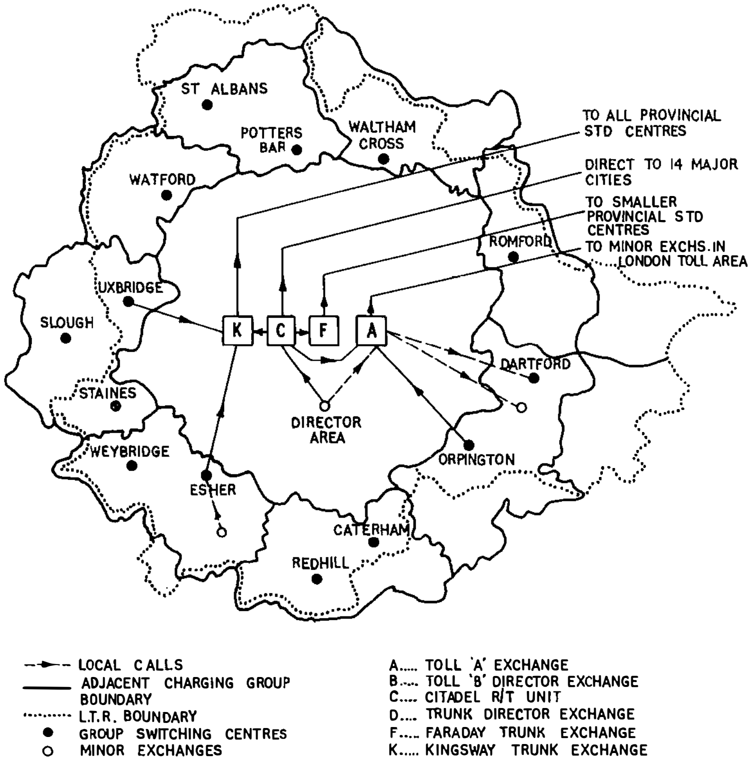
After considering the relative merits of providing STD equipment either at individual exchanges, or at a few centralized locations, it was decided that London would use large centralized units of controlling register-translators in the centre of the City, close to the origin of the greater part of the trunk traffic from the Director Area. The first centralized unit, to be called "Citadel", will be ready for service in Faraday Building this autumn. It will be equipped with magnetic drum type register-translators capable of producing more than 1,000 separate translations for routing purposes, although initially not more than 250 may be required. The existing extensive trunk network radiating from the Kingsway, Faraday and Toll "A" trunk units will be used to circulate the STD traffic to other switching centres throughout the United Kingdom but will be augmented by 14 direct routes from the equipment in Citadel to the larger provincial cities (Fig. 1b). These 14 direct routes have the attractive feature that fewer switching stages will be involved, with a resulting greater initial range of exchanges obtainable under STD. Newer forms of signalling can also conveniently be used and some relief given to the already overloaded London trunk units.

The design for Citadel was finally based on two switching stages, the first using the newer 4,000-type two-motion selector to provide links totalling approximately 1,500 circuits to the London trunk units, the second stage using 40 outlet high speed motor uniselectors to obtain the 14 direct routes. Sufficient flexibility was included in the trunking design to allow the future connexion of more direct routes as required. In the initial stages of STD from London, this arrangement will permit director exchange subscribers to dial approximately 55 per cent. of their own trunk calls, increasing to 75 per cent. in 1965. STD access to the remainder will not be achieved until all manual exchanges are converted to automatic working and translating facilities are provided at intermediate trunk switching centres.

Dialling Trunk Calls

In common with other areas converted to STD, the director exchange subscriber wishing to make a long distance call will first dial "O". This will provide connexion via level "O" of the local A digit selectors to a local register to be provided in the director exchange. The local register will store all subsequent digits of the national number

Fig. 1b:
Routing of subscriber dialled calls *from* the London Director Area and adjacent charging groups



and transmit a predetermined digit to the director exchange first code selectors which will establish a connexion over a direct junction to Citadel (Fig. 2). It will then repeat its stored information to the register-translators in Citadel for further processing to determine the charging rate[4] and routing for the call.

Although it was intended that a fairly rigid pattern should be used to determine the routing of calls from Citadel, this has not proved practicable and a more flexible arrangement has been accepted. In general terms, calls to minor exchanges within 50 miles radius of central London will be completed over Toll "A" routes. Calls to provincial group centres with direct routes from London will circulate via the Faraday trunk unit and via Kingsway to other centres requiring further switching at an intermediate trunk centre. The direct routes from Citadel replace these arrangements on 14 of the larger routes from Kingsway and Faraday but the reduced load on these two units will be taken up again by the growth of operator controlled trunk traffic.

Some impression of the task allotted to Citadel may be gained from its design figures. By 1965 it will be required to handle nearly 50,000 calls in the morning busy hour from 200 director exchanges connected to it over 8,000 junctions. The first live traffic processed in Citadel will probably be controlled by operators at certain central London exchanges who will, temporarily, be able to dial through the register-translators and switching equipment; this arrangement, besides providing useful operational experience of the unit, will ensure that optimum use of the direct routes is made during the early stages of STD in London.

Dialling local calls

The London subscriber will continue to dial the standard three letter-four figure codes to obtain other director exchange subscribers. Any code

4. *Charging for STD calls.*

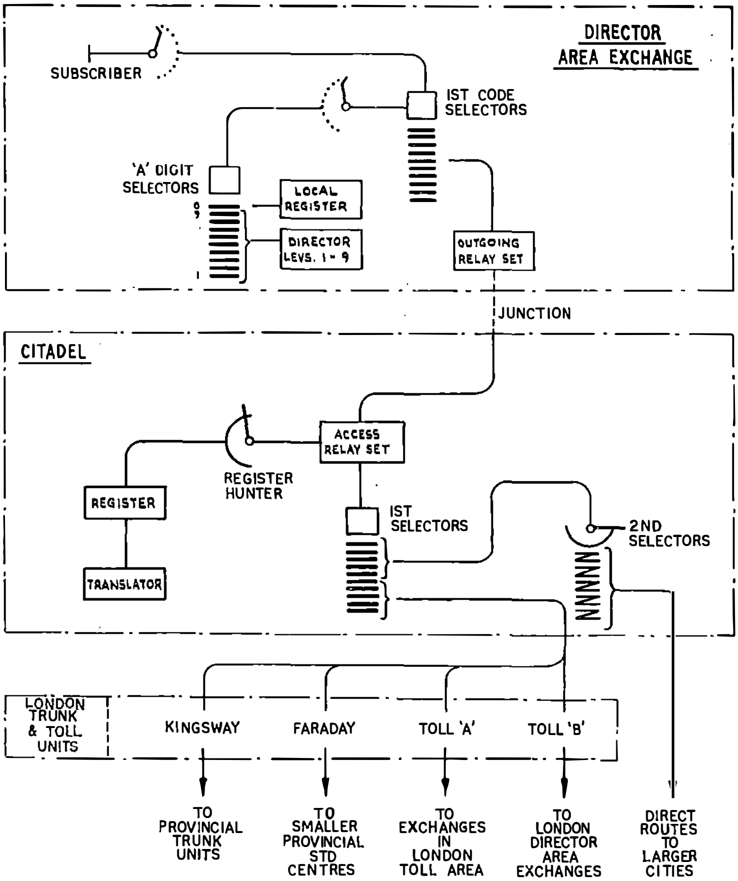


Fig. 2: Routing of STD calls from a London Director Area exchange

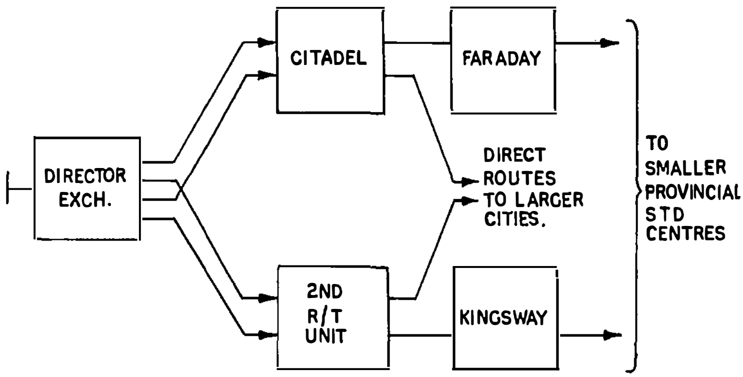
beginning with the digits 1-9, or any letter other than "O", will not be connected to the register-translator equipment but will be processed by the local director equipment as before. Should a subscriber dial the full national number of another London director exchange subscriber, access has been provided from Citadel to Toll "B" Director Exchange. After receiving the digit "1", the register-translator equipment in Citadel will repeat the remainder of the national number to the directors in Toll "B" for disposal via the director network.

Calls already dialled from the Director Area to exchanges in the Non-Director Area will also follow their existing routing pattern via Toll "A" without recourse to the centralized register-translators. The subscriber will continue to use short two letter-one figure codes; for example, CA4 to obtain Caterham exchange, followed by the local number. Should the full national number be dialled, the call will be processed as a long distance call at Citadel, but completed via Toll "A".

Future Planning in London

Although, quite naturally, present endeavour in London is primarily concerned with introducing STD as quickly as possible, plans for its future development are much in evidence. A second centralized register-translator unit, with facilities similar to Citadel, is being planned for 1965 and probably each exchange in the Director Area will be connected to both units over a system of alternative junctions so that the effects of a breakdown

Fig. 3: Future routing of STD calls from London Director Area exchanges



anywhere within the system will be minimized. For disposing of STD traffic to smaller provincial centres, Citadel will use Faraday Trunk Exchange and the second register-translator unit will use Kingsway (Fig. 3). An additional trunk exchange, to terminate more than 5,000 incoming trunk circuits, is also being planned to come into service at about the same time and will greatly extend the capacity for subscriber dialling into London.

The introduction of International STD raises other technical and administrative problems yet to be solved but it is hoped to provide ISD via Citadel to Europe by 1964 for subscribers in the Director Area.

STD in the Non-Director Area

The Non-Director Area of the LTR includes approximately 220,000 subscribers on nearly 100 exchanges, of which 30 are still manually operated. It is divided into 10 charging groups, all exchanges within a group having common charges for trunk calls. Each charging group contains one or more number groups in which all exchanges will be identified by a common group code for STD purposes. Eight of the charging groups adjoin the Director Area and are referred to colloquially as the "adjacent charging groups". The communities they serve tend to be dormitory suburbs and consequently have a marked community of interest with central London, but comparatively little between each other. The remaining two groups are not adjacent but are more than 20 miles east of London and, for routing trunk traffic, are considered provincial areas.

Short range trunk traffic (less than approximately 50 miles distance), from manual exchanges in the adjacent charging groups is controlled by

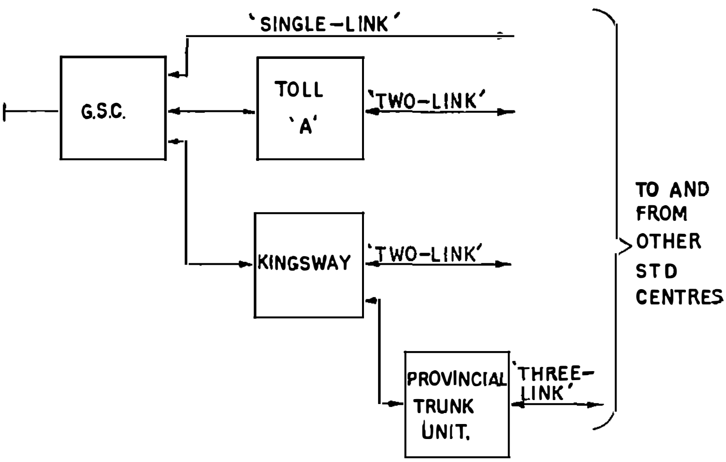


Fig. 4: Routing of STD calls to and from a non-director GSC

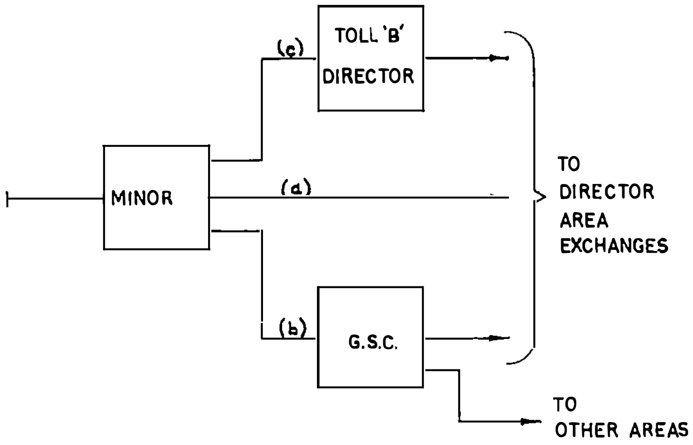


Fig. 5: Routing of subscriber dialled calls from a minor exchange equipped with short-range register-translators

the local operator. Longer distance traffic, with all trunk traffic from subscribers on automatic exchanges, is concentrated at operating positions in certain larger exchanges called Group Centres. This pattern has already produced cable networks radiating from the centre of London by which all Group Centres within 50 miles are connected to Kingsway Trunk Exchange, and the majority of minor exchanges in the same area to Toll "A". (The word Toll lost its original significance with Group Charging in 1958 but the term persists for convenience in the names of certain of the London trunk exchanges.) The Kingsway trunk unit is also connected to most other major towns and cities in the United Kingdom over a network of 130 routes in both directions and is used by provincial operators to obtain exchanges in the Non-Director Area of the LTR.

STD to and from the Non-Director Area

STD to and from exchanges in the Non-Director Area will generally follow the same basic pattern adopted for the outskirts of the larger cities in other regions. The routing and charging of STD calls will be controlled by electro-mechanical type controlling register-translators concentrated at certain exchanges, called Group Switching Centres (GSC). As it is impracticable for all GSCs to be interconnected by direct or "single-link" routes, intermediate switching centres have to be used, usually the trunk units in the larger cities (Fig. 4). The extensive cable network of Kingsway Trunk Exchange will provide a considerable amount of "two link" working between many provincial areas and the London Non-Director Area. STD access to and from the remaining areas requiring "three-link" connections will not be obtainable until additional translating facilities are later provided at Kingsway and similar provincial trunk units. Some "two-link" working will also be provided over Toll "A" to a few exchanges in the original London Toll Area; this is intended as a temporary arrangement which will cease with the provision of trunk switching units at Cambridge, Reading and Tunbridge Wells in the Home Counties Region in 1963 and the subsequent re-routing of the Toll "A" traffic.

The number of provincial exchanges initially obtainable via STD at London non-director exchanges is therefore largely dependent on whether they are directly obtainable via Kingsway or Toll "A".

Adjacent Area Problem

Subscribers on automatic exchanges in the adjacent charging groups may already dial local calls into the Director Area via Toll "B" Director Exchange in central London, using four digit dialling codes; as subscribers on these exchanges have hitherto had figure-only dials, the codes comprise the numerical equivalent of the first three letters of the director exchange name, prefixed by the digit "7"; for example, the code

7 928 followed by the local number is used to obtain a subscriber on Waterloo Exchange. On calls to manual exchanges obtained in this way, the caller is not required to dial the local number but to pass it orally to the incoming B position operator in the manual exchange.

Direct dialling of local calls to other nearby automatic or manual exchanges, using special numerical codes individual to the exchange concerned and varying between two and six digits, is also provided. This facility is often used to obtain a few exchanges in the Director Area, thus avoiding the round path of approximately 25 miles via Toll "B" Director. To prepare for STD, telephones in the Non-Director Area are gradually being fitted with letter-figure dials similar to those used in the Director Area and this opens up the possibility of using three-letter codes for calls into London. Although calls of this type are not regarded as true STD traffic, they are considerably affected by the introduction of STD at exchanges in the adjacent charging groups.

Access to London Director Area

With the changeover to STD and timing of local calls, subscribers on the adjacent charging group exchanges will discontinue using the prefix "7" to obtain central London exchanges. Instead, they will dial the national number; that is, 01 followed by the first three letters of the exchange name to obtain all director automatic exchanges. On dialling "O", the subscriber will be connected automatically to the controlling register-translator in the GSC which will then store all subsequent digits and examine the remainder of the code to decide whether the call is intended for the London Director Area. If it is, and no direct route exists between the GSC and the director exchange whose code has been dialled, the controlling register-translator will route the call to Toll "B" Director for further processing.

For both technical and operational reasons, STD to manual exchanges will not normally be provided and manual exchanges will be omitted from the STD dialling code lists. However, in respect of the adjacent charging group exchanges, it is desired to avoid withdrawal of the existing facilities for dialling to 17 manual exchanges in the Director Area. This problem has been overcome by instructing the subscriber to dial the digit "9", and one or more other specified digits, followed by the first three letters of the manual exchange name. These calls will by-pass the controlling register-translator at the GSC and be connected direct to Toll "B" Director for completion as before STD.

Short Range Register-Translators

The marked community of interest that exists between minor exchanges in the adjacent charging groups and nearby exchanges in the Director Area could lead to an undesirable concentration of short range traffic at the GSC if it were all required to circulate via the controlling register-translators. Some minor exchanges are therefore to be provided with simplified, or "short-range" register-translators, to deal with calls into the Director Area (Fig. 5). The subscriber on an exchange so provided will be connected to this equipment after dialling "O". Should the second dialled digit be "1", the short-range register-translator will continue to receive and store the remaining digits of the national number but will examine the director exchange code to determine whether (a), to route direct from the minor exchange to the objective director exchange or (b), to use a direct route obtained via the GSC or (c), to route via Toll "B" Director exchange. The total number of outlets from the minor exchange under this arrangement is limited by equipment design to 25 but as there should always be at least one outlet to the GSC, and also one to Toll "B" Director, the number of direct routes to individual director exchanges cannot exceed 23.

Should the second digit of the national number be a letter, or a figure other than "1", the short-range register-translator will continue to store the succeeding digits but will repeat this information to the controlling register-translators at the GSC for further processing.

Earlier planning for STD in the LTR assumed that short-range register-translators would be liberally provided at many minor exchanges in the adjacent charging groups but subsequent cost studies have shown that they are likely to be installed at only a limited number of exchanges.

The changeover to STD in London is an immense project that has required the fullest efforts of the various staffs in Regional Headquarters, and the Telephone Managers' Areas. It is with sincere appreciation that the writer and his colleagues in the Telecommunications Branch pay tribute to their associates in the Engineering Branch for their unfailing enthusiasm in seeing a new technique through to fruition.

Museum Tower

The Post Office is planning to build this 500-foot tower to replace the radio mast on Museum Exchange, London.

The mast stands up only 180 feet. The higher tower is desirable because the high buildings already erected or planned in London threaten the public telephone and television links. Museum Exchange contains the London Television Network Switching Centre, which Mr. W. L. Newman described in our Autumn 1956 number. It is also the London focal point for micro-wave radio links which are carrying more and more trunk telephone traffic.

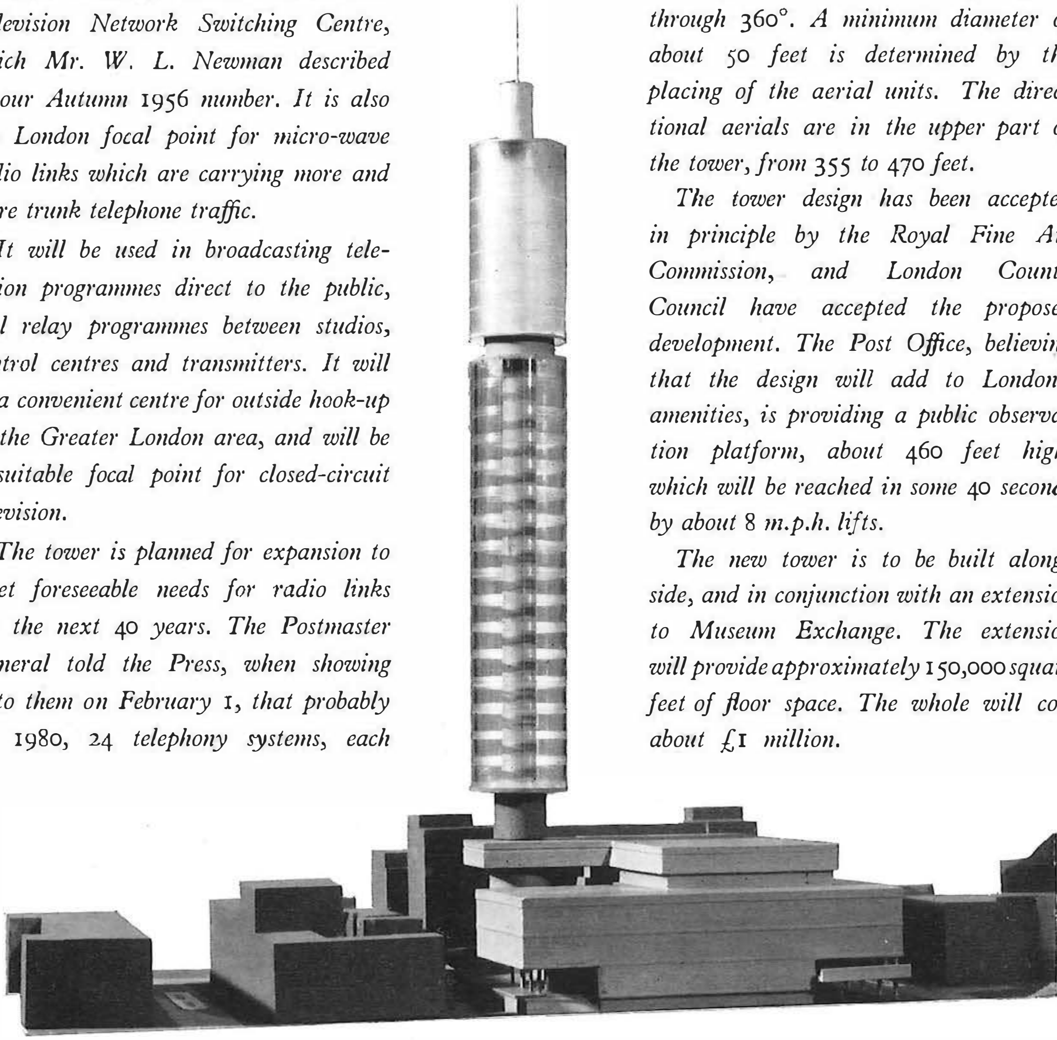
It will be used in broadcasting television programmes direct to the public, will relay programmes between studios, control centres and transmitters. It will be a convenient centre for outside hook-up in the Greater London area, and will be a suitable focal point for closed-circuit television.

