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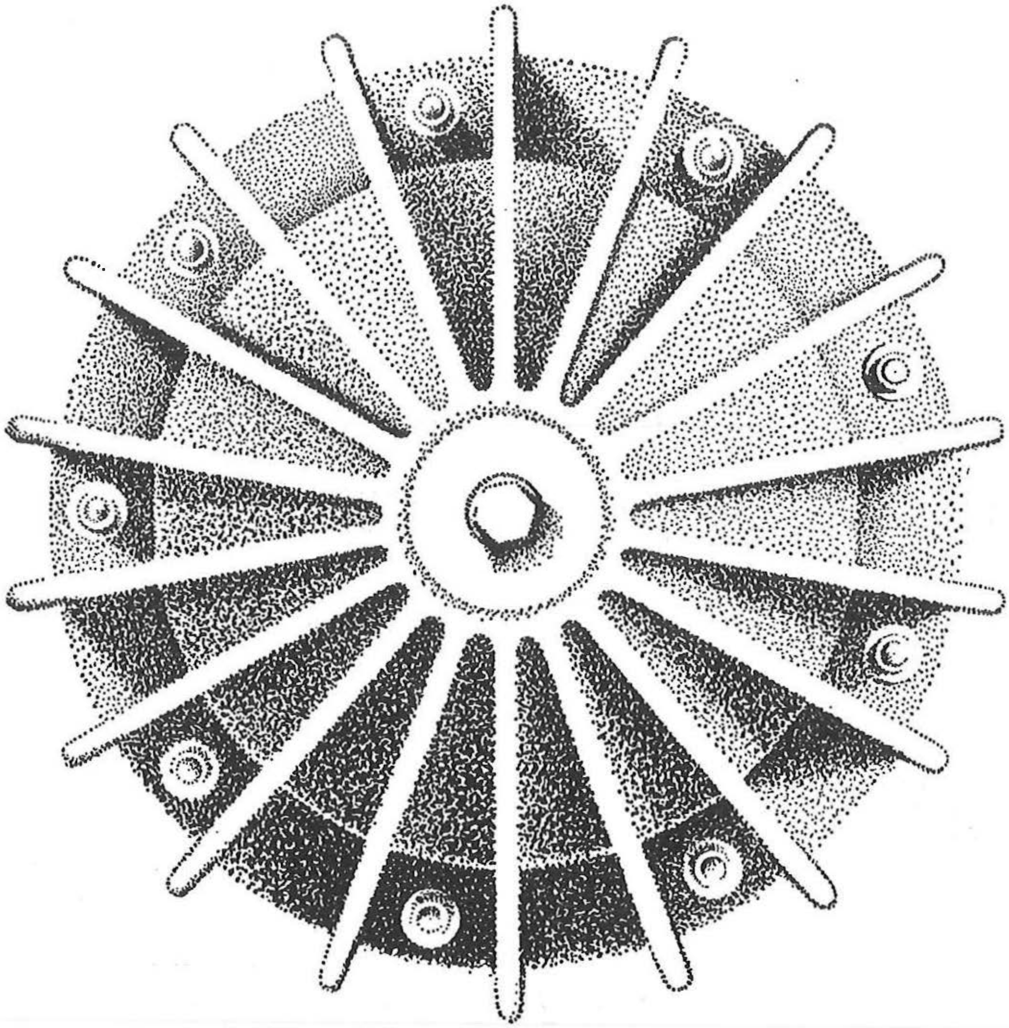

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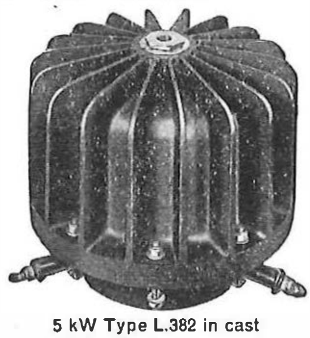

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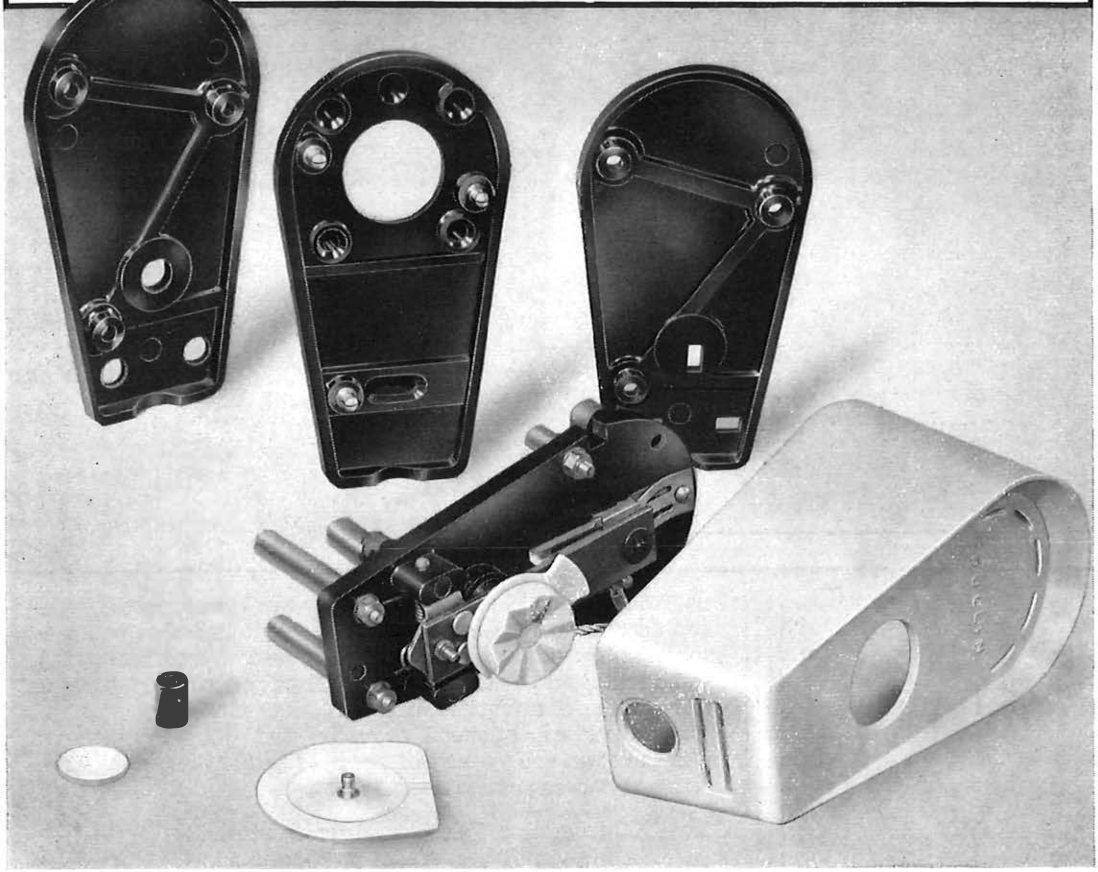

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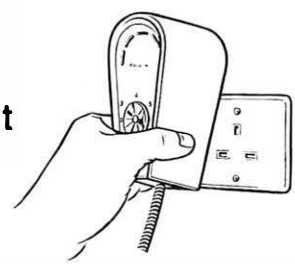

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Post Office Telecommunications Journal

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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The First Link

HER Majesty the Queen, when inaugurating CANTAT with a call to Mr. Diefenbaker, and the speakers at the opening ceremonies in London and Ottawa, described the event as being in the fullest sense a Commonwealth occasion. The new Anglo-Canadian cable is the start of a great adventure. It is the first link in the Commonwealth "round-the-world" submarine telephone cable system which, in a few years, will enable many peoples of the Commonwealth to exchange telephone conversations, telegrams and telex messages over a strong and reliable network interlinked over a distance of some 30,000 nautical miles.

Conferences to plan the whole project already held in London, Sydney and Kuala Lumpur have given evidence of collaboration at high levels. No less necessary will be close and continuous collaboration between the operators and others in the various fields. For example, a call or message between the United Kingdom and Canada cannot be successfully carried, however reliable the equipment, without close understanding between operators and engineers throughout both the British Isles and Canada. The Canadian inland network, connected with both the Atlantic and Pacific routes, will be a particularly important link in the chain.

Post Office scientists and engineers have devised, and manufacturers in this country have made, this cable, its repeaters and equalizers; Post Office ships have laid it and will maintain it; a British company—Cable & Wireless Ltd.—has provided much of the finance; but to put the complete project into service for customers will demand the closest co-operation between men and women of many countries.

A New Submarine Telephone Cable System to Canada

CANTAT

R. J. Halsey, C.M.G., B.Sc.(Eng.), F.C.G.I., D.I.C., M.I.E.E.

AT 23.45 GMT on November 21 1961 the final splice in a new transatlantic telephone cable system was consigned to the ocean off Newfoundland by HMTS *Monarch*. Linking Great Britain and Canada, this is, without question, the most advanced submarine cable system in existence today. In particular it is notable as being:

(i) the first all-British transoceanic telephone cable;

(ii) the first transoceanic system to use rigid repeaters;

(iii) the first transoceanic system to use bothway transmission over a single cable, and

(iv) the first system to use the new lightweight, non-armoured, deep-sea cable.

It will be recalled that the first transatlantic telephone cable system, TAT1, planned in 1953 and brought into service in 1956, had two sections, each using armoured coaxial cable with 0.62 inch diameter polyethylene core, but differing in other respects:—

1. Between Oban, Scotland, and Clarenville, Newfoundland, a distance of 1,960 nautical miles, there were separate "go" and "return" cables, each with 51 flexible, unidirectional repeaters of American design, providing a bandwidth of 144 kc/s. This section produced the equivalent of 36 telephone circuits with 4 kc/s spacing. The terminal driving power was 2,000 volts d.c. at each end.
2. Between Clarenville, Newfoundland, and Sydney Mines, Nova Scotia, a distance of 330 nautical miles, a single cable with 16 rigid bothway repeaters of British design, provided a bandwidth of 240 kc/s in each direction, producing the equivalent of 60 telephone circuits with 4 kc/s spacing. The terminal driving power was 1,200 volts d.c. at each end or 2,400 volts at one end.

