POST OFFICE

tele communications

JOURNAL

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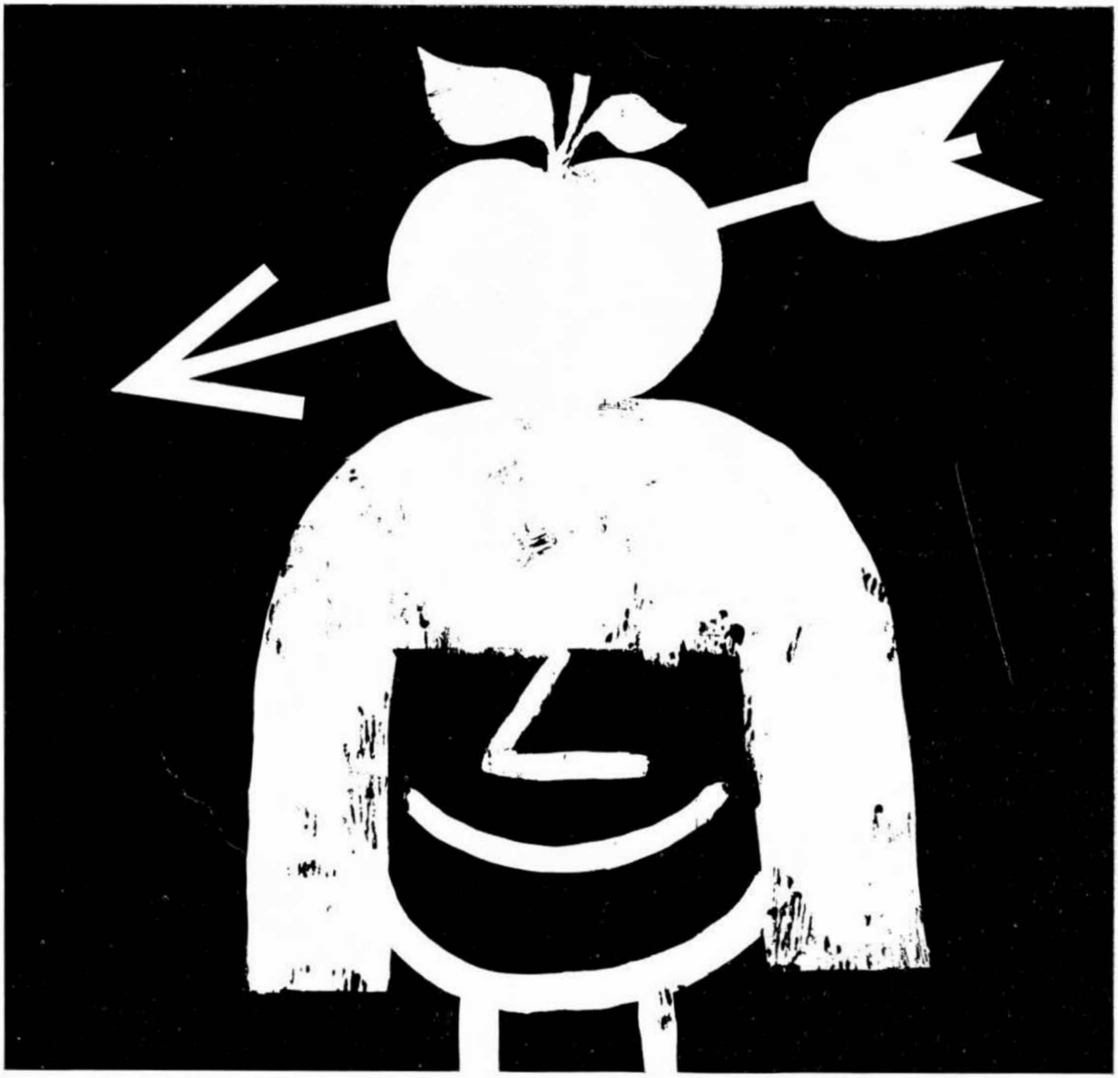
SIXPENCE

SUMMER 1958



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

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To the Next Ten Years!

THE FIRST NUMBER OF THE *Journal* WAS PUBLISHED in November, 1948. Mr. Wilfred Paling, then Postmaster General, sent a message of welcome, expressing "every confidence" that it would "make a real contribution to the discussion of current practice and of new ideas".

Mr. Ernest Marples, our present Postmaster General now congratulates the *Journal* on completing its first decade of service:

The Post Office Telecommunications Journal *has now completed ten years of service to the world of telecommunications in general and to the Post Office in particular. I congratulate all connected with the* Journal.

Also, I both congratulate and thank the staff of the Post Office on the skill and energy they have displayed during these ten years. They have discovered new techniques, examined new processes, and continually improved our telecommunications services to the public.

Free interchange of ideas and information is necessary to progress. The Journal *has proved a most valuable medium for keeping everyone informed on the latest ideas and practices in telecommunications technique.*

In the recent White Paper on Telephone Policy: The Next Steps, *outlining plans for the next decade, I said that the "sweeping changes" announced "should revolutionize telephone habits in the next ten years". I do not doubt that the* Journal *will play its part both in contributing to the revolution and in recording its progress.*

On to the next ten years! We must never be satisfied. We must continually progress.

Subscriber Trunk Dialling simply explained

A. Kemp, C.B.E.

In our Autumn 1957 issue we included the text of the White Paper, Full Automation of the Telephone Service, and in our Spring issue there was a summary of the White Paper, Telephone Policy, The Next Steps.

Until the proposals for Subscriber Trunk Dialling—STD—set out in these White Papers had been announced to Parliament we could not publish articles describing the plans as a whole. Now the story can be told.

The following article explains the general principles of STD. We hope to publish further articles dealing more fully with particular features and with the plans for introducing it throughout the country.

WE HAVE ALL BECOME SO USED TO CALLING the operator for our trunk calls that the idea of dialling them ourselves just like local calls seems quite revolutionary, but it is a very natural development.

Four out of five subscribers now have dial telephones. They already dial many calls to other exchanges 20 miles away and even further. On about half the trunk calls which the operator connects she dials directly to the distant number, using a dial exactly the same as that on a subscriber's telephone. So what could be more natural than to give subscribers access to the trunk lines and let them dial the calls themselves?

If it were just as simple as that it would have been done long ago. The problem of long distance dialling by the operator was solved before the war. Why have we had to wait until now for long distance dialling by subscribers? To answer that question one needs to consider what the operator has to know and do.

Taking Over the Operator's Work

In the first place the operator has to know which trunk lines to choose to reach any exchange in the country. Then she has to know what figures to dial over those lines to reach a particular exchange before she dials the number. She also has to know the rate of charge for the call. Then she has to time the call, since the charge depends upon the duration. Finally, she has to price it at the rate appropriate to the distance.

Before subscribers can be enabled to dial their own trunk calls without the operator's help, some means must be devised of doing all these things automatically. The problem is not so much one of providing the long-distance dialling facility as of devising a system to route and charge the call automatically under the subscriber's control. It must be simple enough for the subscriber to operate and not too costly in automatic equipment.

In considering how this can be done it is convenient to deal with the routing of the call and the charging for it as separate problems though, in one important respect, as will be seen later, they are very closely bound up with each other. First, then, the problem of routing.

Routing Calls Automatically

Clearly the subscriber must dial some figures which will result in the call being steered to the required exchange, and follow this by dialling the required subscriber's number. If we could give all the subscribers the kind of training we give to the operators and provide them with the kind of dialling code list which the operator uses, and keep all the lists up to date, there would be no routing problem. But that, of course, is quite out of the question.

The codes the operators use to call a particular exchange steer the call step by step and, as the routes differ, according to the exchange from which the call starts, so must the codes. This causes no difficulty because an operator gets the code from a reference file on her switchboard. But it would be most confusing to the public, particularly to those moving about the country, if different codes had to be dialled according to where the caller happened to be. And such an arrangement would make it impossible for a subscriber to show the trunk code with his telephone number on his notepaper.

Moreover, a code which steers the call step by step has to be changed if the routing or switching arrangements are altered and this can frequently happen in a growing service. It is not too difficult to ensure that the operators always have and use an up-to-date dialling code list. It would be quite impracticable to arrange this for subscribers.

So the first requirement for subscriber trunk dialling is a dialling system in which the code for a trunk call to a particular exchange is the same from any part of the country, and will never need to be changed. This is known as a national numbering scheme, because each subscriber can be regarded as having a national number, consisting of the trunk code of his exchange followed by his local number, the whole being different from the national number of any other subscriber in the same country.

National Numbering Schemes With and Without Translation

Rather surprisingly, it is possible to introduce a pattern into a trunk network so that, while still routing the call step by step, the same figures are dialled to steer it to the right exchange from any point in the system. This can be done by dividing

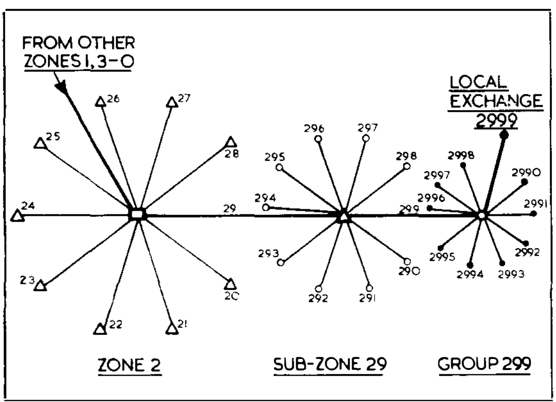

Fig. 1: The decade numbering system

The system is divided into 10 zones — □ zone
Each zone has 10 sub zones — Δ sub zone
Each sub zone has up to 10 groups — O group
Each group has up to 10 exchanges — ● Local Exchange
Routing follows the numbering

the country into ten numbered zones, each of which is divided into 10 numbered sub-zones, each of these again into ten numbered groups with ten numbered exchanges in each group. (Fig. 1.) The whole trunk network is then made to conform to this "decade" pattern. If a subscriber dials a national number in his own zone the unwanted figures are ignored. This method is in use in some countries, but it is inflexible and it would have been much too costly to rearrange our trunk network to conform to such a pattern.

Most STD systems include a device to translate the uniform trunk code of the called exchange into the necessary routing signals which vary according to the point of origin of the call. Translation makes things easier for the subscribers because it gives freedom to allot dialling codes in the most helpful way. At the same time it enables the administration to use the most economic routings and to change them if the need should arise without affecting the codes dialled by subscribers. It is for these reasons that we shall be using translation here.

Incidentally, the equipment has to remember (or register) the whole national number while it is translating the trunk code. It is therefore known as a register translator. The register translator is associated with a call only while it is being put through; it is then released and tackles another call.

Simplifying the Work of the Register Translators

As one would expect, the cost of register translators depends on the complication of the task they are given to do. It would be quite possible to devise them so that they could recognize the code for each one of the 6,000 exchanges in the country and then issue complete instructions to route a call to that individual exchange; but if they had to do this they would be complicated and costly.

The task of the register translator is therefore simplified in two ways. The first simplification is that it is not expected to recognize from what the subscriber dials which particular exchange he is calling. Instead, exchanges are divided into groups (as described in Mr. Longley's article in the Winter 1958 issue of the *Journal*) each of which is served by a switching centre, and the register translator is only expected to recognize the distant group. It then gives instructions which route the call to the centre serving that group and repeats (without translation) the rest of the code. This enables the distant switching centre to pick out the

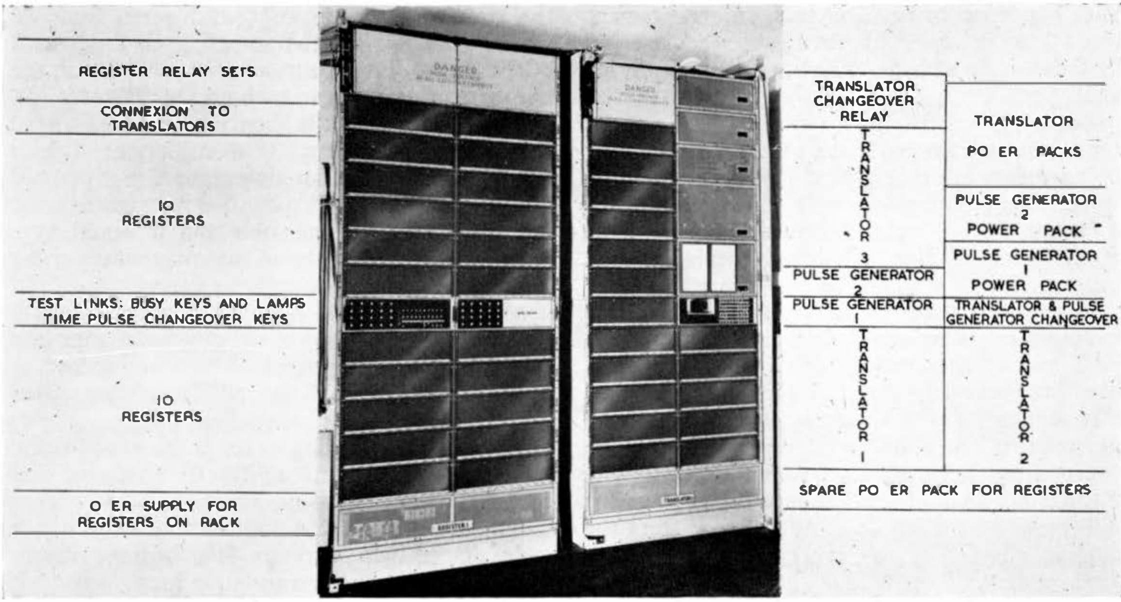

Fig. 2: GRACE: main equipment showing the electronic registers and translators

particular exchange. Finally, the register translator repeats the wanted number.

The second simplification is that the register translator is not expected to give complete instructions for calls with complicated routings via intermediate exchanges. It confines itself to selecting the route to the next intermediate exchange and then repeating the trunk code to another register translator there. It is as though it said to the call "Go along this way as far as the next cross roads and ask again". By this means each register translator is given a simpler task.

"GRACE"

The register translator, working in conjunction with other STD apparatus, also applies the appropriate charge for the call. The whole of this equipment has been popularized as "GRACE", a name derived from the initial letters of Group Routing and Charging Equipment which describes the equipment quite accurately—though not so humorously as some other names that were suggested! GRACE is in effect a robot operator. It takes a note of the called exchange and number, decides the route, guides the call, decides the rate and applies the charge. In other words, it does all the things described earlier which are now done by a human operator.

There are electro-mechanical and electronic versions, and Fig. 2 shows what the electronic version looks like. How the register translator works will no doubt be described in a later issue of the *Journal*.

How National Numbers will be Built Up

First the subscriber must dial something to secure the service of a register translator. To keep down the total number of figures to be dialled he will dial one digit only, namely "O". This is the only suitable single-figure code available at all exchanges. It has been used since the earliest days of automatic working for calls to the operator but, with the coming of STD, the number of such calls will diminish and the code for the operator will become "100".

After the "O", the subscriber must dial something to indicate the distant group. If the task of the register translator is to be kept reasonably simple each group must be identified by not more than three figures, which means that there must be fewer than 1,000. Actually there will be about 640 and most of them will be given three-digit codes.

After the three digits to indicate the group centre there will generally follow one or two figures to identify the particular exchange. Then will follow the wanted subscriber's number. The first example in Fig. 3 shows how the seven exchanges in group 234 might be numbered.

There will, however, be many groups of the pattern shown for group 456 in Fig. 3 where the main town is identified by the group code only and other exchanges by five-figure codes, the fourth and fifth digits being so chosen that they do not clash with the local numbering scheme of the main town.

Some groups will have two codes, one to identify the main town and another to identify the surrounding exchanges as shown for the group 885/889 in Fig. 3.

The biggest group of all, the London group, will be identified by the single figure "1" and the five other director area groups by the codes 21, 31, 41, 51 and 61. The individual exchanges in these groups will then be identified by the first three letters of their names as shown for group 61 in Fig. 3.

After identifying the exchange it remains only to follow with the dialling of the local number.

These different arrangements are necessary for two principal reasons. First, to make the most efficient use of the existing local switching equipment and junctions. Second, to ensure that the total number of digits to be dialled, including the

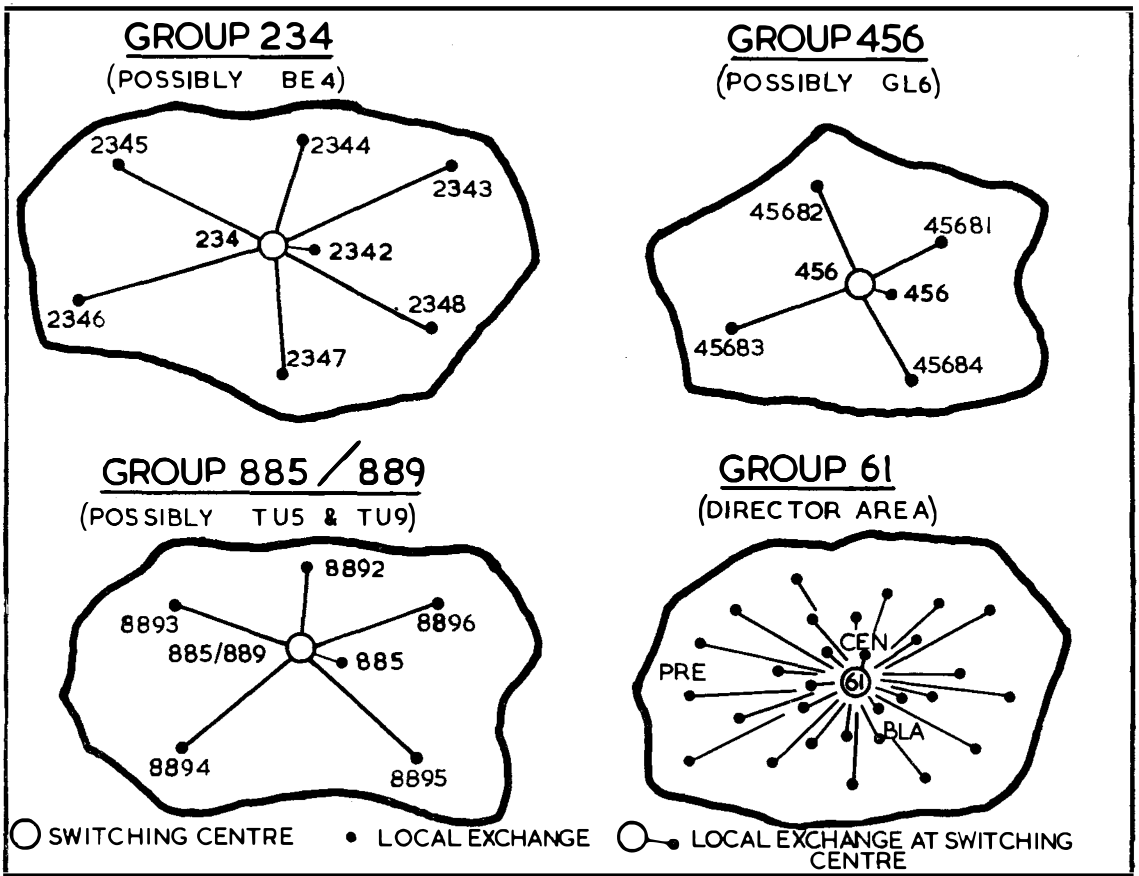

Fig. 3: Numbering system proposed for U.K. Exchanges are divided into less than 1,000 groups mostly with 3 digit codes. Translation makes routing to a group independent of group numbering. Routing within a group is by extra digits which are part of the national number

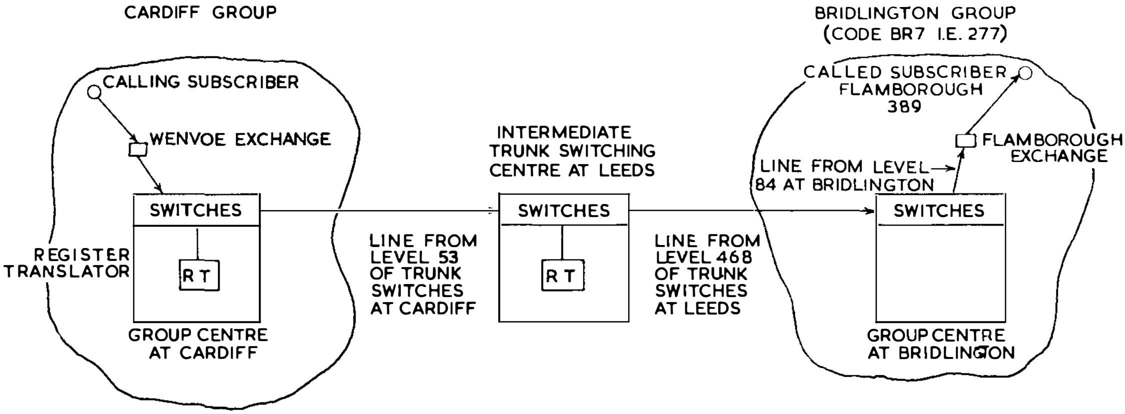

Fig. 4: Example of STD call from Wenvoe to Flamborough under full STD conditions
The translations shown are for illustration only

Caller dials '0' and is connected to switches and register translator (RT) at the group centre.
Caller dials BR 7 84 389, which RT stores. RT translates BR 7 (i.e. 277) to 53 which is the switch level to Leeds. RT repeats 277 to RT at Leeds.
Later, repeats 84 to switches at Bridlington. Then 389 to switches at Flamborough.