The tower is planned for expansion to meet foreseeable needs for radio links for the next 40 years. The Postmaster General told the Press, when showing it to them on February 1, that probably by 1980, 24 telephony systems, each capable of carrying 960 separate conversations, will be in use; this number could be doubled in 20 years and still leave room for more than 100 television outlets, capable of serving colour service among other needs.

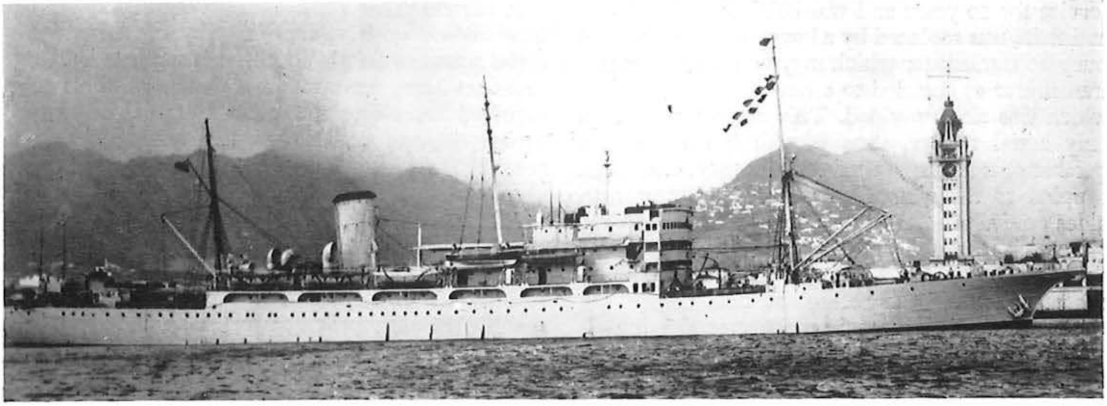
The upper part of the tower, containing the aerial galleries, requires a circular shape enabling the transmission of signals through 360°. A minimum diameter of about 50 feet is determined by the placing of the aerial units. The directional aerials are in the upper part of the tower, from 355 to 470 feet.

The tower design has been accepted in principle by the Royal Fine Art Commission, and London County Council have accepted the proposed development. The Post Office, believing that the design will add to London's amenities, is providing a public observation platform, about 460 feet high, which will be reached in some 40 seconds by about 8 m.p.h. lifts.

The new tower is to be built alongside, and in conjunction with an extension to Museum Exchange. The extension will provide approximately 150,000 square feet of floor space. The whole will cost about £1 million.



H.M. Telegraph Ship "MONARCH"



Crew Accommodation and Radio Equipment Modernized

Captain I. R. Finlayson

AN extensive programme for modernizing crew accommodation and radio equipment in H.M.T.S. *Monarch* has recently been completed.

Crew accommodation in Post Office cable ships is designed to conform to the standards laid down in the regulations governing merchant shipping. When *Monarch* was planned during the Second World War the standards were those of the early and mid-thirties, plus a measure of war-time austerity. Since then the standards of crew accommodation at sea have improved tremendously, with the result that the accommodation for Petty Officers and ratings in *Monarch* had become very much out of date.

A year ago a staged modernization programme of the accommodation for Petty Officers and ratings was put in hand. The first stage was to abolish the system of separate messrooms for quartermasters, seamen, stokers and catering staff and to provide a central messroom instead. At the same time the Petty Officers' mess was moved to another part of the ship and completely modernized. These rearrangements made available space for five extra cabins, thus permitting the berths in the ratings' cabins to be rearranged to a maximum of three per cabin.

The modernized accommodation was panelled with plastic-faced material, leaving only a minimum of painted surfaces on the deckhead. The messrooms were fitted with pantries equipped with stainless steel sinks and refrigerators. Air-conditioning units were provided in the Petty Officers' and crews' new messrooms to make these spaces comfortably cool under tropical conditions.

These new arrangements proved very successful and were very popular with the crew—to such an extent in fact, it was decided that instead of modernizing by stages the remaining accommodation would be dealt with in one operation. Accordingly forty-five cabins were modernized on the same lines in fifty-four days, during the refit recently completed. The amount of work involved can be really appreciated only by those familiar with ships. All cabins had to be completely stripped of furniture, fittings and bulkhead wiring. The bulkhead surfaces had to be prepared and then fitted with plastic facings, new floor coverings were laid, new specially-made furniture in timber was fitted to replace steel furniture, electric wiring and ventilation trunking were replaced, and painted surfaces renewed. This modernization has resulted in accommodation of the highest standards for Petty Officers and ratings, equal to the best modern practice at sea.

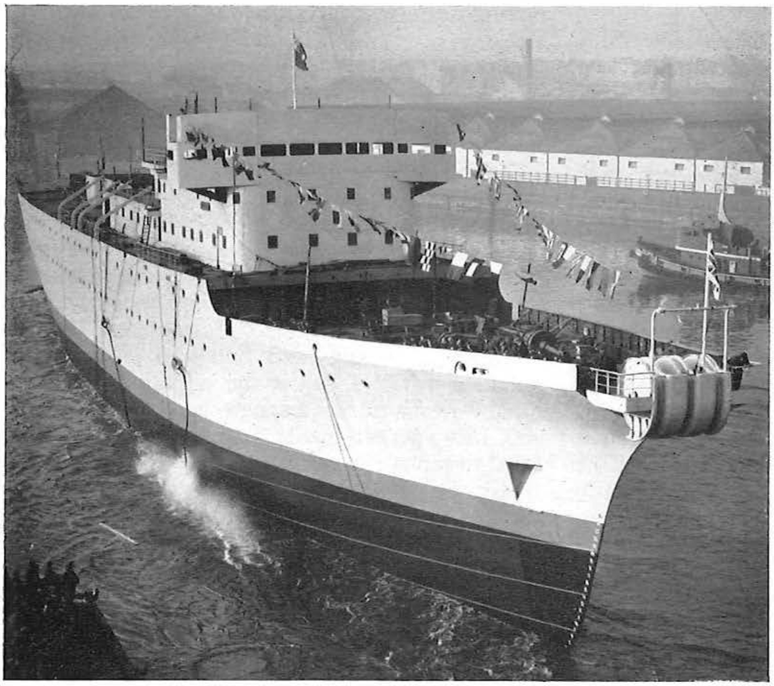
The opportunity was also taken to rearrange the extensive radio installation, providing a new operational layout and other ancillary features to improve convenience of working and extend facilities. A single side-band transmitter, one of the first to be installed on a ship, which had been in service for 10 years and was becoming difficult to maintain, was replaced by a lower-powered general purpose transmitter which may be used as a single transmitter or coupled to a new type of amplifier, which was also provided. This amplifier requires only aerial tuning, thus providing simpler and quicker changes in operating frequency, and when coupled to the general purpose transmitter provides equivalent power output compared with the old equipment. The amplifier also permits alternative coupling to a second general purpose transmitter which existed before the refit.

The new equipment is more compact and it enabled allocation of part of the accommodation as a working area to carry out service and repair of equipment when at sea, and to achieve much improved storage of spare components, valves and so on. Space was also gained to allow provision of a separate kiosk for ships' personnel to use when making radio telephone calls, and provide more suitable arrangements for handing in telegrams.

VHF radio telephone equipment has been installed on the Bridge for communication with Port and Harbour authorities, and with other similarly equipped ships. This also provides additional channels for radio telephone calls.

A second radar set providing either relative or true motion on a 12-inch display was fitted, the aerial scanners for this equipment and an existing radar set being mounted on a new mast. This also involved extending the radar hut on the upper bridge deck to house the radar transmitter and receiver and ancillary units of both systems. Opportunity was taken to arrange the equipment to afford convenient bench and working space for servicing the radar units and provide storage for spares.

The AC power supplies for the radio equipments previously provided by 8 kVA and 800 Watt alternators were increased by installing a new 30 kVA three-phase alternator in the engine room. Distribution of these three power supplies was rearranged, providing a new switchboard in the radio office annexe to facilitate switching of equipment loads to the alternator supply appropriate to the level of supply needed for the working load. This varies between a low load for essential watch-keeping equipment only and maximum load when all radio equipments are in operation.



H.M.T.S. *Alert*, fourth of her name, whose launching on November 7 we reported in our Winter issue

Inspection by Batch Sampling

F. T. Weston

Batch sampling is the method used by the Post Office Engineering Department's Test and Inspection Branch to safeguard, with minimum cost, the quality of most engineering stores. Below, Mr. F. T. Weston outlines some of the main considerations underlying the Branch's methods.

ACCEPTANCE testing in which every item is inspected and tested is commonly known as 100 per cent. inspection. At one time the Test and Inspection Branch generally used this method, though with some curtailment in appropriate conditions. Although costly, it was considered the most reliable means of guaranteeing the quality of accepted stores.

Experience not only in the Post Office but throughout industry has, however, proved that 100 per cent. inspection often detects substantially less than 100 per cent. of the defectives in stores inspected. Hence, if stores contain many defectives, the number of defectives remaining after 100 per cent. inspection may still be undesirably high. This conclusion is not a reflection on the skill or reliability of inspectors; it is simply a recognition of the fact, as shown by the Medical Research Council,* that in dealing with bulk supplies, no inspector can consistently maintain the high degree of vigilance and concentration necessary to ensure that every defective item is detected.

Another serious objection to a system in which the consumer undertakes the detailed inspection of goods is that it gives the supplier little incentive to limit inspection costs. He may find it easier to correct individual defectives rejected by the consumer than to improve his production methods and so is likely to persist in using manufacturing methods which result in a high proportion of defectives. The consumer who undertakes 100 per cent. inspection is therefore commonly faced with the unenviable task of trying to extract a reliable supply of goods from a production of doubtful quality—an exercise which is certain to be expensive and is unlikely to be successful.

These difficulties can be avoided by insisting that the supplier himself should ensure that the goods as a whole are of a general standard of quality acceptable to the consumer when submitted. The supplier's profit then depends not on the cost of production alone but on the total cost of production and inspection. Inspection is no longer a free service provided by the consumer to whatever extent may be necessary to make up for deficiencies in production methods, but is an expensive overhead not to be incurred unnecessarily. The supplier, therefore, has a strong incentive to employ efficient methods of production which avoid the wasteful use of inspection effort. Further, since all suppliers are required to submit goods of acceptable quality, the danger that competitive tendering will encourage poor quality production is avoided.

Acceptable Quality Level

If suppliers are to be held responsible for submitting goods of acceptable quality, it is most desirable to state clearly what is meant by "acceptable"; otherwise delays and disputes will occur. It is not possible to ensure that every single item in bulk supplies meets specification requirements in every possible way. Attempts to obtain such perfection would almost certainly prove abortive. They would also be likely to result in substantially increased production costs, and hence increased purchasing costs to the Post Office.

On the other hand, if too great a proportion of stores were defective, heavy installation and maintenance costs would be incurred and service would deteriorate. A compromise has therefore to be sought between these extremes; the aim must be, not complete freedom from defectives in supplies, but such a level of defectives that service requirements will be adequately met and total costs minimized.

Acceptable Quality Levels (AQLs) based on practical experience of manufacturing and field conditions are now being specified for practically all engineering supplies which the Post Office buys in bulk. For most items, the AQL is expressed as the maximum permissible percentage of defective

*Research on the Measurement of Human Performance—Medical Research Council, Special Report Series No. 268.

items in goods submitted. Defects are usually divided into two classes—serious defects, known as "Major Defects" and defects which are not serious, known as "Minor Defects". A separate AQL is quoted for each.

Batch Sampling

Acceptance testing using batch sampling is employed to ensure that suppliers conform to the desired standards of quality, and a decision whether to accept or reject the whole of a delivery or batch of goods is made on the evidence of a random sample drawn from the batch. A batch is rejected if the number of defectives found in the sample is greater than a prescribed number, called the "Acceptance Number" (AN); otherwise it is accepted. Such acceptance usually means that the batch is put to stock without further examination. In certain very exceptional instances, however, the "accepted" batch may be subjected to a detailed examination by Post Office inspectors, any defective item found being individually rejected. This additional precaution is limited to those items where the greatest possible freedom from defectives is essential: for example, safety belts.

The Test and Inspection Branch has used this system for many years and applies it to practically

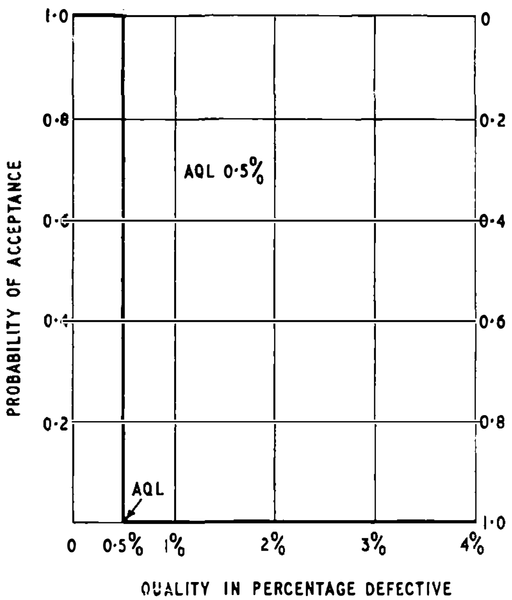


Fig. 1: Ideal OCC

all engineering supplies bought in quantity. The sampling plans have been progressively modified in the light of experience, and at present a revised series of plans is being brought into operation with the object of securing a more effective control of quality.

A variety of different types of sampling plans is available. Plans which require the examination of a fixed number of items per batch are known as Single Sampling Plans; plans in which the decision whether to accept or reject the batch may bc deferred until a second sample has been examined, are known as Double Sampling Plans; and plans involving a larger number of samples are known as Multiple Sampling Plans or Sequential Sampling Plans according to type.

Multiple and Sequential Sampling Plans, and to a less extent Double Sampling Plans, are more efficient than Single Sampling Plans in terms of the average sampling effort required to achieve a desired degree of control. However, Post Office requirements are adequately met by using quite small samples so that the savings involved would be only marginal. Further, with Double, Multiple and Sequential Plans, the number of items examined per batch and therefore the staff required to deal with a supplier's output, will vary widely with quality and cannot be determined in advance. Staff complementing difficulties therefore arise. For these reasons, the Test and Inspection Branch now favours Single Sampling Plans.

Operating Characteristic

A Single Sampling Plan is completely identified by the size of sample and the Acceptance Number (AN). With any sampling plan, the probability of accepting a particular batch depends on the quality of that batch, and the curve for a given sampling plan which shows the relationship between batch quality and probability of acceptance, is known as the Operating Characteristic Curve (OCC).

Ideally, the OCC would be of step form, as shown in Fig. 1. A sampling plan with this OCC would accept with certainty all batches equal to or better in quality than the Acceptable Quality Level, and would reject with certainty all worse batches. However, it would need a "sample" as large as the batch. Sampling plans could be designed to approach the perfect discrimination of the ideal OCC. Since, however, the consequences of accepting batches only slightly worse than the AQL would not be serious, the sampling effort

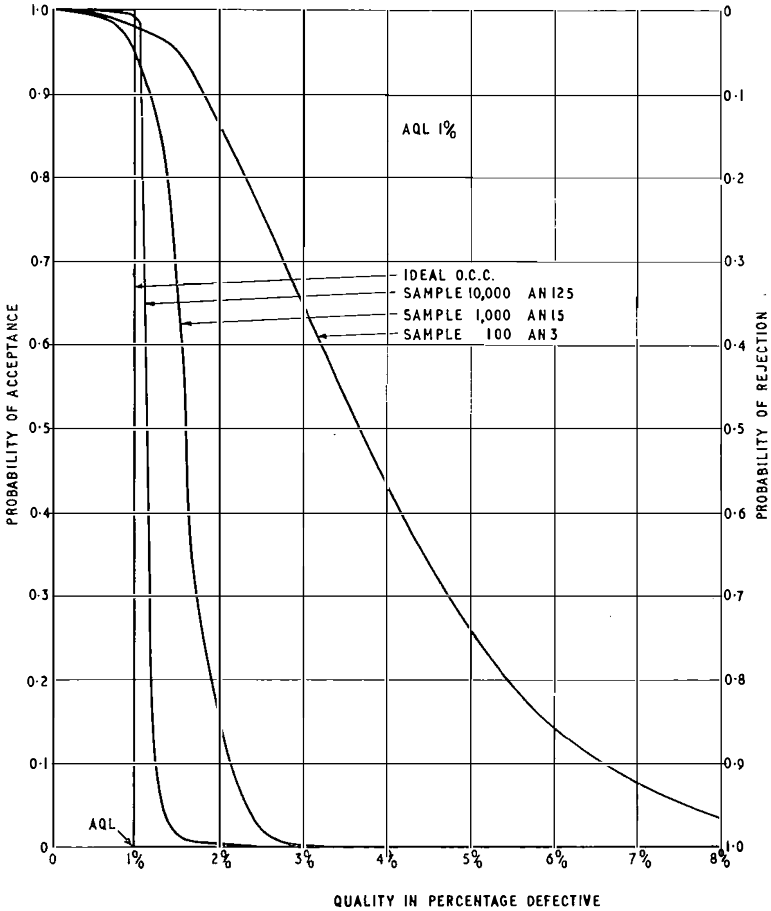


Fig. 2 : Ideal OCC and OCCs of practical sampling plans

needed to approach the ideal OCC could not be justified.

Fig. 2 shows the OCCs of various practical sampling plans. The ideal OCC is drawn in the same figure for comparison. It will be noted that the larger the sample the closer is the OCC to the ideal.

Producer's and Consumer's Risks

Batch sampling plans must meet two requirements: they must protect the producer against an undue risk of having satisfactory batches rejected, and they must protect the consumer against an undue risk of accepting unsatisfactory batches. The producer is protected quite simply by choosing a sampling plan in which the "Producer's Risk"—that is, the risk of rejecting a batch at the AQL—does not exceed some small stated value. With Post Office sampling plans, this risk does not normally exceed one chance in twenty; in other words, the probability of rejection does not exceed 0.05. Hence, if the supplier ensures that the percentage of defectives does not exceed the AQL, then not more than one batch in twenty will on average be rejected.

Fig. 3 shows the AQL and Producer's Risk on a typical OCC. It will be seen that the probability of rejection at the AQL is 0.025; that is, the Producer's Risk is 0.025. Protection of the consumer is more involved, depending on the practical circumstances in which batch sampling is to be operated. One method of protecting the consumer is to specify a quality rather worse than the AQL, and to choose a sampling plan which severely limits the chances of accepting submitted batches of that quality. This specified quality is

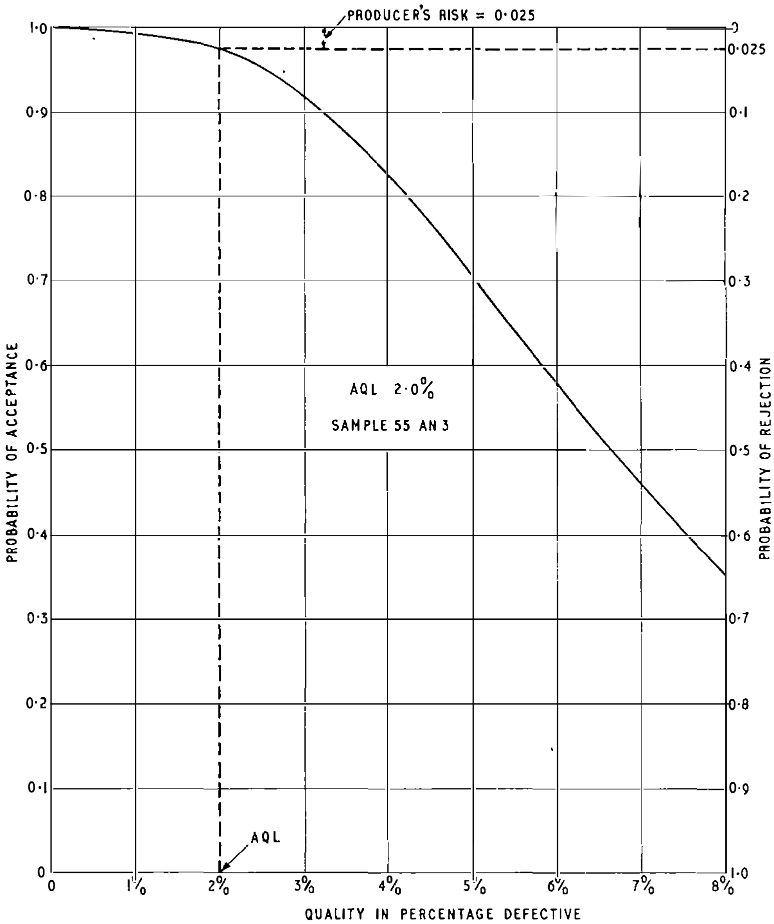


Fig. 3 :
The producer's risk

known as the Lot Tolerance Percentage Defective (LTPD). (Lot is the American term for batch.) The probability of accepting a batch at the LTPD is known as the Consumer's Risk. The Consumer's Risk is generally 0.05 or 0.1.

Sampling plans in which specified producer's and consumer's risks are not exceeded may readily be designed, and will provide a defined minimum protection for both producer and consumer. The closer the qualities AQL and LTPD the steeper the OCC will be, and the greater the size of sample needed. It follows that a high degree of discrimination between good and not so good batches must be paid for heavily in terms of the number of items examined. Fig. 4 shows the OCCs of two sampling plans. Both are based on an AQL of 0.5 per cent., a Producer's Risk of 0.025 and a Consumer's Risk of 0.05. One, however, has a LTPD of 3½ per cent. while the second, which requires a much smaller sample, has a LTPD of 10 per cent. The second plan would not be considered to discriminate satisfactorily between good and bad batches.