The second transatlantic cable, TAT2, laid in 1959, is a replica of TAT1 with the European landing point at Penmarch, Brittany. It serves, primarily, Paris and Frankfurt.

At the time when TAT1 was planned, the American system was the only one which had been tested at ocean depths. The British system, based on that used in home waters, had not yet been developed either for the distances or depths involved in the Atlantic crossing, nor could the rigid repeaters be laid without stopping the cable ship.

As early as 1952 a start had been made at the Post Office Research Station on the design of a completely new type of coaxial cable for use in deep water, where armour wires are required only to carry the tension and not for protection. A major feature of the new design was that it would not twist under tension. With armoured cable in deep water, several thousands of turns are stored between the ship and the ocean bottom and it is this which makes it essential that the ship must not be stopped to lay a repeater. The turns arise from the laying tension because the armour wires are applied helically to enable the cable to be coiled down in tanks and therefore form a long helical spring.

The new cable based on these considerations and commonly called "lightweight" (Fig.1), consists of a balanced heart of steel wires with a tensile strength of 130 tons per square inch in two coaxial groups having opposite directions of lay. The centre conductor is a longitudinal copper tape,

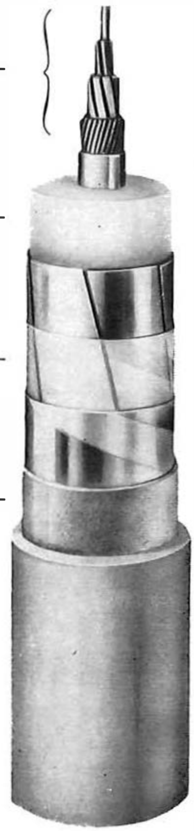


Fig. 1 : Lightweight submarine cable

box-seamed; the outer conductor is of aluminium. This method of construction gives a high ratio of breaking strength to weight per mile in water. The cable has an external polythene sheath. With 0.99 inch diameter core, the overall diameter is 1.3 inch, almost exactly the same as that of a deep-sea armoured cable with 0.62 inch core, but with only two-thirds of the attenuation.

Early in 1957, only six months after the opening of TAT1, Cable and Wireless Ltd. (C & W Ltd)* and the Canadian Overseas Telecommunication Corporation (COTC) agreed to provide a large-capacity system to Canada using British repeaters and a single lightweight cable. It is this system, known as CANTAT, which has just been completed. Like the earlier British systems it provides a bandwidth of 240 kc/s in each direction, equivalent to eighty 3 kc/s-spaced telephone circuits; services provided will include telephony, telegraphy, broadcast programmes, data transmission and both normal and high-speed facsimile, the latter enabling a film to be transmitted frame-by-frame and so provide for slow-scan (delayed) television. Although C & W Ltd is the British partner in the ocean cable section, all buildings and plant in Britain are owned by the Post Office, who also operate the services in the usual way.

Necessary preliminaries to the manufacture of the deep-sea section were:

(*a*) To complete the design of the lightweight cable and test it in laying operations at sea.

(*b*) To modify the design of the rigid repeaters to withstand working pressures of up to three tons per square inch, corresponding to Atlantic depths and preferably up to five tons

**Owned by the British Government*

per square inch, corresponding to 4,000 fathoms, which would be encountered in later projects.

(*c*) To redesign the system to operate with 100 repeaters in tandem; this involved doubling the working voltage and providing an entirely new supervisory system to monitor and identify the repeaters.

(*d*) To design and provide ship's gear which could lay the repeaters without stopping the ship.

To tackle these problems and to engineer the ocean cable itself, the Submarine Cable Division of the Engineering Department Research Branch at Dollis Hill was reconstituted, with the addition of engineers from C & W Ltd, as the Joint Submarine Systems Development Unit (Post Office/Cable and Wireless Ltd.).

All the problems were successfully overcome, including the design and provision of laying gear consisting of a series of interconnected V-sheaves which can be driven or braked in the same way as the conventional drum which they replace. A by-pass rope across the repeater traverses the sheaves and takes the laying tension of the cable, while the repeater itself with a loop of cable is carried past the gear at deck level.

In 1960 a system using repeaters of the type developed for CANTAT was laid between Middlesbrough, England and Göteborg, Sweden. This comprised 527 nautical miles of 0.62 inch armoured cable with 29 repeaters in shallow water; it was an invaluable preliminary to CANTAT itself.

The CANTAT system (Fig. 2) extends from London to Montreal and is in four sections:—

CANTAT A, the main ocean crossing between Oban, Scotland and Corner Brook, Newfoundland, owned jointly by C & W Ltd and COTC. This includes 550 nautical miles of armoured cable in shallow water and across Newfoundland, together with 1,526 nautical miles of lightweight cable in depths up to 2,250 fathoms. There are 90 repeaters and 8 equalizers, the cable attenuation rising to 5,100 dB against 3,200 dB for TAT1. The direct voltage required to energize the repeaters is 9,800 volts, half at each end, and the system provides a bandwidth of 240 kc/s in each direction over a single cable.

CANTAT B, a submarine cable system, 400 nautical miles in length, owned and engineered by COTC, between Corner Brook and Grosses Roches, Quebec, on the south bank of the St. Lawrence River. This provides a bandwidth of 480 kc/s in each direction using 0.935 inch armoured cable with 20 submerged repeaters. The entire section is in shallow water.

CANTAT C, the overland section between Grosses Roches and Montreal, 431 statute miles in length, provided by microwave radio relay.

CANTAT D, the overland section between London and Oban in which there is diversity of routing. Two routes, London–Glasgow–Oban and London–Aberdeen–Inverness–Oban are mainly 24-circuit carrier cables; a third route London–Glasgow–Oban is coaxial cable except for 40 miles. Switching of groups from one route to another is automatic.

The circuit distance between London and Montreal is therefore 3,850 or 4,050 statute miles depending on the routing between London and Oban.

The overland section of CANTAT A in Newfoundland between Hampden in White Bay and Corner Brook is 72 statute miles in length and includes four repeaters buried in wet ground. This section was engineered by COTC and was completed in 1960; two other submarine cable systems follow the same route over most of the distance.

Apart from the shore ends at Oban and Hampden, Newfoundland, which were laid by HMTS *Ariel* and CS *Albert J. Myer* respectively, the whole of the submarine section of CANTAT A was laid in three operations, in the summer and autumn of 1961, by HMTS *Monarch*. Equipped with the new laying gear, this ship had already laid some 50 rigid repeaters and equalizers before the CANTAT project and has now laid nearly 150.

One problem with TAT1 was an unforeseen decrease of attenuation on laying, amounting to nearly 2 per cent. and a continuing decrease after laying which has already amounted to 13 dB (0.4 per cent.). One of the objects in designing the new lightweight cable was to eliminate, or at least to minimize, these changes and this seems to have been achieved. Unforeseen changes during laying were almost negligible while the total change over 1,500 nautical miles in five months, including the effect of temperature, was less than 2 dB.

CANTAT B was laid in July 1961 by HMTS *Alert*, also fitted with the new laying gear.

The lining-up of CANTAT A and of the overall system proceeded immediately after the final splice was completed on November 21 and the system

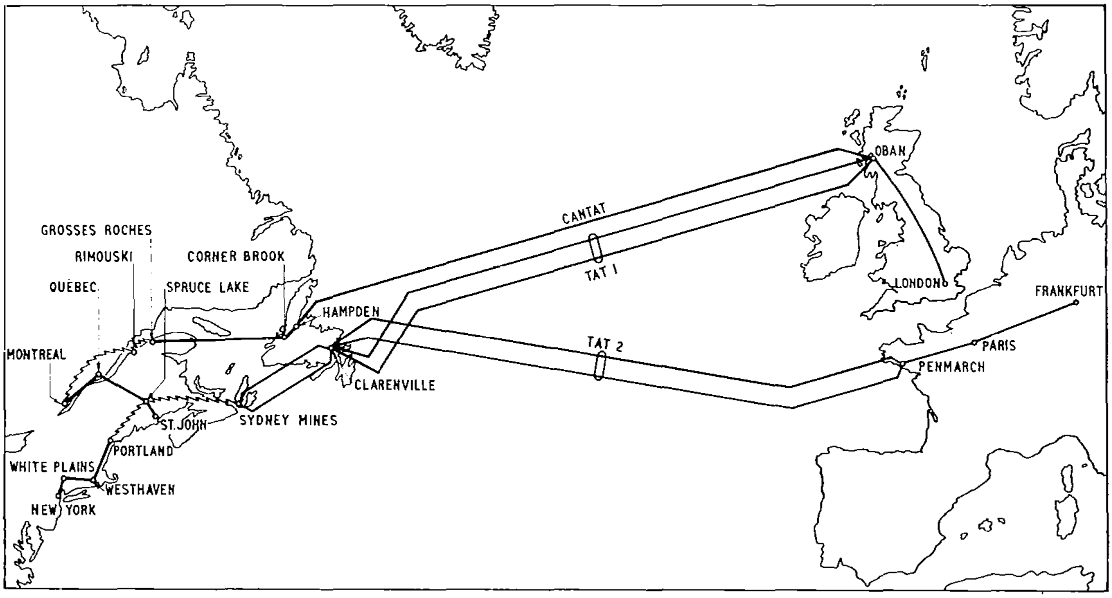


Fig. 2 : The CANTAT system

was ready for the opening ceremony by Her Majesty the Queen on December 19. The quality of the transmission path is excellent and meets the target objectives.