RT receives 277 from RT at Cardiff and translates it to 468 which is the switch level giving lines to Bridlington.

Switches at Bridlington receive 84 from RT at Cardiff and select a line to Flamborough exchange. Switches at Flamborough receive 389 from RT at Cardiff and select the wanted subscriber.

"O", never exceeds ten. They achieve this by producing short codes for the large exchanges with long numbers and longer codes for the small exchanges with short numbers. With this scheme we have avoided making each group into a linked number area for local calls as a preliminary to STD, as has been done in some other countries.

Letters in National Numbers

The need to use letter codes for calls to the director areas means that lettered dials must be fitted on the telephones of all subscribers with STD facilities. This opens the possibility of also using letters for dialling trunk calls to other areas. The use of letters should help subscribers with the dialling because they are easier to remember, are less likely to be transposed, and break up what would otherwise be a long string of figures.

Letters are therefore to be included in the published STD codes for non-director areas. To the equipment, of course, a letter simply means the figure in the same hole of the dial. After the initial "O" the group code will be expressed as two letters and a figure and the letters will generally be derived from the group names. Thus the group code for Leeds will be "LE 2" and that for Leicester "LE 3". As "L" is in the "5" hole of the dial and "E" in the "3" hole these codes simply mean that the Leeds group is No. 532 and the Leicester group No. 533.

Here are a few examples of complete national numbers as they will be dialled by subscribers:

Subscriber's number	National number	
London CENtral 3456 ...	01 CEN	3456
Manchester CENtral 3456...	061 CEN	3456
Leeds 345678	OLE 2	345678
Leicester 34567	OLE 3	34567
Cardiff 34567	OCA 2	34567
Bridlington 3456	OBR 7	3456
Flamborough 389 (in the Bridlington group) ...	OBR 784	389

Subscribers with the STD facility will be supplied with a list showing the codes of all the exchanges to which they have dialling access. The initial digit "O" will always be printed as part of the code.

Fig. 4 shows in skeleton form a possible routing of a call from Wenvoe to Flamborough under full STD conditions. At the outset, however, STD facilities will be given only between directly connected centres or on calls which can be steered through an intermediate centre by the first register translator.

Charging for Subscriber-dialled Trunk Calls

The second part of the operator's work which has to be done automatically if subscribers are to dial their own trunk calls is to decide and record the charge for them. At present the operator writes down particulars of each call on a ticket. The charge for the call is calculated according to its distance and duration (with a three-minute minimum) and the subscriber is sent an account with a separate entry for each call, giving the date and charge.

It is technically possible to arrange for similar particulars of dialled calls to be recorded automatically, but to do so needs extra equipment to trace the number of the subscriber making the call, further equipment to record the full details, and still more equipment to process the record. All this equipment is complicated and expensive and takes up a lot of space. The cost of it and of the separate billing of the calls to subscribers would increase the cost of the STD service and consequently the charges.

If we were to use this method it would probably mean retaining the present three-minute minimum fee for a trunk call and prevent us from giving the facility of cheap, short calls which STD makes possible. It would be a handicap in giving STD facilities from coin-box telephones.

The present system of call charging is appropriate to the manual system because the setting up of a connexion accounts for a large part of the total cost of a manual call; but with automatic calls the setting up costs are comparatively small and a different tariff is appropriate.

A simpler system, and the one which has been adopted by most European administrations with an STD service, is to record trunk calls on the same meter as that used for recording local calls, and this is the system we shall adopt. It has two implications. First, that trunk call charges must be expressed in the same units as local calls, and secondly, that subscribers must accept bulk billing for dialled trunk calls without supporting details.

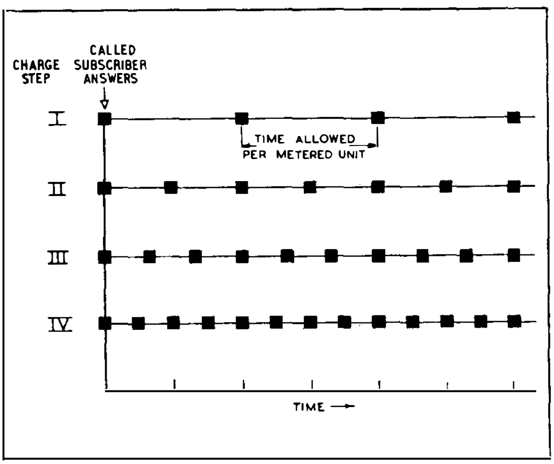

Fig. 5: Principle of periodic metering
■ meter pulses

With a metering system, the equipment must decide how many units to record for a particular call at the time it is made. This is the second job of the register translator. Clearly, the rate of charge must be decided from the code dialled by the subscriber and the register translator must therefore be able to do this.

As already mentioned, charges at present depend on distance and duration. These are still sound principles with an STD service, because long trunks cost more than short ones (though not in proportion), and the quantities of switches and lines required depend on the time for which they are held by each call.

Charging According to Distance

Before January, 1958, the distance was measured point-to-point between exchanges. For STD it would have been possible to provide a register translator to indicate charges based on point-to-point measurement, but to do so the register translator would have had to store in its "memory" the charges for calls to 6,000 different exchanges. Moreover, the charge would vary according to the exchange at which the call originated. This would mean providing separate fee determining equipment for every exchange which would add considerably to the cost of the system.

A great simplification and saving of cost is achieved if the register translator can decide the charge from the three digits (or less) in the dialling code which identify the distant group for routing purposes, as previously described. For this to be possible, the charge for a call from any exchange in one group to any exchange in another group must be the same. The same register translators can then be used to fix the charges for calls from all exchanges in the group and they can be centralized so that fewer are needed. A system of group charging was therefore introduced on January 1, 1958, to prepare the way for STD. This was fully described in the article by Mr. Longley already mentioned. One of its most striking features was a great extension of the local call area.

Charging According to Duration

If a call is to be charged according to its duration, the automatic equipment has to "time" it. There are several possible ways of recording calls in units on subscribers' meters according to the time that has elapsed.

A method close to that at present used for charging calls connected by the operators would be to record a number of units equivalent to the charge for three minutes at the start of the call and again at the beginning of each successive three-minute period. Another way would be to record a smaller number of units at the beginning of each minute. Either of these methods would require precise timing of each individual call because it is necessary to fix with some accuracy in relation to the start of the call the time at which an appreciable amount is added to the charge. And this would mean associating fairly expensive timing equipment with each individual call throughout its duration.

The simplest system, and that best suited to an STD service, is to record one unit at a time on the meter at regular intervals and to do so more frequently for long distance than for short distance calls. This method of charging is shown diagramatically in Fig. 5. Its great advantage is that the required range of time pulses can be generated by common equipment serving a whole group of exchanges. The register translator indicates the appropriate rate and all calls in progress at that rate are metered from a common source. The amount of timing and metering equipment tied up with an individual call is thus reduced to a minimum.

This method of charging also has the great advantage to callers that the charge is closely related to the conversation time and short duration calls cost only a few pence. Possible loss on wrong number calls is reduced and the provision of the STD facility from coin-boxes is greatly facilitated.

It was for these reasons that it was decided to adopt periodic metering in single units for the STD system in the United Kingdom; this led to the idea that the same system should also be applied to local calls. There is much to be said for charging local calls according to duration. It is sound in principle, particularly now that the local call area resulting from group charging is so extensive, and long duration calls can hold up a good deal of plant. It enables the unit fee to be reduced, which means lower charges for most calls. It is fair to subscribers because those who make short calls are not overcharged to subsidize those who talk for a long time. Finally, it gives more flexibility in planning a tariff for ordinary and coin-box calls and for adjusting it in the future.

A good deal of thought was given to what should be the value of the unit charge and what periods should be allowed for it on local and STD calls, but it is not possible here to discuss all the possibilities considered. The rates finally decided were:—

(Distances are Measured Between Group Centres)	Time Allowed for 2d. from a Subscriber's Telephone or 3d. from a Coin-Box Telephone.	
	In full-rate period	*In cheap-rate period*
Within a group or to an adjacent group	3 mins.	6 mins.
Beyond an adjacent group but within 35 miles	30 secs.	45 secs.
35–50 miles ...	20 ,,	30 ,,
Beyond 50 miles ...	12 ,,	18 ,,

This is in striking contrast with the tariff before January 1 this year, when there were four local and seven trunk charge steps, a total of 11 steps altogether.

Three principles behind the plan

In planning the system for STD in the United Kingdom there have been three guiding principles:—

1. That it should be as simple as possible, and so keep down costs.

2. That it should be capable of being grafted on to our existing system without the need for radical alterations.

3. That it should incorporate features appropriate to the new method of working rather than perpetuate outmoded features of the manual trunk service.

It may be of interest to consider how these principles have influenced the features of the new system described in this article.

The first principle led to the choice of meter recording instead of automatic ticketing for trunk calls. It led to group charging for both long and short distance calls and to the extension of the local call area. It led to a national numbering scheme in which routing and charging are indicated in such a way that the register translators can be simplified and concentrated at fewer exchanges.

The second principle led to the rejection of numbering schemes which would have involved a wholesale reorganization of the present trunk network or the creation of new local linked number areas as a preliminary to STD, and to the choice of a system in which existing local numbers of varying lengths will be retained and prefixed by codes of varying lengths to make up national numbers with not more than 10 digits.

The third principle led to the abandonment of the three-minute minimum charge for trunk calls and to the choice of the single-unit periodic metering tariff. It led to the decision to charge local calls according to duration with a lower call fee and to a trunk tariff with only three charge steps. It supported the first principle in leading to the abandonment of point-to-point measurement for determining call charges and the introduction of group charging.

The programme

STD will start at Bristol in December of this year. We have had to wait a long time for it in this country because there have been so many other pressing claims on the limited resources of capital available to the Post Office. For the same reason, we may not be able to extend the new system throughout the country as rapidly as we or the public would wish, but we hope to have it working in more than 100 towns by the end of 1961, which will be quite a good start, and, as the recent White Paper said, to provide for about three-quarters of all trunk calls to be dialled by subscribers by 1970. The total cost is expected to be of the order of £35 million.

The full realization of the complete plan for STD will bring into being a very considerable edifice, and this article does little more than describe the foundations. But foundations are important and a lot of attention has been given to them. We hope that time will show that they were well and truly laid.

EARLIER AUTOMATIC TELEX

Recent review of the installation programme for automatic telex exchanges has resulted in some considerable improvements. First, the equipment contractors expect to be able to speed up manufacture and installation; secondly, efforts to make accommodation available for earlier installation have been successful in a number of cases.

Telex subscribers in the North of England and Scotland will mainly be automatic by the Autumn of 1959, while many others elsewhere will be converted by Autumn, 1960. London and the South East will follow towards the end of 1960, when the automatic telex exchange opens in the new Fleet Building. The whole system will be completely converted by early 1961.

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International Telex.—Nearly one-third of the telex calls from the United Kingdom to continental Europe are to Germany, which has the largest telex network on the Continent. In June the call charges were reduced and a single reduced charge was introduced for the whole country. A single rate was also introduced for all France by reduction of the charge for calls to the south to the level of the charges for the north. Charges for calls to Algeria, Tunisia and Morocco were also reduced.

★ ★ ★

Surveying the Atlantic.—H.M.T.S. *Iris* sailed in June to survey the route of the new transatlantic telephone cable which will be laid in 1961 between Oban and Newfoundland. A Kelvin and Hughes Oceanograph echo sounder, capable of sounding to 4,500 fathoms (compared with *Iris's* normal sounder's reach of 2,250) and a Dektra receiver for long-range position finding were fitted for the survey.

After the survey *Iris* laid the Canadian shore ends of the second TAT which will be laid next year between Newfoundland and France.

August 5 was the centenary of the first completed transatlantic telegraph cable. The first message was cabled on August 17 but signals became unintelligible on September 1 and the cable finally failed on October 20.

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In Line with the Seasons.—Since the opening of the 1956-57 volume of the *Journal*, the issues published in November, February, May and August have been designated Autumn, Winter, Spring and Summer respectively. This has proved puzzling to some readers, as, for example, the "Autumn" issue has been current mainly in December, January and February.

Beginning with our next issue, which will open our 11th volume, the designations will therefore be changed, in effect being put forward. The next issue, due in November, will therefore be designated Winter; the February issue, Spring; the May issue, Summer; and the August issue, Autumn. Thus, there will be no issue designated Autumn, 1958.

Planning the Fleet Building

J. Bellew

WORK ON THE NEW £$2\frac{1}{4}$ MILLION FLEET Building in the City of London, planned to contain telex and telephone exchanges and the City and Long Distance Areas Telephone Managers' Offices is well in hand. Contractors started on May 20, 1957. The telex part of the building is required very urgently and work is being concentrated on this portion; the telex exchange is due to be brought into service by August, 1960, and the remainder of the building should be completed for occupation by the end of 1960.

But from the time when the scheme was first proposed to the time when building work started, many difficulties had to be resolved.

The story of Fleet Building goes back to the dark days of the war. As long ago as 1942-43 the number of sites and buildings likely to be required in the City of London to meet telephone development during the following 50 years was considered very optimistically. The original policy was for each new site to be large enough for a building to take two 10,000-line exchanges and capable of extension to take a third exchange ultimately.

In the search for a suitable site near St. Paul's from 1948 to 1950, the Ministry of Works brought several under notice.

One was in Stonecutter Street and St. Bride's Street, which included a disused burial ground. To acquire this would probably have involved promoting a Sites Bill in Parliament and providing elsewhere an open space of equivalent area.

Another was an island site in Little New Street and New Street Hill, which seemed to offer the best prospects from a location point of view but, while negotiations were being conducted in May, 1949, the *Daily Telegraph* bought half the site to enable its printing works to be extended.

The former site of Thomas Wallis' store in Holborn Circus was then considered but another newspaper company had acquired it and had obtained planning permission to develop.

The Ministry of Works then suggested a site in Farringdon Street adjoining a plot which was due to be developed for the Government Chemist. Although by July, 1950, town planning clearance to develop this site was received the site was not without its difficulties.

Farringdon Avenue, which crossed the site diagonally, was scheduled as a road to be used for turning buses, and the Ministry of Transport, the London Transport Executive, the City Police and the Licensing Authority (the London County Council) opposed the proposal to close the road. A private firm wanted to develop a portion of the Farringdon Street frontage as a petrol filling station. Further, the *Evening Standard* wanted to extend their premises, which adjoined the recommended site. During 1951 it was learnt that the proposal for the Government Chemist had been abandoned and that the Post Office could develop the whole site. Plans were made to erect the telephone exchange building to the south of the site facing Stonecutter Street and to explore the possibility of housing the City Area Telephone Manager's Office (which was dispersed over several leasehold buildings) on the same site, which could then be developed comprehensively.

Some of the difficulties began to resolve themselves: alternative turning arrangements for buses seemed possible in St. Bride's Street; the proposal to erect a petrol filling station in Farringdon Street was abandoned and it seemed possible to agree on an adjustment of boundaries with the *Evening Standard*.

Site Development and Purchase

The total area was about 70,000 square feet. Apart from a few dilapidated buildings, the whole area had been cleared following war damage.

At the end of 1952 planning had started on the basis of erecting a building initially for one full unit local exchange, a tandem exchange and two switchrooms of 100 positions each. Accommodation for a third switchroom was also to be provided, but this would be used for other purposes until required for installing equipment. The upper floors were to be used for offices.

The proposal to erect such a large building as this gave rise to many questions. On the one hand

there was the understandable desire of the local Planning Authority to have the site developed comprehensively. On the other hand, there was the expense involved, particularly as, in 1953, the Government had banned office building. There was the usual overriding necessity not to spend more money on building work than was required for immediate use. Also, would it be possible to erect only the lower half of the building at first? Should only a portion of the site be developed? Much thought was given to this kind of problem. The need for the exchange was clear. The site was in the right position so far as cabling was concerned. It had proved impossible to find premises or sites of the size required to rehouse the City Telephone Manager's Office, and it seemed the obvious thing to take advantage of the new site and to build offices over the exchange portion of the building.

Architecturally, the only proper use of the site was to develop the whole area comprehensively. It would have been bad policy to acquire the whole site and then fail to develop it fully. There would, moreover, have been difficulties in stopping the building in a half completed state and the Planning Authority would, no doubt, have objected to this.

In an endeavour to solve this problem, the architect evolved a new plan in April, 1953, showing how it would be possible to develop part of the site for the operational requirements only, omitting office accommodation. He pointed out that, as operational requirements had increased since the Government Chemist had been included in the scheme, it would mean that about 75 per cent. of the site would have to be taken. The remainder of the land could not be developed economically—if at all, satisfactorily. The architect reported that the Planning Authority found the scheme unacceptable.

This seemed to settle the question of the total amount of site to be purchased and the method of development.

Then came the problem of buying such a large area of site.

Because of the large number of separate ownerships involved—about 50 in all—and the complications likely to be encountered, particularly with regard to the closing of Farringdon Avenue, it was decided that the only practical means of dealing with the problem would be to make a compulsory purchase order on the whole of them. The City Corporation, as part of their plans for the comprehensive re-development of the area, had already purchased a number of interests (about a dozen) but it was recognized that the difficulties of proceeding without the powers conferred by a compulsory purchase order would make final settlement impossible.

Two formal objections to the proposed compulsory purchase order were received: the *Evening Standard* considered that acquisition of the site by the Post Office would prejudice the development of certain areas of land adjoining the site in which they were interested, and the Wenlock Brewery Company wanted to rebuild and reopen their public house, the "Mail Coach", in Farringdon Street. Alternatively, the Brewery asked that the public house should be incorporated in the new Post Office building!

After negotiations, the *Evening Standard* agreed to withdraw their objections provided the Post Office undertook not to take more land than had been specified in the compulsory purchase documents and if they were given rights of light over the northern boundary of the telephone exchange site.

At a public enquiry held at the Guildhall on November 16, 1954, no objections were raised or comments made by any of the public. The City Corporation raised no objection, but stated that they were negotiating with the Post Office with regard to certain street widenings in Shoe Lane and Stonecutter Street which were considered necessary if Farringdon Avenue were closed. The compulsory purchase order was made.

It was not possible to agree that the site of the "Mail Coach" public house should be excluded from the Order, or that a public house should be incorporated on the ground floor of the new building, and arrangements were made to serve the normal statutory notices on the owners to enable the various purchases to proceed.

Many discussions took place about the services to be accommodated in the new building.

The advantages of the site were obvious. By the time the many demands for accommodation had been reviewed, it was found that the operational requirements would be considerable. This, of itself, raised another problem. Too large a concentration of equipment and operating personnel in one building was undesirable, and the position had to be reconsidered and firm proposals prepared for those services which had the strongest claim for inclusion. At the same time economic considerations suggested that the building might have to be put up in two stages if Treasury authority could not be obtained to complete it in one operation.

There was the argument that it might not be possible to authorize at the outset more building work than was needed to meet telephone requirements. The idea would have been to leave the office accommodation to be built some years later when resources became available. The Ministry of Works, on the other hand, strongly advised against erecting the building in stages. Apart from the inconvenience and discomfort caused to those in the telephone part of the building if substantial building operations were to be done later over a long period, and the vacation of the top floor of the initial scheme, there would be a real risk of getting dust into delicate apparatus, extra expense would be involved and there were the likely objections by the local Planning Authority to any proposal to leave the building in an uncompleted state for a number of years.

Telephone and Telex Services

On the telephone side, there was the need for telephone exchanges to cater for local development. Some 150 large office buildings were being erected in the City and great expansion of the telephone service was foreseen as rebuilding proceeded. In view of the likely exhaustion of the Holborn, Chancery, City, Central and Clerkenwell Exchanges, the first 10,000-line unit was needed as quickly as possible, and a second similar unit would be needed soon afterwards.

To provide for further telephone development it was decided, in the special circumstances, to provide space for a third unit exchange but to make temporary use of the space thus provided for some other purpose until it was required for apparatus.

There would also have to be two telephone switchrooms to house the automanual boards to deal with the assistance traffic.

It was also decided that accommodation must be provided for external engineering staff and stores dealing with the areas covered by the local exchanges in the building.

Then came a demand for space for telex services. In fact this has since come to be the largest single operational service in the building.

Early conversion of the telex system to automatic working was regarded as an essential preliminary to full development. Already many European countries had converted their inland systems and were introducing facilities for subscribers to dial their own calls to other countries. It was important that automatic working should be introduced quickly in this country if British firms were not to be placed at a disadvantage. Apart from this, conversion would save operating staff costs of many thousands of pounds a year and reduce manpower requirements.