Sampling plans based on specified producer's and consumer's risks are intended to discriminate between good and bad individual batches, accepting the former and rejecting the latter with defined probabilities. Where, however, the total purchase involves a number of batches, the consumer may be less interested in distinguishing between a good batch and a bad one than in securing a satisfactory average quality.

Sampling plans which discriminate closely between good and bad individual batches require much larger samples than those which do not, and it would be wasteful to pay for such discrimination when it is not needed.

In such circumstances it is preferable to use plans which while not discriminating closely between good and bad batches, nevertheless ensure a satisfactory average quality of accepted batches. These plans are of two broad types; one is largely used where there is a continuous production of a large number of batches and the other where production is discontinuous, the production run involving but a few batches.

Continuous Production

Sampling plans used by the Test and Inspection Branch to safeguard the average quality of continuous production take advantage of the fact that where substantial numbers of batches are concerned, suppliers find that frequent batch rejections are a considerable embarrassment and therefore

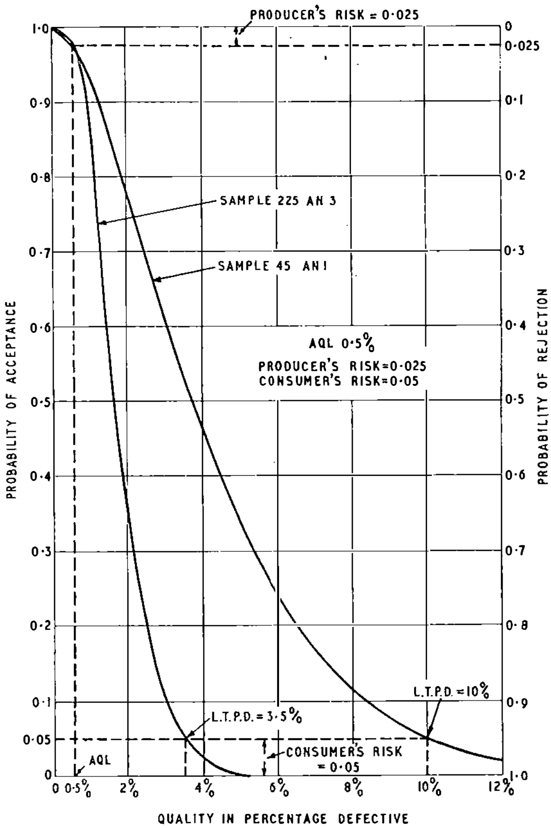


Fig. 4: Producer's risk and consumer's risk

seek to avoid them. These sampling plans are designed to satisfy a specified Producer's Risk, and at the same time to ensure that if quality were to fall below the desired level the rate of batch rejection would be large enough to cause suppliers serious inconvenience. This provides them with an incentive to exercise effective control of quality and to restore it quickly to the desired level should it fall. A sampling plan based on this principle is a form of penalty plan, the penalty progressively increasing in severity as quality becomes worse. A sufficient increase in severity with decline in quality can generally be obtained using quite small samples.

A typical curve showing the relationship between Batch Rejection Rate and quality is given in Fig. 5. It will be seen from this curve that if the incoming quality were to fall to $1\frac{1}{2}$ per cent. (from the AQL of 0.5 per cent.) there would be a Batch Rejection Rate of approximately 1 in 5. Experience suggests that few Post Office suppliers would find this tolerable, and that generally such a sampling plan would effectively constrain suppliers from submitting goods of significantly worse quality than the AQL.

Smaller samples than this are frequently used. For example, a sample of only twenty is usually taken from each batch of 3,000-type relays. A batch is rejected if the sample contains more than one major defective or more than three minor defectives. These sampling plans are based on AQLs of 1 per cent. for major defectives and 6 per cent. for minor defectives. The figure of 1 per cent. for major defectives does not mean that the Post Office is satisfied if no more than 1 per cent. of its relays do not work; it generally means that one relay in 100 may not be completely satisfactory in unusually adverse conditions of use and may require readjustment rather earlier than would a satisfactory relay.

Although the sampling plan illustrated in Fig. 5 is designed to control quality by the Batch Rejection Rate, it can still be examined from the point of view of consumer's risk. The quality corresponding to a Consumer's Risk of 0.05—that is, the LTPD—is in fact 10 per cent. Hence, there is little discrimination between good and bad batches. It follows that the sampling plan, when applied to a substantial number of batches, protects the consumer much better than the LTPD suggests. It will be appreciated that when consumer protection is based on the Batch Rejection Rate, the choice of a suitable sampling plan involves judgment of the extent to which suppliers are in differing circumstances likely to be influenced by the incidence or risk of batch rejections.

Tightened Sampling Plans

If, in spite of increased batch rejections, a supplier were to allow the quality of his product to remain below the desired level, the consumer would need greater protection against the risk of accepting seriously defective batches, and a means of putting increased pressure on the supplier to improve quality. The consumer might, therefore, wish to modify or "tighten" the sampling conditions so as to increase substantially the rate of batch rejection at qualities worse than the AQL.

This could be done in two ways: by increasing the sample size and AN, which increases the consumer's inspection costs, or by reducing the Acceptance Number without necessarily increasing the sample size. The latter has the effect of increasing the producer's risk. While such an increase

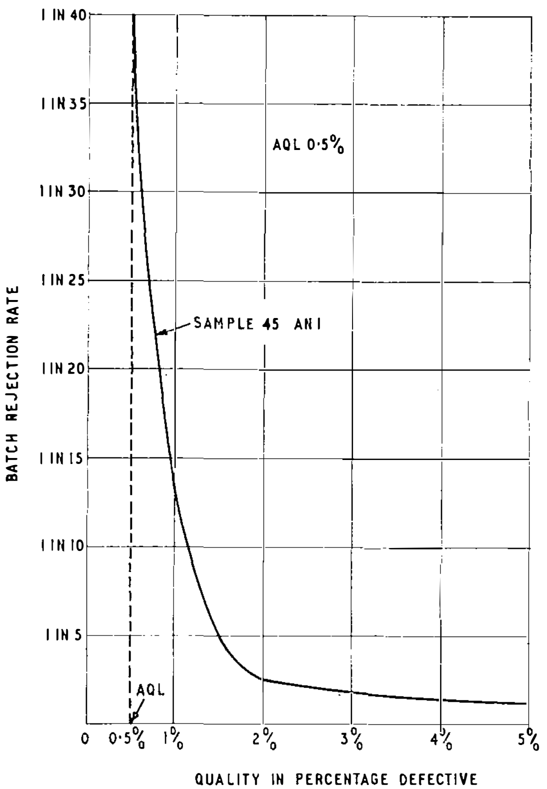


Fig. 5 : Batch rejection rate

is defensible, it must be limited so as not to impose an intolerable burden on the supplier. It is also very necessary to ensure that tightened conditions are not imposed unless from the evidence of samples examined there is little doubt that a fall in quality has occurred.

The Post Office batch sampling system therefore ensures that there is not more than one chance in 100 of introducing tightened conditions improperly, and that the producer's risk under tightened conditions does not exceed 0.5.

The OCCs of two sampling plans, both based on an AQL of 3 per cent. and both needing a sample of 55, are shown in Fig. 6. One is used in normal conditions and has a producer's risk of 0.025, while the other is the equivalent tightened plan with a producer's risk of 0.5. To provide any similar degree of tightening without increasing the producer's risk from 0.025 would require a sample of several hundreds.

The use of sampling plans based on the Batch Rejection Rate presupposes that a supplier can exercise effective control over quality. Where a supplier has not demonstrated his ability to do this, the Test and Inspection Branch uses sampling plans involving relatively large samples and which reject bad batches with sufficient certainty to safeguard the average quality of accepted batches no matter how poor the quality of submitted batches. Their use need not usually be continued beyond the first 10 batches of a production run. To avoid unnecessary duplication, the same series of plans are used as are used for dealing with discontinuous production.

Discontinuous production

Where the number of batches is small—say 10 or fewer—it cannot be assumed that the desire to avoid batch rejections will deter a supplier from submitting goods of unsatisfactory quality. Plans based on the Batch Rejection Rate do not apply in these conditions unless the supplier's reliability is already well-established. Instead, the Test and Inspection Branch again uses sampling plans which reject bad batches with sufficient certainty to safeguard the average quality of accepted batches. The sample sizes required, which are larger than those needed for dealing with continuous production, are varied in accordance with the number and size of batches in a particular order in such a way that the protection given is independent of the number and size of batches into which an order happens to be divided.

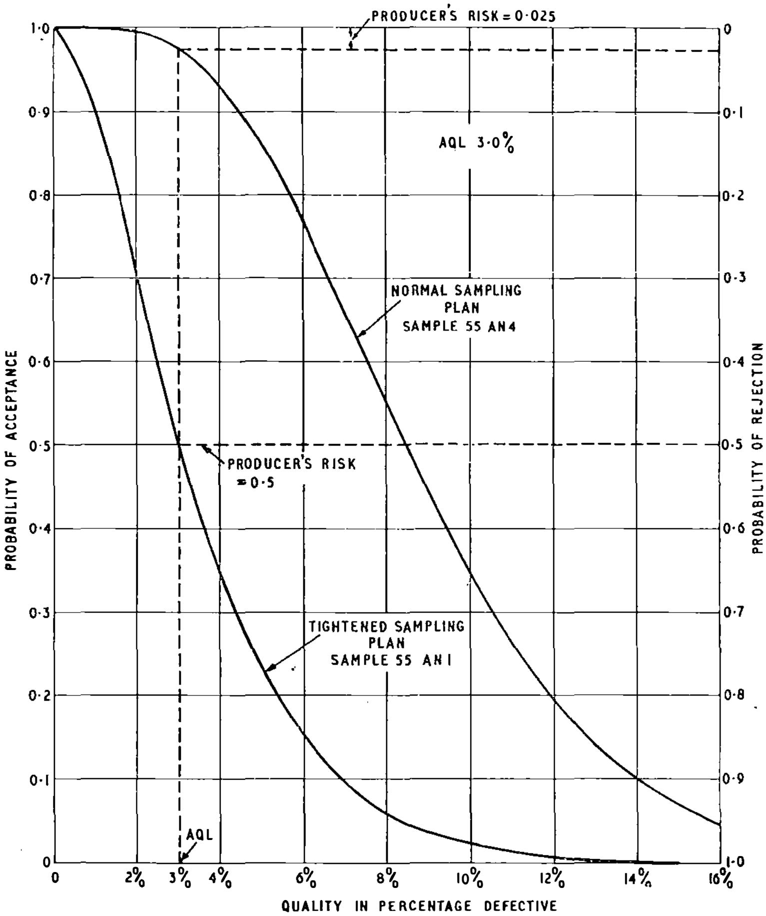


Fig. 6 : Normal and tightened sampling plans

Although statistical considerations play a large part in the design of Batch Sampling Acceptance Testing Plans, the efficiency of these plans can be judged only by observing the extent to which they are successful in controlling quality in widely varying practical applications. The Test and Inspection Branch has used sampling plans of one kind or another for many years, and the wide experience so gained has led to the evolution of the present series of plans. Their practical success will be continually reviewed, and they will be modified in the light of experience and changing conditions.

"The telephone in business . . . open door . . . or obstacle?" is a new 24-page booklet, with *Punch* cartoons being issued to suggest to business men how to use their telephones to the best advantage.

Quite apart from the purely technical aspects of operating a PBX switchboard, it has become increasingly clear that there is scope for a handbook giving advice to the PBX renter on how to make the best use of the telephone service.

The booklet falls naturally into three parts. First, management must know what it wants from its telephone service and how it can fulfil that want; secondly, the PBX operator should be aware of her importance to her organization, and how she should go about giving an efficient and courteous service; third, extension users have to be educated in using the telephone for conducting business economically and to the satisfaction of their customers.

The Challenge of the Floods

A. E. Williams

The wettest autumn on record, 1960, caused widespread damage to the telephone service. Damage was reported from the Wales and Border Counties Directorate and Home Counties, South Western and Midland regions. Lewes telephonists are said to have added a new phrase to their regulation replies—"Out of order, under water". Altogether about 30,000 telephones were affected. Forty small automatic exchanges were isolated for a time. At Treforest Trading Estate, Cardiff, the December 3–4 storm caused faults in all access cables; many subscribers' installations, including PBXs, were lost and in one section line plant and subscribers' apparatus had to be completely renewed.

The challenge presented by the October floods round Taunton and how it was met was typical of many parts of the country. Mr. Williams' record may prove helpful to those who may one day find themselves faced with a similar calamity.

TAUNTON is at the bottom of three-quarters of a saucer of which the Blackdown, Brendon and Quantock hills form the rim; the missing quarter is the valley of the river Tone—into which the hills largely drain—going east through the Sedgemoor plains towards Glastonbury. The hills were already saturated by October 26; on that Wednesday night of torrential rain they completely rejected the extra two inches or so, which consequently ran into the already overloaded Tone. During the night an unusually large number of "999" calls began to creep relentlessly nearer Taunton. At 3 a.m. an engineer was summoned to attend to a prompt alarm on the automatic equipment. The rising flood waters were damaging cables and further engineering staff were summoned to trace and disconnect the increasing number of faulty lines that were severely congesting the automatic equipment.

More and more emergency calls were coming in and at 6 a.m. the officer-in-charge telephoned me about conditions, which indicated very severe flooding. As I drove some four miles into Taunton on that wet and bleak morning, I little realized what was in store. Although my route was over a reasonably dry area, the road was under 18 inches of water at one point in the town. At the exchange I found that flooding seemed to be restricted to the surrounding districts. The staff were handling emergency calls satisfactorily and other traffic was normal. Tests revealed that no exchanges were isolated and only the odd one or two junction circuits were faulty. The Ambulance emergency circuit used for connecting "999" calls and all lines to one of the larger hospitals were out of order.

Ambulance calls were connected to the emergency line of the Police Control room where an ambulance was standing by connected by radio with Ambulance Headquarters.

Operators due off duty at 7 a.m. remained at their switchboards for an extra hour or so to deal with increasing traffic. Day staff, except five telephonists marooned on the wrong side of the floods, came in as scheduled; many had managed to report only at the expense of considerable resource and discomfort from wet clothes. Army Headquarters South Western District, Sherford Camp, offered transport and many of our staff later took advantage of this to get to the other side of the flooded area. All available staff were put on the switchboard and enquiry suite as the traffic was exceptionally heavy. A supervisor was withdrawn to deal entirely with fault reports and to co-operate with engineering staff in recording the ever increasing number of out-of-order lines. Fortunately, we had six trainees who had completed a large part of their telephonist training; we put them on the switchboard under their instructor's supervision and they proved a very welcome addition. An Observation Supervisor was also available to help. We suspended service observations, accounts and all records.

By midday on Thursday nearly 1,000 lines on Taunton exchange were out of order. During the morning the Tone had overflowed to the north of the town and flood waters had risen to over five feet, extensively damaging houses and shops. The Post Office building was out of the flood area but the basement was flooded and water was rising to a point where the electricity supply was in danger. Somerset Fire Brigade, by pumping out flood water until late in the evening, effectively prevented an electricity failure but, as a precaution, a stand-by generator set was installed for use in further emergency; this had been rushed from Bristol by road with police escort to avoid, as far as possible, the queues of traffic waiting at all sections of flooded road.

Because the automatic plant was so congested we appealed to the larger PBXs in the town to restrict their calls as much as possible and their co-operation undoubtedly relieved both the automatic equipment and the exchange staffing.

Many customers asked us to transfer their calls from faulty lines to working numbers in other parts of the town; a few of these requests were from larger business firms but most were from lines classified as emergency in attention to faults. A local doctor, for example, called at the exchange to say that his surgery was under four feet of water—could we transfer calls to his private residence? Several businessmen abandoned their offices and requested transfer of calls to their homes. We met every request.

All lines to the railway station were out of order. British Railways at Exeter co-operated in arranging to transfer calls for the station to a local travel agency, where a BR official dealt with enquiries.

Enquiries, mainly about lines out of order, were particularly heavy. The comprehensive list of out-of-order lines prepared by the Faults Supervisor in co-operation with the engineers was invaluable in dealing speedily with these enquiries.

We expected evening traffic to be quite heavy and arranged for certain day staff to work on after 6 p.m. Additional evening staff were also brought in as we thought that many evening part-time women staff would be unable to report for duty although we planned to ferry over the floods all "marooned" staff we could contact.

Evening traffic turned out to be twice as high as normal; the heavy peaks were particularly noticeable following the broadcast news bulletin telling the whole country about the serious flooding in the area. The number of calls coming into Taunton was beyond the capacity of the plant and facilities; at one time this caused unavoidable delays of up to several hours to incoming calls, chiefly at and beyond Bristol.

Marooned on the wrong side of the floods

The road to Wood Street Stores Depôt

The junction route to Minehead was the only one out of Taunton seriously affected; only two circuits out of nine were working but Exeter and Barnstaple helped in routing calls to Minehead which was itself flooded and attracting much traffic.

Bristol was finding difficulty in obtaining Minehead and incoming Minehead circuits were shared by setting up a Minehead-Bristol link on a delay basis. Three of these circuits were used, enabling Bristol to clear their waiting calls by about 10 p.m. Overtime by day staff, and extra evening staff attending for duty, enabled us to deal satisfactorily with the very high level of traffic.

Apart from many emergency calls, traffic from 10.30 p.m. on Thursday to 7 a.m. on Friday was practically normal. We co-operated fully with the engineers again on Friday and over the week-end in dealing with the fault reports. By this time the full extent and location of the damage had been ascertained. Some eight cabinets in various parts of the town were affected either by being completely immersed in flood water or by main cable breakdowns. The engineers found some 1,660 customers' circuits defective and many faulty trunks and junctions. Their efforts had been impeded by their having to get material and stores from the main Depôt at Wood Street, which was under four feet of water and was inaccessible except by a tractor shuttle service.

By Friday, however, the water had subsided and some 800 faults were cleared that evening. Engineers worked continuously through the night and over the week-end and by Monday morning only 100 faults or so were left.

As the exchange staff were advised that faults were cleared, they called each customer to say service was restored. Friday's traffic was again above normal but we experienced no difficulties in handling it. Naturally we received a few complaints but in the main they were from people who had not realized the extent of the damage to plant.

Such an emergency provides a wealth of experience from which several lessons may be drawn. I would summarize the main points as follows:

> The most difficult job at the outset was identifying and disconnecting faulty lines to clear serious congestion of automatic plant. When several faulty lines had been identified all the lines served by that distribution were disconnected. This helped considerably to clear spurious calls and reduce congestion quickly.
>
> Although where possible we connected the larger business lines to "Number Unobtainable" tone, we could not do this for all subscribers with so many lines out of order. This was a real nuisance in the manual exchange as many enquiries were prompted by the absence of the "NU" tone.
>
> Withdrawing a Supervisor to control the fault reporting and to co-operate with the engineers in listing faulty lines proved extremely valuable. By using suitable forms these faulty lines are best listed in hundreds on separate sheets and in numerical order for quick reference.
>
> Restriction of calls from larger PBXs eased pressure on the automatic plant and switchboards.

When such an emergency is suddenly thrust on an exchange, it is heartening to observe how staff respond to the challenge to maintain the high standard of the service expected of them. The exchange became a compact unit and all departments co-operated fully, each having its own great individual difficulties and responsibilities but not losing sight of the common aim of the service. As usual in emergency, Post Office staff worked very long hours under very arduous conditions to maintain the best possible service and to restore normal service as soon as they could. Many customers praised the Post Office for its service during this emergency.

I would like to thank Taunton Public Library for co-operation in the reproduction of photographs.

Magnetic Storage Devices

K. R. Wilderspin, B.Sc.(Eng.)

A TELEPHONE EXCHANGE, LIKE A CALCULATING machine, frequently needs to store or remember numbers or instructions until it is ready to deal with them. Many devices have been used as memories but in recent years static magnetic devices have been found to provide reliable and compact information-stores and to be especially useful where rapid access is needed to the stored information. Several different materials and many different devices are now available. This article discusses the principles of static-magnetic storage, the materials needed and, briefly, the functions and possibilities of some of the devices which have been constructed. Although frequently used in large capacity stores the motor-driven magnetic-drum store is not within the scope of static-magnetic-storage. Having no moving parts the devices described here cannot wear out.

Principles

A bar magnet (Fig. 1a) can be magnetized in two ways having opposite polarity and will remain in either of these states. It will remember the sense of the magnetizing force originally applied to it. Since bar magnets have free poles they need large magnetizing forces and tend to demagnetize themselves, but a closed ring (Fig. 1b) overcomes these difficulties. The magnetization may be directed either clockwise or anticlockwise and will remain as residual magnetism in that direction until something happens to change it.

The process of finding out what information was stored in a magnetic ring is known as "reading out". Normally, a large magnetizing force is applied. If the read-out field is opposite in direction to the stored magnetism the core magnetism will reverse in direction (see Fig. 2b) and a large voltage will be developed in an output winding. If the read-out field is in the same direction as the stored magnetism it will cause only small change in flux and little output when the hysteresis loop is rectangular.

The magnetic core is here being used as a two-state device and the information to be stored therefore has to be expressed in binary form. For example, in binary notation the number 5 becomes 101 (that is, $1 \times 2^2 + 0 \times 2^1 + 1 \times 2^0$) and therefore needs three two-state devices to store it. The two states are often referred to as the "0" and "1" states.

This method of reading-out the stored information destroys it and if the information will be needed again it must be subsequently replaced. Several devices have been tried in which the read-out is non-destructive; one of these, the transfluxor, will be described later.

Materials

The material used for magnetic storage should be capable of having its magnetism reversed by a small current in a time consistent with the speed of the device it feeds (which in the fastest calculating machines may require a flux reversal in a fraction of a microsecond). The material, especially in a large store, must also be uniform, cheap and easily fabricated. No single material perfectly fulfils all these requirements. The two main classes

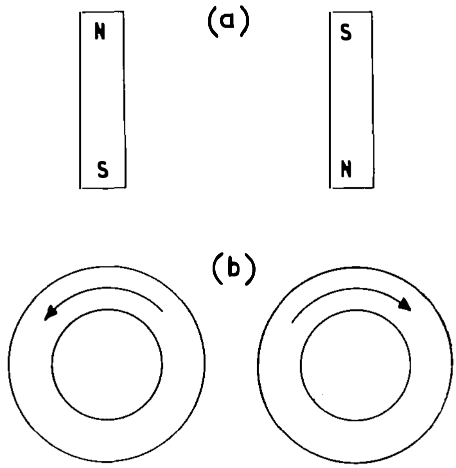


Fig. 1 : (a) magnetic bars
(b) magnetic rings, as two-state devices

of suitable materials are certain ferrites and certain metal alloys, both of which can be made, by special preparation, to have reasonably rectangular hysteresis loops.