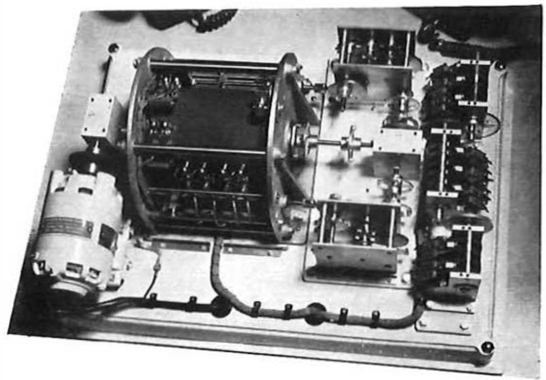
Although the system will be equipped ultimately with the new high-efficiency 3 kc/s-spaced channel equipment, standard 4 kc/s-spaced channel equipment has been fitted in the first instance. With leased circuits it now seems that the system will be filled to capacity right from the start and provision of the 3 kc/s-spaced equipment to provide more channels is in hand. So great indeed are the traffic demands that consideration is already being given to the next cable to Canada, this despite an agreement to provide a TAT3 between Great Britain and the United States in 1963 and the challenge of communication satellites. If it should be decided to provide another cable to Canada it is likely to have a much greater circuit capacity than CANTAT.

On the recommendation of the Commonwealth Telecommunications Conference of July 1958 held in London, the CANTAT system will form the first link in the Commonwealth "round-the-world" submarine telephone cable system. The complete system, some 30,000 nautical miles in length and all to the CANTAT pattern, was estimated to cost £88 million, including £8 million for CANTAT. CANTAT will be followed immediately by COMPAC, the trans-Pacific system from Vancouver to Sydney. The Sydney-Auckland section of 1,250 nautical miles is due for completion in June 1962 and the entire COMPAC system of 8,100 nautical miles by February 1964.

New Chairman for C & W Ltd

Sir John Macpherson, GCMG, MA, LLD, became Chairman of Cable & Wireless Ltd. and its associated companies on January 1. He had a distinguished career in the Colonial Service, becoming Under-Secretary of State for Colonies in 1956 after serving in Malaya, Nigeria, Barbados and other places. Retiring from the Service in 1959, he continues to interest himself in Commonwealth affairs being Chairman of the London Conference on Overseas Students, Deputy Chairman of the Royal Commonwealth Society, and a Member of the Council of the Royal African Society. Sir John succeeds the late Sir Godfrey Ince, GCB, KBE.

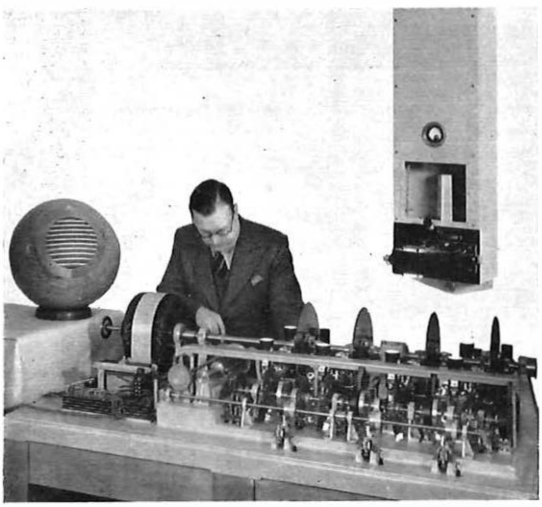
Speaking Clocks



Prototype announcing machine for new speaking clocks

The Speaking Clock Service was introduced in 1936 from equipment installed in London. In 1941 a second installation was opened in Liverpool. The announcements are distributed throughout the telephone network by a double ring system, which provides the local distribution points with announcements from both the London and Liverpool installations. Automatic changeover facilities safeguard the service as much as possible against breakdown of either cable or equipment.

The clock announcements are recorded photographically on glass discs, and are reproduced by a photo-electric technique. The discs are rotated by a synchronous motor driven at 60 rpm by a pendulum controlled supply. Automatic hourly correcting pulses received from the Royal Observatory maintain the clocks within one-tenth of a second of correct time. These clocks have proved to be thoroughly reliable, but have disadvantages in that the annual charges incurred are high and the quality of the speech recording is not good when compared with present-day standards.



Control pendulum and clock mechanism of the present clocks

A new and simpler speaking clock has been designed by the Post Office Research Branch, and it has been decided to replace the existing clocks by ones of this new design. They are to be manufactured at Dollis Hill and should be ready for installation early in 1963.

The new clock has the announcements recorded magnetically on a neoprene band impregnated with iron oxide, and reproduction is obtained by techniques similar to those used in conventional tape recorders.

The clock is driven by a synchronous motor driven from a 50 c/s supply derived from a crystal-controlled oscillator, and gives announcements of time which can readily be made accurate to within one-twentieth of a second when corrected once every week.

Compared with the glass disc machines, initial cost of the new design is considerably less, while improved speech quality and lower maintenance costs are obtained.

New Engaged Tone.—The present engaged tone (400 c/s—750 milliseconds on, 750 milliseconds off) is to be replaced by a new faster engaged tone of the same pitch (375 milliseconds on, 375 milliseconds off). The change will bring the United Kingdom engaged tone into line with international standards in readiness for the introduction of International Subscriber Dialling.

STD—The First Three Years

J. M. Harper

IN my article in the Autumn 1960 *Journal* I looked forward to the summer of 1961 as the sternest test of STD, after the first introduction at Bristol. The testing time has passed, and on December 5 1961 it was just three years since Her Majesty made the first STD call in the United Kingdom.

The STD service is now established. By the beginning of December 1961, 592,000 connexions on 167 exchanges had access to STD facilities. This represents $11\frac{1}{2}$ per cent. of the connexions in the United Kingdom. Over 12 per cent. of British trunk traffic is now dialled by callers for themselves. This is equivalent to about a million STD calls a week.

My task this time, therefore, is not to describe more or less experimental results at three places, but to try to draw conclusions from a reasonably large and representative cross section of the whole system. The STD service is now *the* telephone service for more than one subscriber in every ten; what is more, the programme is developing rapidly, and it will not be long before STD is normal, and manual trunk service the exception. The vision of the country as one vast local telephone network is on its way to achievement.

During 1961, STD made its appearance in all six of the Director systems—London, Birmingham, Edinburgh, Glasgow, Liverpool and Manchester, and in many other important places. The Prime Minister and other Ministers including, of course, the Postmaster General, Lords Mayor and Lieutenant, and many other important people have helped to launch the service. A great deal has been written in newspapers and magazines, and a great many statistics and reports have been compiled. What I want to do is to sum up the experience of these three years to show, if I can, the shape of the fully automatic service as it now begins to appear.

Table I: Analysis of calls to diallable exchanges: after 3 months of STD

Centre	Calls to exchanges that can be reached by STD		Percentage of dialled calls on which the operator gave dialling advice
	Percentage dialled by subscriber	Percentage completed by operator	
Bristol Central:			
3 months ...	96.4	3.6	1.4
November 1961 ...	97.0	3.0	0.6
Average of 27 Non-Director Exchanges ...	94.5	5.5	1.3
London (MONarch) ...	88.6	11.4	2.9
Birmingham (CENtral) ...	96.5	3.5	(Not yet available)
Glasgow (CITy and CENtral)	92.5	7.5	1.2
Manchester (BLAckfriars and DEAnsgate) ...	94.8	5.2	1.4

The first test of STD is how far people are actually prepared to use it to dial their trunk calls. An important feature of the British STD system is the choice which the caller has between STD and manual services for any call. The figures in Table I are therefore of great importance. Before we consider them, however, I must explain the "27 exchanges" which will appear at intervals throughout this article. To simplify the presentation of the results, we have combined those for 27 non-Director exchanges to give us, I hope, a representative picture of STD at a typical exchange of this type. The exchanges are listed in the footnote.*

**Aldershot, Avonmouth, Aylesbury, Bodmin, Bristol (Central), Bristol (Filton), Bristol (South), Bristol (Westbury-on-Trym), Chatham, Chatham (Blue Bell Hill), Chatham (Gillingham), Dundee, Evesham, Grays Thurrock, Hereford, Lancaster, Leicester (Central), Leicester (Aylestone), Narborough, Newmarket, Oadby, Rugby, Scunthorpe, Skipton, Syston, Thurnby, Watford.*

These 27 non-Director exchanges show a pattern—about 95 per cent. dialled, and 5 per cent. via the operator—which is fairly general so far. Bristol, after three months, showed a good figure—96.4. It improved still further after 18 months to 97 per cent. and as Table I shows, remained at this level after three years. Results elsewhere also allow us to expect a slight improvement with time in most places.

The figures for the Director systems are generally fairly consistent with this pattern, except London and Glasgow.

The last column shows the percentage of calls to diallable places received at the switchboard on which the caller accepted the operator's advice that he could dial the call himself. This figure—an index perhaps of how far people forget STD or forget that they can dial particular destinations—is consistently low and shows a definite decline with time nearly everywhere.

The reasons for these results are not far to seek—primarily, of course, tariff considerations and the essentially quicker nature of the STD service. What is important is the general consistency over a very wide range of types and sizes of exchange, which seems to confirm original expectations.

Table II analyses the residual operator-handled traffic to diallable exchanges for the 27 exchanges and a selection of individual centres. There is an unusually high percentage of "controlled" calls in London, but this may be due to the fact that many STD subscribers did not have private meters and barred trunk equipment at the time of these measurements. They were therefore making calls via the operator in order to have a record of them.

The most striking general effects are the reduction in the proportion of personal and advise duration and charge (ADC) calls, and the encouragingly low proportion of assistance traffic. The forecast in my previous article seems to be confirmed, and we may reasonably expect the national pattern to develop along these lines.