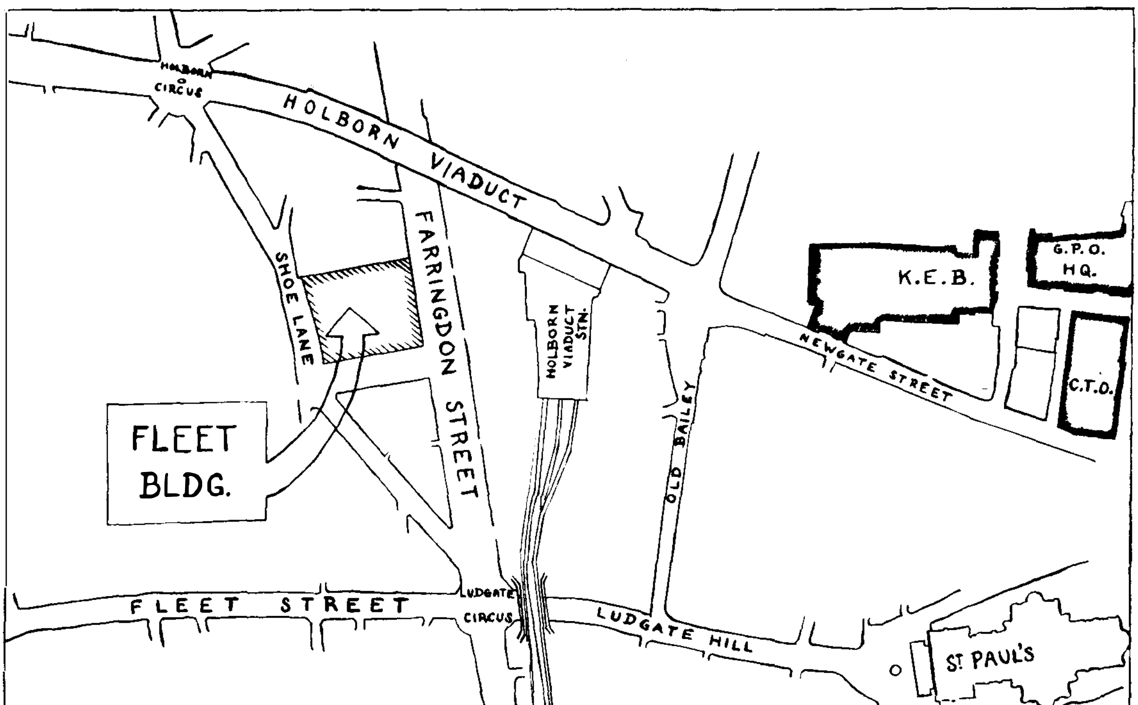
The telex service had therefore been planned on the basis of automatic working. Since the interconnexion between the inland and the international telex systems was in London, it would be economical to house the two sets of apparatus side by side when both services became automatic. Advantage was taken therefore of the opportunity afforded by the planning of the Fleet telephone exchange building to house in it also the permanent automatic apparatus required for the inland and the international telex exchanges.

The design of the building was such that considerable office space would be available on the upper floors. At one time the inclusion of the Regional Director's Office in the building was considered. But because of accommodation difficulties which existed and which were likely to arise in providing for the City and Long Distance Area Telephone Managers' Offices, it was later decided that both should be housed on the upper floors.

Planning

The final decision was to develop the site comprehensively—saving time and money—and to erect the whole building under one contract. The planning of such a large building took much time and thought. The local Planning Authority required that the height of the building should line through with the neighbouring buildings in Farringdon Street. The Ministry of Works on its part wanted to produce a building which would be a credit to all concerned. The final result then had to be agreed by the City Corporation, the London County Council and the Royal Fine Art Commission.

As might well be imagined, the building contract presented its own difficulties. The need to have telex services operating as quickly as possible made the pace for the contract. A target date of



May, 1959, was set for having the first portion ready to receive telex equipment.

The time table for a scheme of this magnitude and importance was such that, if the Ministry of Works were to prepare bills of quantities and invite lump sum tenders in the ordinary way after completing working drawings, they would be quite unable to meet the Post Office date for installing telex equipment. The Ministry proposed, therefore, that the building should be erected under a special contractual procedure which would give the contractor an incentive to efficiency and speed.

Achieving the key target dates meant working to a tight time-table and the best prospects of success lay in undivided control by one contractor. If the main contractor had this control and himself selected the sub-contractors he would have the opportunity as well as the incentive to avoid delay. For this reason it was also agreed that the Ministry of Works—instead of the Post Office—should accept responsibility for installing electric lighting and power, lifts and ventilation.

Features of Interest

The building will be served by six automatic passenger lifts. To help dispense with liftmen, an elaborate form of automatic control is to be provided. The lifts, which will be able to carry 15 persons at one time, will have a maximum speed of 500 feet per minute. The lift motor rooms, and tank rooms on the roof, will be screened by the roof terrace structure.

The windows have been designed to give a large amount of natural light together with adequate ventilation. Window cleaning would have presented a real problem, but this will be overcome by an arrangement for hanging running cradles from the top of the building.

The large cable chamber at sub-basement level runs the full width to take all incoming cables.

Fluorescent lighting will be installed in most rooms.

The basement and ground floor contain apparatus as well as a low level garage reached from a yard at street level.

The main entrance is from Farringdon Street, and there is a staff entrance in Shoe Lane, but this will be on the first floor owing to the slope of the ground. This floor gives direct access to the main telephone apparatus and the refreshment club.

The telephone exchange switchrooms are on the second and third floors, the fourth to twelfth floors accommodate the office staff of the two Telephone Managers, and the total floor space in the building will be about 325,000 square feet.

Arrangements were made for part of the northern half of the site to be used temporarily as a bus turn-round until the work of widening Stonecutter Street has been completed. Thus the work of excavating the northern half of the site could not proceed until some time after work on the southern half had started.

Because of the desire to start installing telex apparatus by May, 1959, the building operations had to be phased so that all the initial equipment could be provided in the southern part of the building. This need to bring portions of the building into service in advance of the remainder brought other problems—such as temporary heating, lighting and power supplies, ventilation and air conditioning for the accommodation concerned as well as temporary welfare facilities, not to mention access to the site for equipment vehicles while building work was still proceeding.

In March, 1958, while the building contractor was excavating a portion of the site he found a large concentration of bones. The Press got to hear of this and Independent Television News took pictures and showed the film one Sunday evening. The Guildhall Museum became very interested and a representative said that apparently part of the site was the old 18th century burial ground of St. Andrew's Church, Holborn. What happened here, as in other parts of the City, was that when the small burial ground became full, all the bodies were dug up and reinterred in a large trench or pit. This was confirmed to a certain extent in this case as the bones were deposited in their various groups. An order was obtained from the Home Office and arrangements were made to box the bones and to have them incinerated at the City of London cemetery.

Since the scheme started the Ministry of Works have made tremendous efforts. Thanks are due to the estate surveyors, the architects, the structural engineers and others, who have contributed so much in the acquisition and development of the site. The building was designed by Mr. W. S. Frost, A.R.I.B.A., A.M.T.P.I., of the Ministry of Works, to which we are indebted for the drawing.

It has been a long and difficult job for everyone concerned and, as we in London Telecommunications Region watch the progress of the operations, we look forward eagerly to the time when we take possession of the biggest building erected for the Post Office since the end of the war.

Push-Button Telegraph System for British Road Services

P. C. A. Raby

THE LIFE BLOOD OF COMMERCE AND INDUSTRY in this complex world is transport. British Road Services—a branch of the British Transport Commission—provide a national competitive road haulage service, operating some 21,000 vehicles driving an aggregate of more than 330,000,000 miles a year.

Soon after inception, it become clear to British Road Services that an efficient and economical private communications system would be required for the nation-wide exchange of information about vehicle movements, rates matters, urgent proof of delivery, load discrepancy reports and so on. B.R.S. decided that the teleprinter message was the ideal medium, and looked to the time when their larger offices and depots would be linked by private telegraph circuits. In addition, telex was planned to serve in particular as a rapid means of communication with their customers, with the Continent, and with the smaller offices.

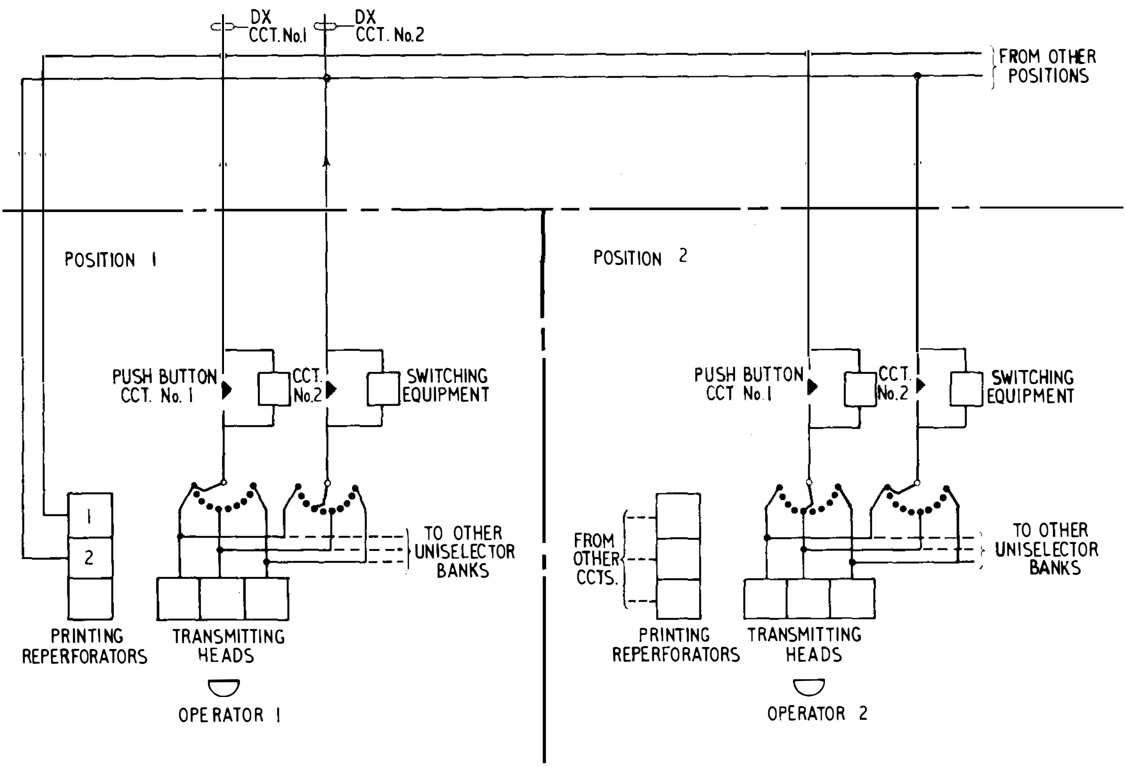


Fig. 1: Push-button switching—a much-simplified sketch

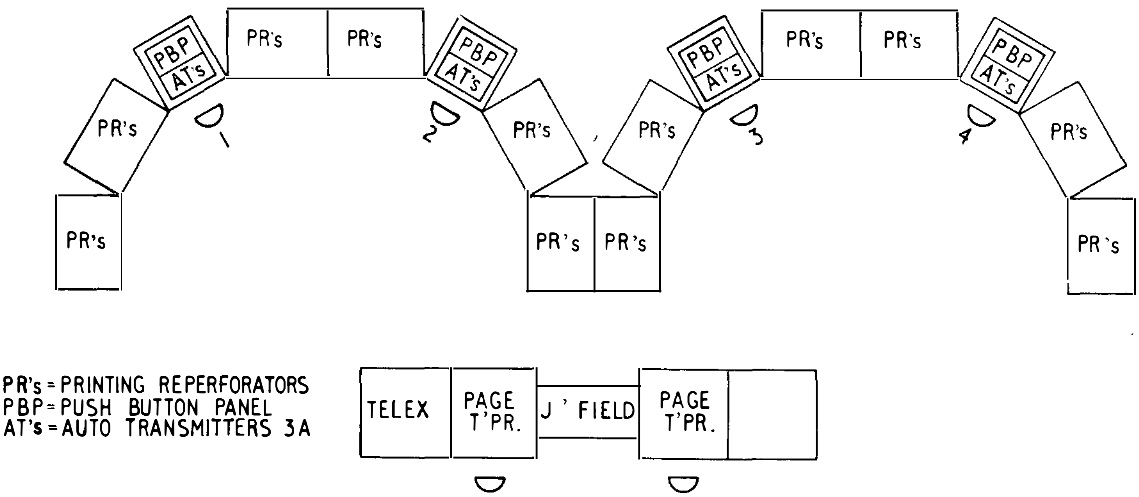


Fig. 2: Layout of tape relay positions and supervisory equipment

Between 1949 and 1957 their long distance telegraph channels rose from 6 to 30. By 1957, the intercommunication network was serving 130 stations and using 370 telegraph machines, linked by private wires of various lengths. More than 50 offices were connected to the telex system.

Other transport organizations have similar communications problems and meet their needs in various ways, but communication by printed word in the form of telex or private teleprinter service is playing a more and more important part in meeting those needs.

A joint study of private circuit requirements by the Post Office and British Road Services in 1957 showed that the basic manually switched system, using simplex circuits, was not the most suitable for this rapidly expanding network.

A number of switching circuits in the network had already been replaced by duplex channels terminating on printing reperforators and triple-headed auto-transmitters—an arrangement known as tape relay, torn tape or tape transfer. Duplex working allows the transmission of messages simultaneously in both directions over a single circuit. Conventional tape relay requires one printing reperforator and at least one auto-transmitter head for each duplex circuit terminating in a switching centre. Operators detach messages received as printed and perforated tapes from printing reperforators and insert them in the transmitters connected to the required outgoing circuits.

The need to transfer tapes from incoming to outgoing machines, which usually have to be some distance apart at large installations, involves labour and time, and inevitably some risk that messages will fail to get to the right destination. The size of this "cross-office" problem may be reduced by connecting more than one transmitter, individually and suitably placed in relation to the printing reperforators, to each "send" channel. On completion of transmission from one transmitter, individual circuit switching equipment will automatically examine the other transmitters concerned and will accept and transmit any waiting message. The repetition of transmission points with this automatic queuing facility saves operator time, reduces the time between receipt and transmission of messages and allows circuits to carry more messages than when they are fed by purely manual means.

Basically, tape relay was accepted as meeting B.R.S. requirements but the size of the network, with the need to make adequate provision for growth, to keep operator costs and retransmission times to a minimum and to provide for multi-address traffic economically, justified something rather more than the conventional system.

A push-button tape relay system had reached the final step of design and was judged suitable for installation in new B.R.S. accommodation in London. This new switching centre, equipped by the Post Office, was opened in January this year.

This system, by avoiding the need for a separate transmitter (or transmitters) for each "send" channel, overcomes the cross-office problem. Switching equipment under the operator's control connects any transmitter to any outgoing circuit. Operators can remain seated.

Circuit selection is arranged by pressing a button individual to the circuit required. To give each operator at a centre access to all outgoing circuits, a push-button multiple is provided in much the same way as an outgoing junction multiple is provided on a telephone switchboard. In fact, a push-button operating position closely resembles a manual exchange telephone switchboard in its arrangement: incoming circuits individual to each telephone operator are replaced by individual printing reperforators; a multipled push-button panel gives access to all outgoing circuits; individual transmitting heads are supplied for each position to operate, in effect, as cord circuits. The number of push-button panels (operating positions) required will depend on the number of messages to be handled by the centre: the number of transmitting heads (cord circuits) per position is determined by deciding how many tapes (calls) an operator can handle at one time.

Operating procedure. The transfer of a message tape from incoming reperforator to outgoing circuit can be followed by reference to Fig. 1.

(i) The operator detaches a message tape from the bank of printing reperforators individual to her position and reads the address.

(ii) She inserts the tape in any free transmitter on her position.

(iii) She depresses momentarily the appropriate outgoing circuit button.

Operating aids. Facilities have been incorporated in the design to keep the operating procedure extremely simple and to guard against failures or delays. An operator can insert a message tape in any free transmitter on her position.

(i) *Outgoing circuit condition indicator.* A lamp is provided with each push-button. The lamp glows whenever the outgoing circuit is in use, either on the position in question, on another position, on a broadcast or on the supervisor's panel. The operator does not need to pay particular regard to this lamp, as depression of the button arranges for her demand for the circuit to be stored in cyclic order until such time as it becomes free, when transmission starts automatically.

Fig. 3: General view of the tape relay centre

Fig. 4: Supervisory position and jackfield

(ii) *Demand stored indicator*. A lamp is associated with each transmitting head. As a positive indication to the operator that all is well, the lamp will glow as soon as the switching equipment has accepted the demand; that is, the presence of a tape in the head. This lamp will flash as soon as transmission starts and will darken when the message ends. The head is then free for further tapes.

(iii) *Delay indicator*. Normally, an operator is not called on to take any action after depression of the circuit button. If, however, the required circuit remains in use in some other part of the centre for a predetermined period (say, five minutes), an alarm lamp associated with the head and a position alarm lamp will glow. If required, audible and visual signals can be provided on a supervisor's panel to call attention to the need for special action. The alarm condition is re-set by withdrawal of the tape concerned from the transmitting head. After finding the reason for the delay, the centre supervisor decides if the message is sufficiently urgent for transmission by other means—for example, telex.

(iv) *Queueing*. Equipment is provided so that once a demand has been stored (as indicated by the transmitting head lamp), the circuit push-button concerned becomes free to accept further calls in queue. A second tape may be inserted in another head and the same circuit button depressed. The appropriate transmitting head lamp will glow again, indicating acceptance of the additional message in the queue. The number of calls which can be placed in the queue is limited only by the number of free transmitting heads.

(v) *Multi-address*. Messages for more than one addressee may be handled on the operator positions by "snaking" the tape. A message may be addressed to X, Y and Z. The tape will be inserted in a free head and push-button X depressed. If circuit X is free, the tape will pass through the transmitter. Without waiting for the end of transmission to X, the leading edge of the tape may be inserted in another free head and press-button Y depressed. Similarly, the leading edge of the tape may be inserted in a free head for transmission to Z. Thus, depending on the length of the message, transmission of some part can take place simultaneously to as many addressees as there are free transmitter heads. For transmissions to more than three addressees, however, separate multi-address facilities would probably be justified. A special broadcast unit, for use in conjunction with push-button installations, is described later in this article.

(vi) *Serial numbering and time injection*. When required, equipment can be associated with each outgoing circuit which will automatically insert between 23 and 41 characters at any point in the message, usually before transmission of the message itself starts. These characters may include up to three serial number digits, automatically stepped from 001 to 999, and the actual time of transmission. Keys would be provided to re-set the serial numbering equipment to any desired point—usually back to 001 at the end of the day. If required, a meter registering serial number transmissions may be associated with each circuit but, with multiple push-button access to circuits, this would be required only at a supervisory point.

(vii) *Printing reperforators*. Standard facilities which may be provided are:—

(a) *Tape run-out*. One key per printing reperforator may be provided on the operator's position. The depression of a key will cause blank tape to emerge from the printing reperforator concerned, to allow the operator to detach the tape at a convenient point.

(b) *Over-ride alarm.* If the distant station sends while the circuit tape run-out key at the centre is depressed, the message will be accepted—incoming signals over-ride the tape run-out facility. The operator must be warned of this, to avoid the risk of the tape being detached at a point in the over-riding message This is arranged by associating an alarm lamp with each tape run-out key; the lamp glows on receipt of incoming signals if the tape run-out key concerned is depressed.

(c) Other minor facilities, such as tape exhaust alarm and message incoming indicator.

The B.R.S. Installation

The new centre was required to act as a switching point for 30 long-distance circuits serving 25 of the larger B.R.S. offices. Each of these offices forms the centre of a secondary network serving individual areas. In addition, the London installation has to function as a switching centre and control point for its own area.

Push-button access to 30 long-distance duplex, 11 short-distance simplex and 5 internal circuits was required—a total of 46. A push-button panel with a capacity of 48 circuits was judged to be adequate.

Position requirements. Trials on prototype equipment suggested that it would be appropriate to allow 15 seconds for each complete operator-transaction; that is, 240 tape transfers an hour per operator. This made some allowance for miscellaneous and personal actions. Records taken on the existing network showed that the centre would be required to deal with a minimum of 570 messages in the busy hour, which would call for three operators, working at 80 per cent. maximum load. To cater also for growth, it was decided to install four positions.

Transmitter requirements. The average B.R.S. message approached 40 inches in length; that is, 400 characters or about 66 words. The transmission time of the average message would therefore be about one minute. To enable an operator to dispose of 240 tapes in one hour, each tape

Fig. 5: Broadcast position through which messages are transmitted simultaneously to all centres

occupying a transmitting head for not less than one minute, at least four heads would be required. Allowance would need to be made for the fact that, before transmission took place, some tapes would occupy a head while waiting in a queue. Serial numbering or time injection facilities were not required on this installation. It was concluded that two triple-headed auto-transmitters would be required on each position.

Printing reperforators. Printing reperforators for 32 incoming circuits were required. It was decided to mount these in twelve 3-tier metal cabinets. Thus, each of the four operating positions would need to be equipped with three 3-tier cabinets holding eight printing reperforators. Space would be available for one reserve machine on each position.

Fig. 6: The Glasgow position during trials

Layout of operating positions. Each operating unit would consist, therefore, of a 48-circuit push-button panel, two triple headed auto-transmitters and three 3-tier printing reperforator cabinets. Although up to four operators would be required in the busy periods, two would be enough at times. Bearing in mind, also, the aim to provide positions which could be staffed by seated operators, a double U array was selected, and the equipment has been disposed shown in Fig. 2. A difficult problem in considering physical design and layout was to find "the average operator", who could get easy access while sitting down to much, if not all, of the equipment comprising an operating unit. After "mock-up" trials with short girls and tall girls satisfactory measurements (of the position equipment) were obtained.