Ferrites and Metals

Many of the devices for magnetic storage have used magnesium-manganese ferrite material. Ferrites are non-metallic mixtures of oxides and give a fast switching performance which is not limited by the generation of eddy currents inherent in metals. Such cores normally operate at speeds of about one microsecond.

The field required to switch a magnetic ring-core increases as the diameter of the ring and cores have been produced with very small diameters (down to 2 mm—as illustrated in Fig. 3).

New ferrites are reported from America, using cadmium-oxide in place of magnesium oxide, which are claimed to be five times as fast in the same switching fields, but they are not suitable for coincident-current storage.

Metal-tape cores (illustrated in Fig. 3) are capable of giving a larger output than the same volume of ferrite material. They also switch with much smaller current than ferrites. However, eddy-current loss tends to limit severely the switching speed unless the thickness is reduced to 0.001 inch or less. Tape of this thickness needs the protection of a box. Where only small currents are available to supply the switching fields, small-diameter metal cores may well be used. In shift-registers nickel-iron-molybdenum alloy cores give a better switching performance than the available ferrites.

If very fast switching speeds are needed, evaporated metal films may be used. The metal is

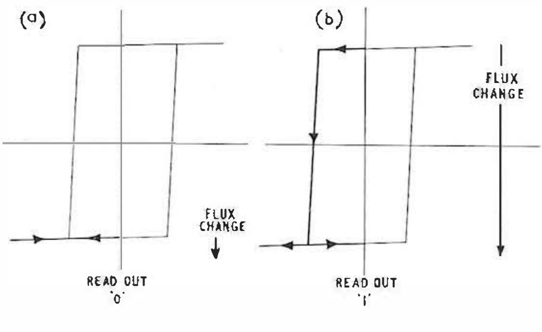


Fig. 2 : The flux changes in a core when a negative field reads-out (a) "0" and (b) "1"

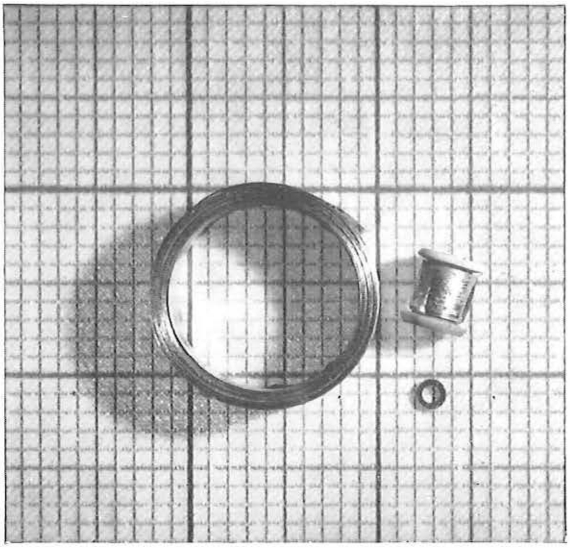


Fig. 3 : Two metal-tape cores and a small ferrite core. The squares in the background are 1 mm.

usually an alloy containing 80 per cent. nickel and 20 per cent. iron and is evaporated in the form of spots a few millimetres in diameter on a glass base. The thickness is only about a hundred thousandth of a centimetre and switching times of only a few millimicroseconds have been measured when transverse and longitudinal fields are applied together. Large numbers of storage sites can be evaporated simultaneously on which some of the associated conductors can then be printed.

Shift Registers

One of the basic elements used in information storage on magnetic cores is the shift-register. Fig. 4 shows diagrammatically the arrangement of a two-core per-digit shift register.

The information in binary form is fed into core 1. If the first is a "1" it reverses the polarity of core 1. A further pulse is then applied to line A which resets core 1 and feeds the information into core 1^1. Core 1 is now ready to receive the next binary digit.

The next step is to apply a pulse to line B, transferring the first digit to core 2. Two drive lines are used and two cores per digit, since a core cannot both receive and transmit information at the same time. The transfer circuit (shown in Fig. 4 merely by an arrow) must ensure that the information can progress only in one direction. It may

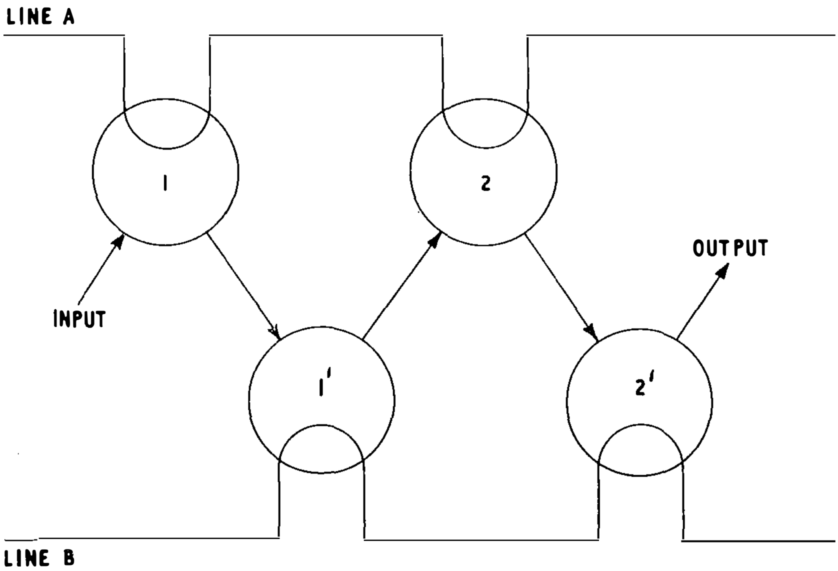


Fig. 4 : A two-core-per-digit shift register

consist of rectifiers and resistors, or of transistors which have the advantage of giving a current gain.

Such a device has several uses. It can give a delay between input and output. A shift register is thus able to act as a buffer store between two devices operating at very different speeds. For example it can accept information at a slow rate from a manually operated device and feed it into a fast electronic device at speeds in excess of 100,000 digits a second.

Coincident-Current Store

The coincident-current or matrix store has been evolved to give the minimum possible access-time to any particular piece of information in the store. A single plane of cores is shown in Fig. 5a. Each circle in the diagram represents a storage position. Every such position is intersected by two conductors which form the co-ordinates in a two-dimensional array. A third conductor links every position and carries the output.

To find whether "1" or "0" has been stored in position B, for example, the two conductors X3 and Y2, which define that particular position, are each supplied with a current. The two currents acting together are sufficient to reverse the magnetism of the store at position B. An output voltage then appears in the output wire. If the core was storing in the same direction as the applied field, there is little flux change and little output appears in the output wire. It will be noted that only the material in the selected position has sufficient field applied to it to reverse its flux. All other positions remain virtually unaffected. The method of reading the

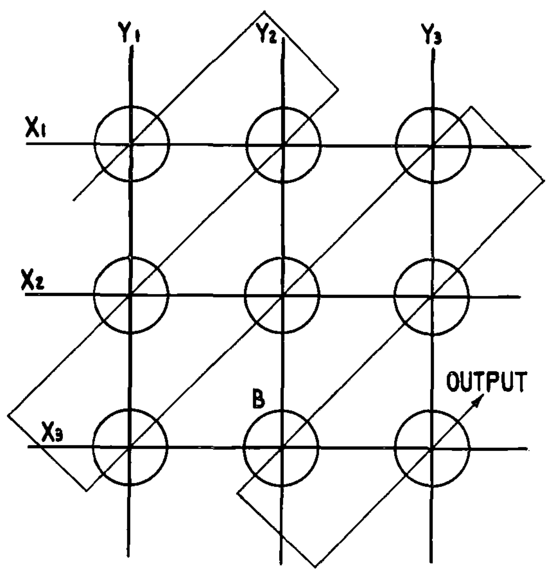


Fig. 5 (a) : A coincident-current memory matrix

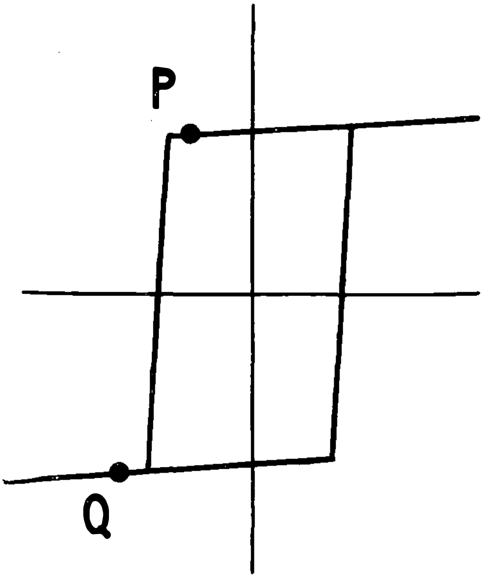


Fig. 5 (b) : The effects on a core of a half read current P, and a full read current Q

information into the store is the same as the read-out, except that when the digit "1" is to be stored the coincident currents will be in the opposite direction.

The Transfluxor

The transfluxor (Fig. 6) is a magnetic core with two holes; a large one, slightly offset from the centre, and a small one in the widest part of the ring. Fig. 6a shows the three windings needed. The device may be regarded as a transformer in which the transfer of power from the drive to the output windings can be controlled, between certain limits, by a direct current previously applied to the set winding.

If the current in the set winding is arranged to saturate the entire core in, say, a clockwise direction (see Fig. 6b), both sides of the small hole are fully magnetized in the same direction and there will be little coupling between the two windings passing through this hole. This is the blocked or "0" state of the device (see Fig. 6b). If now a current is applied to the set winding in the opposite direction to the first and of just sufficient magnitude to reverse only the inner ring (see Fig. 6c) the flux around the small hole can vary in sympathy with the applied drive current and power is now transferred to the output winding. This is the unblocked or "1" state of the transfluxor. In this device a continuous indication is given of the state of the memory-core without destroying the information.

The Twistor

The twistor uses nickel-iron wires as the magnetic material. The wire is twisted and the direction in which it is most easily magnetized shifts from the axial direction to a helical path inclined at 45° to the axis. The two possible stable states of magnetization are illustrated in Fig. 7.

The sensing wires are small coils around the magnetic wire or copper wires which merely intersect it. About 10 memory cells can be accommodated to the inch on a 0.002 inch wire. An output wire is already provided by the magnetic wire itself. The output voltage obtained can be considerably greater than the voltage needed across the read-out coil due to a transformer action between the small coil and the helical path of the flux in the wire.

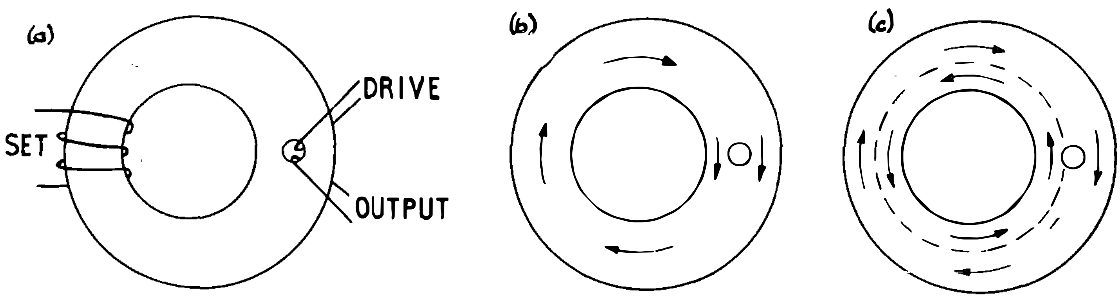


Fig. 6 : The Transfluxor: (a) the windings (b) the blocked condition (c) the fully unblocked condition

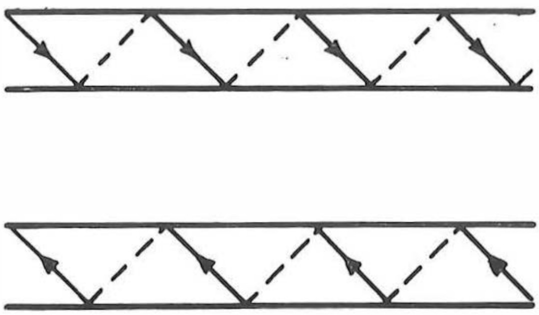


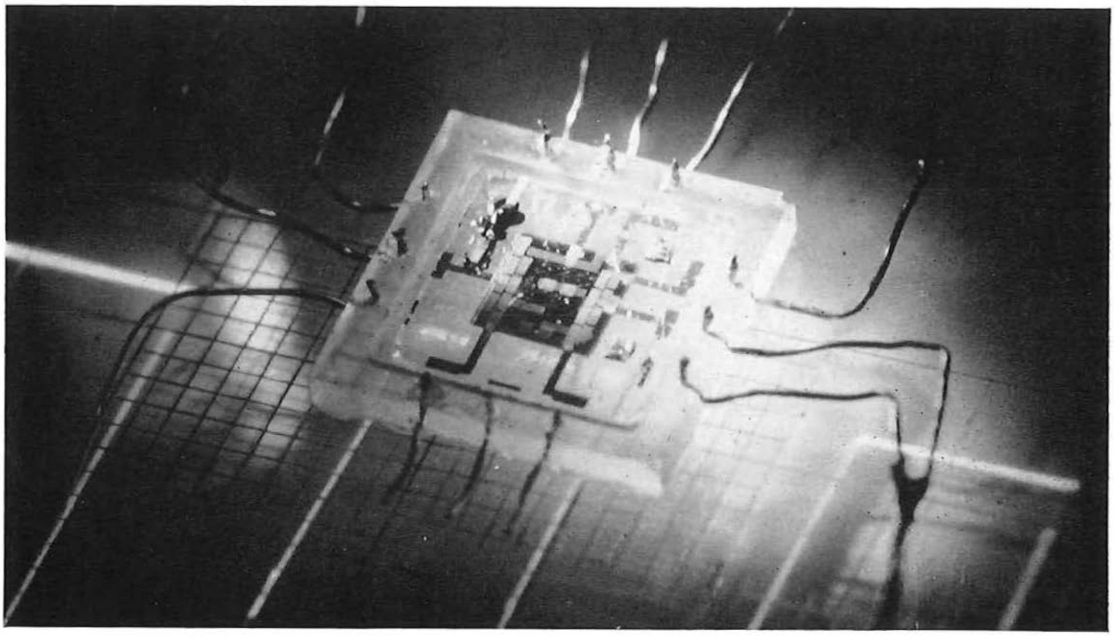
Fig. 7 : The two stable states of magnetization in a twisted magnetic wire

Experimental shift registers and matrix stores have been constructed on this principle. In one matrix store switching times of the same order as for ferrite cores were achieved. The matrix consists merely of twisted magnetic wires in one direction interwoven with copper wires in the other direction and should be very cheap to manufacture.

We have seen that suitable magnetic materials can be used to store numbers or instructions. This type of store will retain its information without expenditure of energy and if necessary the information can be made available very rapidly. The speed of operation required is one of the principal factors controlling the choice of material and type of store.

The magnetic core and its conductors together make a unit in which there is no reason to expect failure in any normal temperature or atmospheric condition. The magnetic core is a current operated device well suited to operation with transistors.

Microminiaturization: a multi-layer thin film circuit



In our Winter issue Dr. Tillman discussed progress with microminiature components. Here is a multilayer thin film circuit, developed by International Business Machines (whose permission to reproduce is gratefully acknowledged) which contains 18 evaporated layers on an area 0.3″ × 0.3″, making up seven components to which have been added two transistors to complete a NOR logic circuit; for example, for use in a computer

The Post Office Solicitor's Department

THE Solicitor to the Post Office has the whole of the Post Office in England and Wales for his client; his office is in Headquarters Building and his staff consists of Legal, Executive and Clerical Grades to the number of 79 in all.

The Department is divided into six branches: two Conveyancing, two Advisory, a Litigation Branch and a Prosecutions Branch.

The Conveyancing branches deal with some 300 purchases of land and buildings and 320 leases of premises every year. The other branches advise on any legal problem which crops up in the multifarious activities of the Post Office, conduct prosecutions, civil litigation and arbitrations, and draft documents of all sorts, including statutory regulations, in an unending stream.

The Department examines all Bills presented to Parliament and reports on their effect on the Post Office, and arranges for protective clauses in favour of the Post Office to be included when they are needed. It takes an important part in preparing Bills which the Post Office is to introduce. In addition to the cases which the Conveyancing branches deal with, some 5,400 cases reach the Department for advice or action in the course of a year.

Telecommunication services, of course, account for a large part of the work. There are prosecutions of boys who stone telegraph posts, thieves who steal thousands of pounds worth of cable from cable depôts, and rogues who find ways of getting telephone calls without paying for them. There are purchases of cable repeater station sites for a few pounds and of telephone exchange and radio station sites for thousands, agreements about the joint use of a few posts for telegraphic and electricity lines, and agreements about joint use of trans-ocean cables.

Motorists who damage telegraph poles, mechanical pick operators who puncture underground cables, and mariners whose anchors ravage submarine cables are pursued through the Courts for

Left to right (seated): Mr. A. T. ROBERTS, Assistant Solicitor; Mr. F. HESKETH, CBE, LLB, Principal Assistant Solicitor; Mr. J. P. RICKS, MA, The Solicitor; Mr. P. TURNER, LLB, Assistant Solicitor; Mr. W. VAUGHAN WILLIAMS, BA, Assistant Solicitor. (Standing): Mr. S. PEMBERTON, LLB; Mr. C. B. MAXTED; Mr. A. R. C. GRIFFITHS, Assistant Solicitors.

sums ranging from a few pounds to thousands. Bulk Supply Agreements, stores contracts and engineering contracts are drafted.

The Department can be expected to advise about many telecommunication matters: for example, general staff questions and pensions, wayleave disputes, non-payment of telephone accounts, accidents at work, protection of telegraphs from interference by electricity lines and the reinstatement of streets after cable laying. New legal points frequently arise in all these matters.

Mr. Hobcraft's article in the Autumn 1960 *Journal* gave an interesting account of many legal matters arising from the work of the "Wayleaves' Damage and Claims" duty in Post Office telecommunications branches, some of which need reference to the Solicitor's Department.

Wireless telegraphy gives rise to a variety of legal work, in addition to the prosecution of people who use unlicensed receiving sets; leased circuit agreements and new forms of licences have to be drafted, and advice given on the many problems which arise from the Postmaster General's special relationship with the BBC, the ITA, and the broadcast relay companies.

Occasionally quite unexpected questions arise: for example, damage to a Post Office cable ship tied up in the Thames, consequent on a heavy wash caused by a passing ship proceeding too fast.

When civil or criminal cases are to be heard in Courts outside London, the Solicitor usually instructs local firms of solicitors as his agents.

The Solicitor's Department is consulted formally by sending in the official file with a request for advice on specified questions, but oral informal advice is given when occasion demands.

New "Status" Bill before Parliament

THE "Post Office Bill" to give the Post Office a more commercial status less subject to Treasury control, was published on December 15 and is being debated in Parliament this session. Substantially, it expresses in statutory form the March 1960 White Paper which we published in our Summer 1960 issue.

1. A Post Office Trading Fund is to be established, under the Postmaster General's control. With certain exceptions all receipts are to be paid into this Fund and all payments will be made out of it. The exceptions are Ministers' salaries and payments to the BBC and ITA—if any—which will come out of the Broadcasting Vote.

2. The Post Office's initial capital debt to the Exchequer (as recorded in the Commercial Accounts Balance Sheet), hitherto treated as perpetual, will be divided into 25 equal portions maturing in successive years from the first to the 25th year of severance. At maturity the debt will be eligible for renewal. Since the Bill imposes on the Post Office liability for payments of interest and principal on all past capital debt, the Post Office will be relieved of any similar liability under past Money Acts. The existing liability to the National Debt Commissioners (who lent part of the money) will become a charge on the Exchequer.

3. The Post Office will still have to pay an annual sum in lieu of taxation; in 1955 when this provision was first made, the amount was fixed at £5 million. Now the amount will vary according to tax law and trading results.

4. Parliamentary control will be exercised by various means. In particular, Post Office Ministers' salaries will be voted annually, a resolution of the House of Commons will be required each year to permit expenditure from the Fund, and borrowing will continue to be subject to Parliamentary authority.

5. The Post Office is authorized to borrow up to £30 million from its bankers, the Bank of England, to cover short-term fluctuations in its cash position which cannot be dealt with otherwise; the Treasury may guarantee the principal and interest on such borrowings. The Exchequer will advance longer term capital for financing fixed assets or to provide permanent working capital. A debenture rather than an annuity basis will be adopted, each year's advances being repayable after a term of years; for fixed capital a term roughly corresponding to the average life of the assets financed—25 years is in mind; for working capital, possibly on a shorter basis with a 25-year maximum.

6. It is estimated that the initial debt when the Bill becomes an Act will be about £800 million. The effect of the Bill is to authorize additional borrowing up to about £80 million for the next two years, or £160 million over the next four; these

limits may be increased under a subsequent resolution by the Commons.

7. It is assumed that Post Office requirements for fixed and working capital will be nearly £500 million in the next four years and that about two-thirds of this will be financed internally; the proposed £80 million limit should therefore meet requirements for the next two years, and £160 million for the next four.

8. The Post Office will be able to invest moneys outside the business but only on a relatively short-term basis.

9. As originally proposed, Post Office staff will remain Civil Servants. Pension payments will come from the Exchequer and the Post Office will pay annual sums to the Exchequer in respect of pension liability.

10. The Post Office will pay cash for all services rendered to it by other departments, which will reciprocally pay cash for all services rendered by the Post Office.

A new White Paper (Cmnd. 1247) was published with the Bill as an explanatory memorandum.