Two departures from the normal, however, show how, in smaller places, local characteristics may completely alter the national pattern. Newmarket has had a consistently low percentage dialled—varying between 73 and 84 per cent. Business in Newmarket is concerned very largely with horse racing. Both the residual special facilities traffic and the assistance and controlled traffic are high and there seems little doubt that this is because of the special type of caller in the town and especially the large influx of visitors at certain

Table II: Composition of remaining operator handled traffic, 3 months after STD

Centre	Percentage of total calls to diallable exchanges									
			Special Facilities							
	Assistance	Controlled	Personal		Transfer Charge		ADC		Total	
			PRE-STD	POST-STD	PRE-STD	POST-STD	PRE-STD	POST-STD	PRE-STD	POST-STD
Bristol Central (3 months) ...	0.5	0.7	7.1	0.7	2.1	1.1	6.4	0.6	15.6	2.4
Bristol Central (Nov. 1961) ...	1.1	0.2	—	0.3	—	1.0	—	0.3	—	1.6
Average of 27 exchanges	1.8	1.2	4.4	0.4	2.3	1.6	5.1	0.9	11.8	2.9
London (MON) ...	3.1	5.6	14.0	0.8	0.6	0.2	14.0	1.4	28.6	2.4
Glasgow (CIT and CEN)...	1.8	0.9	9.5	1.2	3.0	1.9	19.2	2.2	31.7	5.3
Manchester (BLA and DEA)	1.9	0.7	6.3	0.8	1.1	0.8	7.9	1.2	15.3	2.8

Table III: Stimulus to effective calls per 24 hours after 3 months of STD

Centre	Calls to diallable exchanges				Calls to non-diallable exchanges Percentage increase
	Percentage increase	Chargeable durations of F/R dialled calls (Mins)		Percentage increase in chargeable time	
		Pre-STD	Post-STD		
Non-Director					
Bristol Central:					
3 months	54	4.5	3.9	47	23
November 1961	113		3.4	86	45
Aylesbury	25	4.2	4.0	24	9
Dundee	11	4.1	4.1	11	1
Leicester Central	17	4.6	4.1	15	4
Lancaster	33	3.9	4.2	35	19
Newmarket	—6	3.9	4.2	—5	—2
Rugby	30	5.1	4.3	25	2
Watford	41	4.7	4.7	41	—
Director					
Edinburgh (FOU) (2 months)	10.1	3.7	3.7	10.1	—3
Glasgow (CIT & CEN)	14.6	4.4	4.3	14.2	—6
Manchester (BLA & DEA)	12.4	4.3	4.1	—11.8	—3.1
London (MON) (provisional)	45.5	3.8	3.8	45.5	—5.5

times. Another centre, Bridlington, was the subject of special study because its percentage dialled was also low—in the region of 80 per cent. It was discovered that this was caused almost entirely by transfer charge calls made by one particular subscriber. It will be noticed from Table II that the STD effect on transfer charge calls tends to be less, generally, than on other classes of special facility traffic. People making transfer charge calls are not, of course, likely to be affected by the introduction of STD.

Stimulus to Trunk Traffic

Whereas the proportion of residual manual board traffic is fairly consistent at nearly all of the centres we have examined, there is little or no consistency in the stimulus which STD has given to traffic.

Table III gives the results at a selection of places chosen to include business, residential and mixed exchanges in various parts of the country. A glance at the first column shows just how wide the variations are after three months. Even the general effect at business centres which I speculated about in my previous article seems far from clearly established. The generally lower apparent stimulus in the Director systems is noticeable, apart from London. The effect on durations seems to be equally varied, and it is difficult to draw any clear conclusion about this.

There is little doubt that this varied pattern is to a large extent caused by seasonal variations, and this is effectively illustrated by the reductions in non-diallable calls at some centres. As at Bristol, however, significant increases in the latter occurred in several of the places where there was also a substantial stimulus to diallable calls.

The impact of the stimulus related to time is interesting. The STD centres generally seem to fall into three groups; those where the stimulus was immediate and has been maintained; others where there was relatively little initial stimulus, but STD calls have grown much faster than normal so that a relatively high level is reached after about 3 months; and those where there was both an initial stimulus and subsequent increase.

Bristol, of course, has had STD for three years, and the figures quoted for November 1961 cannot be treated as an index of the effects of STD without reference to the normal growth of traffic. Fig. 1 shows what has happened there. The initial stimulus

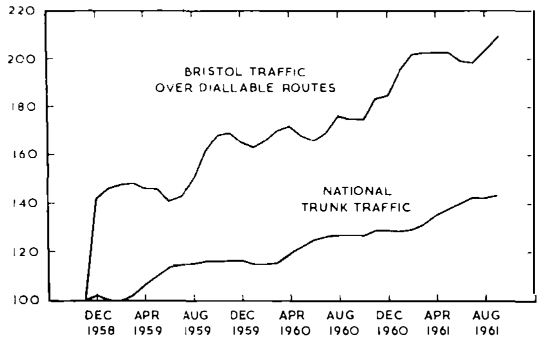


Fig. 1: Percentage increase of trunk calls made per weekday at Bristol (3 monthly moving average)

is very well defined, and, as will be seen, STD traffic at Bristol has actually grown faster than trunk traffic nationally. The inference in my original article that the effects of STD showed no sign of wearing off after just over a year still seems to apply.

The varying impact of the stimulus with time at other places is illustrated in Table IV, which quotes figures for two centres in each category:—

Table IV: Variation of stimulus to 24 hour effective diallable calls with time

Centre	% increase in diallable trunk calls after			
	1 month	2 months	3 months	6 months
(a) *Initial stimulus with no significant subsequent increase*				
Dundee ...	15	15	15	20
Rugby ...	30	25	30	33
(b) *Small initial stimulus but subsequent increase*				
Hereford ...	8	10	15	17
Evesham ...	4	14	20	30
(c) *Both initial stimulus and subsequent increase*				
Bristol Satellites and Avonmouth	30	40	50	60
Grays Thurrock	30	40	50	50

Even allowing for seasonal fluctuations and normal growth we may detect quite different responses at, say, Rugby and Evesham.

Staffing Effect

The introduction of STD on a significant scale has coincided with a continuing steep rise in trunk traffic generally. As a result, taking the country as a whole, the reductions in exchange staffing requirements which it has produced have been masked by the increasing staff required to handle the expanding traffic. The reduction in requirements directly resulting from STD up to August 1961 was about 1,000 telephonists.

In practice, of course, this figure is composed of substantial reductions at some centres and smaller ones at others, depending on the local impact of STD. The Post Office has always been concerned to do everything possible to avoid hardship for the staff involved. The Staff Associations were consulted from the early stages, and have given their full co-operation in securing a smooth transition from pre- to post-STD conditions at individual centres.

Revenue Effect

The various changes in traffic which we discussed earlier are bound, of course, to have an effect on revenue. This effect has been studied at 17 exchanges. Before STD the average value of a trunk call from these exchanges was 38.3d. Mr. Longley in his article (Winter 1959) forecast that the STD tariff would produce a reduction of 25 per cent. in this figure. The average value of STD calls at these same exchanges is 28.4d.—a reduction of almost exactly 26 per cent. This forecast has therefore proved extremely close.

We have seen how the effect of STD is felt in different ways when related to time at particular exchanges (Table IV). This, of course, has a similar effect on gross revenue. Table V shows the net

Table V: Reduction in trunk call revenue and increase in calls at 17 STD exchanges

Months	1	2	3	4	5
Reduction in revenue ...	10%	7.5%	6.4%	5.8%	3.2%
Increase in calls ...	21%	25%	26%	27%	31%

Table VI: Effect of STD in terms of originated trunk traffic to diallable destinations

Exchange(s)	Pre STD to diallable destinations: Period of Return	Pre STD to diallable destinations: Traffic in Erlangs	Post STD: Period of Return	Post STD: Traffic in Erlangs	% Increase
Glasgow DOUglas	April 1961	31	May 1961	40.3	30%
London LONdon Wall, " METropolitan, " MOOrgate	April-June 1961	53.6	July 1961	64	22%
" TATe Gallery, " ABBey, " SULlivan	May-June 1961	38.4	July 1961	46	20%
" WHItehall	July 1961	45.7	Aug-Sept 1961	53.5	17%

reduction in trunk call revenue at 17 exchanges, and illustrates very effectively how the net loss of revenue is rapidly off-set by the rise in traffic. To show the relation between these two factors, figures are also given for the average STD increase in calls at the same 17 exchanges, at the same points in time.

Effect on Traffic Loading

One aspect of STD of great importance to those responsible for the provision of equipment and circuits to carry traffic is its effect on the actual traffic load in terms of Erlangs. The figures in Table VI illustrate the effect of STD on trunk traffic at five Director exchanges in London and Glasgow. The records covered fairly short periods of time, and did not allow for seasonal effects.

Before STD was introduced short-term staffing and other difficulties affecting several of these exchanges probably meant that a certain number of calls attempted in the busy hour were abandoned and others were made at other times because of public awareness of these difficulties. STD generally gives a first-class service, so that these difficulties disappear, and some of the increase in busy hour load may also be due to traffic of this kind.

Table VII: Percentage increase in effective calls by Charge Steps—Diallable Calls—24 hour

Exchange	Increase in: Charge Step (a)	Increase in: Charge Step (b)	Increase in: Charge Step (c)
Bodmin	16%	—	32%
Evesham	30%	150%	77%
Leicester	5%	7%	10%
Rugby	15%	3%	40%
Scunthorpe	—5.8%	4%	8%
Taunton	—1.6%	24%	27%

These measurements, of course, relate to changes in total traffic passing through particular *exchanges*. They cannot, in themselves, be used to infer anything about traffic on particular groups of *circuits* between exchanges. There are wide variations in the impact of STD on traffic to different destinations, which appear to be governed by the interaction of community of interest and tariff. This is illustrated by Table VII, which shows the percentage increase in calls in each charge step at the centres concerned.

Readers may be able to deduce the effect of particular large towns in individual cases, but it is safe to say that no general pattern can be seen here. The importance of local measurement and of the accumulation of local information about the impact of STD on traffic loads is well illustrated by this table.

Timing Local Calls

The timing of local calls is of course an integral part of the STD tariff (for a discussion of this see Mr. Longley's article in the Winter 1959 *Journal*).