It was found possible to arrange for easy access to six printing reperforators, the six transmitting heads and the push-button panel. Although the remaining two (plus one reserve) printing reperforators could just be reached from a sitting position, experience has shown that some operators welcome the opportunity to stretch their legs.

The busiest incoming circuits are connected to the cabinets adjacent to the transmitters, but "patching" facilities are provided in the centre so that the position of incoming circuits can be rearranged if necessary to equalize operator loads. Fig. 3 shows the tape relay console in use.

Supervision, flexibility and control. The efficiency of such a centre is measured largely by the number of messages which can be handled, without delay, in a given period. Supervisor control facilities are provided to ensure that one simple operating procedure meets all machine and circuit conditions and message requirements.

Fig. 4 shows a supervisor's position comprising a key and jackfield and monitor teleprinters. All machines (working or reserve) and circuits are wired to the jackfield to enable a supervisor to enter any circuit for conversation or monitor purposes; to transfer a receive channel to a reserve machine when tape re-loading became necessary, or when a machine fault occurred; to transfer a send channel from its push-button outlet to a reserve printing reperforator installed near a telex machine for alternative routing by non-operating staff in the event of line difficulty.

The multi-address position is shown in Fig. 5. Operator push-button access is provided to a printing reperforator placed adjacent to a special broadcast panel, for transmission of messages addressed to more than three offices. This panel, equipped with a key and two lamps for each send channel, an auto-transmitter and a teleprinter, was designed to give priority access and allow selective broadcast transmissions by manual or automatic means. Manual or automatic start and release facilities were provided.

The opening of the centre in January this year coincided with unusually bad weather: many roads in the United Kingdom were made impassable by snow and ice. Telegraph traffic on the B.R.S. network reached new heights and offered a challenge to the new switching centre. The system stood the test and during the first week 4,000 messages daily between 9 a.m. and 6.45 p.m., representing more than 250,000 words, were handled, and 700 were re-transmitted in the busy hour, 4.30-5.30 p.m. This was a 25 per cent. increase on 1957 traffic quantities. Despite the greatly increased traffic carrying capacity of the network, B.R.S. anticipate an annual saving of £7,000 a year on the centre costs.

Proof of the pudding....

Experience at the London centre confirmed that a tape relay installation using push-button switching equipment would meet the needs at B.R.S.'s Glasgow office serving the Scottish Division. Here the requirement called for one main operating position, comprising five printing reperforators, one triple-headed transmitter, and push-button access to five duplex and five simplex circuits. The new centre opened in June and was hailed a complete success. The position was designed as a U-shaped console and was built in the Post Office Engineering Department's Telegraph laboratory. Fig. 6 shows the position, equipped with only four printing reperforators, undergoing design trials.

The future....

It is true to say, at the time of writing, that the installations described in this article provide the most efficient telegraph relay service in the country.

Tape relay systems, however, rely on the production and acceptance by mechanical processes of parchmentized paper ribbon, carrying information in the form of punched holes. Operators are needed to feed the machines.

Nowadays, thoughts of the future on many subjects inevitably turn to electronics, and so it is with telegraph relay systems. In fact, such a system has been designed (and is being installed at Gatwick New Airport) which will, receive, store, route and transmit teleprinter signals by purely electronic means.

Some Inland Telecommunications Statistics for the year 1957-1958

In this issue we are able to present some main statistics for the whole year, compared with those for the two previous years. The order list for telephones fell by over 74,000 during the year, while both inland and overseas telex calls rose by one million.

	31st March, 1956	31st March, 1957	31st March, 1958
The Telephone Service at the end of the year			
Total telephones in service	6,887,400	7,225,900	7,361,200
Exclusive exchange connexions	3,176,700	3,286,100	3,345,700
Shared service connexions	1,088,500	1,187,700	1,153,900
Total exchange connexions	4,265,200	4,473,800	4,499,600
Call offices	68,200	70,400	72,100
Automatic exchanges	4,662	4,784	4,897
Manual exchanges	1,282	1,196	1,099
Orders on hand for exchange connexions	343,600	246,100	171,400
Work completed during the year			
Net increase in telephones	396,300	338,500	135,300
Net exchange connexions provided	436,600	417,700	350,800
Net increase in exchange connexions	258,100	208,600	25,900
Traffic	*Millions*	*Millions*	*Millions*
Inland telephone trunk calls	333	321	327
Cheap rate telephone trunk calls	87	78	74
Inland telegrams (excluding Press and Railway) ...	20	16	14
Greetings telegrams	4	3	3
Inland telex calls	1	2	3
Overseas telex calls	1	1	2

Development and Application of Line Connectors

A. J. Barker, A.M.I.E.E. · *G. M. Blair*, C.G.I.A., A.M.I.E.E., A.M.Brit.I.R.E.

IN THE BRITISH TELEPHONE SYSTEM MUCH OF the plant is provided on a common-user basis, the scale of provision being dependent on the busy hour calling rate and the grade of service required. The local network, however, is such that each exclusive line, or pair of shared service connexions, is served by an individual pair of wires. For the average subscriber this plant is in use during only a small fraction of the day: indeed, many residential subscribers use their telephones only a few times a week—often outside the exchange busy hour.

It would seem, therefore, that the line plant associated with most residential and many small business users would lend itself to the application of common-user techniques. Such a proposal is made especially attractive when it is remembered that local line plant involves a vast capital investment.

The line connector represents a convenient means of applying common-user principles to the local line network. Connectors have been in use on the Continent for some years, are likely to come into extensive use in America and are now on trial in this country. They are designed to work in association with any standard automatic exchange. The principle is illustrated in Fig. 1.

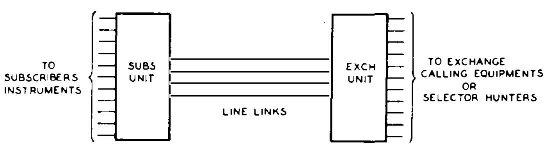


Fig. 1: Principle of line connector

The line connector consists essentially of two components. One is in the exchange and is termed the Exchange unit, while the other is in the distribution network and is known as the Subscribers' unit. The two units are connected by line links which are fewer in number than the subscribers, but available to all of them.

The line connector therefore applies to line plant the basic principles of exchange switching. In fact it can be considered as part of the pre-digital switching stage of the exchange outstationed in the distribution network. Hence, just as the quantity of exchange equipment is adjusted at all switching stages to give a predetermined grade of service, so the subscriber line-link ratio on the line connector can be adjusted to give a prescribed grade of service. In fact it can be arranged so that the service given to a subscriber on a line connector need not be noticeably different from that provided by orthodox means. It must be borne in mind, however, when considering grades of service, that calls between subscribers on the same line connector use two links, one to the exchange and one back to the called subscriber.

Subscribers on the connector have main exchange numbers and standard telephone instruments. Calls are made in the normal way by dialling; secrecy and an individual meter per subscriber are provided.

Uses of Line Connectors

There are likely to be three main fields in which the line connector will be used:—

First, the connector may have considerable value as an expedient to overcome a temporary shortage of plant.

Secondly, when line connectors become generally available they are likely to become an important factor in line plant planning as a permanent feature of the local line network, justified by normal costings.

Finally, there appears to be a useful field for exploiting line connectors as a means of replacing small manual and country satellite exchanges, without incurring the expense of an unattended automatic exchange (UAX).

We do not wish to outline all the facilities and other requirements for the British network, but the following points should be emphasized:—

1. A connexion established over a line connector should be capable of providing all the facilities at present permitted by a standard distribution cable pair.

2. The subscribers' unit must be designed so that:—

(*a*) It can be accommodated in a street cabinet.

(*b*) It is fault-free and all parts are easily accessible and easily removable.

(*c*) It is independent of local battery or power supplies; that is, it can be operated from the exchange battery supply.

3. The connector system can work under Subscriber Trunk Dialling (S.T.D.) conditions.

Types of Line Connector

The line connectors described below, are either in use or on trial in this country.

1. *Line Connector No.* 1.—This is in use in Scotland, mainly as an alternative to C.S.Xs (country satellite) or U.A.Xs No. 12. It serves 10 subscribers over two line links and operates on the synchronous switching principle. When calls are made, relays in the exchange unit and the subscribers' unit operate in unison to locate the calling subscriber and establish connexion between the instrument, via a line link, and the exchange equipment.

The special feature of this line connector is the type of selecting relay used in the subscribers' unit. These relays have carbon steel cores and are termed remanent relays as, once the core is saturated, it remains magnetized after the energizing current is disconnected and remains operated until it is released by passing a current pulse in the opposite direction to that which originally energized it. The advantage of using this type of relay is that no local power supplies are required.

2. *Line Connector No. 2x*.—This uses standard equipment and is under field trial in the South Western Region. It can serve 22 subscribers' lines. The basic principles are shown in Fig. 2.

Calls are set up and cleared down by a control relay set situated at the exchange unit. When not in use the control relay set allotter always stands on a free line link. Calls are originated by the calling subscriber's loop operating his line relays which mark his position on the connector/finder banks and initiates the start condition which is passed over the line link to the control relay set.

The control relay set on receipt of this signal starts to pulse out to both the subscribers' unit and the exchange unit over the link circuit on which its line allotter has been standing. The uniselectors at both units step in unison until the marked contact is reached. The control relay set also causes the calling equipment associated with the line link to be pre-operated and for a group selector to be seized. When the marked condition is reached on the finder/connector at the subscribers' unit, the control set ceases to pulse out and the link circuit is switched through to the group selector, the subscriber receiving dial tone. At the exchange unit the subscriber's meter is connected through to the calling equipment and the final selector multiple outlets are busied to incoming calls.

An incoming call follows the same pattern except that one of the exchange multiple calling relays is operated from the final selector over the *P* wire and this relay marks the required contact on the exchange connector/finder.

The most important features of this line connector are that it requires only one calling equipment per line link, it provides a metallic path free of insertion loss, no control wires are required, and the subscribers' unit can be accommodated in a cabinet cross connexion No. 1. However, a local battery is required at the subscribers' unit.

3. *Line Connector No. 3x*.—This is under field trial in Wales & Border Counties. It is similar in principle to Line Connector No. 2x. It can serve 24 subscribers and has five line links, but it requires in addition a control pair for setting up and clearing down calls.

4. *Swiss and American Type*.—Finally, there is a type of line connector in extensive use in Switzerland and America which utilizes a special type of cross bar switch. Its main features are speed of operation, reliability and ease of maintenance, and no local power supply. A typical size is 49 subscribers served over nine line links.

Application to Local Line Network

The size of connector most suitable for application to local lines has yet to be determined. Service to a community of subscribers could be provided either by a single large connector, or a number of smaller units. The economic size of connector would depend on many factors, including:—

(*a*) the number of subscribers to be served and the degree of dispersion of the subscribers;

(*b*) the physical construction of the route, which in turn depends upon the number of circuits to be carried;

(*c*) the variation of the cost of connector equipment with size;

(*d*) the ratio of the number of subscribers to number of links.

It is necessary to consider whether a range of

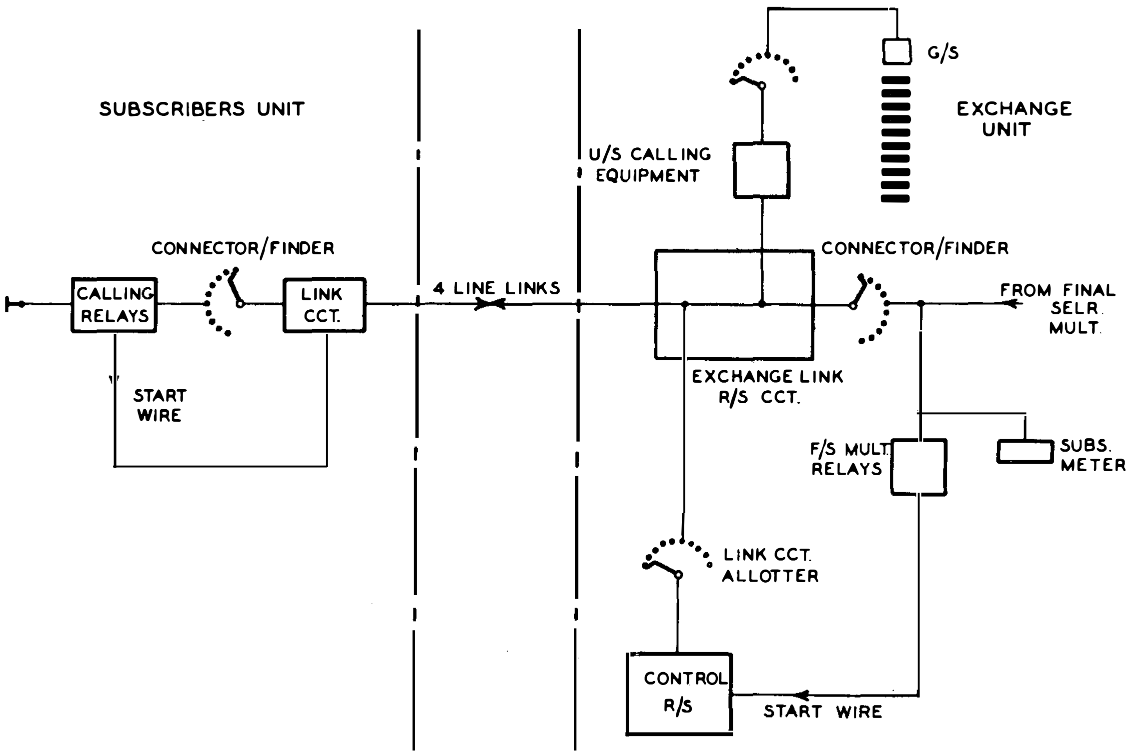


Fig. 2: Line Connector No. 2x

sizes is to be preferred to a single economic size which need only be partially equipped for small groups of subscribers, or could be stacked for larger groups. At present the size 20–25 promises well.

Use of Connector as an Expedient.—The principal way in which connectors are likely to be used in the immediate future is as an expedient. Connectors will often enable service to be given when normal means of provision cannot be undertaken for some considerable time. Each case must be dealt with on its merits, but as a general guide it would appear that one and a half years' additional rental would about compensate for the cost of the expedient; thereafter it would show a profit.

Use of Connector as a Long-term Measure.—A line connector could be incorporated as an integral part of a cable network as a long-term measure, justified by normal costing methods. A new balance between line plant costs and switching plant is established when a connector is introduced into the network. It is, therefore, necessary to compare the cost of a connector, and its appropriate line plant, with that of line plant provided under normal development. This is done by reference to the "economic distance", which is the length of route at which connectors prove-in. It can be stated simply as:

$$\frac{\text{Annual charges on connector equipment}}{\text{Annual savings in line plant per mile}}$$

It is not possible to state a precise distance at which connectors are economic. In practice, a study would have to be made of each individual case where connectors are proposed. However, to give a general indication of the economic distances involved it can be stated that, if two 25-line connectors were used with an overhead route serving a community or distribution area of 50 subscribers, incurring an inclusive capital cost of £10 per line (£500 total), the "economic distance" would be about two miles; and if the costs were £20 per line the "economic distance" would be about 2.8 miles.

Examination of various sizes of communities up to 1,000 telephones shows, however, that the economic route distance will always fall within three route miles (or approximately two miles radius) of the exchange. This demonstrates that there is scope for the use of connectors within an average exchange area. In actual practice, of course, these economic distances will be conditioned by the amount and type of existing plant. Obviously, if the need for augmenting the local line network can be avoided by exploiting existing pairs by the use of connectors, considerable savings are possible.

Planning Considerations.—The local line planning officer will be faced with an alternative method of providing plant and this he must now consider on the basis of engineering requirements and economics. If a connector scheme is justified, its flexibility, that is, its facility to allow for provision and cessation of telephone service within prescribed limits of a development forecast, is important. Arrangements have therefore been made to associate a cross connexion assembly, as used in pillars and cabinets, with the subscribers' unit of the connector. The present design of connectors permits the installation of the subscribers' unit, with an assembly, in a cross connexion cabinet of the smallest size. Not all circuits in a given distribution area need be connected through the connector and the assembly permits any subscriber's line to be served via the connector or over a direct pair of wires. Fig. 3 shows an assembly and the subscribers' unit of the Line Connector No. 3x housed together in a cabinet, cross connexion No. 1.

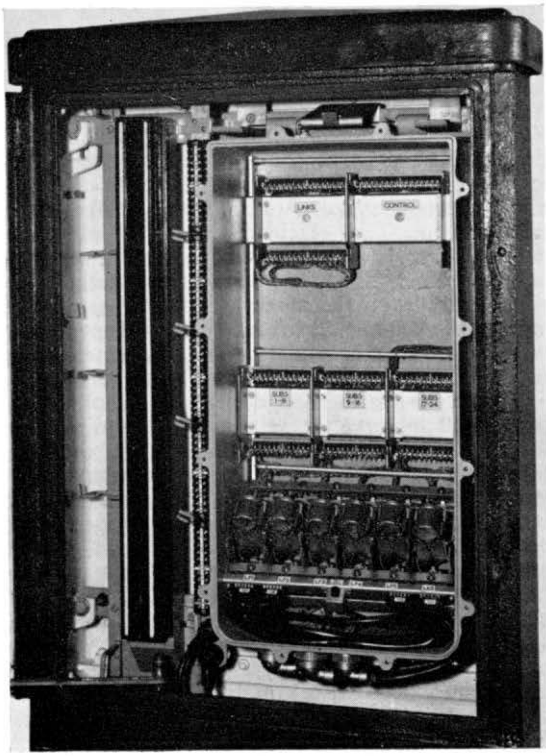


Fig. 3: Subscribers' unit of Line Connector No. 3x
(Courtesy A. T. & E. Co. Ltd.)

What of Shared Service?

Both shared service and line connectors are very valuable expedients. The connector could increase circuit carrying capacity up to five times compared with only twice with shared service.

Studies indicate that neither shared service nor line connectors are likely to prove economic within one mile of the exchange, and that in the outer areas line connectors are probably the better proposition. This conclusion is based on the premise that shared service lines incur hidden imponderable charges which include costs to allow for the difficulties associated with the procedural and technical requirements in the provision and maintenance of shared service lines.

It will be technically possible to permit the connexion of shared service subscribers to later designs of line connectors, but it has yet to be decided whether a form of shared service will be provided and what rentals would be appropriate.

The technique of line connectors is new to this country. The design of the equipment has yet to be standardized and the conditions of use determined so that the particular requirements of the British telephone system can best be suited. Further practical experience will no doubt cause some modifications to the ideas expressed in this article. Nevertheless, present developments are encouraging and the discriminate use of line connectors may prove to be a valuable aid in providing telephone service.

The Post Office Engineer-in-Chief and his 1,100 staff will have moved by the end of August to a new building, 2–12 Gresham Street, London, E.C.2, from Alder House and the six other City buildings in which they have for some time been scattered.

Communication between nations and between peoples

SIR GORDON RADLEY,

KCB, CBE, PhD, MIEE

'COMMUNICATION BETWEEN NATIONS AND between Peoples' is a subject that is very difficult to cover in the compass of an hour. In no branch of applied science—with the possible exception of the application of nuclear physics—has progress been more rapid during the past few decades. And there is a stimulating prospect of development during the remaining decades of the twentieth century far exceeding that which has already taken place.

It has been suggested that a time will come when most of us may possess, along with the other accessories of an electronic age, an instrument not much larger than a pocket-watch. It would have a screen on one side and ten buttons on the other. Using those buttons the owner would be able to call any other telephone subscriber the world over. The person answering would appear on the screen of the caller's instrument in three dimensions and in colour. The two would talk as if face to face.

Before dismissing that peep into the future as an idle fantasy, it is as well to remember that nearly all the facilities provided collectively by that pocket instrument can be provided separately now, although only by the use of expensive and bulky equipment.

Telephony between a mobile station and most of the 110 million telephone stations existing in the world is technically possible; subscriber dialling to call any telephone within the national network is an objective in many countries. By 1970, three-quarters of all long-distance calls in the United Kingdom should be dialled by the callers, and plans for international subscriber dialling are being made by the appropriate International Consultative Committee. Eurovision, enabling viewers in many Western European countries to enjoy programmes of foreign origin, has become an accomplished fact, and there are about 200,000 television sets receiving programmes in colour in the United States. Stereoscopic vision, like stereophonic sound, only requires duplication of the communication channel.

The development of communications is at a most interesting stage. The basic ideas for providing more immediate and more intimate communication have been worked out in terms of broad functional designs. The speed with which our ideas can be realized in the form of cheap and compact apparatus will depend very largely on the development of new or improved components, in some cases of components that will effect an electrical or electro-physical transformation more neatly than at present.

My paper will take the form of a report on the effects, past and prospective, on world communications, of four inventions. They are the telephone, the thermionic valve, the cathode-ray tube, and the transistor.

The Telephone

In a brief history of this kind I must leave out the telegraph, although it marked the start of electrical communication. My report stems from Dr. Graham Bell's first transmission of the spoken word beyond the range of airborne sound. Neither the electromagnetic telephone receiver nor the carbon microphone has changed fundamentally since their introduction. The efficiency of both has been greatly increased as a result of unceasing research and experiment, and the latest British designs are good examples of the modern telephone set. Some are notable because all the internal components can be mounted on a base-plate with interconnexion by means of printed circuits.