Telecommunications Statistics

	Quarter ended 30 September, 1960	*Quarter ended 30 June, 1960*	*Quarter ended 30 September, 1959*
Telegraph Service			
Inland telegrams (excluding Press and Railway) ...	3,523,000	3,086,000	3,651,000
Oversea telegrams:			
Originating U.K. messages	1,694,248	1,593,251	1,679,725
Terminating U.K. messages	1,698,065	1,555,448	1,616,692
Transit messages	1,435,165	1,399,936	1,397,408
Greetings telegrams	860,000	725,000	902,000
Telephone Service			
Inland			
Gross demand	135,144	123,022	109,860
Connexions supplied	111,699	108,415	100,010
Outstanding applications	155,181	145,432	137,683
Total working connexions	4,889,308	4,835,104	4,680,680
Shared service connexions	1,129,928	1,129,676	1,131,768
Total inland trunk calls	107,283,000	100,918,000	97,149,000
Cheap rate trunk calls	26,858,000	22,700,000	23,691,000
Oversea			
European: Outward	ø773,590	753,375	699,815
Inward	ø742,466	719,950	697,700
Transit	ø3,500	3,325	*3,879
Extra-European: Outward	ø70,000	69,082	61,863
Inward	ø76,000	77,073	68,280
Transit	ø17,000	17,055	19,366
Telex Service			
Inland			
Total working lines	6,459	6,181	5,438
Calls from manual exchanges	422,000	487,000	698,000
Calls from automatic exchanges	266,000	264,000	220,000
Metered units from automatic exchanges ...	6,515,000	*5,315,000	945,000
Oversea			
Originating (U.K. and Irish Republic) ...	712,653	648,142	568,352
Terminating (U.K. and Irish Republic) ...	648,917	607,574	550,091
Transit	12,979	11,577	7,291

* Amended figure ø Estimated figure

The Transportable Traffic Recorder

A. J. Hutton, B.Sc.(Hons.)

Some 250 transportable traffic recorders are being distributed to Telephone Areas to eliminate "Idle Jack Counting" when taking traffic records as a basis of long-term forecasting.

THE flourishing state of the trunk service today brings many problems. In the earlier days of telephony, trunk circuits were very expensive compared with other costs and consequently were scarce. Until 1932 all trunk calls were booked in advance and connected in turn, the delay depending on the number of waiting calls. The "delay" returns indicated the extent to which the service could be stretched before an additional circuit need be provided. However, the plant was comparatively simple and the time taken to provide additional lines was not very great.

The continuing development of new techniques in the telephone service and the use of more complicated switching equipment have created the need for longer term forecasting and planning. Cables and ducts cannot be laid without considerable preparation. Large trunk switching exchanges housing rack upon rack of relay sets and switching equipments must be planned years in advance. Provision has also to be made for the increasing number of repeater stations throughout the country. The bases for all this forecasting are telephone traffic records.

Traffic Records

When traffic records were taken the emphasis during the trunk delay period was on assessing the amount of work a telephonist could perform, to ensure effective staffing of switchrooms at varying periods of the day. These were the days of the "peg count" records, the forerunner of Operating Statistics and more recently, Traffic Incidence; trunk line records were in terms of "paid time" and "delay".

On toll, or shorter distance circuits, demand working was in operation and, to keep these under constant surveillance, there were records of calls failing because of "lines engaged", "call count" records and "average holding time" records, the last two giving the call-time values: that is, Traffic Units or, as they are known today, Erlangs.

During this period automatic exchanges were coming into use and these had to provide a demand service. Each telephone call required an immediate outlet and consequently circuits had to be provided generously. In the absence of ticket records and other regular returns available in switchrooms, no ready means existed for assessing the traffic level and making plans to increase circuit capacity.

As early as 1929 arrangements were made for engineers to take switch counts at automatic exchanges to obtain a complete record of traffic on circuits, internal and external. These switch counts were taken on incoming groups of circuits by

Fig. 1: Telephonist taking "Idle Jack Count" record

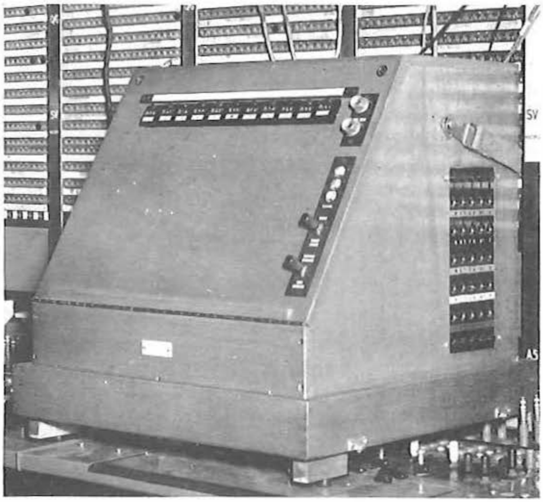


Fig. 2 : Transportable traffic recording unit

counting the switches (or selectors) in operation, and on outgoing groups of circuits by a test lamp. They were taken at three-minute intervals between 10 o'clock in the morning and 12 noon on three representative days in each quarter. In this way the average number of occupied circuits was obtained. These were the original Circuit Occupation Records, as applied to automatically selected circuits.

Circuit Occupation Records

About 1936 Post Office Headquarters Traffic Section saw the possibilities of using "Circuit Occupation" records on switchboards in conjunction with "Call Count" records to assess the average holding time, and it was decided to take these on all demand trunk routes. Eventually the circuit occupation records in switchrooms replaced the "call count" and "average holding time" records. With the general change-over from manual to automatic working and joint access working this became the most important circuit record.

In telephone switchrooms, at prescribed times, a telephonist counts the number of idle circuits in a specified group, or groups of circuits, during the busiest period of the day (Fig. 1). She touches the switchboard circuit termination (the "jack") with the tip (the "plug") of the operating cord; a "click" in her headset indicates an engaged circuit, and no sound indicates an idle one. All circuits are tested in this fashion every two minutes. The average number of idle circuits (or jacks) is obtained from the results and thus the average number of occupied circuits and the telephone traffic carried by the group are calculated.

Traffic Recorders—

Although the function of "idle jack" counting has been performed manually in switchrooms since the 'thirties, the switch-counts performed by engineers on automatic plant were replaced by automatic traffic recorders at an early date in larger automatic exchanges. Circuit occupation records on groups of automatically selected circuits could then be taken more frequently and accurately. However, the automatic traffic recorders were mounted on racks in apparatus rooms and occupied considerable space, so they could not be installed in switchrooms for circuit occupation records ("Idle Jack Counts").

Nevertheless the demand for more frequent records on both automatically selected circuits and circuits from switchboards continued to grow, but because they were required at busy periods, the staff for taking more "idle jack" records could not be afforded. Consequently the number of records was restricted. Also, because the automatic traffic recorders in apparatus rooms tested in 30 seconds as many circuits as a telephonist took two minutes to test, records on both automatically selected and manual board components of a route could not be aligned with confidence. There was an obvious need for a small transportable traffic recorder.

Several years ago an article in the *Telephone Journal of Australia* described a portable traffic recorder for use at small automatic exchanges. This type suffered from the disadvantage that contin-

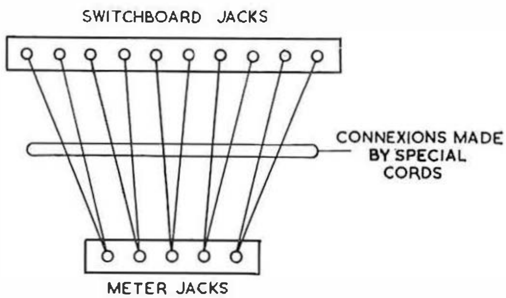


Fig. 3 : External connexions of meter jacks on recording unit to switchboard jacks

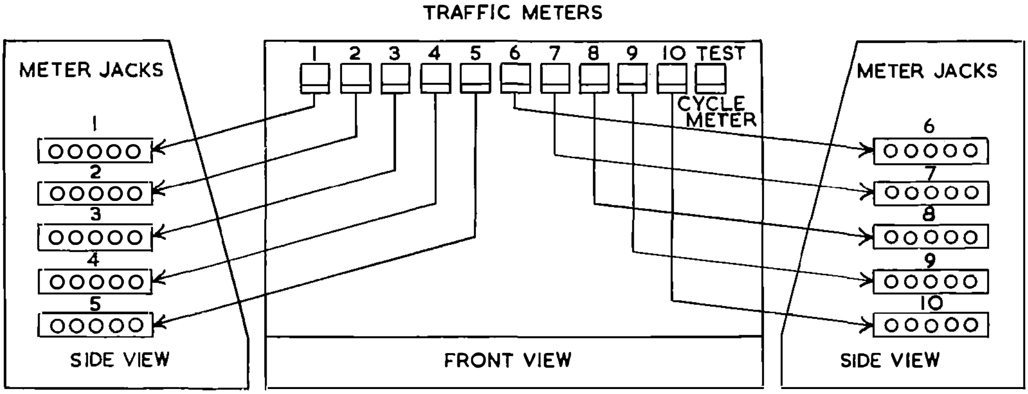


Fig. 4 : Internal connexions of traffic meters to meter jack rows on recording unit

uous attention was required to switch it from one group of circuits to another and it was not considered economic to reproduce it in this country.

However, work was started on designing a portable traffic recorder which could be left unattended and at the same time the design of a traffic recorder which could be used at the switchboards was considered. Indeed, all effort was eventually directed towards this objective as this was thought to promise better results.

—Transportable for Switchboards

The facilities originally envisaged were :—

(*a*) Connexion from the recorder to the Outgoing Junction Multiple to be made by cords;
(*b*) Capacity for recording on up to 100 circuits;
(*c*) A frequency of testing all circuits connected to the recorder of about 30 seconds;
(*d*) Silent operation;
(*e*) Total traffic carried by a route during consecutive half-hours to be recorded automatically and separately for each half hour with half-hourly manual supervision if necessary.

Silent operation was the only facility in doubt from the design stage. It was anticipated that a meter would have to operate every time an engaged outlet was found. This would be repeated every 30 seconds and in itself would be comparatively noisy. Further, the circuits would have to be offered to the recording device in rotation by a uniselector, and while it was hoped to encase this item in a sound proof box, complete sound insulation was more than could be expected.

The recorder, now produced and on trial in 20 Telephone Areas, consists of a recording unit and power unit which, before use, are connected by a multiway cord. Mounted on the sloping face panel

	Engaged test made on :—		
Test Cycle 30 seconds	0–6 seconds	–	circuits connected to traffic meters 1 and 6
	6–12 seconds	–	,, ,, ,, ,, ,, 2 and 7
	12–18 seconds	–	,, ,, ,, ,, ,, 3 and 8
	18–24 seconds	–	,, ,, ,, ,, ,, 4 and 9
	24–30 seconds	–	,, ,, ,, ,, ,, 5 and 10

Fig. 5 : Sequence of testing during one test cycle

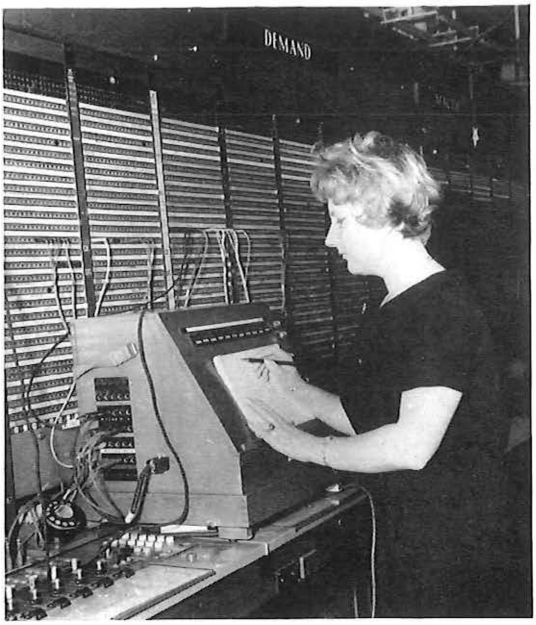


Fig. 6 : Reading meters on transportable traffic recording unit

of the recording unit (Fig. 2) are 10 meters for registering telephone traffic, and one meter (the test cycle) for registering the number of times all circuits are offered to the recording device. Power for operating the recording equipment is fed from the mains via the power unit, and from the exchange battery via the switchboard battery jack. The recording unit is connected to the switchboard circuits by special cords which, when not in use, are stored in a wooden box, the lid for which is designed to fit over the switchboard key shelf so that the recording unit may be placed on top.

The traffic meters are numbered 1 to 10, and each can be connected to a maximum of 10 switchboard circuits by selecting the appropriate special cords and connecting the switchboard circuit jacks to the recording meter jacks. Fig. 3 shows diagrammatically the maximum of 10 circuits connected to five meter jacks, each of which can accommodate two switchboard circuits. Each row (there are five rows on each side of the recording unit) of five meter jacks is numbered to correspond to one of the traffic meters to which it is permanently connected (Fig. 4).

The total capacity of 100 circuits is therefore divided into groups of 10 with one recording meter associated with each group. Thus, the traffic carried on 10 separate groups each of up to 10 circuits can be recorded simultaneously.

Coupling facilities to provide flexibility between the groups of cords and recording meters are not provided; if traffic on a route of (say) 15 junctions has to be recorded, 10 circuits of one recorder group are employed and five circuits on an adjacent group. The traffic is then the sum of the readings on both meters.

When the equipment is working, each associated switchboard circuit is offered to the recording device once every 30 seconds, or test cycle, and an engaged condition operates the relevant meter. Circuits connected to meters 1 and 6, 2 and 7, 3 and 8 and so on are tested together. In approximately 30 seconds each of a possible 100 circuits is offered to the recording device, and this comprises a test cycle (Fig. 5). On completing a test cycle the test cycle meter operates.

A two-position control key on the face of the recording unit can cause the recorder to operate continuously, or to operate for approximately 25 minutes (that is, 50 test cycles) when it will automatically stop. This latter facility enables the usual circuit occupation records to be taken during consecutive half-hours. Five minutes are available for reading the meters before restarting for the next half-hour's recording (Fig. 6).

The readings of the traffic meters are divided by the test cycle meter readings to obtain the average number of occupied circuits in each group.

Future Use

At the time of writing (December 1960) arrangements are being made to distribute about 250 recorders to Telephone Areas throughout the country, so that in a large number of places the need for "Idle Jack Counting" will be eliminated.

With widespread use of the transportable traffic recorder most "circuit occupation" records will be taken automatically. The records taken on circuits terminating on automatic selectors in the exchange by use of the rack mounted traffic recorder, and the records taken at switchboards by the Transportable Traffic Recorder will now have a common denominator; this trend should provide more frequent records on all circuits to enable changes discernible from traffic records to be detected early, and consequently provided for well in advance.

The Manufacture of a Telephone

C. A. R. Pearce, M.Sc.(Eng.), A.C.G.I., A.M.I.E.E.

and

T. C. Harding, T.D., A.M.I.E.E.

PROGRESS in the design of telephone instruments depends quite as much on new materials and advances in manufacturing techniques as on improved understanding of the basic requirements and the technical operation of the instrument. The new materials and the improved production methods which had become available since Telephone 332 was first produced enabled the telephone industry to meet the stringent requirements of the Post Office for their new instrument, Telephone 706, shewn in Fig. 1. This is generally acclaimed for its attractive appearance and broad design. Among the considerable advantages it offers over its predecessor are greatly increased transmission efficiency, which allows its use on lines of much higher resistance, improved reliability due to careful detail design, and flexibility in use.

The intimate connexion between design and production techniques necessitates the closest possible co-operation between all those associated with the development of a new telephone instrument. At first, such work is concentrated on the manufacturer's development unit and the Post Office engineers, but it is not long before the production engineers are brought into the discussions. When the design of Telephone 706 was far enough advanced to be considered settled in its main lines, it was discussed in some detail with those who would have to plan its production and they, in turn, set about devising the production methods to be employed.

It may be difficult for those unaccustomed to large scale industrial production to appreciate the full extent of this sort of planning. It is not easy for them to conceive the detailed consideration necessary before the manufacturing of a new product such as a telephone instrument can be started.

Telephone 706 comprises some 300 parts of various metals and plastics. The majority are to be seen in Fig. 2 where they appear in their correct relationship to the base on which most are mounted. Each of the 300 parts requires one or more operations for its production. Generally, some half a dozen or more separate operations will be needed in addition to the finishing processes. Each one of this series must be planned and related to all the others before manufacture can be started.

In addition, all the tools by which the operations are to be performed have to be planned. It is easy to see, therefore, that the tooling on a project of this sort is a really major operation, costing a company many thousands of pounds. Fig. 3 is a picture of the tools used in producing the ordinary telephone dial and should convey some impression of the design and manufacturing effort entailed in the tooling portion of such a project.

A large proportion of the operations entailed in manufacturing telephone instruments is carried out on presses, such as the 70-ton press used to manufacture the main bracket of the gravity switch of Telephone 706.

This bracket is produced in six distinct operations. The first is called, for obvious reasons,

Fig. 1 : Telephone 706

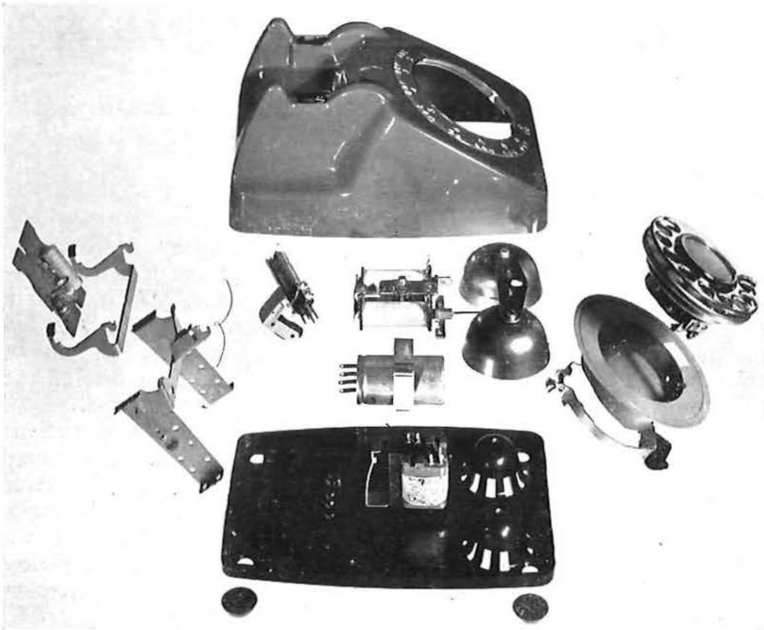


Fig. 2 : Exploded view of telephone showing main components

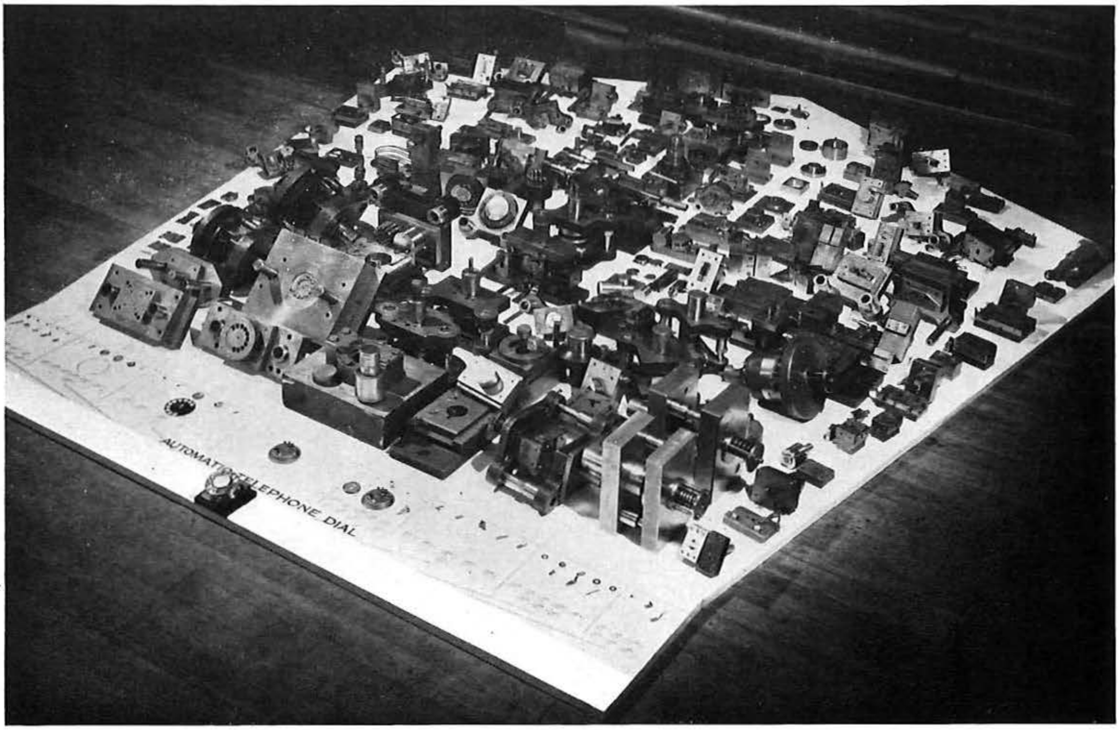


Fig. 3 : Machine tools used for manufacture of dial

"blanking", and in it a metal strip is fed into the press by hand and a blank is cut from the strip which is the developed shape of the bracket in the flat, see Fig. 4. Such an operation would typically be carried out at the rate of about 1,000 an hour. The blanks are collected automatically in trays ready for the next stage, notching the blank and punching the holes. The result is seen in the second part of Fig. 4.

Three bending operations then follow, including piercing and drawing the material. Finally there is the tapping of all the holes.

Were it not for the accuracy required in the finished product, some of these operations could be telescoped but the accuracy normally necessary to the correct functioning of the telephone equipment sets a very definite limit to the degree to which press operations can be complicated in this way. At the end of the sequence, the part is of the correct shape but it must now be cleaned, plated, and lacquered. These operations have themselves to be studied in detail to ensure that they are carried out as economically as possible.

The good appearance of the new telephone owes a great deal to the moulding processes employed in manufacturing the handset and the cover. These are of injection moulded from polymethyl methacrylate, a material better known by its trade name of "Diakon". Hitherto, most of the mouldings in telephone instruments purchased by the Post Office have been of thermo-setting plastics typified by the trade name "Bakelite" and have, of course, been black. The colour range and physical properties of such plastics are restricted and the extended use of Diakon opens up big new possibilities.