The most obvious effect of local call timing, and the one which has been most widely measured, is on the duration of local calls. The effect at the 27 exchanges referred to earlier has been summarized, and the result is illustrated in the pillar graph, Fig. 2. The actual change is relatively small, both in the cheap and full rate periods; even before the advent of STD, people tended to make longer calls in the evening. This, of course, is natural but it

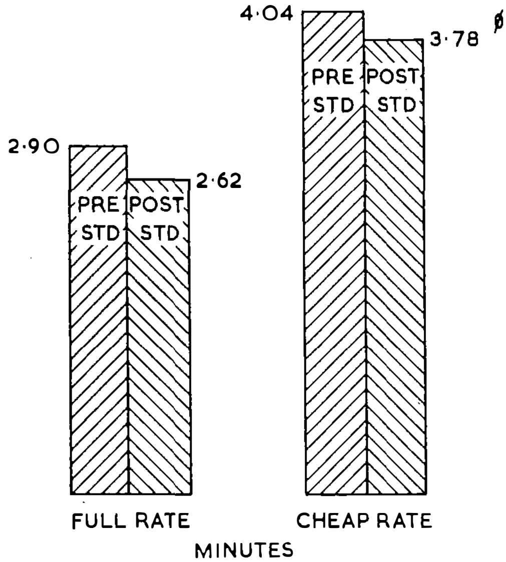


Fig. 2: Local call conversation times: (ordinary lines) at 27 exchanges

ø *Note: Records taken before cheap rate tariff was changed to 2d. for 12 minutes*

confirms the general picture that, in fact, the timing of local calls has not imposed an excessive financial burden on subscribers or made a marked difference to their calling habits. The actual average charge for a local call before STD (allowing for the reduction to 2½d. a call for residence subscribers introduced in 1960) was 2.85d; after STD, on the basis of 3 minutes for 2d. in the full rate period and 6 minutes in the cheap rate period it was 2.78d. So there was actually a reduction, and this will have been increased for residence subscribers by the new cheap rate tariff of 12 minutes for 2d. introduced on August 1 1961.

Table VIII shows the effect of timing on the distribution of durations, as distinct from average durations, and this again has been very slight. These effects, of course, vary fairly widely between particular places. I have chosen a few centres at random to illustrate this, and Table IX shows how wide these variations can be. The proportion of residential subscribers which might be expected to have some effect is also shown, but there does not seem to be any clear connexion between this figure and the effect of timing.

Table VIII: Effect of local call timing on distribution of calls at 27 exchanges

	Percentage of calls under	
	3 minutes in Full Rate Period	6 minutes in Cheap Rate Period
Before STD	71.1%	80.2%
After STD	73.5%	82.6%

Table IX: Percentage reduction in duration of local calls

Exchange	Percentage of Residential Connexions	% Reduction in Durations	
		Full Rate Period	Cheap Rate Period
Dundee	25	10	22
Rugby	50	8	+ 13
Watford	67	12	5
Westbury-on-Trym	83	15	14

We have seen that so far the results for most places show only a low proportion of calls on which callers seek assistance, and this is an encouraging sign of their success with STD. Service observations, however, enable us to take a closer look at the difficulties they experience.

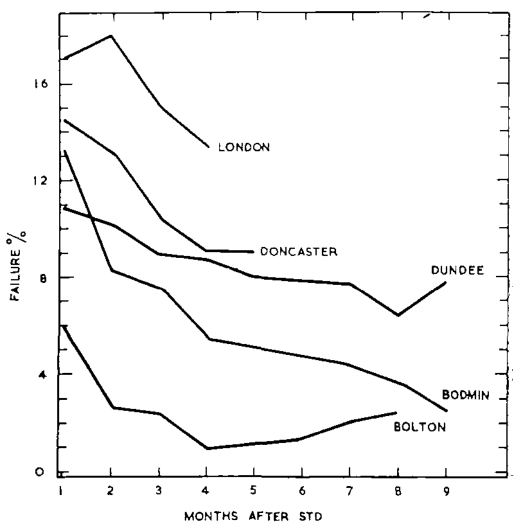


Fig. 3: Dialled trunk calls failing due to caller

Table X: Callers' success after 3 months STD

Centre	Percentages of dialled trunk call attempts: Dialled Incomplete National Number	Dialled Unavailable National Number	Abandoned Prematurely	Other Causes	Total	
Non-Director						
Bristol Central	5.9	5.2	1.3	0.2	12.6	
Aylesbury	2.8	4.7	1.7	2.4	11.6	
Bodmin	1.6	2.7	0.7	0.4	5.4	
Bolton	0.2	1.4	0.6	0.3	2.5	
Dundee	2.9	3.7	0.6	1.5	8.7	
Leicester	1.6	4.7	1.3	2.4	10.0	
Lancaster	0.5	1.0	0.5	2.0	4.0	
Newmarket	4.0	4.0	0.4	1.0	9.4	
Rugby	3.9	4.2	1.6	1.9	11.6	
Watford	1.0	2.5	1.6	0.7	5.8	
Director						
Edinburgh/FOU	1.5	4.7	2.5	2.9	11.6	After
Glasgow/CIT/CEN	1.2	2.7	1.2	0.9	6.0	2
Manchester/BLA/DEA	2.6	4.1	2.6	1.6	10.9	mon-
London/MON	2.8	6.8	1.6	2.4	13.6	ths
London/VIC	5.5	6.5	1.0	2.0	15.0	only

Table X presents a detailed analysis of observation results for several places, dealing only with failures which probably arise from the STD procedure. The actual composition of these difficulties deserves further analysis, but the very wide range of total failures—varying from 2.5 per cent. at Bolton to 15 per cent. in London—is striking. To those concerned with devising the STD procedure, this is a most puzzling feature, and I shall examine some possible causes later.

First, however, let us see whether callers improve with practice; that is, what the trend of performance is in the months that follow the opening of STD. Fig. 3 shows that results did improve fairly consistently. An overall impression is given by Fig. 4 which shows the trend of the weighted averages for 25 places, and gives a rough guide to the standard to be expected in the future. Returning to Table X, the most obvious fact seems to be that performance is least successful in the Director systems. This effect is not confined to STD traffic, and Table XI shows the pattern of performance on local and STD calls in different classes of place. Director (3+4) numbers are longer than non-Director (5 & 6 digit) ones, and this leads one to expect a better relationship between local and STD performance in Director areas than in non-Director areas. This seems to be the case, in the sense that non-Director callers make four times as many errors on STD calls as on local ones, whereas those in London make rather less than twice as many.

Two exceptionally good STD cases were Bodmin and Bolton. These were manual-to-automatic

Table XI: Percentage of calls failing due to caller

	Local Numbers	STD National Numbers
ND (National)	5 & 6 Digits	8, 9, 10 Digits
	2%	7.9%
Director (National)	7 Digit (3+4)	8, 9, 10 Digits
	5%	11.7%
London	7 Digit (3+4)	8, 9, 10 Digits
	7.4%	14.3%

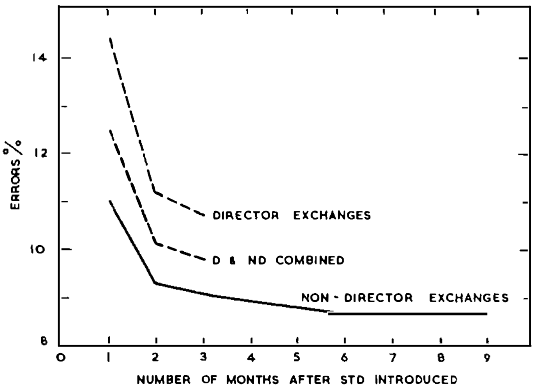


Fig. 4: Dialled trunk calls failing due to caller

conversions and every subscriber in each place was visited individually before STD so that they could be introduced to the new service. This, of course, is not practical for every centre, and does not explain the difference between other non-Director cases, and the Director systems; in all these cases similar caller instructions and publicity techniques were used.

In an effort to identify some other causes, several variables have been studied to provide a selection of the worst and best cases. The results are summarized in Table XII. The variables were:—

(1) Composition of the STD traffic in terms of percentage to one destination and to a small number of destinations in relation to the total amount. Obviously the greater the concentration on a few centres, the fewer the codes any given caller is likely to be concerned with, and the greater his chance of dialling correctly.

(2) The penetration of STD in the area concerned. In a small centre, introduction of STD affects all lines. In a really large linked numbering scheme like a Director system, many individual callers will tend to move from STD to non-STD telephones and back again, and the lower the penetration of STD the lower the percentage of users familiar with it.

(3) The actual size of the list of codes presented to the caller.

The interplay of these variables can be seen in the table. The exchanges are listed in descending order of callers' success, and the percentage of calls to one destination is almost exactly in step with this. There is a marked difference, however, between D and E. D with 30 per cent. calls to one place and 50 per cent. to three, is no better than E with much more varied traffic. 100 per cent. of the connexions in E have STD, however, whereas in D only 15.4 per cent. have it.

The correlation would not, perhaps, prove so close if a larger range of exchanges were studied, but it does seem that all three of these factors play a more or less identifiable part. (1) is beyond Post Office control, and (2) will become of less significance as STD spreads.

Analysis of individual call failures to see whether some might be due to the actual form of national numbers has been inconclusive. There does not seem to be any evidence of confusion between I and 1. Considerable trouble was taken in compiling the National Numbering Scheme to avoid this difficulty—for example, the code for Lincoln is LC rather than LI so that callers will not be confused between LI and L1.

The Coin-Box

In his article in the Autumn 1959 *Journal* Mr. Leaver described the new pay-on-answer coin-box, which is being introduced with or soon after STD. It is a major innovation in itself, since it dispenses with the traditional buttons A and B, and replaces them by a system in which no money is inserted until the called number actually answers.

At the beginning of December 1961 pay-on-answer coin-boxes were fitted, or were in course of being installed on 43 exchanges, including some in London, Birmingham, Liverpool and Bristol, where installation in the central area was completed in February 1960.