Within the United Kingdom a new telephone set is planned to meet the international requirements for transmission when connected to a subscriber's line with a loop resistance of 1,000 ohms. The greater efficiency of the instrument can mean worthwhile reductions in the size of the copper wires required in the distribution cables and in the amount of space which a cable providing a given number of connexions occupies in an underground conduit. Distribution by underground cables is almost universal in all urban areas, and the civil engineering costs involved in placing cables underground have been rising rapidly. They have followed the upward trend of labour costs all over the world. Therefore, any technical development which can reduce the need for civil engineering work, or postpone it, is particularly useful.

The problem of the rising cost of connecting a telephone subscriber to his local exchange will remain while each subscriber requires a separate pair of wires, or a share in a pair of wires, for this connexion. Any cheap method of providing multiple voice-paths over wires in local cables, so that each additional subscriber does not mean an additional pair of wires, would hold great promise for the future. A complete change of practice and the adoption, in simplified form, of techniques hitherto applied only to long-distance transmission would be necessary. A cheap solution may be brought nearer with the use of equipment employing transistors. In the meantime the outstationing of what are effectively parts of the telephone exchange, such as line connectors and ultimately electronic units, may keep down the cost of distribution.

The Thermionic Valve

The invention of the thermionic valve and the subsequent development of the valve repeater converted telephony from a local to an international means of communication. In combination with the coaxial cable, repeaters capable of handling a wide band of frequencies have made long-distance telephone circuits comparatively cheap. Cables transmitting up to some 1,000 speech channels within a single coaxial tube provide large groups of circuits between the main centres of population in many countries. In the United Kingdom the same line plant with appropriate repeaters is used to provide television links rented to the broadcasting authorities. As traffic demands, the spacing between repeater stations on some main routes in the United Kingdom will be reduced from 6 to 3 miles (9.7 to 4.8 km.). The traffic capacity will thereby be increased and each tube will provide a path for

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Sir Gordon Radley, Director General of the Post Office, and Sir John Cockcroft, Director of the Atomic Energy Research Establishment, were the only two speakers at the British Electrical Conference organized in May by the British Electrical and Allied Manufacturers' Association during the Brussels Exhibition. Sir Gordon's paper is reproduced by courtesy of B.E.A.M.A., the Association's journal.

1,000 telephone channels plus a 5-Mc/s. television channel. To meet both these requirements requires the use of valves of a performance better than anything in current use, but we have already achieved a measure of success in this direction.

The coaxial cable system is being augmented in some national networks by radio-relay systems operating on centimetric wavelengths (micro-wave) and capable of providing several independent broad-band transmissions. Each of these transmissions will carry several hundred telephone channels or a television channel. In these systems the signals are beamed over a line-of-sight path, amplified and retransmitted. A micro-wave radio-relay system, provided for television in the United Kingdom in 1952, was the first in Europe to use the travelling-wave tube as an amplifier.

Long-distance communication networks are developing in many countries on the basis of an integration of radio and physical links. In the United States these links take the form of micro-wave systems and coaxial cables. In some countries where the communication requirements are less—in Africa for example—they consist of V.H.F. radio relay systems and open-wire carrier.

The United Kingdom has traditionally been to the fore in the development of radio communications. Marconi brought his invention to England. Spark transmitters were used for the early experiments and for the early telegraph services. High-power valve transmitters came next and the British Post Office was a pioneer in the use of them for long-distance services. They made radiotelephony, and ultimately broadcasting, possible.

The American Telephone and Telegraph Company and the British Post Office were together responsible for the first public radiotelephone service between Europe and the United States. The service was opened over thirty years ago using high-power long-wave single side-band transmitters. Short-wave (high-frequency) transmitters with directional aerial arrays followed quickly and many of these were installed at Rugby, working to stations all over the world. Largely as a result, the United Kingdom became a centre for world-wide telephony. Many conversations between the widely dispersed Commonwealth countries and the rest of the world are still switched in London. For example, a telephone connexion from Beirut in the Lebanon to Sydney in Australia would be via London.

Rugby Radio

Radio transmissions must continue to play an important part in the longer distance point-to-point inter-connexions for many years to come and will continue to provide the only links to mobile stations, for example, ships and aircraft. In order to provide for services terminating in, or switched through, the United Kingdom, a new radio transmitting station has been built alongside the old one at Rugby. It was opened in 1955. The new station is probably the biggest ever to be built as a single project. It is certainly well in advance of any other in technique, and houses 28 high-frequency transmitters capable of providing independent transmissions on the two side-bands. The site will accommodate over 70 aerials, mainly of the rhombic type, arranged for communication to most main centres throughout the world. The station has been designed to reduce operating costs. All the transmitters are operated and monitored from a central control from which any transmitter can be brought into service on any one of the prescribed frequencies, connected to any aerial, and its performance monitored.

The particular susceptibility of the North Atlantic route to ionospheric disturbances, together with the inadequate number of radio frequencies to provide circuits, had long emphasized the limitations of radiotelephony for communications between Europe and North America. The long-life thermionic valve made inter-continental telephony by cable possible.

Transatlantic Telephone Cable

An agreement to lay a cable was announced in December, 1953; it was between the American Telephone and Telegraph Company, the Canadian Overseas Telecommunication Corporation, and the British Post Office. In order that the very large capital investment required should be profitable, revenue had to be earned on traffic carried by a large number of circuits. A long submarine telephone cable, particularly one transmitting a wide band of frequencies in order to provide many telephone channels, poses problems additional to the many that were associated with the first transatlantic telegraph cable. This operated at a speed of only three words a minute, corresponding to a top frequency of 1.5 cycles per second. The inductively-loaded telegraph cables constructed in the 1920s handled traffic at speeds corresponding to frequencies up to 100 c/s. If one of the new transatlantic telephone cables had to transmit signals at no frequency higher than this, its overall attenuation would be about 200 db; at the top frequency at which it is actually used the overall attenuation is 3,200 db—a power ratio of 10^{320}. Herein lies the greatest difference between the new transatlantic telephone cable and the world network of telegraph cables which have been installed during the past ninety years.

One of the large rigid both-way repeaters for the Canadian telephone cable being by-passed round the cable drum on H.M.T.S. *Monarch* during trials last year

It is only the amplification of the signals at intervals along the route that makes telephony possible over long submarine cables. A device to do this—the underwater counterpart of the repeater station on land—was constructed in the Research Laboratories of the British Post Office in 1942. It was used in the Irish Sea. In 1946 a coaxial telephone cable was laid between Lowestoft and Borkum, a distance of 196 nautical miles (314 km.), which contained one repeater in comparatively shallow water. These two early applications were the first uses of submerged repeaters for telephone traffic anywhere.

The next stage was to develop repeaters for operation in tandem. British experience of the frequent damage to cables in the North Sea and the Channel by fishing trawlers had led to a firm preference for making every cable self-contained. The Post Office therefore took as its target both-way speech transmission for a super-group of 60 circuits over a single cable. Separate frequency bands have to be used for the two directions, and the system designed originally for use in cables which already existed in the North Sea transmits 60 speech channels in the 'go' direction in the frequency band 24 to 264 kc/s; the corresponding channels in the 'return' direction are transmitted in the frequency band 312 to 552 kc/s. Low- and high-pass filters are necessary to separate 'go' and 'returns' channels in each repeater. The outputs from the filters are arranged to feed into a common amplifier.

The use of a single both-way cable, instead of two separate one-way cables, poses additional problems. First, because of the higher maximum frequency that has to be transmitted, both-way cables require more repeaters than would be required for voice channels in one direction only. Second, the electrical components necessary to make up the high- and low-pass directional filters in the repeaters are somewhat bulky. There was, however, ample room for these filters in the comparatively large rigid steel housings used for the early British repeaters. On routes where a single both-way cable will suffice for the traffic it is, however, much cheaper than two one-way cables.

Normal commercial valves were used for the early British repeaters. They were of a type known to have good life characteristics. Three failures have occurred, but in the shallow waters of the North Sea it is a comparatively easy operation to replace a repeater. On the other hand, replacement of a repeater in deep water may be a most hazardous and expensive operation, particularly if it has to take place in winter. Faced with the probability of valves being required for use in ocean cables, the British Post Office Research Laboratories gave attention to the design of valves meeting the specific requirements of submerged repeater usage. The objective was a high-transconductive valve, capable of wide frequency coverage but only requiring a low anode voltage. Expectation of very long life was essential. It was also necessary that performance should not change appreciably during life. As a result of intensive laboratory research on the electro-chemical processes occurring during the life of a valve, a considerable measure of success has been achieved. Valves are now available in the United Kingdom meeting these exacting requirements.

A telephone cable containing seven repeaters in housings of an improved type was laid in 1954 between Scotland and Norway. The cable is about 300 nautical miles (560 km.) long and was, at the time, the longest submarine telephone cable in the world.

This Scandinavian cable introduced a new technique in repeater circuit design. The amplifier in each repeater had two forward paths in parallel with a single feed-back path. The duplication of valves and other components provided by the two forward paths was so arranged that any valve or other component could fail in practically any way without affecting the overall performance of the repeater. The arrangement enables modern valves and other components without a long life history behind them to be used with greater confidence.

At the end of 1954 when manufacture of the translantic cable was started, there were 41 submerged repeaters operating in telephone cables in European waters. All these cables and repeaters had been constructed in the United Kingdom and laid by British ships. The only other submarine telephone system anywhere in the world containing repeaters was that consisting of a pair of cables connecting Key West in the United States with Havana. These cables are approximately 120 nautical miles (221 km.) long and lie in water nearly a mile deep. Each cable contains three repeaters and provides one-way transmission for 24 voice channels. This system represented the culmination of many years of work in the American Bell Telephone Laboratories on the development of coaxial cable and repeaters suitable for a transatlantic crossing.

It here becomes necessary to say something about the process of laying cable at sea. The basic machinery now in use on ships is a drum about which the cable is looped as it passes from the cable tanks to the sea. The drum is braked to prevent the cable from slipping too rapidly into the water; it is driven when cable is being picked up.

Repeater Housings

The British repeater housings used for the cable between Scotland and Norway were designed to withstand the water pressure at depths of more than two miles below the surface. Each housing was a rigid steel case, about 10 inches (25 cm.) in external diameter, nearly nine feet (2.7 m.) long, cigar-shaped and in line with the cable. These rigid repeater housings will not, of course, follow the cable around the cable drum but, with manual handling of the repeater past the machinery, it has proved quite practicable to lay large, rigid housings at intervals of about 16 nautical miles (29.8 km.) in comparatively shallow water. The ship must be stopped and the assistance of practically all the deck crew is required. A risk of damage to the cable arises if the operation is undertaken in deep water because the stored torsional forces in the steel armouring wires tend to throw turns in the cable. The turns may be subsequently pulled into kinks, so damaging the cable structure. This is likely to happen if the ship stops with a long length of cable suspended below it.

The desirability of a structure which would behave as nearly as possible like a corresponding length of cable led engineers in the Bell Telephone Laboratories to the design of a flexible repeater housing. This housing will go round the normal cable machinery without damage to itself and can be paid out without stopping the ship. It consists of two layers of butt-jointed steel rings which support an envelope in the form of a long copper tube. The housing, and the seals by way of which the inner conductor is admitted to the central compartment, will withstand a water pressure of three or four tons/sq. in. (6 kg./sq. mm.). The internal diameter of the central compartment is not much more than 1 inch (2.5 cm.); the compartment is about 10 feet (3m.) long. It contains three valves and about 60 other electronic components. This housing was first used for the Key West–Havana cables.

The choice of this form of repeater housing for the main section of the first transatlantic cable was determined by the fact that proved reliability and the avoidance of unnecessary risks in handling cable and repeaters were essential in the pioneering and costly venture to be undertaken. The small amount of space available in this flexible housing for the electrical components, the knowledge that every additional component would add a potential risk of failure, and the fact that simplicity of design and reliability usually go together, dictated the choice of repeaters which would only amplify signals passing in one direction. There are, therefore, twin cables between Scotland and Newfoundland; one transmits speech from East to West, the other in the reverse direction. Each cable contains 51 repeaters. Each repeater compensates for the loss in the 38 miles (61 km.) of cable preceding it, increasing the power of the signals roughly one million times. Together the two cables provide 36 telephone circuits, each circuit occupying a 4 kc/s. channel in each cable. The highest frequency transmitted is 164 kc/s.

Newfoundland is joined to Nova Scotia by a single both-way cable providing 60 telephone circuits. The cable lies in comparatively shallow water. It contains 16 repeaters. The core design and diameter is the same as that used for the main transatlantic crossing, with armouring appropriate to the depth of water in which the cable lies. Because of the higher frequencies that have to be transmitted to meet the requirements of a greater number of circuits and both-way transmission, the 16 repeaters are only 20 miles (32 km.) apart.

Practically all the cable required for the first transatlantic system was manufactured in the United Kingdom. American-made repeaters for the main crossing were flown to the United Kingdom and joined into the cable before it was loaded on to the cable ship *Monarch*. The repeaters for Newfoundland–Nova Scotia were of generally similar design to those first used for the Norwegian cable and were made in the United Kingdom.

The key to the success of this project was the possession by the Post Office of the cable ship *Monarch*. *Monarch* is the only cable-laying ship afloat capable of laying a cable across the deep section of the North Atlantic in one operation. This was desirable in order to avoid the risk of kinking if the laying operation had to be stopped in order to make a joint with deep water under the ship. The whole operation, including the laying of the cable from Newfoundland to Nova Scotia, took two summers, during the course of which at least one repeater had to be laid in a gale which would have made any cable-laying operation difficult.

Installation of the cable system meant the placing of 400 valves and about 7,000 other components on the ocean-bed. Between Newfoundland and Scotland, failure of any valve would mean that telephone conversation over the cable would cease. So far none has failed.

The cable was opened for traffic in September, 1956. During the first twelve months very nearly 300,000 telephone calls were connected between the United Kingdom and North America. In addition the cable carried about 130,000 calls between the United States and Continental countries over seven circuits leased to foreign administrations, including one circuit terminating at Brussels. At the end of last year telephone traffic between the United Kingdom and the United States was twice what it was before we had the cable; traffic to Canada had increased three times. Cable capacity, especially to Canada, has become a limiting factor at peak traffic periods. The number of circuits to Canada has recently been doubled at peak traffic periods by the use of specially designed narrow bandwidth channels. Traffic is still increasing.

Speech Channels

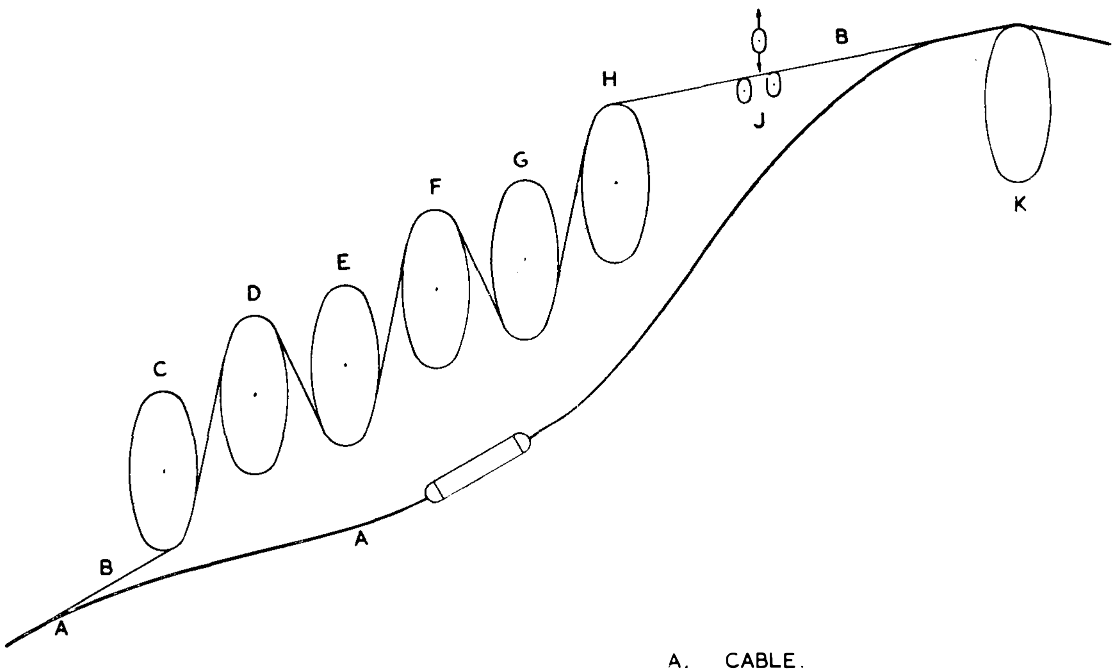
At present the speech channels are normally spaced 4 kc/s apart. The range of speech frequencies effectively transmitted extends from 300 to 3,400 c/s, thus meeting the international requirements for long-distance telephone circuits. The British Post Office, working in conjunction with a manufacturer, has developed equipment which will give practically the same quality of speech transmission with channels spaced only 3 kc/s apart. The result represents a notable achievement in the design and construction of channel filter equipment, wasting less than 200 c/s per channel in place of the 900 c/s lost with the normal channel spacing. Use of 3 kc/s channels will, of course, increase the traffic capacity of the cable by $33\frac{1}{3}$ per cent., and it is likely that all new cables will be planned on the basis of 3 kc/s channels.

Another engineering development being undertaken by the Bell Telephone Laboratories may, if successful, add further to the capacity of transoceanic telephone cables. This it will do by taking advantage of the intervals when people are listening. The speech channels left temporarily unused will be assigned to other conversations, but when a listener starts to talk he will instantly have the use of a channel which is temporarily idle.

In 1957 the American Telephone and Telegraph Company completed twin cables from the American Pacific seaboard to Hawaii, part way across the Pacific Ocean. This twin-cable system repeats the design of the first transatlantic cables between Newfoundland and Scotland. The American Company has also announced its intention, with the French and Federal German Administrations, to lay a second transatlantic system in 1959. This again, will be similar to the system completed in 1956, and follow the same route except that it will land in France instead of in Scotland.

A cable is proposed for 1961 which will represent a distinct technical advance from these early transoceanic submarine cable systems. The cable will be between the United Kingdom and Canada and provide for the growth in Canadian communications. The project will be undertaken by Cable and Wireless and the Canadian Overseas Telecommunication Corporation, with technical assistance from the British Post Office.

There will be a single cable providing 'go' and 'return' speech channels for 60 telephone circuits (80 if 3 kc/s channels are used). To provide these facilities over one cable instead of two will require about 90 repeaters—one every 25 nautical miles (46 km.).



LAYING GEAR FOR RIGID REPEATERS
H.M.T.S. "MONARCH"

Because the repeaters for the new Canadian cable must amplify signals passing in both directions the repeater housings will have to accommodate directional filters. This means that they must be fairly large, and therefore rigid. The flexible type of housing is not only inadequate for both-way repeaters but provides no room for duplication of circuit elements or components in any repeater. New types of laying machines to handle rigid repeater housings as part of a continuous cable-laying operation have been tried in the laboratory and at sea. The method adopted for the Canadian cable will be to use a loop of dummy cable which will pass round a series of coupled V-sheaves replacing the cable drum. The repeater will be free to by-pass the machinery.

Repeaters in rigid steel housings were laid experimentally by the new method during February, 1958. The trials took place in water 2¾ miles (4,420 m.) deep, some of them in rough weather. No difficulties were experienced with either the repeaters themselves or with the cable because of their inclusion. A new type of deep-sea cable was used.

For the last few years the Post Office has been experimenting with a new type of construction in which the strength member is placed at the centre of the inner conductor. High-tensile steel wires can be used and in stranded form can be designed to have no tendency to twist under tension. Since protection is unnecessary in deep water, where almost perfect quiet reigns, no outer steel armouring is necessary. Armouring must be introduced where the water becomes shallow. But it is possible that armoured deep-sea telephone cable will rapidly become obsolescent.

Radio relay stations of the future operating on centimetric wavelengths will look like this. Microwave links will replace multiple aerial arrays

The Cathode-Ray Tube

From the transmission of sound we pass to that of vision.

Television would have remained in a very elementary stage had not electronic methods of picture scanning and reproduction been devised. By 1935, a stage had been reached in the United Kingdom when Shoenberg was able to suggest a high-definition system of 405 lines with 50 picture frames per second (interlaced). Transmissions using this system were started by the B.B.C. in November, 1936, and Britain takes pride that this was the first regular system of high-definition television broadcasting anywhere. By the end of 1957, coverage of the B.B.C. television service exceeded 98 per cent. of the population of the United Kingdom.

Since 1936, there have been continuous improvements in electronic cameras using cathode-ray scanning of an electrically charged screen, and in the cathode-ray tube as a viewing service. As a result of extensive electronoptical development work by Gabor in the United Kingdom, a flat thin television tube for monochrome or colour now appears feasible. Its thickness is only about one quarter of its screen diagonal. Higher definition systems have been introduced for public entertainment. Quite apart from these, closed circuit television has extended our ability to see at a distance for a variety of purposes, from traffic control to investigations at the bottom of the sea and the inspection of manufacturing processes.