An important consideration in manufacturing a coloured telephone is the extent to which the colours can be controlled and, of course, the extent to which the material is light-fast after moulding. Until recently, coloured compound used for mouldings was invariably manufactured as such by the supplier of the plastics material and any adjustment to the colours, pigments or dyes was carried out remote from the moulder. This arrangement inevitably led to difficulties which, although they were overcome, were nevertheless a handicap.

The mouldings for the new telephone are manufactured altogether differently. The supplier of the moulding material delivers to the moulder a colourless powder, which the moulder mixes with his own pigments and dyes by a process known as "dry mixing", thus becoming responsible for the colour of his basic material. This change enables much more satisfactory and sensitive control over the colour and permits the characteristics of each moulder's individual techniques to be taken into account when the colours are mixed.

In the injection method the moulding material, heated to a soft, plastic condition, is squirted into an empty mould where it cools and stiffens; the mould is then opened and the solid moulding removed. This differs in principle from the moulding of the older thermo-setting materials, in which a mould is closed on a heap of moulding powder which is then cooked to a solid before being removed. Naturally, there is considerably more to the processes than these outlines suggest but they may suffice for our present purposes.

Fig. 5 shows an injection moulding machine with the moulding tool swung out of its normal working

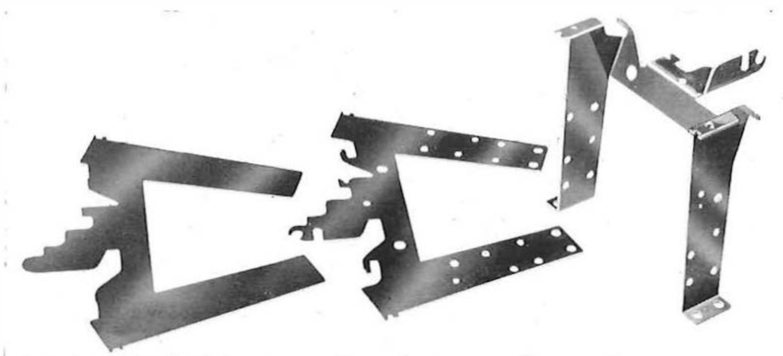


Fig. 4 : Production stages of the main bracket. Left is the "blank" which is punched from strip metal ; centre is the same blank after notching and piercing ; right is the completed frame

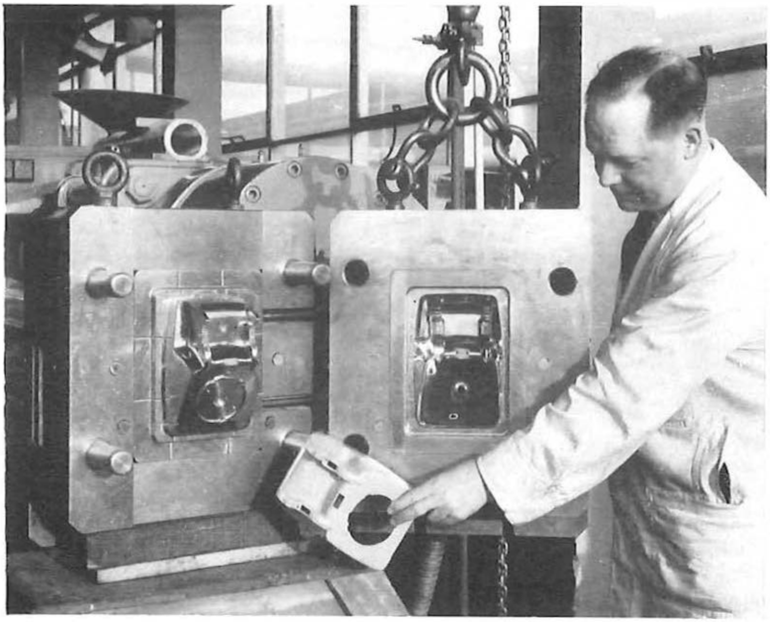


Fig. 5 : Typical moulding press for manufacture of instrument case or handset. Moulding tool shown in foreground

position for the purpose of the illustration. This machine and mould are used for the case of Telephone 706. The machine is continually fed by hand with material but at any one time it holds sufficient for some 50 mouldings, and produces a moulded part for every cycle of operation. The cycle starts with the automatic closing of the two halves of the mould and at the same time the sliding door preventing access to the mould is automatically closed. The various phases of the cycle follow automatically and it is completed when the press opens to deliver a finished moulding to the hands of the operator.

It would be out of place in an article of this sort to describe in detail all the processes involved in the manufacture of all the 300 parts which make up the telephone. Some of the processes, such as coil winding, are adequately described by their names; others are highly specialized, such as rumbling, in which parts that may have rough edges or burrs are "rumbled" or tumbled in a rotating barrel with such diversified materials as pebbles or gramophone needles. They come out of the barrel with the rough edges and burrs smoothed over and in a fine condition for their function in the telephone.

Through one or other of a hundred different processes the parts of the telephone are manufactured and they are ultimately brought together on the assembly line ready for putting together into the completed instrument. In fact, some sub-assemblies are produced before the parts reach the

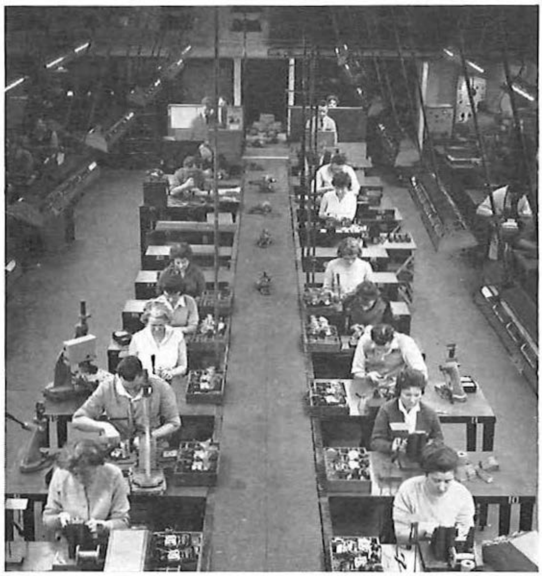


Fig. 6 : Part of final assembly line

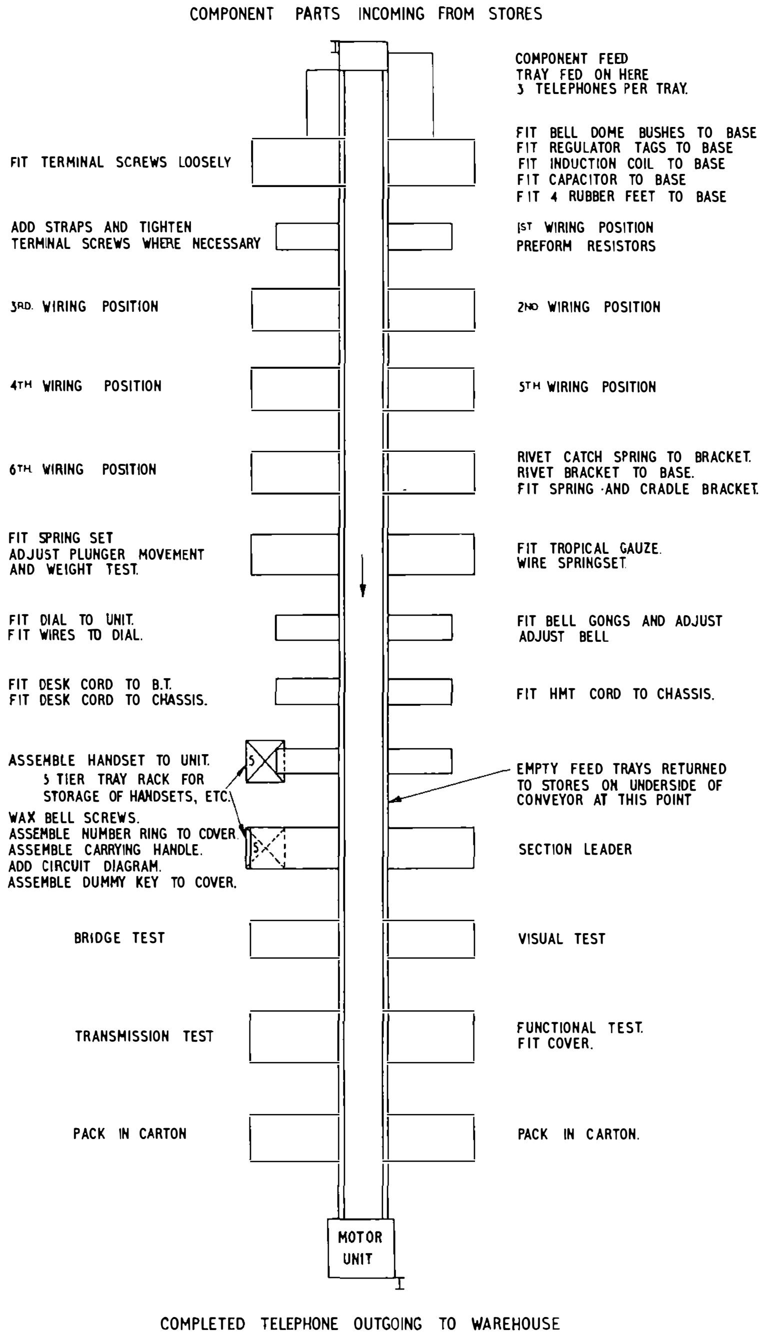


Fig. 7: Manufacture of a telephone: organization of assembly line

assembly line. The receiver, transmitter, induction coil and bell and other such items come together as complete units on the main assembly line illustrated in Fig. 6.

In manufacturing the pieceparts the predominant factors are the machines and the tools, although as in all industrial processes the importance of the human factor must never be overlooked, but its effect on the efficiency of these processes is not so important as it is on assembly and adjustment. In effect, the forms of the assembly processes are dictated by the requirements and skills of the human operators.

Each operative on the line performs a part of the total assembly operation and passes on his or her work to the next worker for another contribution. Such an arrangement is not only a highly organized activity but one which can be effective and efficient only if a high degree of willing co-operation exists between the individual workers. They work as a team and their individual wages are directly related to their total effort as a team.

Assembly Cycle

At the beginning of each cycle the parts for three telephones are placed in a tray and passed to the first operator. She removes all the components required to complete her sequence of operations. These operations comprise fixing the bell gongs, bushes, regulator tags, induction coil, capacitor and four rubber feet to the base plate moulding. When her task is completed, and on a given signal, the three bases carrying the fitted components are returned to the tray which then passes to the next operator who, in turn, carries out her part of the total task. The leader of the team sets the time cycle to which the whole line works and it becomes in effect a group decision determining the rate of working for the individuals and also the payment each receives for the work. It is perhaps relevant to mention that the men who can be seen on the line working alongside the women are there only because of the local shortage of women workers.

Seventeen stages of assembly are necessary to complete each instrument ready for electrical, mechanical and visual tests, and when tested and approved it is packed ready for despatch at the last positions on the line (Fig. 7).

In the planning stage, even before development was completed, the assembly operations were studied and jigs, fixtures, tools and gadgets of all sorts to simplify and cheapen assembly were devised. As these began to take shape, motion studies of the operations were made in the Work Study Laboratories with selected operators, many of whom were eventually to work on the assembly line in the production shop. These studies aimed at perfecting the equipment and arriving at the best layouts for the work benches. Later, time studies were made of all the operations. During all this, improvements were being made not only in the methods but in the pieceparts and, of course, operators were being trained in what, to them, were new processes. By the time the tools were in their final form and the line was ready for transfer to the production shop, the methods were settled, and a number of key operators already trained.

Furthermore, the management had a pretty good idea of the possible output of the line and the price to be offered to the team for piecework.

Piecework prices are invariably negotiated between the workers and the management and it is fundamental to the maintenance of good industrial relations that they should be acceptable to both sides. Only if the team feels that it has had a fair deal will the individuals put forth their best efforts and maintain the quality of product which the Company and the customer expect.

Telephone 706 is the result of close co-operation not only between the design engineers of the developing company and the Post Office, but between all those engineers and operatives who play a part in converting ideas and drawings into a first-class telephone to be produced by the million.

TAT1 Revenue

"British investment so far in transatlantic telephone cables is £7.5 million, this being a half share in the cable laid in 1956 linking the United Kingdom with Canada and the United States", said the Postmaster General, answering a Parliamentary question on December 9.

"The only other existing transatlantic telephone cable is one linking France with the United States. There is no British investment in that cable, but the United Kingdom will have a half share in cable to Canada to be laid in 1961 and a cable to the United States to be laid in 1963, and also a 25 per cent. share in a United Kingdom/Iceland cable to be laid in 1961.

"The total British revenue from the 1956 cable and the associated radio facilities has amounted to £7.9 million."

Problems of

Electronic Exchanges

J. A. Lawrence, M.I.E.E.

A summary of ideas discussed at the first international Conference on Electronic Exchanges organized by the Institution of Electrical Engineers in November 1960.

THE first fully electronic telephone exchange in the world is already in service at Morris, Illinois, capable of serving some 600 subscribers connected to an experimental exchange designed by Bell Telephone Laboratories. In this country the first all electronic exchange is nearing completion at Highgate Wood in London Telecommunications Region—it should be ready late this year. In Germany two quasi-electronic exchanges are in a fairly advanced stage of development, one for Munich developed by Siemens and Halske and the other for Stuttgart developed by Standard Electric Lorenz. Thus it may fairly be claimed that the first phase in the development of electronic switching for telephone systems is nearly completed. This is perhaps the most significant conclusion which emerges from the first International Conference on Electronic Telephone Exchanges held in this country last November 22–24.

The Conference was very successful. Many visitors attended from Europe, the United States and Japan. More than a third of the papers presented were from foreign delegates—a good indication of the intense competition in this field. The proceedings occupied two full days and closed with a visit to the Post Office Research Station, where delegates inspected the working model of the Highgate Wood exchange.

There can now be little doubt that electronic exchanges will, in the long run, displace existing types; the basic technical problems have largely been solved and the telephone manufacturing industry is entering a period of intensive development leading to production beginning, according to present forecasts, during 1965. As might be expected in such a new development the experts, although they all agreed that reliable and economic electronic exchanges are now feasible, are by no means in such close agreement on the technique most likely in the long run to displace all others. Some indeed hold the view that this will not be possible; others take the view that the possible application of electronic exchanges is so wide, in terms of traffic usage and number capacity, that no single technique can be expected to satisfy all the objectives. From the many papers presented to the Conference two basically different techniques for electronic switching of telephone traffic could be distinguished: namely *space-division* and *time-division.* These terms describe the way in which a speech path is provided through the switching apparatus.

In *space-division* systems each conversation requires its own physical path through the network, and the network as a whole comprises a multiplicity of such paths sufficient in number to handle the expected busy-hour traffic without overloading. In principle this does not differ from existing electro-mechanical systems; there are, however, considerable differences in technique particularly in control functions.

In *time-division* systems many conversations are concentrated simultaneously on a single physical path. The switching network for a typical time-division exchange would comprise several such multi-channel paths, called rather appropriately *highways*, suitably inter-connected. The number of physical paths or highways required even for a large exchange would, however, be many times smaller than the number of physical paths required for a comparable space-division exchange.

The terms *space-division* and *time-division* have now become well known to those engaged in development work but to those responsible for day to day operation their significance may be less apparent and it is appropriate at this point to digress briefly to make the distinction clearer.

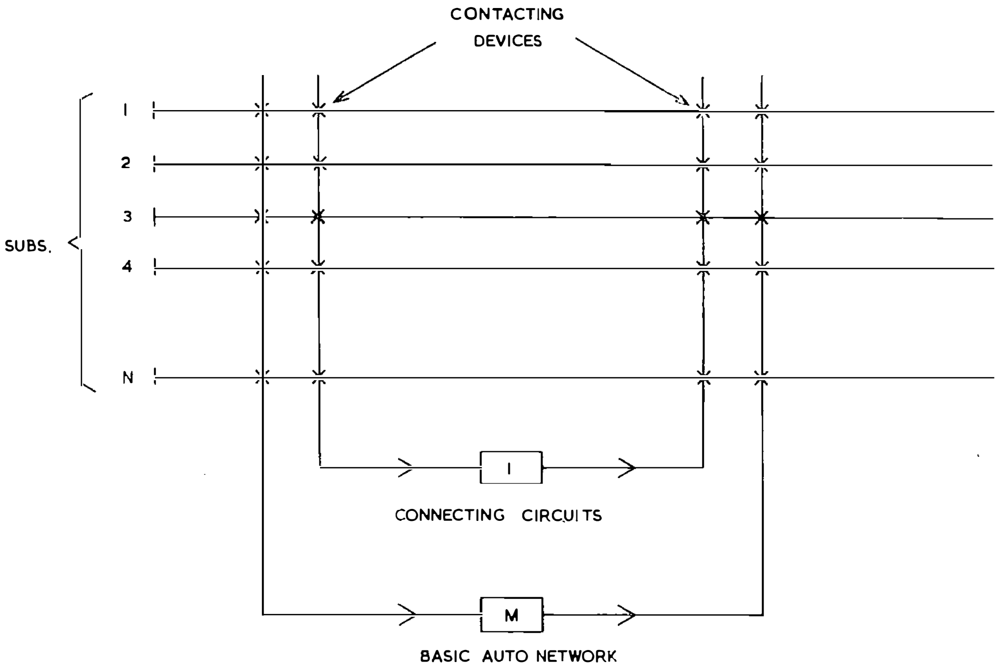


Fig. 1 : Simple switching network

Fig. 1 shows a simple switching network in which each horizontal line represents a subscriber's line, the vertical lines representing possible physical paths over which a connexion might be made. Each vertical path has two intersections with the horizontal lines—one incoming and the other outgoing—interconnected by apparatus which provides for call supervision and other facilities. Each intersection is marked with a cross, showing where there is a connecting device; the term used to describe this device is, in fact, *crosspoint*. A call from any one line to any other may proceed via any connecting circuit. The means for controlling connecting operations is not shown. The similarity of the arrangement to a manual system will readily appear, the connecting circuits being cord circuits, the crosspoints multiple jacks and the controlling means the operator.

If, in Fig. 1, each horizontal and vertical path can carry only one conversation at a time, the system represents an elementary form of *space-division* exchange.

In practice the simple arrangement shown would require very large numbers of crosspoints for any appreciable numbers of lines and connecting circuits. To avoid this the switching network usually comprises several stages of switching in series and is considerably more complex than that illustrated although the principle is unchanged.

Two points gave rise to much discussion; first, the nature of the crosspoint device and, second, the nature of the trunking (that is, how many switching stages are needed and how they should be arranged for maximum efficiency).

As the Conference proceeded it became clear that no completely satisfactory fully electronic crosspoint has yet emerged although there were advocates of gas-tube devices in which a conducting path is established through glowing gas, and transistor-like devices in which a conducting path is formed through a semi-conductor material such as germanium or silicon. The problems still to be solved are partly technical, partly manufacturing but principally economic; crosspoints are required in such large numbers for any given exchange that they must be cheap, and cheapness does not go with close manufacturing tolerances. Thus fully electronic devices as crosspoints do not yet seem to be economically within reach although some speakers asserted their confidence that this phase would soon pass.

Several speakers described an alternative crosspoint device that is really a relay contact sealed-in to a glass tube; it is known as a dry-reed relay. The idea is simple: two pieces of magnetic material are sealed, one each end, into a glass tube with their ends, inside the tube, just overlapping but normally out of electrical contact. When the device is placed inside a bobbin of wire encircling the tube the application of a current to the bobbin causes the contact pieces to become magnetized and mutually attractive so that an electrical contact results. The device is small, very fast in operation and cheap to produce in large numbers. It is in fact already in pilot production. It has many of the attributes of an ideal electronic crosspoint—so much so that several speakers apparently preferred to think of the device as being electronic.

Dry-Reed Relay

Space-division systems using the dry-reed relay are in an advanced stage of development in Germany; they appear to have most of the characteristics of an electronic exchange and yet to retain some of the characteristics of an electromechanical system. For this reason some speakers expressed the view that their introduction into existing networks would be simple. It seems fairly safe to predict that exchanges of this type, with fully electronic control apparatus, will be on trial in public service within about two years with the possibility that production might follow from about 1965 onwards.

The trunking of space division exchanges was described in several papers. The problem facing space exchange designers is that of minimizing costs by securing an optimum balance between the number of crosspoints used, the number of interstage links, and the amount of control apparatus required—all problems familiar in crosspoint systems.

It is worth pointing out at this stage that most designers base their systems on control apparatus common to the whole exchange and which operates so rapidly that only one call need be set-up at a time. This greatly simplifies control operations and permits several switching stages to be used in series without affecting setting-up time. It follows that common control permits advantage to be taken of optimum switching arrays but carries with it the need to provide safeguards against system breakdown. The best compromise between the conflicting factors has yet to be demonstrated, chiefly from the economic point of view; there was clearly much difference of opinion on this subject.

Principle of Time-Division

The principle of time-division operation represents a radical departure from accepted techniques in switching speech. The underlying idea is simple; it has been found that speech intelligence can be transmitted from one point to another through a network without necessarily transmitting the whole waveform representing the intelligence. Fig. 2 shows a typical speech waveform which is in effect an electrical current varying with time in the same manner as sound pressure varies while speaking. At intervals of time the amplitude of the speech waveform is measured electronically from some arbitrary zero. Looking only at the successive samples of amplitude the gaps may be filled in by tracing visually a continuous line between the tips of the samples. If the same operation is performed electronically only the samples need be transmitted and the original waveform can be discarded at the sending end.

An electronic device—the filter—capable of reconstructing a waveform from samples is simple in form and already well known in carrier telephony and it becomes possible to consider a speech transmission path which carries only samples of speech. Perfectly satisfactory speech can be transmitted by samples if the rate of sampling exceeds 8,000 a second; 10,000 is the more usual sampling rate. The duration of a sample need be no longer than one-half of a millionth of a second and any given conversation need occupy the transmission path only for one millionth of a second every 100 millionths of a second. Single samples of 99 other conversations can therefore be inserted between two successive samples of one conversation and a single physical path becomes capable of handling 100 different conversations apparently simultaneously. For those familiar with traffic quantities a time division path of this type would be capable of carrying 60 to 70 Erlangs of traffic.