The tariff applied to the coin-box corresponds to that for ordinary users except that the value of the unit is 3d. STD and local facilities, including access to special services, are otherwise the same for coin-boxes as for ordinary lines. Because of the characteristics of coin-box users and traffic, however, the response to STD has been rather different. Table XIII illustrates the main features of STD traffic at a selection of centres equipped with the new coin-box.

The variation in response, in terms of increase in calls, is even greater than for ordinary STD. There are some grounds for thinking, however, that at places where the number of calls rises very sharply the durations of calls seem likely to show an equally sharp decrease, although figures are only available so far for Bristol, which show a reduction of 28 per cent.

Table XII: Analysis of variables affecting callers' success

Exchange	% Ineffective due to caller	% calls to one destination	Composition of traffic	% STD in LNS	No. of exchanges in DC Booklet
A	0.9	70	90% to 7 destinations	100	486
B	2.0	41	60% to 3 destinations	100	535
C	4.0	24	73% to 4 destinations	100	448
D	12.6	30	50% to 3 destinations	15.4	369
E	12.5	15	56% to 7 destinations	100	442
F	13.8	25	40% to 2 destinations	15	825
G	15.0	9	25% to 4 destinations	5.6	920
H	15.0	8	23% to 4 destinations	5.6	920
K	15.5	9	34% to 5 destinations	5.6	920

The percentage of diallable calls actually dialled is fairly constant in most centres. It is, however, much lower than for ordinary traffic, and to assess the effect realistically it is important to notice the high proportion of transfer charge calls. In fact, the actual number of these does not change significantly, since people who make them are not, after all, affected by the change in tariff. If we discount these, and consider the proportions of assistance, controlled and other special facilities calls, a pattern similar to that for ordinary traffic can be seen. The relatively high percentage of calls on which the caller went straight to the operator ("controlled") may arise partly from the fact that the manual tariff is slightly more favourable than the STD one at precisely 3 minutes at certain charge steps.

A fascinating, though perhaps predictable effect

Table XIII: Analysis of Pay-on-Answer CB trunk traffic three months after the introduction of STD

Centre	Diallable Calls % increase over pre-STD	Percentage of total calls to diallable exchanges								
		Percentage Dialled of Diallable	Assistance	Controlled	Special Facilities					
					Personal		XFC		ADC	
					PRE-STD	POST-STD	PRE-STD	POST-STD	PRE-STD	POST-STD
Bristol Central	92	71.4	1.6	2.2	3.0	1.1	44.3	24.1	—	0.4
Bodmin ...	26	72.1	2.3	4.7	0.3	—	3.2	18.6	0.3	—
Evesham ...	86	76.3	—	6.2	1.9	—	26.9	15.5	—	—
Grays Thurrock	33	81.4	2.2	4.0	0.6	0.9	16.5	10.6	—	—
Rugby ...	113	75.8	—	4.2	6.3	0.8	32.4	17.4	—	—
Westbury-on-Trym ...	83	76.6	3.1	1.6	5.7	3.1	25.6	14.1	—	1.6

arises from the impact of Local Call Timing on coin-boxes. Whereas there has been a certain amount of criticism of the timing of local calls from ordinary lines, there has been strong support for the timing of local calls from coin-boxes. Fig. 5 shows how it has actually worked out in terms of the distribution of local call durations from coin-boxes. Before STD local call durations at Bristol conformed to the roughly exponential distribution also found on ordinary lines. Now, however, there is a distinct concentration in the first 3 minutes followed by a very pronounced drop after $3\frac{1}{2}$ minutes. The facilities of the coin-box include a period of 12 seconds "grace time" over and above

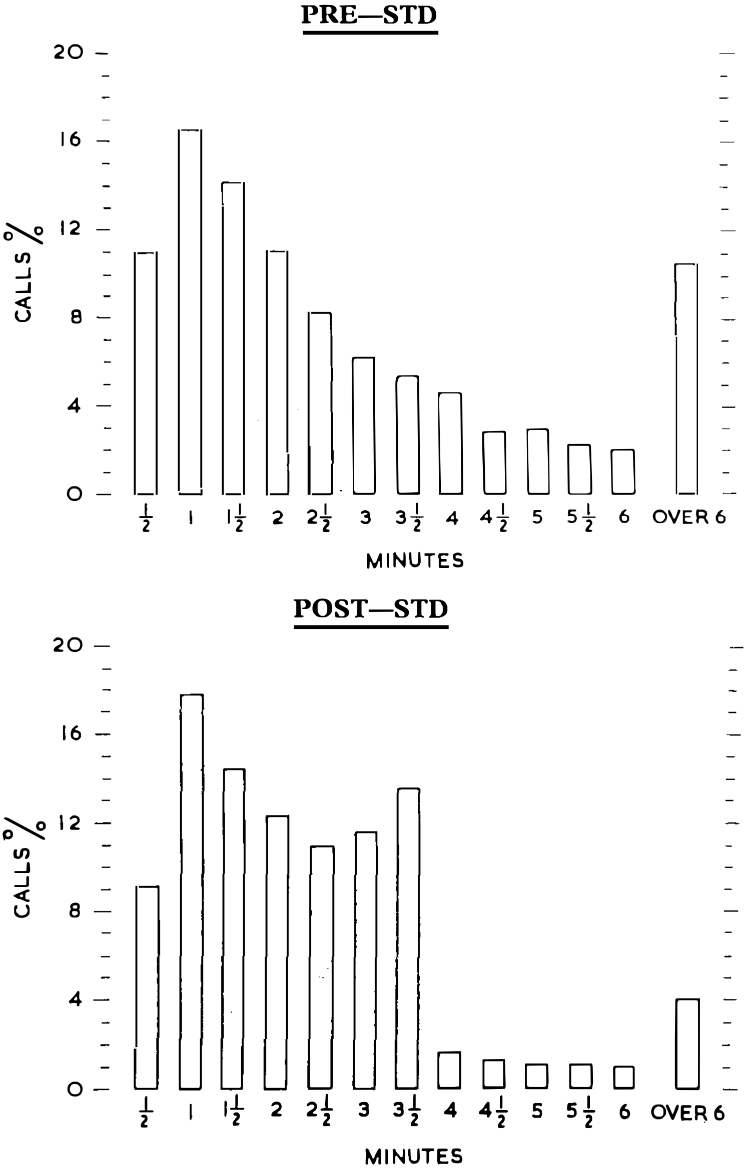


Fig. 5: Bristol Central coin-box local calls—distribution of conversation durations

Table XIV: Analysis of errors due to Caller and Called subscriber three months after introduction of PA coin-boxes

Exchange	Percentage of all attempts — Coin-box difficulties: Caller cleared during Pay tone	Caller failed to insert coins during first Pay tone	Called subscriber cleared during Pay tone	Percentage of STD attempts only — Other difficulties (Total failures due to caller—not involving coin-box facilities)
Bristol (Central)	2.5	2.4	0.86	19.5
Dartford	2.8	4.0	2.25	20.0
Grays Thurrock	3.1	3.94	1.4	13.5

the time actually paid for, and were the distribution plotted at closer time intervals we should find the drop actually occurred between 3 minutes and 3 minutes 12 seconds. It really seems that the cartoonist's idea of the queue outside the call office may soon disappear. It should even be possible, with timing, to reduce the number of call offices in town areas.

Observations of users' experience with the new coin-box yield some interesting results. Table XIV shows the more important aspects of this at three centres.

One of the fears about pay-on-answer coin-boxes was that people answering calls from them might be confused by pay tone—the signal given to the caller to insert coins—and might hang up. In practice this trouble is not so serious as that of callers hanging up during pay-tone or failing to insert coins and being force-released. Both these latter characteristics, however, show an encouraging reduction at the places which have had the new coin-box for some time, and although further education of subscribers is necessary I think we may say that our fears have proved to be largely without foundation.

One interesting feature of callers' performance with the new coin-box is their relative lack of success with STD, compared with the standards examined earlier for ordinary users (the last column of Table X). I think this can be explained by the high proportion of travellers and visitors among coin-box users, who, not surprisingly, find STD unfamiliar at present.

The effect on gross revenue from the public call offices in the Bristol Central area of the introduction of the pay-on-answer box was as follows:

Revenue December 1958—
February 1959 £4,391

Coin-Boxes introduced September 1959—
February 1960

Revenue December 1959—
February 1960 £4,395

Revenue December 1960—
February 1961 £4,709

Revenue increased only marginally during the year in which the new boxes were installed, but in the following year there was an increase of about 7 per cent.

We can best relate this to the large increase in trunk calls which we noted in Table XIII by looking at Table XV.

Table XV: Average charge to user for calls from public call offices at Bristol

	Local	Diallable Trunk Calls*
Pre-payment Coin-Boxes ...	4d.	2.7s.†
Pay-on-Answer Coin-Boxes ...	3.6d.	1.25s.

* Revenue from all trunk calls except transfer charge.

† Average charge for calls to destinations which subsequently became diallable.

This table explains the relationship between the increase in trunk calls and the virtually stable revenue. The reason for the reduction in the average charge for trunk calls is probably because the change from a 3 minute minimum to periodic pulse charging, both limits charges to a much closer relationship with time consumed and gives callers an incentive to make shorter calls. This is even more apparent with coin-boxes as the caller is very conscious of paying for his call. This result is consistent with the reduction in durations referred to earlier. The local call charge effect is somewhat different in that the 4d. charge was for untimed calls, whereas 3.6d. represents the mean cash value of the distribution in Fig. 5. It is encouraging to note that the decrease in the unit charge for local calls, which comprises the bulk of call office calls, has not resulted in an overall reduction in the revenue.

The smallest value coin inserted in the new coin-box is the 3d. piece, in place of the penny in the old box. The resulting reduction in the volume of coins accumulating in boxes has made it possible to reduce the number of collections by 75 per cent., with appreciable savings on staff and transport costs.

Public response to the new coin-boxes has been very encouraging and criticism has been small. Immediately following the introduction of the new boxes the Post Office has staff available to assist users with the unfamiliar operation. The change-over has been successfully accomplished at every centre so far.