The introduction of colour has appeared imminent for several years, and broadcasts in colour have been regularly made in the United States since 1953. But although great technical ingenuity has been exercised in the development of colour systems, and field trials are being carried out in the United Kingdom and elsewhere, the large-scale introduction of regular colour services appears to be some way off. To a great extent colour development must be influenced by the existence of some 64 million receivers capable of receiving in monochrome only. A fully compatible system is essential. This means that colour transmissions must be receivable in black and white on normal monochrome television receivers, and conversely that a monochrome transmission should be receivable in black and white on a colour receiver. Both these results should be obtainable without undue degradation of the picture.

And finally they should be achieved without any very large increase in the frequency bandwidth required for the colour transmission.

The American National Television Standards Committee (N.T.S.C.) system was designed to meet these requirements. In it the luminance and chrominance information is transmitted separately, the chrominance signal being located within the frequency band normally occupied for the transmission of the black and white picture. In the receiver the colour effect results from the simultaneous viewing of red, green, and blue pictures, using a threegun cathode-ray tube with an in-built shadow mask. Many engineers feel that a basically simpler reproducing device is required before colour television can become cheap and popular.

The Transistor

The invention of the transistor was announced on June 30, 1948. The transistor illustrates in a beautiful way the manner in which developments in widely separated branches of science can come together, and all play an essential part in producing a new facility. Much of the basic research in the realm of solid state physics leading up to the invention was undertaken by Bardeen and Brittain in the Bell Telephone Laboratories, but the contributions made in the more theoretical field by such workers as Mott must not be overlooked. The announcement of this device seemed at once to open up the possibility of new developments in telecommunications. I propose to mention three.

The first is in the development of carrier-frequency telephone transmission systems suitable for short distances and lightly loaded routes. The transistor amplifier requires only a small amount of power which can be taken from a low-voltage source, and with care in the manufacturing process the life of a transistor should be long. These are great advantages. So, of course, is the very small size of the transistor itself and consequently of the apparatus which uses it. There is the possibility of reliable, cheap, and small transistor amplifiers being installed on poles and in manholes, and a transistorized rural carrier system of British design and manufacture is now in fact available. This carrier-frequency equipment is operated from batteries and this enables the benefits of multichannel working to be extended to areas where no electricity mains are available.

The second possibility is the use of transistor amplifiers in trans-ocean telephone cables, where the supply of power to valve amplifiers often constitutes a problem. In the first transatlantic telephone cable system, d.c. power is fed to the 51 repeaters in each of the cables between Newfoundland and Scotland by constant current generators at the two ends. The total driving voltage required is 4,000; with transistor amplifiers the voltage requirements would be much less.

Much work has yet to be done to mature the transistor art to the level of the thermionic valve. Positive evidence of long-term consistency of characteristics and long trouble-free life is required before they are adopted for underwater working. The art is, however, a progressive one and transistor amplifiers suitable for submarine cables may be developed.

If transistor amplifiers with low power requirements can be embodied in small repeaters connected into a cable at relatively short intervals, the widening of the transmission band could provide for more speech channels with accompanying decrease in cost per circuit. During the first 90 years of electrical communication across the North Atlantic, the highest frequency which could be transmitted on a cable channel increased from $1\frac{1}{2}$ c/s to 100 c/s. Within the last five years it has increased to 164,000 c/s. With the opening of the Canadian cable in 1961 it will become over half-a-million c/s. One-way transmission of television of reasonable definition and quality should be achieved within a frequency bandwidth of not more than 2 Mc/s. Television cables between Europe and North America appear quite a technical possibility within the next ten years.

The third application of the transistor is in the switching of telephone circuits. Eighty per cent. of the world's telephones now depend on automatic switching for local calls. In most countries the operators who handle the remainder are rapidly being replaced by machines.

The development of automatic switching in the United Kingdom has been based on the use of the step-by-step system and two-motion mechanical switches. The system and equipment are simple in principle, easy to maintain compared with some other electro-mechanical systems, and versatile in application. Embodied into a director network, step-by-step equipment has provided for the requirements of very large multi-office areas, such as London and Manchester. It has provided also the simpler switching facilities required in a small rural exchange. British-made step-by-step equipment is giving satisfactory service all over the world under widely varying conditions of service. Switches and apparatus have been improved in mechanical design during recent years, and the installation of modern step-by-step equipment should remain a satisfactory way of meeting telephone switching requirements for many years to come. Taking a slightly longer view, however, it appears that developments in the electronic field should make it unnecessary to rely on the positioning of mechanical switches as the only practical way of connecting two telephone circuits together. Use of electro-mechanical switches and relays to store dialled information, for the later control of a complicated switching operation, seems likely to be even less necessary in the future because of the great amount of progress that has been made in the development and use of electronic memory devices in computers and control systems generally. Cathode-ray tubes with thousands of tiny capacitors deposited on the screen, assemblies of cheap mass-produced ferrite cores, delay lines, and the magnetic drum are four different forms of electronic memory that have been used for storing large amounts of information. Magnetic storage has made considerable progress during the past year or two. The art of storing information electronically has now reached a stage when all such requirements of a telephone exchange could be easily met. The problem of connecting two speech circuits together is a more difficult one. There are three possible ways of doing this. The first is by using gas diodes, or some other device for interconnecting the speech circuits in a space multiplex. The second arranges the circuits to which connexion can be offered in a frequency-division multiplex. The third does the same in a time-division multiplex. The system which has reached a late stage of development in the United Kingdom uses time-division multiplex for interconnecting the speech circuits and for control.

Many telecommunication laboratories throughout the world are pressing on with the development of electronic switching systems which, sooner or later, will render the present electro-mechanical systems obsolescent. In the United Kingdom, research and development resources have been pooled for this purpose by the Post Office and the telephone industry, as represented by the five principal switching equipment manufacturers in it. A basic design has been chosen after consideration of the experimental work done by all. Development and construction of the functional units is now being shared between the parties with the target of having an all-electronic exchange constructed and ready for bringing into public service at Highgate Woods in North London in 1960.

Ultimately the production cost of an electronic exchange is likely to be less than that of the corresponding mechanical equipment. Smaller and cheaper buildings will suffice to house the equipment, and incidental savings in capital expenditure on local cables will be possible if the network can be adapted to the system. Maintenance costs should be appreciably less.

All this, however, will depend on the extensive use of transistors within the exchange circuits. Valves could be used for the particular functions for which transistors are envisaged, but the power and space requirements of an all-electronic exchange, engineered exclusively with valves, would make it impossible to realize the expected savings under these heads.

It is perhaps appropriate that I should conclude with this reference to progress in the art of switching telephone circuits. It will become easier to connect two people together wherever they may be. The other developments which I have been able to describe in this paper leave us far short of that peep into the future which I gave you at its beginning. But research is vigorously in progress in many laboratories. It has been said that its objective is to enable anyone, anywhere, to pick up a telephone and to speak to anyone else, anywhere else, quickly, clearly and at reasonable cost.

Dr. M. A. Andrada

News of the sudden death on June 18, 1958, of Dr. Marco Aurelio Andrada, the Secretary General of the International Telecommunication Union, was received with the deepest regret by his many friends in the Post Office.

Dr. Andrada, who would have been 54 on June 24, became Secretary General of the ITU on January 1, 1954. He was a native of Argentina, a graduate of the Law Faculty of the University of Buenos Aires and a Doctor of Legal and Social Sciences of the same University. He held many important posts in the Argentinian Administration of Posts and Telecommunications, and from March, 1949, until he took up his appointment in the ITU, was Secretary General of Posts and Telecommunications in Argentina.

In addition to his official duties, Dr. Andrada had held several public offices in Argentina including that of Minister of Public Finance and Education in the Province of Corrientes. He represented Argentina at many ITU conferences including those at Atlantic City in 1947, and led the Argentinian delegation to the International High Frequency Broadcasting Conference at Mexico City in 1948–9. He also represented Argentina in the Administrative Council of the ITU from 1948 to 1952 and in the Executive and Liaison Committee of the Universal Postal Union from 1948 to 1951. He was Chairman of the Conference and Head of the Argentine delegation at the ITU Plenipotentiary Conference at Buenos Aires in 1952 during which he played a notable part in framing the International Telecommunication Convention (Buenos Aires) 1952.

As Secretary General of the ITU and Secretary of the Administrative Council, Dr. Andrada earned the respect and affection of all those members of the United Kingdom Administration who worked with him. They knew him as an extremely able, sincere and conscientious man who directed the general secretariat and the day-to-day work of the ITU with humanity, wisdom and a whole-harted devotion to the cause of international telecommunications. His tragic and untimely death is a grievous loss to the Union.

Radio link for Rheinigidale

L. Davies

IN THE HOUSE OF COMMONS ON MARCH 28 THE Postmaster General promised telephone service by radio link by the end of June for the 30 inhabitants of Rheinigidale, a hamlet at the foot of steep cliffs, at the southern end of Loch Seaforth on the east coast of Harris in the Outer Hebrides. The service was in fact opened on May 28.

The only overland route to Rheinigidale is by three miles of road from Tarbert, four miles of moorland footpath, and a track down the cliff face. It can also be reached by boat from Tarbert, and by boat from Maaruig on Loch Seaforth.

An overland line to Rheinigidale would be impracticable because of the difficulty of erecting and maintaining a pole route across the moors and down the cliff, and it would have cost £2,000. A submarine cable would also have cost £2,000.

For a radio link there is no optical path between Rheinigidale and Harris Exchange. Experiments showed that a link along Loch Seaforth to a point above the Stornoway–Tarbert road would give insufficient margin to cope with failing batteries or bad weather affecting propagation. To connect the radio terminal by landline from the north end of the Loch with Harris Exchange would have cost £3,000, in addition to the cost of the radio link.

Further experiments showed, however, that a radio link would be practicable by way of Duntulm on the northern tip of Skye and the existing radio station at Gairloch on the West Coast.

Equipment for the Rheinigidale terminal was transported along the Stornoway–Tarbert road and over a mile and a half of unmade road to Maaruig. There is no pier at Maaruig and loading the small boat, which was hired at a cost of £5 per trip to Rheinigidale, was no small problem. The 50-foot spliced pole used for mounting the aerial was towed behind the boat. The equipment was unloaded at a pebbled beach about half a mile from Rheinigidale, and rocks forming a natural pier simplified the problems of unloading. This could not have been done in the winter because of the rough seas; even at other times of the year the wind has to be favourable (south-west to north), otherwise landing is impossible. More than 400 yards of polythene cable were buried in a hand-dug trench to connect the radio terminal 300 yards up the cliff face to the house of the local postman who had already agreed to act as a call office attendant and to receive all incoming calls.

At Gairloch, four 55-foot stoutpoles each weighing about half a ton, had to be hauled 600 yards by tractor and winch up to the radio station, to 500 feet above sea level. The road up to the radio station resembled a river bed. At some points the gradient was one in four and where the poles could not be dragged by tractor the winch had to be used.

Gairloch Exchange is in the Inverness Trunk group and calls between it and exchanges in the Isles of Lewis and Harris are connected via Inverness and Stornoway. The circuits connecting Inverness and Stornoway exchanges are routed via underground cable and overhead to Gairloch, thence by radio or by submarine cable to Stornoway. A call between Rheinigidale and Harris Exchange—radial distance, five miles—would therefore have normally been connected over four links with a total of 216 radial miles. To cut down the number of links and to lessen fault liability a direct route of one both-way circuit has been provided between Gairloch and Stornoway. There were spare channels in the carrier between these two places and this new route reduced the radial mileage on calls to Harris to 100 miles.

Rheinigidale is in the Harris charging group and the charge for a call between Rheinigidale and Harris Exchange is 4d.!

Quality Control

H. Moran

THE POST OFFICE BUYS AND USES VAST quantities of stores and equipment each year. Much of this equipment, like most other things which are used in modern life, is made under a system of mass production. British manufacturers pride themselves on the high quality of their goods, but how do they maintain this high quality? The purpose of this article is to give some idea of the theory behind "quality control".

The basic principle of quality control is to prevent faulty work being produced, by warning the producer—before the work is outside the limits laid down—that the job is deteriorating. This principle applies equally well whether the control is applied to a manufacturing process or to the measure of a public service.

Before proceeding further some attention should be given to the laws governing the distribution of individual items, which are subject to variations, in relation to the whole population of which they form part.

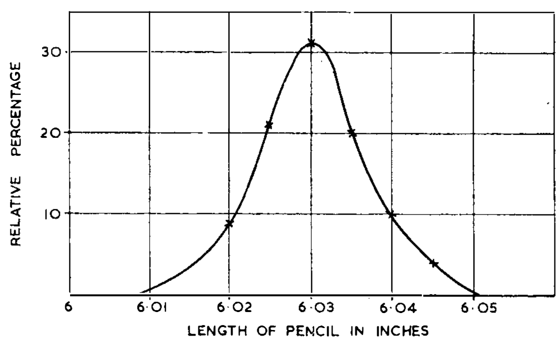
It is usual to assume that the arithmetical mean gives a measure of central tendency, that small deviations from the mean are more likely to occur than very large ones, and that positive and negative deviations with respect to the mean are equally likely.

If a number of items subject to chance variation are observed and the results plotted on a graph the resultant curve will be symmetrical. This is known as the curve of *Normal Distribution* and is shown in Fig. 1. In this example 10,000 new pencils have been measured for length and the results are tabulated. The relative frequency percentage is plotted on the graph. The result is shown as a symmetrical curve.

The value X is used to indicate the arithmetical mean of all the readings taken. The symbol σ represents a measure of the amount by which individual items tend to deviate from the average, taken to the arithmetic average of the total of these deviations. This is usually known as the root mean square of the deviations or the *Standard Deviation*. It can be seen from Fig. 1 (*a*) that 68 per cent. of the items are in the range $\pm \sigma$, 95 per cent. within the limits $\pm 2\sigma$, and 99.7 per cent. within $\pm 3\sigma$. Thus, the length of the base of the curve can be regarded as 6σ. All distribution under this law follows the same pattern, the only difference being in the value of X and σ. This is shown in Figs. 2 and 3. It will be obvious from Fig. 3 that, to keep the area within the curve constant, the height must increase as the base decreases. The area under any portion of the curve is the probability of any particular event happening within certain limits of σ, the total probability being unity. An example of this is shown in Fig. 1. The probability that the pencils will not be more than 6.04 inches or less than 6.02 inches is given by the ratio of the area enclosed by the curve and the ordinates erected at 6.02 and 6.04 to the total area of the curve which is unity.

Suppose we could take a batch of an infinite number of items; that is, a batch that would be

Fig. 1: Curve of normal distribution and table of results



Length in Inches	Quantity Found	Relative Percentage
6.01 to 6.015	50	0.5
6.015 to 6.02	380	3.8
6.02 to 6.025	900	9.0
6.025 to 6.03	2100	21.0
6.03 to 6.035	3110	31.1
6.035 to 6.04	2000	20.0
6.04 to 6.045	1000	10.0
6.045 to 6.05	400	4.0
6.05 to 6.055	60	0.6
TOTALS	10,000	100

virtually unaffected by the extraction of the sample and let us assume that in this batch there are 10 per cent. defective items. Now, if we take a sample of one item at random, the probability of its being defective, which we shall call P, will be $\frac{1}{10}$ or 0.1, and the probability of its being good, which we shall call G, will be $\frac{9}{10}$ or 0.9. By this same reasoning any combination of probability of defective or good items in a sample of two can be calculated, as shown in the table.

Both defective	Both good	Both either good or defective	One of each
$P \times P = P^2 = (0.1)^2$ $P^2 = 0.01$	$G \times G = G^2 = (0.9)^2$ $G^2 = 0.81$	$P^2 + G^2 = 0.01 + 0.81$ $P^2 + G^2 = 0.82$	$1 - (P^2 + G^2) = 1 - 0.82 = 0.18$

Put another way, the probability of one defective item and one good item being present in the sample can be expressed as $2PG = 2 \times 0.1 \times 0.9 = 0.18$. The above figures will now become familiar as the terms of expression $(P + G)^2$ which are $P^2 + 2PG + G^2$. It can now be supposed that the probability of a number of defects in a sample of n items in a batch, taken at random, is given by the successive terms of the expression $(P + G)^n$ reading from left to right, when P = proportion of defects and G = proportion of good items, for example in a sample of four items, when the number of defective items is 10 per cent. $(P + G)^n = (0.1 + 0.9)^4 = P^4 + 4P^3G + 6P^2G^2 + 4PG^3 + G^4$.

The probability of—

4 items being defective	$= (0.1)^4$	$= 0.0001$
3 „ „ „	$= 4(0.1)^3(0.9)$	$= 0.0036$
2 „ „ „	$= 6(0.1)^2(0.9)^2$	$= 0.0486$
1 „ „ „	$= 4(0.1)(0.9)^3$	$= 0.2916$
0 „ „ „	$= (0.9)^4$	$= 0.6561$
Total Probability		$= 1.0000$

If we use these figures as a percentage of a number of samples of four items taken from a batch of items of which 10 per cent. are defective then 0.01 per cent. of the samples will have four defective items which might suggest that all items in the batch were faulty; 0.36 per cent. of the samples will have three defective items, which might suggest that 75 per cent. of the batch were faulty, while at the other end of the scale 65.6 per cent. of the samples will have no defects at all, which might suggest that the batches from which they were taken were perfect. Thus, two-thirds of the samples give an optimistic estimate of the number of defective items in the bulk. This is to be expected when the proportion of defects in the bulk is small. However, one-third of the samples will give a very pessimistic estimate of the proportion of defective items; that is, 25-100 per cent., which is much worse than the actual proportion of defects in the bulk. It is seen therefore that small samples are of little use in isolation.

In the foregoing distribution of probability p of defective items being present in a sample of n items the mean would be np; for example, in a sample size of 100 items and a total of 10 per cent. defects in the batch the mean equals $np = 100 \times 0.1 = 10$. Pursuing this a little further the standard deviation—$npg = 100 \times 0.1 \times 0.9 = 3$.

In modern times inspection of mass produced items takes the form of sampling. The usual practice is for the goods to be submitted in batches of N items and a small sample of n items examined and if the number of defectives found is more than d then the whole batch is rejected. In arriving

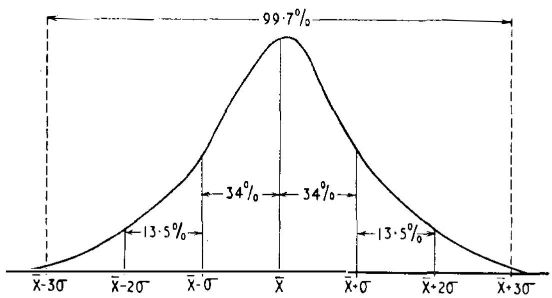


Fig. 1a: Normal distribution

at a value for d two controlling limits must be set: one to protect the manufacturer, called the Process Average, and one to protect the customer, called the Tolerance Per Cent. Defective.

The Process Average is the normal quality which the manufacturer can maintain and the Tolerance Per Cent. Defective is the quality limit which the customer would want to be sure of rejecting. An example of this is shown in Fig. 4. This arrangement is fair to both sides and in practice many such schemes are agreed on.

Turning back to the normal curve, we have seen the X and σ represent the Mean and the

Standard Deviation of individual items. Now consider the effect of a sample of *n* items. The larger the sample the nearer, of course, will the mean of the sample approach the mean of the population from which they were drawn. It can easily be seen then that the distribution for sample averages will have a smaller Standard Deviation than that for individual items (Fig. 5). In actual fact, while the Normal Distribution is maintained the Standard Deviation decreases as the square root of the number of items in the sample.

$$\frac{\sigma}{n} = \frac{\sigma}{\sqrt{n}}$$

e.g. Average number of peas in 1 lb. bag = 580
Standard Deviation σ = 60

$\therefore$ Standard Deviation for 9 separate 1 lb. bags

$$= \frac{\sigma}{9} = \frac{60}{\sqrt{9}} = \frac{60}{3} = 20$$

$\therefore$ Standard Deviation for 144 separate 1 lb. bags

$$= \frac{\sigma}{144} = \frac{60}{\sqrt{144}} = 5$$

The purpose of control charts is to show at a glance whether or not the population from which the sample is taken is up to the required standard.

If a large number of mass produced items were measured for some particular characteristic, say the make-break ratio of dial impulsing springs, then, if the manufacturing process is constant, the results will be in the form of the Normal Curve. The average will be X and the standard deviation will show the degree of control exercised. If the quality of the manufacturing process and testing is high the variations between separate items would be small and the standard deviation would also be small. On the other hand if the process is less efficient the variation would be greater and also the standard deviation.

The object of mass production is to break down the manufacture of a product into its component parts so that one workman or machine performs a single operation over and over again. To this end the factory is carefully planned and laid out and a good deal of expensive machinery and jigs are used. Each operation is carefully timed. Large numbers of standardized parts are turned out and each operation is carried out by one person, who becomes an expert.

In mass production consistency of quality is the main aim so that in the finished product any two items picked at random should be more or less identical.