Once the principle is established it soon becomes apparent that time-division lends itself to particularly elegant and simple trunking schemes. Going back, for example, to Fig. 1 each of the horizontal lines can now represent a time-division highway drawing traffic from many lines; similarly each vertical line can also represent a time-division highway crosspointed as shown. Instead of very large numbers of crosspoints for full interconnection being needed, the number now required is only 100 or 200—each much more expensive than the corresponding space-division crosspoint—but the saving in numbers is so large that it would outweigh the additional costs.

At present 100 channel highways appear to be the practical maximum and there are advantages in reducing this somewhat for production schemes. There is considerable difference of opinion about the optimum number of channels—a curious reflection of past controversy on the best size of switch to use in electro-mechanical systems. Fewer channels per highway mean more highways and more crosspoints for a given traffic but easier engineering tolerances and perhaps a lower overall cost. According to a speaker from Japan thcrc may bc little to choose in overall efficiency between any channel capacity from about 30 channels per highway upwards. Events may therefore ultimately favour lower channel capacities but more work needs to be done in this field to resolve the problem.

The devices required to construct a time-division exchange are those now generally available in the electronic field. Opinions differ about whether the transmission path of a time-division exchange should give both-way transmission over a single physical path (two-wire) or unidirectional transmission in opposite directions over two physical paths (four-wire). Either method is feasible and has been shown to work. The trunking of a time-division exchange follows the same general pattern as that for space-division systems, except that the large traffic capacities of the transmission highways lead to simpler patterns and fewer switching stages.

Control techniques, as already indicated, tend to favour control by common apparatus. The precise arrangement of the control apparatus caused some discussion; several speakers advocated a centralized control system similar to that used in computing equipment, the underlying idea, in its simplest terms, being that an exchange

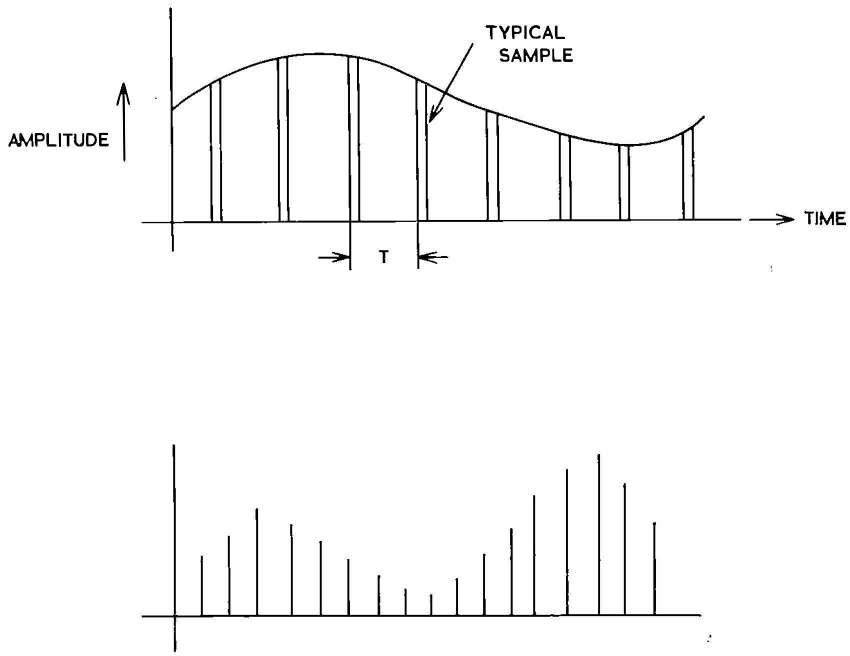


Fig. 2: Typical speech waveform

PRINCIPLE OF TIME DIVISION

should consist of a switching network controlled by a computer. The computer would be more or less standardized but the precise operations it effects would be determined by a programme (in the computing sense) inserted into the equipment by the administration. The programme would determine the facilities given by the exchange and, within limits, a change in programme would change the facilities or, perhaps, add new ones without otherwise altering the apparatus.

The Morris exchange is an example of a fully electronic space-division exchange controlled by a programme stored in the control apparatus, the original programme being prepared on punched paper tape by a programming team. The description of this Morris exchange by a speaker from Bell excited much interest and some discussion. Some speakers felt that despite the advantages in flexibility of facility provision the stored programme system of control was unnecessarily complicated and insufficiently reliable for telephone switching applications.

Stored Programme Control

Unfortunately time did not permit fuller discussion on this subject nor is there yet sufficient experience of its operation properly to assess its value. It was clear, however, that those concerned with facility provision were intrigued by the possibilities of stored programme control. With the Morris exchange the control apparatus not only provided all the standard facilities but had made possible a trial of several new facilities for customers; for example, numbers frequently used by particular customers could be included in the exchange memory unit and brought into use at will by dialling two or perhaps three digits only instead of seven to twelve digits; incoming calls could be transferred automatically to any designated number by dialling into the exchange a special code number followed by the designated number, conference calls could be arranged by subscribers and so on. Apart from the Bell contribution to the Conference, authors from Belgium and Sweden also advocated a form of stored programme control and described experimental systems based on this concept. It seems inescapable that much more will be heard of this technique during the next few years.

A conference of this kind would be incomplete without some discussion on reliability. No system can entirely eliminate apparatus faults; nevertheless the service given by an exchange must approach 100 per cent. so nearly that any falling off due to faults is either unnoticed or causes so little irritation that it does not engender complaints. The designer is, therefore, faced with the requirement that the exchange must continue to give service in the face of faults. This turns out, in practice, to be a question of system organization and there are clearly many differences of opinion as to the best form of organization to adopt.

Economic Difficulties

Some of the control apparatus needs at least duplication and in attempting to provide fault tolerance in a design there are economic difficulties to overcome. Some designers prefer to rely on high quality components and extensive automatic fault detection and localizing facilities and to depend on the rapid removal of faults by replacing faulty plug-in electronic units. Others do not accept this contention and propose that an exchange design should be so organized that sufficient alternative paths are available to every call to ensure that the faulty paths merely degrade service slightly without ever interrupting it entirely. This question will not be resolved until field experience has been obtained.

In connexion with fault tolerance, stored programme control systems require expensive common control apparatus. This requires duplication to guard against breakdown but more extensive safeguards (for example, triplication) cannot be justified economically. With only two equipments of a similar kind there are considerable difficulties in detecting faulty operations automatically but it so happens that stored programme control permits the inclusion of extensive checking routines in the programme. This increases the length and complexity of the programme considerably but tends to make the apparatus self checking and provides in addition, automatic fault locating facilities.

Some experts argue that this more than offsets the risk of breakdown inherent in the use of only two control units. The technique carries with it two important overhead charges that must not be overlooked: first, the cost of programming which can be high, and second, the need for rapid maintenance attention once a fault has been located. This could mean continuous maintenance attendance which is contrary to present day trends.

The economics of electronic exchanges although mentioned at various places in this report, received overall far too little attention during the Conference, possibly because of the crowded programme but also perhaps because the various manufacturing interests represented were understandably reluctant to disclose figures. It was, however, a fairly general opinion that the cost of electronic exchanges was falling rapidly and that production prospects were good.

In conclusion the Conference must certainly be repeated as soon as justified by events, and the Institution of Electrical Engineers is to be congratulated on calling the first conference at what turned out to be an opportune moment. The electronic exchange is clearly on its way; there are many reasons for believing that 1965 or thereabouts will become the base year from which administrations will be able to consider electronic exchanges as practical units suitable for inclusion in their networks. For this reason it is worth emphasizing that although electronic exchanges will of necessity have to be suitable for replacing an existing exchange their operating characteristics will differ sufficiently from those of existing exchanges to justify a wider study of network problems aimed at extracting the maximum advantage from their introduction.

Articles on the Highgate Wood electronic exchange by Brigadier Sir Lionel Harris and Mr. S. W. Broadhurst appeared in our Spring 1960 number.

OUR CONTRIBUTORS

T. C. HARDING (joint author, "The Manufacture of a Telephone") is an Assistant Staff Engineer in the Subscribers' Apparatus Branch. He started his career in 1930 as a Youth-in-Training in Birmingham Test Section and after passing Probationary Inspector and Probationary Assistant Engineer examinations moved to Nottingham in 1938 as Power Engineer. From 1939-1946 he served with the Royal Signals in Europe and the Middle East, and on demobilization spent a year in Centre Area, London Telecommunications Region on internal maintenance duties. Then followed 10 years in Research Branch and promotion to his present post where he is currently concerned with the design of subscribers' apparatus.

A. J. HUTTON ("The Transportable Traffic Recorder") is a Telecommunications Traffic Superintendent in the Planning Branch of Inland Telecommunications Department. He joined the Post Office as a Boy Messenger in 1937 and was Postman, Clerical Officer and Assistant Traffic Superintendent. Since 1952 he has been employed on traffic work at London West Telephone Area, Belfast Telephone Area and Post Office Headquarters.

J. A. LAWRENCE ("Problems of Electronic Exchanges") is an Assistant Staff Engineer in the Telephone Development Branch of the Engineer-in-Chief's Office and has charge of a division responsible for the development of the all-electronic exchange and for the application of electronic techniques in existing exchanges. He joined the Post Office in 1929.

THOMAS W. MANSFIELD ("Subscriber Trunk Dialling in London") is a Telecommunications Traffic Superintendent in the Long Distance Development Division of the London Telecommunications Region. He entered the Post Office Engineering Department in 1941 as a Youth-in-Training and from 1943 to 1947 served with the Royal Air Force. In 1952 he was appointed Assistant Traffic Superintendent but left the Post Office in 1954 to join the Bell Telephone Company of Canada. He returned to England in 1956 and has since been engaged on planning for Trunk Mechanization and STD in London.

C. A. R. PEARCE (joint author, "The Manufacture of a Telephone") who has been Controller of Engineering at Ericsson Telephones since 1958, joined the Post Office Engineering Department in 1934 as a Probationary Assistant Engineer (old style). After a period on telephone instrument development in "S" Branch, he took charge of the Power Section in London Telecommunications Region and later became Regional Efficiency Engineer. In 1948 he became Chief Factories Engineer and in 1951 went to the Department of Scientific and Industrial Research as a Senior Principal Scientific Officer. From then until he took up his present post, he was engaged on research and development in the fields of mechanical and instrument engineering.

F. T. WESTON ("Inspection by Batch Sampling") entered the Post Office in 1937. He served for four years on various engineering duties in the Shrewsbury Area before his appointment to the Engineering Department in 1941. During the war he was concerned with the planning of defence communications. Since then he has held various posts in the Local and Main Lines branches. He joined the Test and Inspection Branch as Senior Executive Engineer in 1954. His duties there include the development of sampling techniques.

K. R. WILDERSPIN ("Magnetic Storage Devices") entered the Post Office Research Branch as a Youth-in-Training in 1943 and studied part-time for his degree at Northampton Engineering College. In 1946 he went over to the Scientific Grades by open competition as an Assistant Experimental Officer. He worked in the Materials Division on research and development of, first, dielectric materials and components and, since, magnetic materials. He was promoted to Experimental Officer in 1954.

A. E. WILLIAMS ("The Challenge of the Floods") entered the Post Office Engineering Department on demobilization from the Royal Air Force in 1947. Promoted to Technical Officer in 1950, he was employed on exchange construction and maintenance. On transferring to the Traffic side in 1953, Mr. Williams was appointed to Taunton Area and has been employed on a wide range of duties in the Traffic Division. At the time of the floods he was acting Exchange Superintendent at Taunton.

Telecommunications Trading Results, 1959-60

FOLLOWING are the main telecommunications trading results for 1959–60 shown in the *Post Office Report and Commercial Accounts*. The overall surplus, £21.9 million, included £16.9 million surplus on telephones and £6.4 million on postal services, less £2.4 million deficit on telegraphs. Comment on the overall surplus was briefly reported in our Winter issue.

Telegraphs

The telegraph deficit, which was 4 per cent. less than for 1958–59, resulted from a loss of £3.2 million on inland telegrams, offset by £0.8 million net gain from the other telegraph services. Total income from telegraph services was £20.8 million against expenditure of £23.2 million.

During the year 13,827,000 inland telegrams were sent, about a fifth of the 1946 total. The rundown is becoming slower and the 1959–60 total only 1.8 per cent. lower than that in the previous year. Greetings telegrams made up about a quarter of the total traffic; a third of all greetings telegrams went at *de luxe* rates on special forms. The popularity of *de luxe* greetings telegrams is growing as new designs are introduced.

The total number of oversea telegrams increased from 19,632,000 in 1958–59 to 20,384,000; nearly 6,000,000 of these were transit messages.

By the end of the year there were 5,923 telex subscribers, an increase of about 18 per cent. During the year international telex was available to 46 oversea countries and operators in nine European countries were able to dial direct United Kingdom subscribers on automatic exchanges. The number of manual telex calls rose from 3,269,000 to 3,609,000, and of automatic units from 1,811,000 to 8,135,000. International telex calls rose from 3,873,000 to 4,813,000.

Telephones

The telephone service earned £208.5 million against costs of £191.6 million, compared with £194.8 million income and £186.6 million costs in 1958–59. The main contribution to the surplus of £16.9 million was £12.8 million from inland trunk calls.

The increase of 324,000 in the number of telephones in service to a total of 7,856,000 was more than 50 per cent. higher than in 1958–59. One thousand fewer orders were on hand at the end than at the beginning of the year; of the total of 144,000 on hand at March 31, 95,000 were under enquiry or being met. The waiting list—orders awaiting cables or exchange equipment—was, at 49,000, the lowest since the war and compared with 60,000 at the beginning of the year. About 40 per cent. of all applicants were connected by the end of the following month.

Manual exchange subscribers were reduced to just over 900,000 during the year and the number of manual exchanges was reduced from 1,027 to 921.

Total telephone traffic rose from 4,046 million calls to 4,189 million. The greatest increase was in long-distance calls, inland trunk traffic rising by 14 per cent. by day and 7 per cent. by night (compared with an average expected annual increase of just over 4 per cent.). Oversea telephone traffic increased by 10 per cent. overall, despite a reduction in transit traffic largely owing to the opening of TAT2 (France–North America).

At March 31, 1960, the value of telephone plant, excluding sites and buildings, at historical cost, was shown as £858,467,493, less depreciation, £270,921,849, having depreciated value at £597,545,644. Depreciation provision for the year, at historical cost, was £33,078,395.

Error Detection for Auto-Telex

Error-detecting equipment, similar to that used in the oversea telegraph service, will be available for automatic telex within a year or so.

Announcing this when inaugurating London automatic telex, the Postmaster General said it would reduce the risk of error to one in a million; at present this is one in 20,000–40,000 characters.

Notes and News

Autophone for the desk.—The Pony Autophone is a device, developed in Japan, which will "remember" up to 30 different telephone numbers and can be caused to dial them by pressing a button.

This is one of the many devices that may be developed with the expansion of Subscriber Trunk Dialling; the Post Office is, in fact, planning to develop similar equipment. Such devices are, however, likely to be expensive because they must be reliable.

* * *

Orders for some £18 million worth of cable and repeaters for the transPacific cable have been placed with Standard Telephone and Cables, and Submarine Cables. The conditions stipulate that as much of the raw material as possible shall be supplied by Australia and Canada.

The programme calls for the Sydney-Auckland line to be ready by July 1962. The whole cable is to be laid by mid-1964.

* * *

Plan 2 Telephone Service.—A new extension telephone arrangement, known as Plan 2 and now available, is specially suitable where several people who need telephone service are in the same room. Plan 2 comprises from two to six instruments which can be switched at will to either of two lines from the exchange (or PBX) by press buttons on each instrument. There is no secrecy between stations switched to the same line but there is, of course, secrecy between the exchange lines.

* * *

Freefone—started experimentally in 1958—now has 100 subscribers among many kinds of businesses. Customers can call a Freefone subscriber without paying for the call.

Telephone Week

Telephone Week, during which customers throughout the country will be specially invited to visit their local exchanges, will be held from April 10 to 15.

Telephone Week is being organized to do for the telephone service what Postal Week did so successfully for the mail services last year: to give customers an insight into what is involved in providing telephone service and enable them to meet the men and women who provide the service.

Local controlling officers will invite Members of Parliament, civic leaders and representatives of local organizations and business to visit exchanges personally during the week. Every visitor will be given a leaflet, "Welcome to Our Exchange" and explanatory material; maps showing the local call area, wall charts explaining simply how the telephone works, and so on, will be displayed in the exchanges.

* * *

Sir Godfrey Ince, G.C.B., K.B.E., Chairman of Cable & Wireless Ltd. since 1956, died on December 20, aged 69. Sir Godfrey retired from the Civil Service in 1956 after being Permanent Secretary to the Ministry of Labour since 1944. During the war he was Director General of Man Power. He brought to Cable & Wireless a first-class intellect, wise, with much experience; a great sense of the importance of the Commonwealth in the world of today; and a clear realization of the valuable part which could be played by really efficient Commonwealth telecommunications. He will be sadly missed by his colleagues, both in the Company and in the Post Office.

* * *

Captain I. R. Finlayson has succeeded Captain W. H. Leech, O.B.E., D.S.C., who retired from the post of Submarine Superintendent on January 31. Captain J. F. Betson, O.B.E., Commander of H.M.T.S. *Monarch*, will be Deputy Submarine Superintendent.

* * *

Regional Representative.—Mr. J. Sharp has become *Journal* representative for North Eastern Region, Mr. P. Frost having been appointed Regional Public Relations Officer.

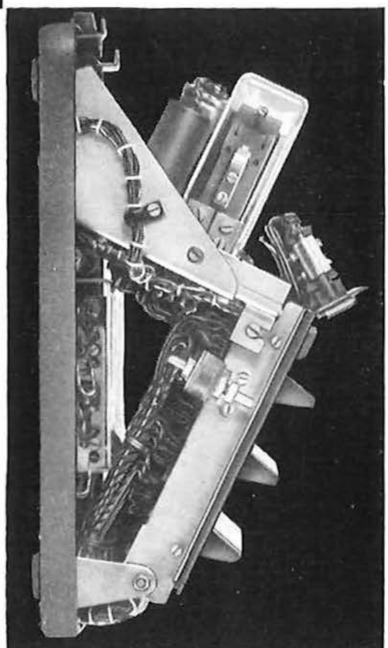
NEW STYLE CORDLESS SWITCHBOARD

Attractive appearance is an essential consideration when designing subscribers' apparatus, but important, too, is small size. Both these objectives have been achieved in this **lamp signalling** switchboard, designed in conjunction with the B.P.O. to supersede the existing indicator signalling 2 + 4 switchboard housed in a bulky, outmoded wooden cabinet. Although considerably smaller than its predecessor, it provides two more extensions and has a total capacity for two exchange lines and six extensions.

Much of the reduction in size has been obtained by the adoption of a new 4-wire principle for local extension lines. This has enabled certain additional facilities to be provided with fewer components, as for example, operator re-call and secretarial 'hold'.

A grey plastic drop-on cover, with a simple release action, provides easy access to all components conveniently arranged on a 3-section, hinged chassis of drawn steel. The key and lamp panel is tastefully finished in a durable coating of grey P.V.C. and the ivory coloured key handles are shaped and marked to facilitate operation.

Power for transmission and signalling is normally derived from a mains driven unit.



ERICSSON TELEPHONES LTD.
ETELCO LTD.

HEAD OFFICE: 22, LINCOLN'S INN FIELDS, LONDON, W.C.2
TELEPHONE: HOLborn 6936

New Year Honours

Mr. W. T. Gemmell, Director, Midland Region, was awarded the C.B.E. in the New Year Honours list.

Following are the honours conferred on Post Office telecommunications people:

Mr. S. J. Giffen, Senior Assistant Telecommunications Controller, Post Office Headquarters, Northern Ireland—a former Regional Representative of the *Journal*; Mr. C. W. Sowton, Assistant Staff Engineer, Engineer-in-Chief's Office and Mr. P. G. Hallett, T.D., Assistant Engineer, Telephone Manager's Office, Bristol, received the O.B.E.

Mr. R. B. Dickinson, Executive Engineer, Engineer-in-Chief's Office, and Mr. F. E. Huckfield, Assistant Engineer, Gloucester, received the M.B.E.

The B.E.M. list included Mr. E. J. Easter, lately Technical Officer, King's Lynn; Miss D. M. Evans, Travelling Supervisor, Cardiff; Mr. C. Maddison, Technical Officer, Newcastle upon Tyne; Miss D. M. Marshall, Chief Supervisor, Bradford; Mr. L. R. Sparks, Technical Officer, Post Office Research Station; Miss D. M. Raymond, Chief Supervisor, Carlisle; Mr. S. A. J. Thwaites, Supervisor, South West Area, London Telecommunications Region; Mr. A. Wooldridge, Technician IIA Jointer, Victoria (London) Telephone Exchange.

* * *

Cable & Wireless Ltd. launched a new Cable Ship *Retriever* in December. Until 1962, when an 8,000-ton laying ship will be commissioned, the 4,000-ton *Retriever* will be the largest of the Company's seven ships and the first constructed to recover and overboard repeatered telephone cables. Her range is 8,000 miles, with 15 knots maximum speed, a 7-week sea endurance, and a cable capacity of 21,000 cubic feet.

Retriever will probably be based on Suva, Fiji—one of the landing points of the planned trans-Pacific cable. The Company has since ordered the new ship from Cammell Laird at a cost of £1.9 million.

Publication and Price. The *Journal* is published in November, February, May and August, price 1/6. The annual postal subscription rate is 6/6 to any address at home or overseas.

Contributions. The Editorial Board will be glad to consider articles of general interest within the telecommunications field. No guarantee of publication can be given. The ideal length of such articles would be 750, 1,500 or 2,000 words. The views of contributors are not necessarily those of the Board or of the Department.

Communications. Communications should be addressed to the Editor, Post Office Telecommunications Journal, Public Relations Department, Headquarters, G.P.O., London, E.C.1. Telephone: HEAdquarters 4345. Remittances should be made payable to "The Postmaster General" and should be crossed "& Co."