Public Reactions to STD

Much of the public interest in STD continues to be focused on the introduction of timed local calls as an integral part of the STD tariff. We have already examined the measured effects of local call timing at a selection of centres, and have seen that its real overall effect has not been particularly striking.

There has, however, been a certain amount of public reaction to the new tariff. Correspondence in local newspapers continues from time to time, and there have been articles in the national press. Certain characteristics of this are worth noting. In particular, there has been greater reaction from those who have not yet had experience of the new service than from those who have. This is more or less consistent in every place which has had STD so far. Incidentally, feminine reactions to the new tariff have been recognizably stronger in many places than those of men. Much of the comment, however, has been based on a lack of information about the details of the tariff, and in particular about the cheap rate period. The Post Office has done everything possible to inform subscribers about the tariff by leaflets and general publicity in correspondence columns of newspapers and, with considerable success, by Post Office speakers at meetings. The relative lack of comment from subscribers who actually are on STD testifies to the effectiveness of this programme.

The effect of STD, with its periodic metering tariff, has been generally to highlight inefficient service given by PBXs. This is especially true with local calls because they have not been timed in the past and much of the complaint over timing has been due to this. Again, the Post Office is doing all it can to draw the attention of PBX owners, particularly large organizations having heavy telephone enquiry traffic like the railways, to the importance of rapid and efficient incoming telephone service. Great emphasis was laid on this in a booklet called "The Telephone in Business" which was recently produced to help firms perfect

Table XVI: Summary of replies to questionnaire sent to subscribers on seven STD exchanges

Do you prefer the STD service to the old service			Yes 74%
If you like dialling your trunk calls is this because it is			
	Quicker		27%
	Cheaper		7%
	Both		50%
Do you consider the range of places to which you can dial trunk calls			
	Extensive		20%
	Reasonable		54%
	Limited		18%
		Business	Residence
Timing local calls has enabled the minimum charge to be reduced to 2d.			
Do you	Welcome this	36%	26%
	Accept it	40%	34%
	Regret it	20%	37%
		Business	Residence
Has the extra time allowed on local calls in the cheap rate period caused you to make them in the evening rather than in the daytime			
	Yes	14%	33%
	No	77%	62%
		Business	Residence
Has the new system caused you to make more calls than you did before			
TRUNK calls	Yes	20%	14%
	No	74%	80%
LOCAL calls	Yes	11%	8%
	No	82%	85%

their telephone arrangements. The Post Office is also preparing a film on PBX operation under STD conditions, and has co-operated with an outside body in the preparation of two film strips on the same general theme.

This concern with the incoming service plays an important part in the programme carried out by the Travelling Supervisor who visits PBXs during the preparation period before STD to familiarize operators with all aspects of the service. A most effective step to help PBX operators was taken at Leicester, where a Post Office school trained over 700.

Of the popularity of STD with business users, and indeed everyone who makes trunk calls, there can be no doubt. There is considerable pressure for the list of places which can be reached by STD to be extended.

In February and March last year questionnaires were sent to subscribers on seven exchanges with 6 months or more experience of STD, and they were invited to express their opinions. Nearly 10,000 replied. Table XVI summarizes their answers to some of the important questions.

The results are quite encouraging. There is a strong body of opinion in favour of STD; a substantial proportion of users would like more of it, in the sense of being able to dial calls to places they cannot yet reach. A majority both of the business and residential subscribers who replied either welcomed or accepted local call timing, and an encouraging proportion of the latter say they are making calls in the evening rather than in the daytime—an important aspect of local call timing since it increases the earning capacity of equipment and circuits. Finally, there is an interesting indication of a stimulus to the use of the telephone, in that a proportion of each class say they are making more calls.

In my previous article I referred to callers' willingness, under conditions of breakdown and congestion, to continue making repeated attempts for themselves, rather than to go to the operator for assistance. In an attempt to confirm public reactions on this the grade of service on the Leicester-London route was intentionally reduced for a short period. There was no complaint, and no distinguishable effect on assistance traffic to the manual board. Further evidence under conditions of real breakdown tends to confirm this.

To assist subscribers with difficulties which the STD bulk-billing charging system might cause, especially business subscribers with large installations, the Post Office has provided meters which can be installed at a subscriber's premises. These show the units accumulated either on individual calls or in total over a period. There has been substantial demand for these meters, particularly on PBXs, and a meter designed to fit into the PBX keyshelf is now available. A total of 5,731 private meters altogether was in use by August 31 1961.

These meters are essential for debiting particular calls to departments or individuals. A more drastic step is to deny the ability to make trunk calls to particular telephones. Facilities are available to do this, although the Post Office has not encouraged subscribers to take this step, for obvious reasons. In the event only 40 lines have been equipped in this way out of the half million who now have STD, although similar facilities have been provided on a number of larger PABXs.

The bulk-billing of trunk calls means also that disputes become more difficult to deal with, and Mr. Harvey in his article in the Summer 1961 *Journal* described the Meter Check Printers which have been developed to meet this need. In practice the actual volume of disputed accounts work has not increased significantly. This may be because subscribers, when not provided with detailed trunk call statements no longer have the "raw material" of disputes, but these printers have proved invaluable not only for this purpose but for a variety of statistical and service purposes.

Conclusion

What is the picture of the future telephone service which we can draw from these results? I think we might sum the position up like this:—

> The STD service has proved both efficient and popular, and people use it generally for 90 per cent. or more of the trunk calls on which it is available.
>
> It has given a stimulus of about 20 per cent. to trunk calls in most places, and this shows no sign of wearing off.
>
> Callers seem to find the STD procedure quite simple, and they improve with practice. The new coin-box has proved a success, and has had the expected effects on the pattern of coin-box traffic.
>
> Despite a certain amount of reaction when people first hear of it, local call timing has been accepted as a feature of the service, and has not had any marked effect on subscribers' bills.

The overall revenue effect is quite close to that predicted, and the initial drop in revenue is soon overtaken by traffic growth.

We seem, in fact to have passed the test of 1961, and we can contemplate the future spread of STD with confidence.

The Future

The introduction of STD has coincided with a period of quite unusual growth of trunk traffic. Prodigious efforts have been, and are still being made to keep pace with the immensely increased demand for trunk circuits and equipment, but it is possible, despite these, that the programme may have to be slightly modified over the next year or two. The net effect will be slight however, and we still look forward confidently to our general target of 90 per cent. STD by 1970. Plans are now being made to extend STD to the smaller communities which are served by Unit Automatic Exchanges, and we hope to introduce the first STD for these in 1965 or soon after.

STD will not be complete until every trunk call can be dialled. Messrs. Thompson and Longley described the transit network which is essential to this target in their article in the Autumn 1961 *Journal*. Once this is working we shall really have achieved the target of "Full Automation" set in the 1957 White Paper.

The author wishes to express his thanks to the very large number of people who, by their contributions to the collection of STD results have made this article possible, and to the ITD/TMB staff who have devoted a good deal of time and energy to the preparation of these results in their present form.

PMG at TEMA Dinner

Speaking in London on February 13 at the annual dinner of the Telecommunication Engineering and Manufacturing Association, the Postmaster General, the Rt. Hon. Reginald Bevins, MP, said that the satellite ground station building at Goonhilly Downs in Cornwall was almost complete and that installation of the equipment had begun.

The station, which is being built by the Post Office in connexion with the forthcoming tests of communications via satellites, in association with America, will also have to be linked with the national network in this country to enable television signals to be relayed to and from London, and also by a telegraph channel in the transatlantic cable system to the Goddard Space Flight Centre near Washington, from which it will receive orbit prediction data for satellite acquisition and tracking.

Mr. Bevins went on to say that "the forthcoming transatlantic tests of communications via satellites should yield very valuable new information. In particular we hope to learn something of the useful life which can be expected of a satellite in commercial use.

"But please do not assume that we have tacitly decided to become the titchies—the little people—in space communications. That is not how I think".

The Postmaster General mentioned that in recent years the Post Office had earned a good return on capital and it must maintain a good standard of performance if it was to have a strong case for a good share of national resources when planning expansion of its services.

During 1962-63 another 100 manual telephone exchanges are due to be converted to automatic working, said Mr. Bevins. By the end of March 1963, more than 500 exchanges, serving about one-third of the country's telephone subscribers, will have Subscriber Trunk Dialling facilities. "That is pretty good-going".

Commenting that later this year the Post Office will be opening an electronic telephone exchange at Highgate Wood, Mr. Bevins said, "This will be the first all-electronic public exchange to be tested on live traffic in Europe.

"But this is only a beginning and already work is well advanced on new and greatly improved systems. So confident are we in these developments that I have recently re-affirmed the policy that the Post Office should plan to move straight from the existing system . . . to fully electronic telephone exchanges.

"We believe that we are as well advanced on this work as the United States and well ahead of any other country".

The Transfer

E. C. Baker, M.B.E.

January 1 1962 was the 50th anniversary of the transfer of the National Telephone Company's staff and plant to the Post Office. In the following article E. C. Baker, the Post Office archivist, describes the events which led to the take-over, and we hope to follow this in the Summer issue with a description of technical developments since the take-over.

THE story of the transfer of the National Telephone Company's staff and plant to the Post Office on January 1, 1912 could fairly be said to have started at Westminster Hall on November 29, 1880. In the High Court of Justice on that day a case was opened before Mr. Baron Pollock and Mr. Justice Stephen; it was the Crown versus The Edison Telephone Company of London, Limited. The hearing lasted for five days. The Attorney General had pleaded "that it shall be declared that the transmission of messages by the Defendant's Company . . . is an infringement of the exclusive privilege conferred upon the Postmaster General by the Telegraph Act of 1869".