To obtain this consistency a proper system of inspection is necessary. This inspection should be carried out whenever possible at the place where the goods are being made; that is, the production line. One method would be to have an inspector making periodic spot checks. This would have the advantage of enabling defects to be found on the spot and any corrections made. However, an inspector making spot checks is in effect taking

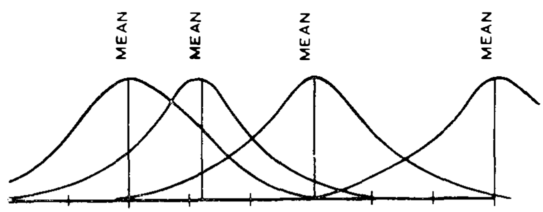


Fig. 2: Normal distribution—varying values of $\bar{X}$

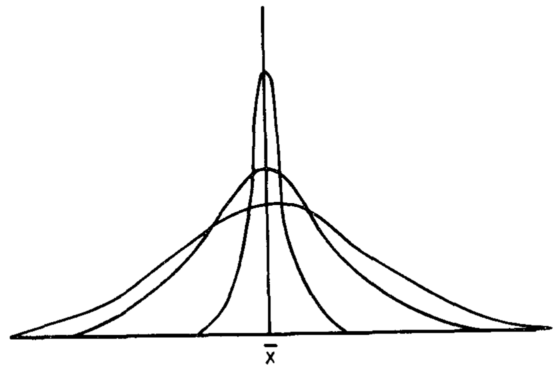


Fig. 3: Normal distribution—varying values of σ

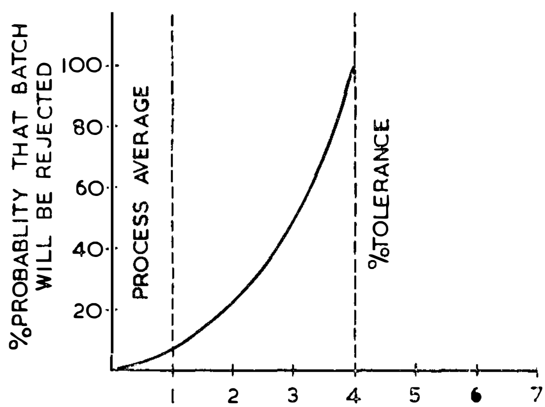


Fig. 4: Percentage defective

small samples every now and again, and we have already seen how unreliable small samples can be on their own. The answer is for the inspector to record the results of the sample on a chart on each visit to the production line. This will now give a cumulative impression of the standard of production.

Suppose we take a sample of each day's output from the factory for 100 consecutive days and record the results; we would expect all the samples to be within the range of $\pm \frac{3\sigma}{\sqrt{n}}$ and if they were not then it would be a good indication that something was wrong.

Let us take an example. Fig. 6 shows the results of a number of samples of dials measured for the make-break ratio of the impulsing springs. Samples 1-40 are steady and if produced in the form of the Normal Curve would be well within the limits $\pm \frac{3\sigma}{\sqrt{n}}$, as indeed would be samples 61-100. Samples 41-60 however indicate that something is wrong. It is unlikely that the deviation of this particular group of samples would be greater than $\pm \frac{3\sigma}{\sqrt{n}}$ but some unknown factor has caused a general lowering of the average.

From this information the manufacturer knows the particular period when the fault occurred and also that it affected all items equally. The investigation would probably start, of course, at the first indication of trouble. It may be the use of a new machine, new unskilled labour, poor batch of raw materials, and so on.

Another example is given in Fig. 7. For a long

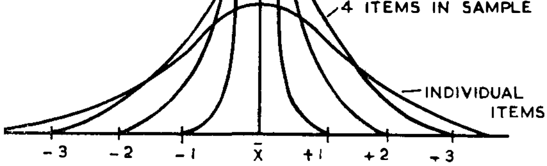
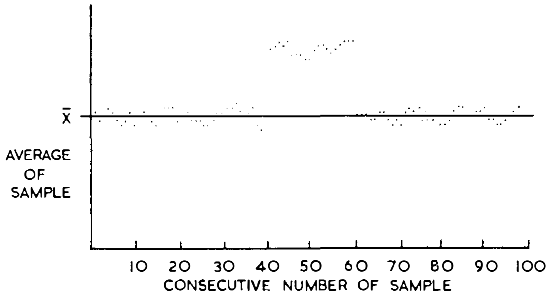


Fig. 5: Normal curve for samples of varying qualities

Fig. 6: Working control chart



period the product is stable, but suddenly it becomes very erratic. This would indicate a serious breakdown in a system designed to give uniformity of quality. In this case the cause might be, say, due to an old worn tool or machine. These are two straightforward examples of the use of control chart data. In practice the results are not so straightforward and the analysis is much more difficult.

Samples, should of course, be plotted on the chart in the order in which they are taken. Use should also be made of the chart to note any factors which might reflect on the quality of the product.

Mass production aims at cutting out any factors which would upset the manufacturing process and also that all operations be performed under identical conditions. Owing to chance causes the production of completely identical items is not possible. However, it is possible to determine to what extent the ideal is being achieved and if any controllable factors are present.

We have said earlier that quality control can be applied to a service as well as to a manufacturing process.

Frequently in the telephone service it is necessary to obtain information about certain aspects: for example, traffic, exchange equipment, subscribers' plant, and so on for the purpose of planning and costing the telephone service. This information is obtained by taking regular samples. In using controlled sampling, it is possible to assess the risk involved in using the sample instead of the whole.

The quality of service to be given to the public having been assessed, regular observations are taken to check that this quality is being maintained. These observations, which are in the form of samples of the service taken at regular intervals, are known as *Service Observations*. The detailed results are recorded. From these recorded results the quality of service given by an exchange, or group of exchanges, can readily be assessed.

In order that full information about the efficiency of the various classes of equipment and operating procedure may be obtained, observations are taken on the following types of calls:—

(1) Automatic calls dialled by subscribers.
(2) Originating manual calls at local exchanges.
(3) Originating manual calls at Zone and Group centres.
(4) Incoming calls at Zone and Group centres.
(5) 2 V.F. calls.

(5) Percentage of calls not completed due to P.O. (No lines, etc.)
(6) Percentage of calls not completed due to subscribers. (No reply, Engaged, etc.)
(7) Percentage wrong numbers, cut off, overcharged, undercharged, operating irregularities, etc.

These summaries are prepared monthly. The items which affect the operating staff, that is, time to answer, operating irregularities, etc., are produced on graphs and exhibited in the exchange. The results of these observations enable weakness to be disclosed, so that early action can be taken to remedy any defects in the system. For example, if the summary showed a high percentage of calls

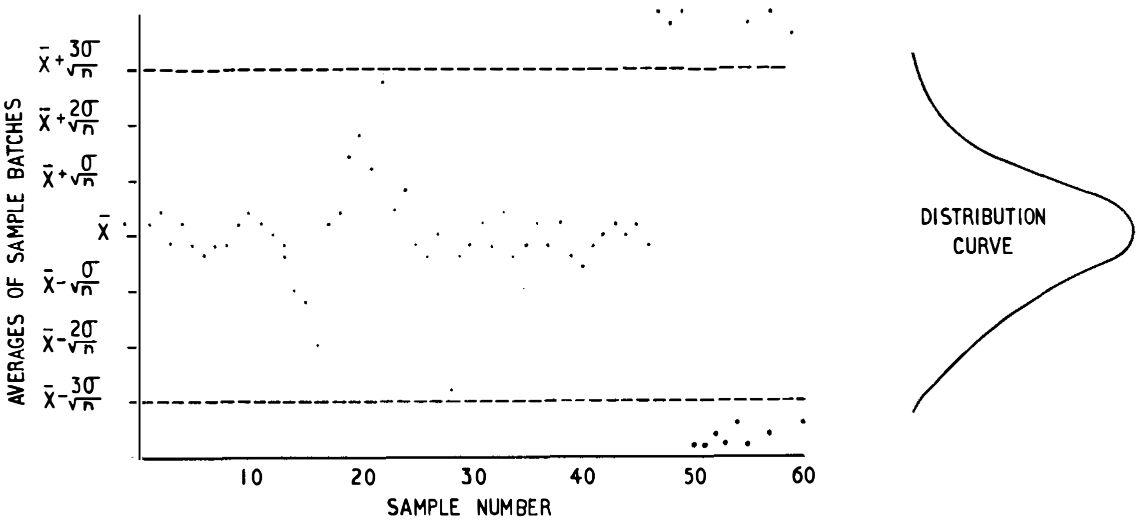


Fig. 7: Working control chart

To obtain a representative and satisfactory sample, a minimum number of observations must be taken. The size of the sample is governed by the limitations of the observation equipment and by the need for economy in staff hours. A minimum number of observations to be taken is laid down for each of the above types of call. There are, of course, limitations to the minimum size of the exchange for which observations are taken.

Observation officers are specially selected Assistant Supervisors possessing a wide knowledge of operating procedure. Details of all calls observed are recorded, and the results summarized. From these summaries it is possible to find:

(1) Average time to answer.
(2) Percentage of calls unanswered in 10 seconds.
(3) Percentage of calls unanswered in 30 seconds.
(4) Average time to disconnect.

lost due to "No Lines", then examination of the detail sheet would perhaps show that the difficulty was being experienced on one route only, and steps would have to be taken to increase the number of circuits on that route.

On the other hand if the "time to answer" was high, examination of the detail sheet might show that the time to answer throughout the period was normal, except perhaps for one period, say 5.30-6.30 p.m., when it was very high. An examination of the staffing details at this time would have to be made.

It can be seen, therefore, that the laws which govern sampling and quality control can be applied equally well to a particular service as to a mass-produced article. By this method of analysis it is possible to determine and control such variable factors as are present.

Home Counties Region

THE HOME COUNTIES REGION OF THE POST Office completely surrounds London and its Headquarters are, in fact, in Great Titchfield Street in the London Borough of St. Marylebone.

The name of the Home Counties Region at once brings to mind its relationship with London. The mutual problems of Home Counties and the two London Regions so often interlock that a Headquarters outside proves an advantage.

The Region, excluding London, covers the whole of East Anglia, south-east England and southern England to a line west of Whitchurch, Hampshire, and passing between Portsmouth and Southampton to take in the Isle of Wight. It reaches the South Midlands to the north of Banbury in Oxfordshire. In all, the Region includes 13,000 square miles employing 41,424 staff. With its 12 telephone areas and 100 Head Post Offices it is the largest of the English regions.

The Home Counties have shared prominently in much of our country's history. Many perhaps know them best by virtue of their geographical position which through the centuries, has made them a bastion of defence against the invader—from the Battle of Hastings and earlier up to the Battle of Britain. Many of the R.A.F. and U.S.A.A.F. airfields are still continuing this tradition in the Home Counties. Their communication systems add to the considerable defence networks of the Region.

No less, of course, has this corner of England carried the spearhead of attack by our forces as in the two world wars, for it includes many of the ports leading to the Continent, from Harwich round to Portsmouth.

Despite their many and familiar beauty spots and holiday resorts the Home Counties are far more than a holiday playground and dormitory for Londoners. No one large town dominates the territory. A glance at a road or railway map would show how virtually all their roads lead to London. Nevertheless, each of the 14 counties wholly or partly in the Region contains a number of medium-sized and smaller towns, as well as its own county town, many of which are known the world over. There are Portsmouth and Chatham, with their naval traditions; Windsor, Ascot and Sandringham with their royal associations; Oxford and Cambridge with their universities; and now Harwell and Aldermaston, homes of atomic research.

From the hop fields and orchards of Kent to

The Regional Board (*left to right*): Mr. L. G. FAWKES, Public Relations Officer; Mr. E. W. CROSS, Staff Controller; Mr. C. R. SMITH, O.B.E., Postal Controller; Mr. A. F. JAMES, Deputy Regional Director; Mr. J. McA. OWEN, C.B.E., M.I.E.E., Regional Director; Mr. A. B. HARNDEN, Deputy Regional Director; Mr. W. E. HUDSON, O.B.E., Chief Regional Engineer; Mr. H. A. PENN, M.B.E., E.R.D., Telecommunications Controller; Mr. P. DAVIES, Finance Officer; Mr. P. STIMPSON, Secretary to the Board the agricultural lands of the Fens and East Anglia, from the white cliffs of Dover to the Cotswold hills in the west, the Region can show as wide a diversity of scene and activity as any part of the country.

Apart from the coalfields of Kent there is very little heavy industry in the Region, but there has been tremendous growth in light industry. This century has seen a southerly trend of manufacturing which has been very evident in the Home Counties. Many country towns are developing their industrial areas and modern factories are springing into existence. Some towns have specialized, like Luton and Oxford, famous as motor manufacturing centres, while others, such as Slough, have grown greatly with "trading estates". One of the largest developments in the south, related to the population growth in the London area, is that of the "New Town". Nearly all the new towns are in the Region—Crawley, Basildon, Bracknell, Harlow, Hemel Hempstead and Stevenage.

Although Home Counties Region has no telephone zone centre and the bulk of its long distance traffic circulates through London, it has more group centres, 51, than any other. Within the next few years three zone centres will be opened at Cambridge, Reading and Tunbridge Wells which will radically change telephone call routings for the country. Major line plant changes are already being planned.

There are now just over 1,000,000 telephone stations in the Region, which make 63,000,000 timed calls and 420,000,000 untimed calls a year, providing call revenue of £12,000,000.

Articles about the cordless switchboard at Thanet and the mechanized accounting system employed for telephone accounts in the Canterbury area have already appeared in the *Journal*. These are only two of the interesting experiments the Post Office is conducting in the Regions.

On the postal side, ten of the newest electronic letter sorters are being installed in Norwich Head Post Office as part of the policy of mechanizing the handling of the mails.

The recent opening of Gatwick Airport by the Queen marked the completion of another project in which the Region played a large part.

There is no single factor which combines the Home Counties Region into a homogeneous whole as there is in some regions, but its position and the diversity of its interests join to give it a most important part in our national life.

Gatwick Airport

Since late 1955 the Post Office has been working with the Ministry of Transport and Civil Aviation to provide telephone and telegraph facilities for Gatwick Airport, which the Queen opened early in June.

The telephone equipment comprises a central P.A.B.X. with 20 switchboard positions and 1,200 extensions, with subsidiary P.B.Xs for the operating companies and others.

The high speeds of modern aircraft demand rapid transmission of messages and to achieve this a semi-automatic telegraph system is being provided. The equipment (known as "STRAD") is the first of its kind and uses electronic switching based on computor techniques with magnetic drum storage.

The provision of navigational aids, the airport emergency communications, the telephone and telegraph facilities and the diversion of the London–Brighton road involved the laying of over 12 miles of new duct, 37 miles of new cable and extensive rearrangement of existing cables. The direct cost of the internal and external works will be approximately £365,000.

An article on the installations will be published in our Autumn issue.

Pope on the 'Phone

The *Church Times*, assuming that the Postmaster General, "in pursuance of his professed intention to brighten up his Department", had decided to employ Shakespeare, Pope, Wordsworth, Carroll and Belloc to introduce a dose of culture into the telephone section, offered prizes for extracts from their verse intructions on how to use a telephone.

Mr. H. A. C. Evans, of South Croydon, won a prize with instructions headed "Tel. POPesgrove":—

First, with prehensile palm and firm intent
Remove from's place th' appointed instrument;
Then hasten, with attentive eye, to scan
All th' alphabetic and numeric plan.
Your finger now in's rightful place insert
And heedfully a gentle strength exert,
That, with unerring purpose, you enforce
The circling dial on his proper course.
Thus for such titles as the eye engage
With black and bodeful print upon the page.
For those that lighter capitals equip
You must attend th' automatous "pip-pip".

Automatic Tester for Subscribers' Lines and Apparatus

E. W. Chapman and H. C. Nott

IN ANY WORK AIMED AT INCREASING productivity, the time element in co-operation between individuals must not be overlooked. In day-to-day work involving the installation and maintenance of subscribers' lines and apparatus, co-operation of exchange staff is necessary for acceptance testing of new subscribers' lines or confirming the absence of faults on existing lines. The load on the test desk due to incoming calls is always uneven and delay in answering due to pressure is common experience. It will be realized that the total time lost by waiting will be in proportion to the number of men in the field parties.

As a primary step towards increasing the output of installation units, London Telecommunications Region considered eliminating test desk co-operation entirely. This was thought to be practicable since the apparatus is generally new and connexion work between the distribution point and the instrument location is straightforward. A field trial was conducted which confirmed this

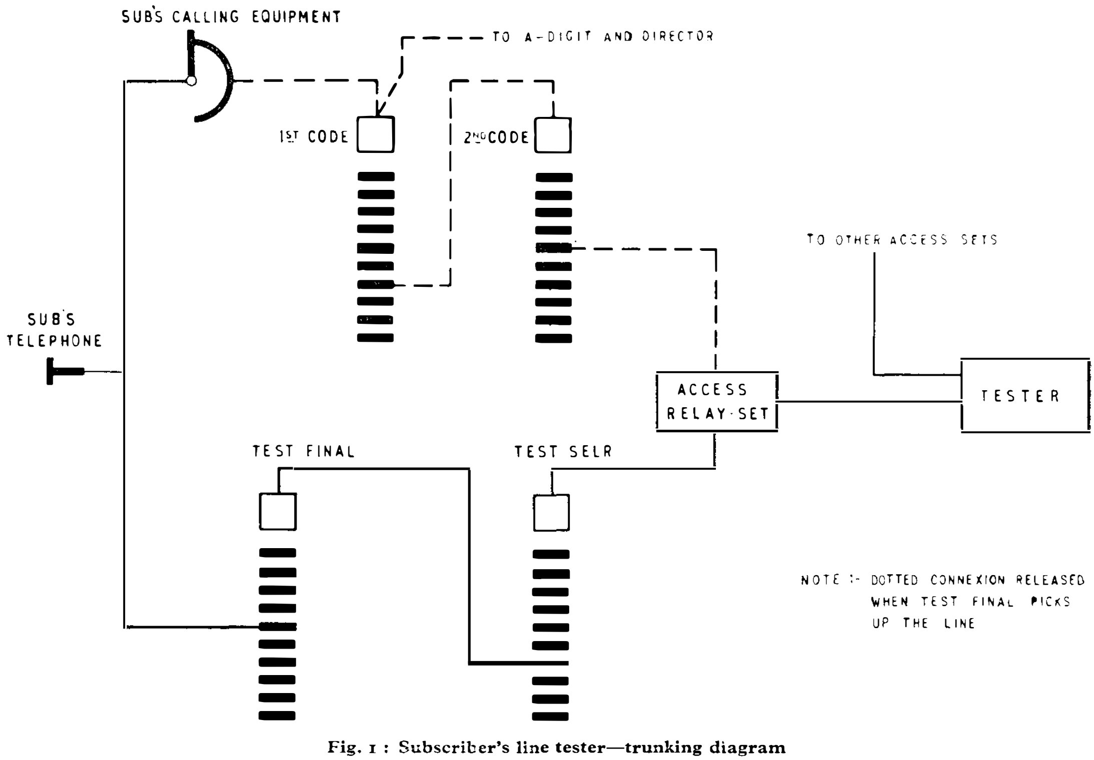


Fig. 1 : Subscriber's line tester—trunking diagram

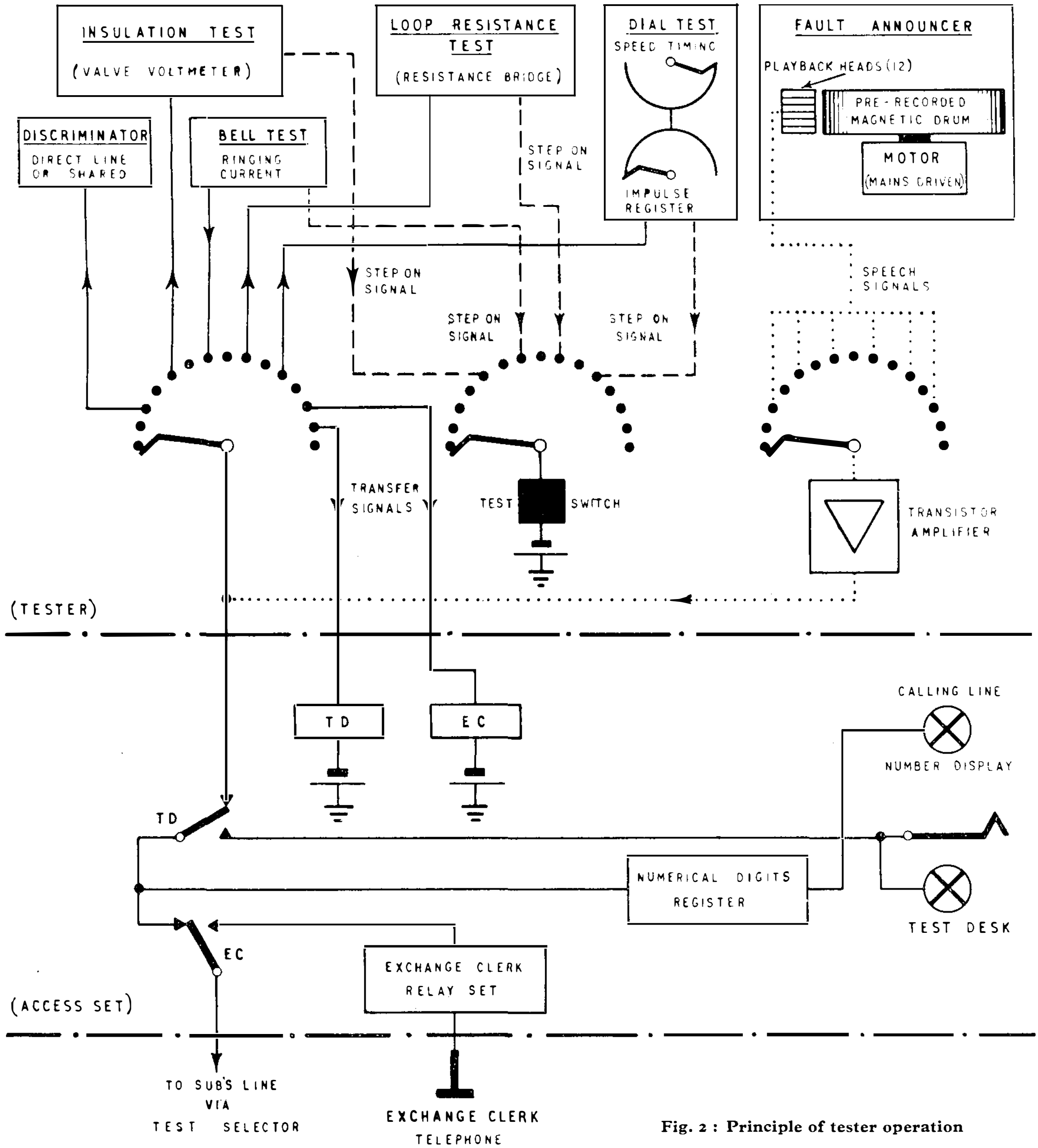


Fig. 2 : Principle of tester operation

by producing only a small percentage of faults.