GPO

The above illustration shows a battery of Automachines applying spade terminals to telephone cords

G.E.C.

use

*A-MP

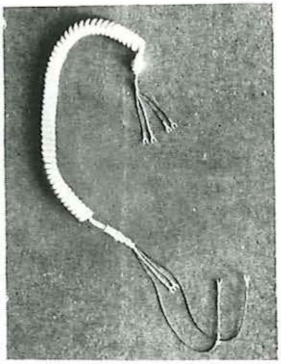
solderless

wiring

devices

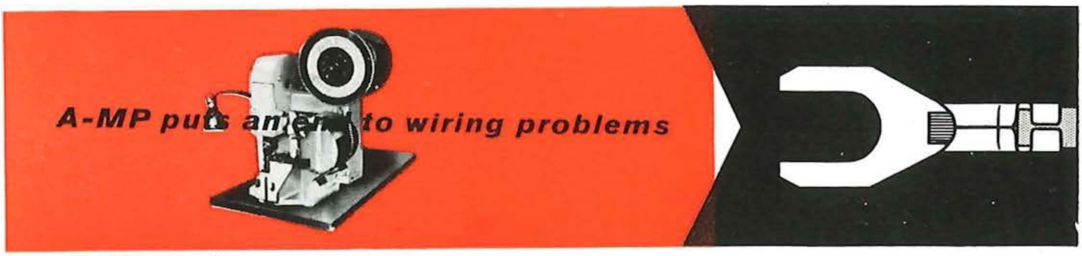
GEC are one of the many leading British Companies who use A-MP products on telephone equipment.

Close up of Automachine in operation



Completed cord with terminals

The new telephone



A-MP* TRADE MARK

*Trade Mark of AMP Incorporated, U.S.A.

WRITE NOW ABOUT THE **CREATIVE** APPROACH TO BETTER WIRING

AIRCRAFT-MARINE PRODUCTS (GT. BRITAIN) LTD.

Head Office: Dept. 24, AMPLO HOUSE, 87/89 SAFFRON HILL, LONDON, E.C.1
Tel: CHAncery 2902 (7 lines) Cables: AMPLO LONDON TELEX. Telex 23513
Works: Scottish Industrial Estate, Port Glasgow, Scotland

South Africa: Distributor: E. S. Mowat & Sons (Pty) Ltd. 51-57, Milne Street, P.O. Box 437, Durban, Natal, South Africa

Australia: Manufacturing Company: Aircraft-Marine Products (Australia) Pty. Ltd. Box 78 P.O. Auburn, N.S.W. Australia

Distributor: Greendale Engineering and Cables Pty. Ltd. 43-51 Nelson Street, Annandale, N.S.W. Australia

Associated Companies in: U.S.A., Canada, Holland, France, Germany, Italy, Japan, Puerto Rico and Mexico

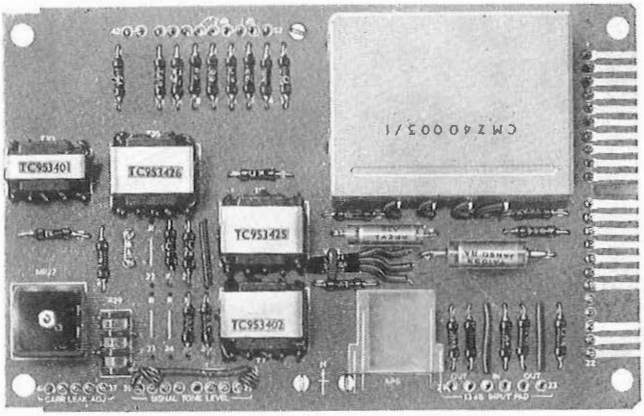
AP. 114

For Your Next Project

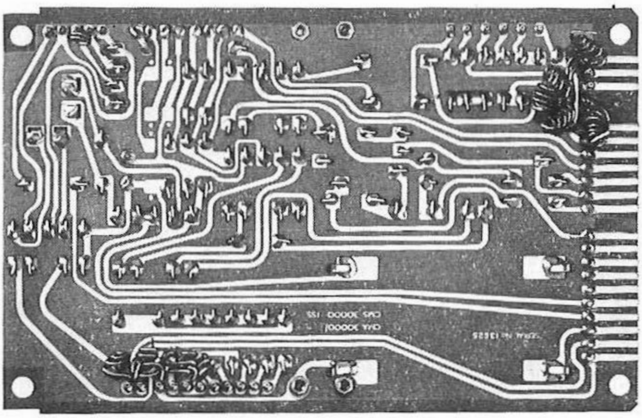
ATE

Transmission Equipment

TYPE CM



Front and back of channel equipment board, half actual size.



THESE PHOTOGRAPHS of a typical Type CM sub assembly show that printed wiring, transistors, ferrites, tantalum capacitors and gold-plated contacts are just some of the more obvious features of the compact equipment design.

To the user, the fact that every feature has been submitted to the most prolonged and painstaking proving before production is equally important and an assurance that maintenance and installation requirements have been minimised.

A.T.E. TRANSMISSION EQUIPMENT TYPE CM FOR LINE, CABLE AND RADIO SYSTEMS

For further information on Type CM Equipment write for Bulletin TEB 3001 to:—

AUTOMATIC TELEPHONE & ELECTRIC CO. LTD.

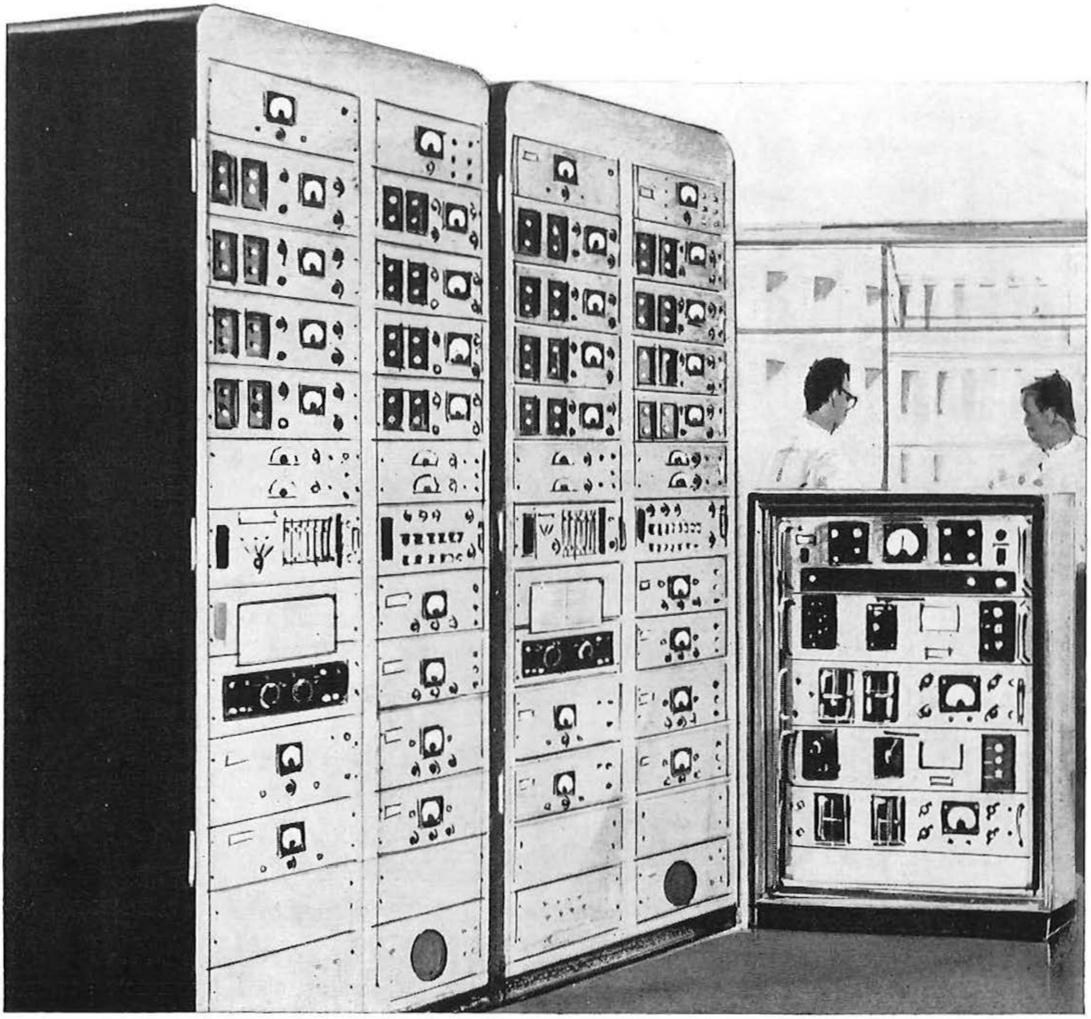
STROWGER HOUSE, ARUNDEL STREET, LONDON, W.C.2 TELEPHONE: TEMPLE BAR 9262

AT 8951

Plessey

TELECOMMUNICAT

speed the



In almost every country there's an STC system in service

Malaya for instance

In Malaya, STC have installed an SHF microwave system covering a route of 270 miles. This system forms the 'backbone' of the trunk telephone system in Southern Malaya and connects Kuala Lumpur and Singapore with other main centres of population.

In most countries of the world Standard Telephones and Cables Limited have installed telecommunications systems extensive in coverage and employing the most advanced techniques.

But the magnitude of the project is not the chief concern of STC—the same painstaking thought and care are brought to bear on a simple inter-communication system between a few offices or the production of a single component.

It is due to such attention to detail and to the expansion of research, development and production resources throughout seventy-eight years, that STC are able to handle communications projects of any kind . . . any size . . . anywhere!

STC PRODUCTS COVER: LINE TRANSMISSION · TELECOMMUNICATION CABLES · SOUND AND VISION BROADCASTING · RADIO COMMUNICATIONS · AIR NAVIGATION AIDS · REMOTE CONTROL · RAILWAY COMMUNICATIONS · TELEPHONY · TELEGRAPHY · SUBMARINE COMMUNICATIONS · ELECTRONIC EQUIPMENT · ELECTRONIC COMPONENTS · SOUND REPRODUCTION

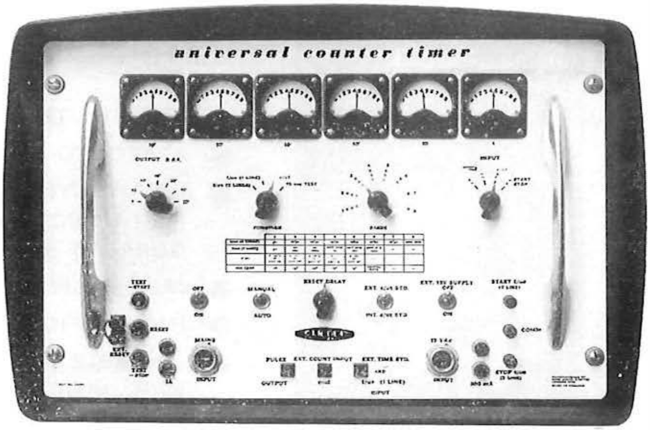
Standard Telephones and Cables Limited

TELECOMMUNICATIONS AND ELECTRONICS

CONNAUGHT HOUSE · 63 ALDWYCH · LONDON W.C.2

61/6G

Transistorized UNIVERSAL COUNTER TIMER



Frequency Measurement

Random Counting

Frequency Division

Time Measurement

Frequency Standard

This fully transistorized portable equipment provides for a wide range of time and frequency measurement as well as facilities for counting, frequency division and the provision of standard frequencies. The facilities available are briefly listed below:

TIME/UNIT EVENT (1 LINE): For the measurement of the time interval between two occurrences in a continuously varying electrical function in the range 3μsec to 1 sec. The time for 1, 10 or 100 such events can be measured.

TIME/UNIT EVENT (2 LINE): For time measurement in range 1μsec to 2777hrs. of any interval defined by a positive or negative going pulse in any combination.

EVENTS/UNIT TIME: For frequency measurement in range 30c/s to 1 Mc/s over period of 0·001, 0·01, 0·1, 1 or 10secs. Crystal accuracy ±2 parts in 10^6/week. For mains or 12Vd.c. operation.

Full technical specification available on request.

CINTEL

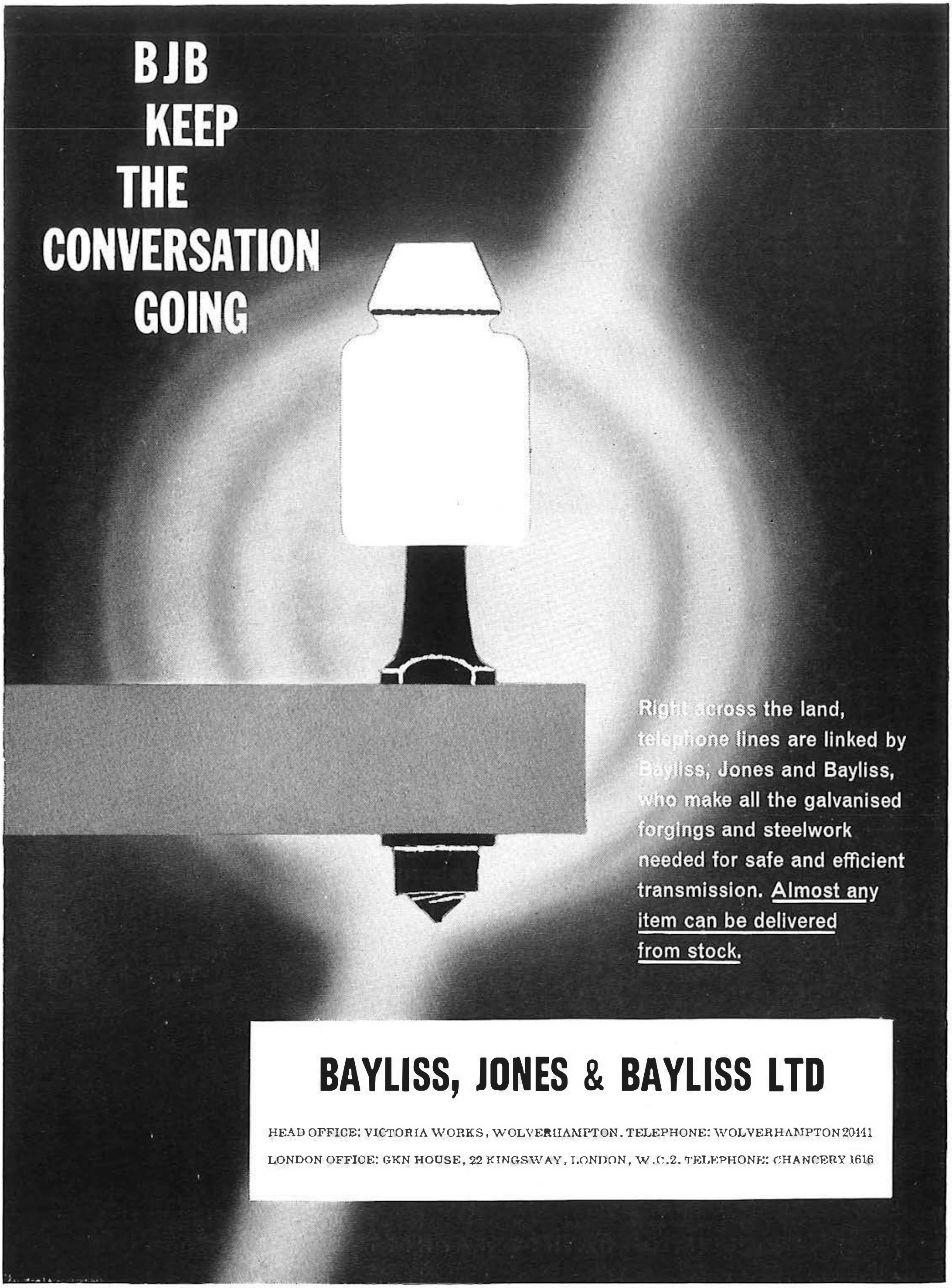
RANK CINTEL LIMITED

WORSLEY BRIDGE ROAD · LONDON · SE26

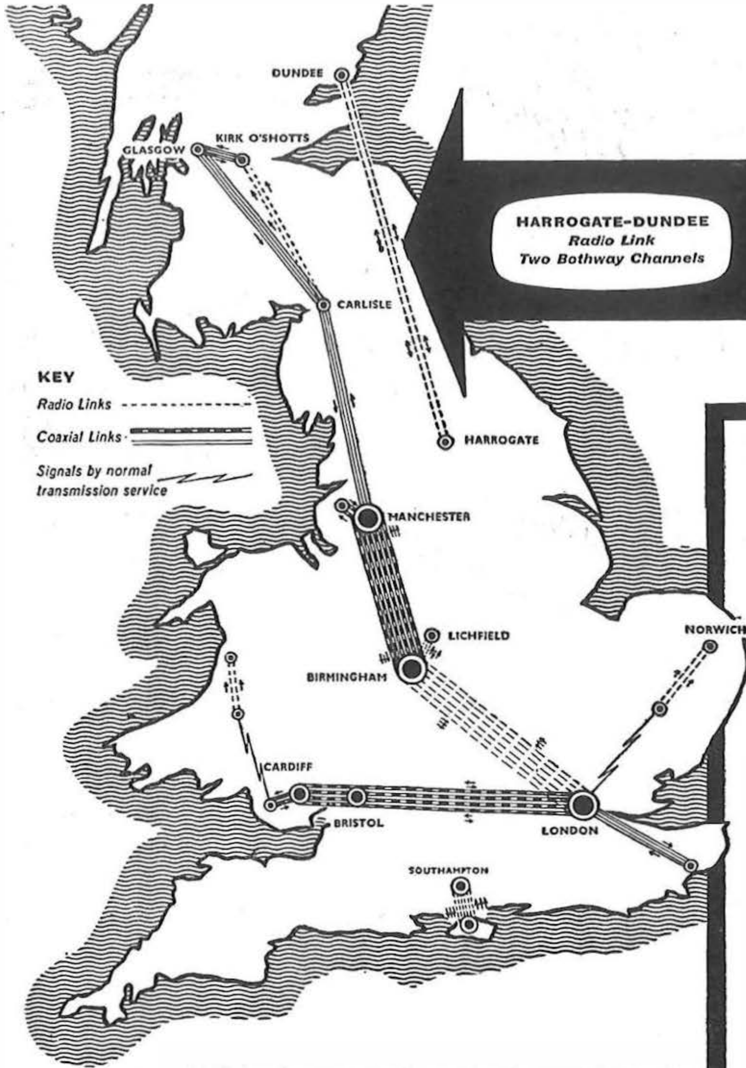
HITHER GREEN 4600

Sales and Servicing Agents: Atkins, Robertson & Whiteford Ltd., Industrial Estate, Thornliebank, Glasgow; McKellen Automation Ltd., 122 Seymour Grove, Old Trafford, Manchester, 16; Hawnt & Co. Ltd., 112-114 Pritchett Street, Birmingham, 6.

dm CL 57



BJB
KEEP
THE
CONVERSATION
GOING
Right across the land, telephone lines are linked by Bayliss, Jones and Bayliss, who make all the galvanised forgings and steelwork needed for safe and efficient transmission. Almost any item can be delivered from stock.
BAYLISS, JONES & BAYLISS LTD
HEAD OFFICE: VICTORIA WORKS, WOLVERHAMPTON. TELEPHONE: WOLVERHAMPTON 20441
LONDON OFFICE: GKN HOUSE, 22 KINGSWAY, LONDON, W.C.2. TELEPHONE: CHANCERY 1616



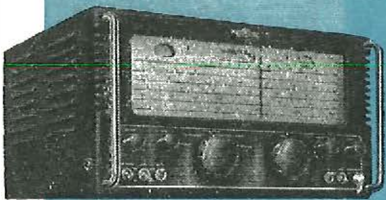
THE POST OFFICE TELECOMMUNICATIONS JOURNAL IS PRINTED FOR H.M. STATIONERY OFFICE BY BROWN KNIGHT & TRUSCOTT LTD. 11/12 BURY STREET, LONDON, E.C.3, AND IS PUBLISHED QUARTERLY IN NOVEMBER, FEBRUARY, MAY AND AUGUST BY H.M. POSTMASTER GENERAL AT THE POST OFFICE HEADQUARTERS, LONDON E.C.1

There's an EDDYSTONE COMMUNICATIONS RECEIVER for EVERY SERIOUS PURPOSE

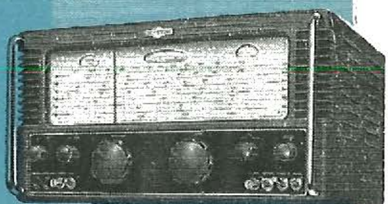
Between 10 kc/s and 1000 Mc/s

Model "880" High Stability HF receiver. Superb specification and performance—designed to meet professional requirements. Range 500 kc/s to 30 Mc/s. Dial setting accuracy within 1 kc/s. Combines the advantages of crystal control with continuous tuning.

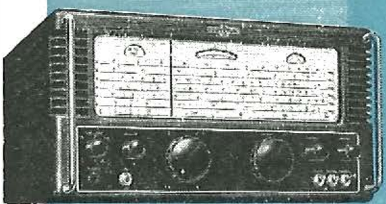
Model "730/4" General purpose HF receiver. Developed to meet a Government specification and capable of an excellent performance. Range 480 kc/s to 30 Mc/s. (Special versions available giving crystal control and low frequency coverage.)



Model "850/2" General Purpose LF/MF receiver. Range 10 kc/s to 600 kc/s approximately. Full communications facilities.



Model "770U" Ultra High Frequency receiver, covering from 150 Mc/s to 500 Mc/s. Excellent performance throughout and suitable for receiving either FM or AM signals.



Model "770R" Very High Frequency receiver, covering from 19 Mc/s to 165 Mc/s in six ranges. Accepts AM, FM and CW. High sensitivity, fine control, thoroughly reliable.

Model "770S" Extra High Frequency receiver, having a range from 500 Mc/s to 1000 Mc/s. Specially developed circuitry gives high performance.

RADIO PRODUCTS EDDYSTONE TRADE MARK

Please write for full Technical Specifications to the Manufacturers

STRATTON & CO. LTD., BIRMINGHAM, 31