In the meantime, however, the South East Area of the L.T.R. had tackled the installation problem from a different angle and successfully produced an automatic line tester as an accessory to the test desk. Regional trials of this equipment indicated that it would be equally valuable for maintenance work on subscribers' apparatus and lines.

The tester described in this article is the result of development work carried out by the Efficiency Group of the L.T.R. Engineering Branch, in conjunction with the Post Office Engineering Department. It affords the following facilities:—

(*a*) Discrimination between exclusive and shared-service lines

(*b*) Limit tests of:—
  - (i) Line insulation resistance
  - (ii) Loop resistance
  - (iii) Dial speed
  - (iv) Resistance to earth on shared-service lines

(*c*) Oral announcements of operating instructions and faulty conditions

(*d*) Transfer of successful calls either to exchange clerk or test desk

(*e*) Visual indication to the test desk of the subscribers' number from which a call has been originated.

The field staff (either installation or maintenance men) obtain the services of the tester (from the line which is to be tested) by dialling a 3-digit code followed by the 4-digit number of the line. This routes the call to the tester access relay set and via test selectors to the line to be tested (Fig. 1).

If the tester is engaged the caller hears the announcement "Wait for tester". When the tester is free it is seized by the access set and the announcement changes to "Start test". The caller now replaces his handset and the test cycle starts by discriminating between an exclusive line and a shared-service line, followed by line insulation tests.

If these are satisfactory, ringing current will be applied to the line. If the bell does not ring within about five seconds of starting the test the caller lifts the handset and hears the relevant line-fault announcement. When the bell rings (indicating that the line insulation is up to standard) the caller removes the handset and receives dialling tone if the loop resistance is satisfactory. Should the resistance be too high, an announcement to this effect will be heard.

On receipt of dialling tone the caller dials 130. If the dial is faulty a fault announcement will be heard (for example, "Dial fast"). If the dial is satisfactory, dialling tone is again received and the caller dials a transfer digit which releases the tester and connects him to the exchange clerk or test desk. The transfer digits used are 3 for the exchange clerk and 7 for the test desk. Digit 5 is used to give an announcement "Testing OK"; this is for the benefit of staff using the tester outside normal hours, when the test clerk and exchange clerk positions are not staffed.

The test desk is fitted with keys which are thrown when the test clerk or exchange clerk is absent and which cause digits 3 and 7 to function in the same way as digit 5. If the caller is testing a shared-service line, dialling the transfer digit will not switch him through until he has pressed the "call exchange" button on the instrument. When he does this the earth resistance is checked and a fault announcement transmitted if the limiting value is exceeded.

Fig. 2 shows the principle of the tester operation. A test switch applies a sequence of limit conditions to the line and is stepped through this cycle provided results are satisfactory. If the limits are

Fig. 3 : Prototype tester

Fig. 4: Magnetic drum for recording oral announcements

exceeded at any point the test cycle cannot continue and an appropriate fault announcement is transmitted to line.

Announcements are recorded on 12 tracks on the $1\frac{1}{2}$ inch edge of a 7-inch diameter magnetic drum rotating at 30 revolutions per minute. The speech signals are picked up on "heads" spaced about one thousandth of an inch away from the drum surface and passed through a transistor amplifier which is no more than $2\frac{1}{4} \times 1\frac{3}{4} \times 1$ inches in size.

The four numerical digits of the subscriber's number are registered in the access relay set and displayed in sequence on a screen $1\frac{1}{2}$ inches $\times$ 1 inch fitted on the test desk.

Time Factor

The minimum time for a complete test is 15 seconds from the time the "start test" announcement is received. The tester is released when the caller transfers the line to the test desk or exchange clerk or when he replaces the handset after a fault announcement has been received. Should the caller prolong the test procedure unduly, a time pulse forces release after 25 seconds. The speed with which a line can be tested will be a great asset to field staff, particularly to maintenance men who will be able to use the tester for fault localization.

The tester shown in Fig. 3 is the prototype built for demonstration purposes and destined ultimately for the London Telecommunications Regional Training School.

The magnetic drum shown in Fig. 4 is the production model. This type of drum is the equivalent of 12 endless magnetic tapes running at a "tape" speed of roughly 10 inches per second. It carries only the recorded oral announcements and it is not used for any digit storage purpose.

Essay Competition Results.—J. G. Philip, Technical Officer, Aberdeen, has won the 5-guinea prize and an Institution Certificate in the Essay Competition, 1957–58, held by the Institution of Post Office Electrical Engineers.

The following (with the titles of their essays) have won prizes of 3 guineas each, and Institution Certificates:—

- R. J. Lukehurst, Technical Officer, Canterbury (Home Counties Region), *Inter-Departmental Staff Relations.*
- K. O. Verity, Technical Officer, Long Distance Area (London Telecommunications Region), *Telecommunications and Atomic Energy.*
- T. A. D. Clark, Technical Officer, Colchester (Home Counties Region), *The Technical Officer, the Youth-in-Training and the Manual Exchange.*
- J. A. Armitage, Technical Officer, Preston (North Western Region), *The Electronic Random Number Indicating Equipment.*

Institution Certificates of Merit have been awarded to:—

- R. I. Jenkins, Technical Officer, Haverfordwest (Wales & Border Counties), *Radio Waves and Beyond.*
- M. G. Hamilton, Technical Officer, Bournemouth (South West Region), *Transistors and Telecommunications.*
- A. Richmond, Technical Officer, Oban (Scotland), *A T.O's Life in the Outer Hebrides.*
- D. M. Rennolds, Technical Officer, Bristol (South West Region), *Developments at Bristol Trunk Exchange.*
- H. Belchamber, Technician, Class 1, Southsea (Home Counties Region), *The Park Road Job.*

The essays were judged by W. S. Procter, G. Spears and A. J. Leckenby.

Ongar Radio Station, one of the main point to point overseas stations now operated by the Post Office, which was described in the Winter, 1956, *Journal*, is being enlarged.

Seven remotely controlled and unattended shortwave transmitters of the latest type are being installed in an extension which has been designed to cope with the need for increasing overseas telegraphic services. A description of the modern techniques to be used, with photographs of the equipment and the station, will be in our next issue.

OUR CONTRIBUTORS

A. J. BARKER (joint author, "Development and Application of Line Connectors") entered the Post Office in 1938 as a Probationary Inspector in the North Wales District. During the war he was commissioned in the Royal Signals and served in the United Kingdom, North Africa and Egypt. On demobilization in 1946 he was appointed Assistant Engineer in the Cardiff Area, serving there until 1948, when he was successful in the limited competition for Probationary Executive Engineer and joined North Area, London Telecommunications Region. He moved to the Engineering Department, Local Line Branch in 1956 on promotion to Senior Executive Engineer.

G. M. BLAIR (joint author, "Development and Application of Line Connectors") joined the Post Office in 1934 as a Youth-in-Training at Brighton. In 1938 he was successful in the Probationary Inspector Competition and trained in Scotland West Telephone Area. He was then transferred to the Engineer-in-Chief's Office, where he was engaged in the design and provision of equipment for R.A.F. operations rooms. In 1943 he joined Royal Signals and served in the United Kingdom, the British Liberation Army, Ceylon and India reaching the rank of Lt.-Col. On discharge he joined Tunbridge Wells Telephone Area where he remained until his appointment to the Engineering Department, Telephone Branch, as Executive Engineer. He was recalled to the Army and served at Port Said during the Suez crisis. Early this year he was seconded to the Home Office as a Senior Communications Officer.

J. BELLEW ("Planning the Fleet Building") is a Deputy Staff Controller in London Telecommunications Region. He started his official service in Post Office Headquarters where he spent a number of years on staff work and later in the Buildings and Supplies Branch. During the war he was on loan to the Ministry of Works as a Deputy Regional Licensing Officer in the Civil Building Control. In 1947 he returned to the Post Office when he was appointed Senior Executive Officer (Buildings) in the Midland Region and in 1954 was transferred to London Telecommunications Region.

E. W. CHAPMAN (joint author, "Automatic Tester for Subscribers' Lines and Apparatus"), an Executive Engineer in the Organization and Efficiency Group, Engineering Branch, London Telecommunications Region, entered the Post Office as a Youth-in-Training and worked on exchange construction and maintenance. He was promoted to Inspector on local line planning and from 1943 to 1946 served in the Royal Signals. On reorganization in 1946, he became an Assistant Engineer, and in 1950 transferred to L.T.R. Engineering Branch on organization and efficiency work. In 1956 he was promoted to Executive Engineer on telegraph construction and maintenance in City Area, but returned to L.T.R. Headquarters in July, 1957.

L. DAVIES ("Radio Link for Rheinigidale") has been a Senior Traffic Superintendent in Aberdeen since 1955. He joined the Post Office as a Sorting Clerk and Telegraphist at Treharris, South Wales, in 1935 and passed the limited competition for Assistant Traffic Superintendent in 1939 but could not take up this appointment until 1946, serving in the meantime in Royal Signals (1939–1941) and R.E.M.E. From 1946 to 1955 he was Telecommunications Traffic Superintendent in Taunton and Exeter successively.

A. KEMP ("Subscriber Trunk Dialling Simply Explained") is an Assistant Secretary in the Inland Telecommunications Department and is in charge of the new Telephone Mechanization Branch set up a year ago. Before that, as head of the Planning Branch, he was chairman of the Subscriber Trunk Dialling Study Group which recommended the national numbering scheme and method of call charging to be adopted for STD in this country and the advance introduction of group charging. Recently he has played an active part in preparing the two White Papers on this subject. He entered the Post Office in 1920 as a Youth-in-Training and moved to the Traffic side in 1923. After serving at York, Manchester, Nottingham and Liverpool he was seconded in 1935 to Palestine where he organized the transfer of Jerusalem and Tel Aviv exchanges to automatic working. He joined the Telecommunications Branch in the North Western Region when it was opened in 1939 and was appointed Telephone Manager at Preston in 1943. After coming to Headquarters as Principal in 1945 and dealing with engineering estimates, stores and provision of service, he became Deputy Controller and later Controller of Telephones in the London Telecommunications Region. In 1950 he returned to Headquarters as Assistant Secretary in charge of the Operations Branch of the I.T.D. He has been a member of the Editorial Board of the *Journal* since its third issue in May, 1949.

H. MORAN ("Quality Control") was with the Automatic Telephone and Electric Company from 1936 to 1941. After serving in the Royal Signals from 1944 to 1948 (including work on developing "Radio SEAC" in Colombo), he joined the Post Office and from 1949 to 1955 was a Technical Officer on Tests and Inspection duties at contractors' works in the North-West, mainly at A.T.E. He became a Telecommunications Traffic Officer in 1955 and has since been at Shrewsbury.

H. C. NOTT (joint author, "Automatic Tester for Subscribers' Lines and Apparatus") contributed to the Summer, 1957, issue of the *Journal* when his career was outlined.

P. C. A. RABY ("Push-Button Telegraph System for British Road Services"), now a Senior Telecommunications Superintendent in the Telegraph Planning Branch of the Inland Telecommunications Department, entered the Post Office in 1934 as a Youth-in-Training in the Engineering Department. He was appointed Skilled Workman I in 1938 and later in the year, Inspector. In 1941 he transferred to the Traffic Division at Norwich as Assistant Traffic Superintendent. Between 1942 and 1946 he served with 13 Line of Communication Signals in Northern Europe, as a Staff Officer (Signals) with Ceylon Army Command and with East Anglian District Signals. Promotion in 1954 took him to Post Office Headquarters, Scotland, where he was engaged on telephone equipment and building planning until 1956.

Personal

The Editorial Board had the pleasure at their June meeting of congratulating their Chairman, Mr. F. I. Ray, on the honour of Companion of the Most Honourable Order of the Bath (C.B.) conferred on him by the Queen in the Birthday Honours List.

Since he became Chairman two years ago, on his appointment as Director of the Inland telecommunications Department, Mr. Ray has guided the *Journal* with the wisdom of many years experience and—as all those who know him will expect—a lively appreciation of the modern outlook in the telecommunications services.

★ ★ ★

Mr. H. A. Williams, who has been on the Editorial Board of the *Journal* since Autumn, 1955, has been appointed an Assistant Engineer-in-Chief of the Post Office. He joined the Engineering Department in 1926 as an old-style Assistant Engineer and for 12 years worked with the Research Branch Signalling Group. From 1938 to 1953 he was with the Main Lines Branch, taking charge from 1947. Mr. Williams returned to the Research Branch in 1953, where he has since been concerned with research on line transmission for telephony and television. He takes up his new appointment in October.

Mr. F. I. Ray, C.B., C.B.E.

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 telecommunication 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."

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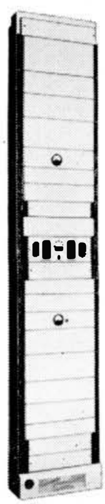

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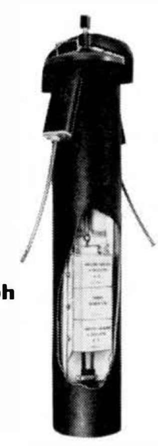

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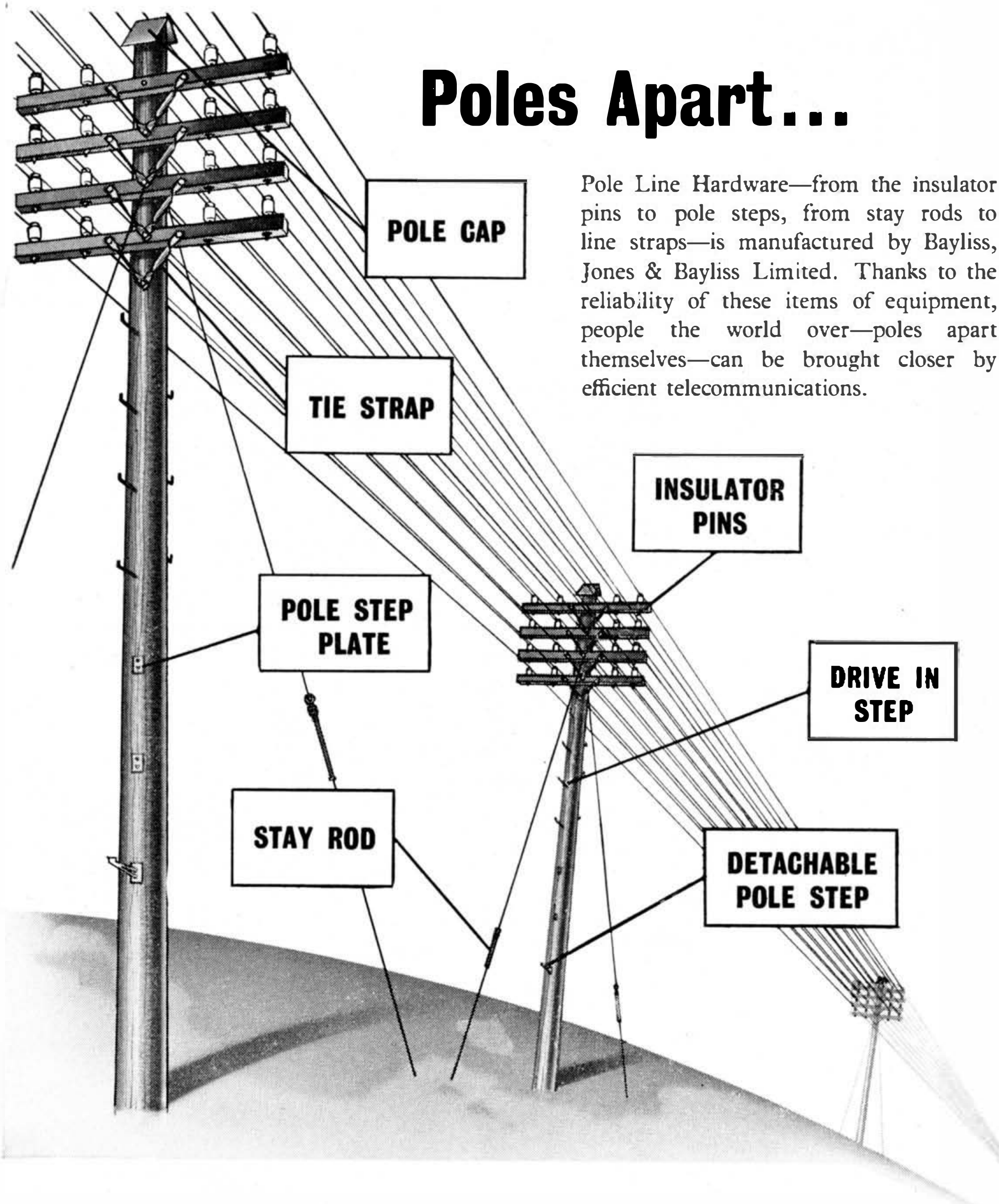

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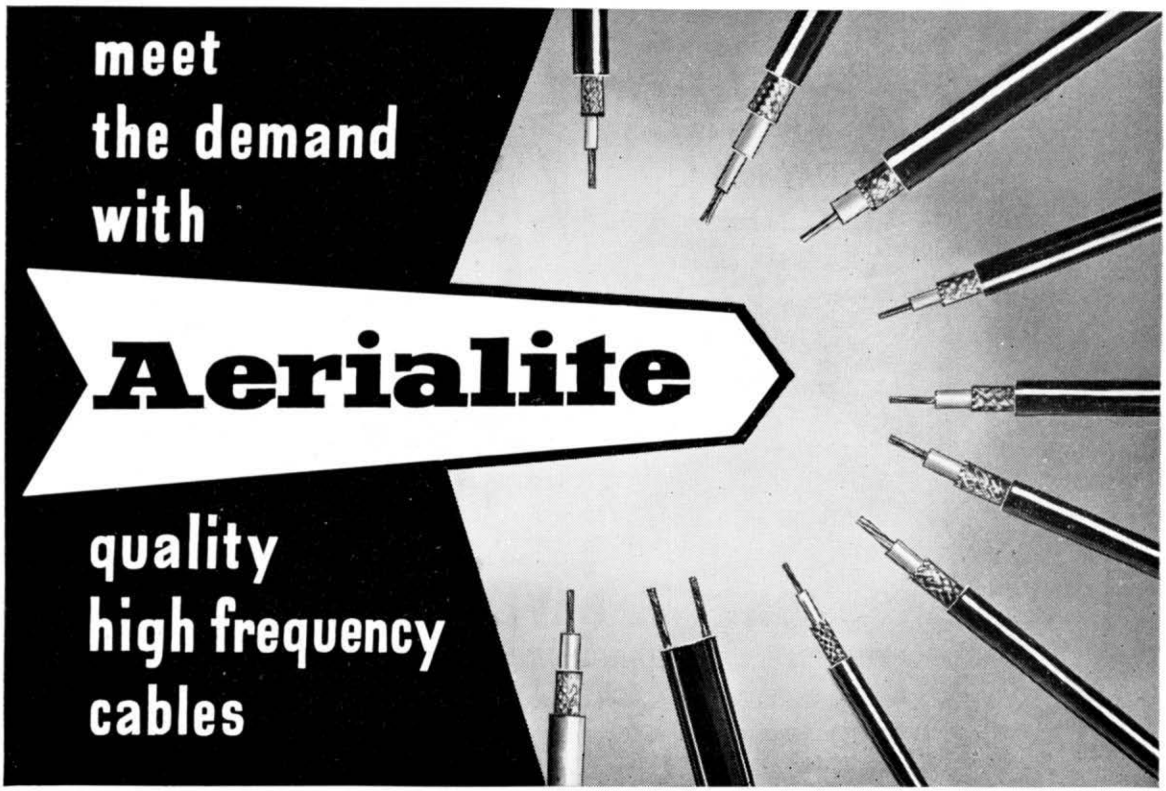

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