During the hearing Mr. Baron Pollock asked whether it was possible to distinguish one voice from another on the telephone and was informed that "you may distinguish a rough voice from a tenor voice, but it comes out more like the voice you hear in a Punch and Judy". Judgment was given for the Crown whereupon the Attorney General stated that the Postmaster General was fully alive to the advantages to be derived by the public from telephonic communication and assured the Court that "nothing shall be done to stop telephonic communication, so far as it is required by the public". Mr. Justice Stephen concluded the proceedings by observing that "of course, everyone would, in every respect, wish to treat the Defendant Company as having been proprietors of a most beautiful invention, as it has been used entirely to the public advantage to the extent that they have done. If . . . they have done any illegal act, all one can say is, that they have simply taken a wrong view of the construction of the Act of Parliament".

The Company named in the action had been formed to exploit two of Thomas Edison's telephone patents and had opened an exchange in London a month after the Telephone Company Limited (Bell's Patents) had begun service at an exchange in Coleman Street in the City of London in August 1879. By the time the action was heard the two companies had amalgamated to form the United Telephone Company Limited, which company had accepted service of the writ. Thereafter, private telephone companies operated under licence from the Postmaster General. Companies were soon formed in the main centres of population. Litigation over alleged infringements of instruments then in use and take-over bids were features of those early years. The National Telephone Company Limited first appeared in 1881, with headquarters in Glasgow where it took over the Bell and Edison systems working there. From this time it absorbed one company after another throughout the British Isles and within a few years had become a monopolistic body.

At the end of 1880 Henry Fawcett, the blind Postmaster General, applied to the Treasury for authority to establish Post Office telephone exchanges throughout the country. The Treasury, however, was apprehensive of the large expenditure involved and authorized only sufficient exchanges to provide the Post Office with some practical experience to negotiate with companies applying for licences. At a number of towns in north east England the Post Office had been operating central exchanges for renters of ABC telegraph instruments and these telegraphs were replaced with telephones. The first newly-designed exchange opened by the Post Office was at Swansea in 1881.

Treasury policy changed in 1892 when preliminary arrangements were made for the Post Office to purchase the National Telephone Company's trunk wire system and undertake the development of an extensive trunk network. It was not until 1896 that details were worked out and the transfer completed, the Post Office paying half a million pounds for less than three thousand miles of overhead trunk lines. A year earlier, because of widespread criticisms of the National Company's services, a Select Committee of the House of Commons had looked into telephone problems but had made no recommendations. The States of Guernsey, granted a licence at the end of 1897, opened exchanges the following year and, like the States of Jersey, which acquired the telephone system in that Island from the Post Office in 1923, are still running the local and inter-island telephone services today.

In 1898 the House of Commons appointed another Committee "to inquire and report whether

1901: *Laying underground cable in London*

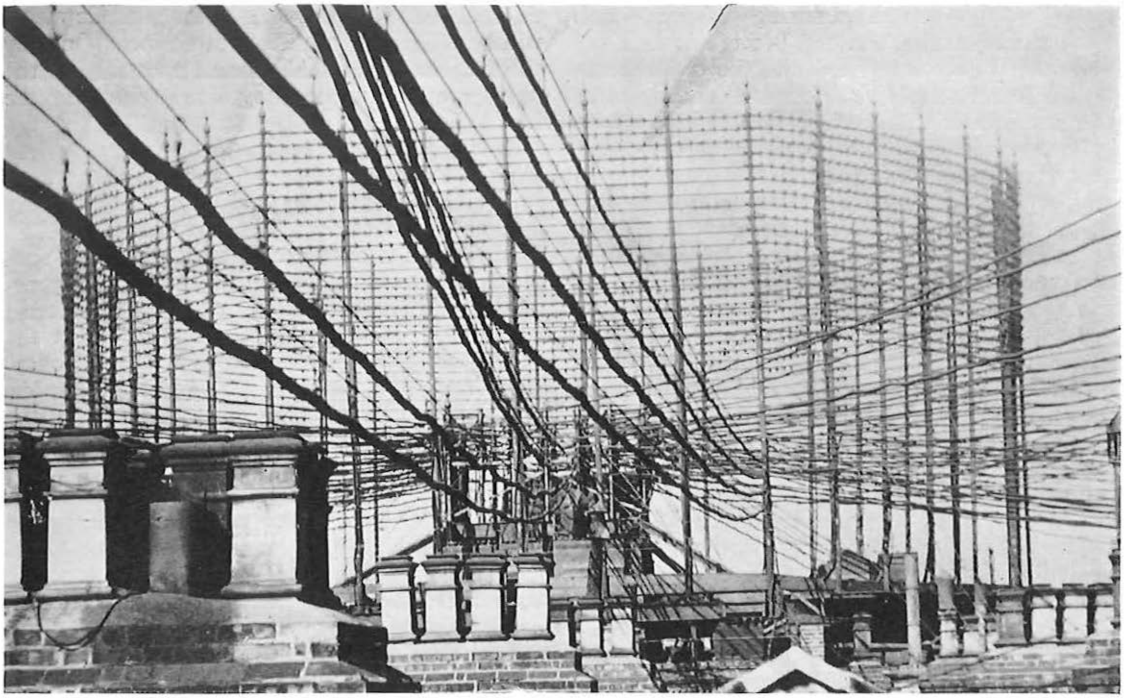
the telephone Service was calculated to become of such general benefit as to justify its being undertaken by municipal and other local authorities". The Committee reported in favour of competition with the National Company by municipalities and by the Post Office. The following year the Treasury authorized the Postmaster General to establish exchanges in London. To avoid wasteful competition and unnecessary duplication of plant in the London area it was agreed that the Post Office develop the western half of the region. The Post Office also opened a number of exchanges in the City area, the first being Central in March 1902.

Underground Lines

By that time an extensive system of underground lines was being laid, including work for the National Company, and London became the first city in the world with a substantially underground system of telephone circuits. The huge spiders' webs of wire that criss-crossed above the streets over the roofs to converge on equally unsightly derricks above the exchanges, became phenomena of the past.

What of the competition that had been asked of municipalities? Sixty local authorities applied for information, but of these only thirteen reached a stage where they could be issued with licences. Of these only six got as far as actually installing telephones. The Tunbridge Wells venture quickly passed into the hands of the National Company (1902), as five years later did that for Swansea. The Post Office also took over systems; at Brighton in 1906, Glasgow in 1908, and Portsmouth in 1913. The only local authority which had any continuing success in operating a municipal telephone system was Kingston-on-Hull and the local telephone service in that city is still run by the Corporation.

Almost inevitable was an agreement of 1905 whereby the State was to take over the whole of the National Telephone Company's undertaking at the end of 1911. Ironically, much of the public criticism of the Company's services was also transferred to the Post Office at the same time. Over half a million subscribers' telephone stations, working to 1,565 exchanges, were transferred. Stocks of equipment were low; a fair amount of plant needed renewal; some exchanges were overloaded and, as a result, provision of lines for new subscribers was restricted. The purchase price of the system was fixed at £12.5 million sterling, the Company having claimed £18.4 million and the Post Office having valued it at £9.4 million.



1908 : "The huge spiders' webs of wire that criss-crossed above the streets"

So on New Year's Day 1912, 5,070 men and 7,126 women employees of the National Telephone Company found that they had become Civil Servants overnight. Although ostensibly every attempt was made to treat the newcomers as well as possible, settling in was not an easy process, and the appointment of a Select Committee of the House of Commons in April 1912 to enquire into the wages and conditions of employment of Post Office servants was timely.

There were marked differences in the organization of the National Company in which our new colleagues had been trained. Whereas the Post Office was divided functionally into departments which were then organized independently on a local territorial basis, the National was organized territorially throughout with only limited functional administration from headquarters. It is clear, therefore, that in the event the organization of the absorbed Company exerted a lasting, if gradual, effect on the organization of the Post Office.

That an immediate fusion of the two organizations would not be possible was manifest even before the transfer. The highest officials of the Company did not enter the Post Office service so that no great difficulties arose on central administration. However, the Post Office had no counterpart to the district managers of the National Telephone Company. In the Post Office the traffic and operating staffs were under provincial postmasters and the engineering staffs under sectional engineers who were responsible respectively to surveyors and to superintending engineers. The Company's district manager, however, had under his control sales staff, traffic and operating staff, and engineering construction and maintenance staffs. After the transfer the position of a district manager, who was to be borne on the surveyor's staff, was altered as all engineering staff came under the control of superintending and sectional engineers. The National Company's district manager was, in fact, the earliest of our telephone managers.

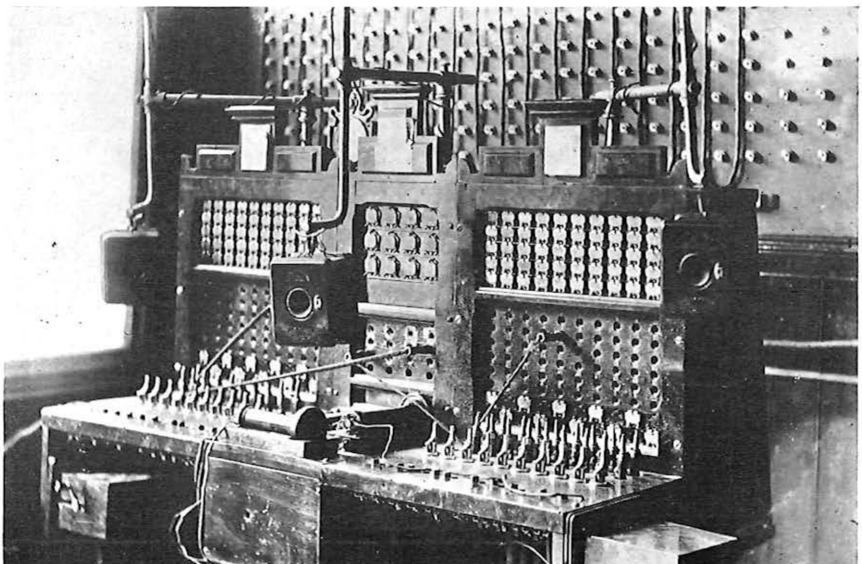
London, as would be expected, provided special problems. The area of the London telephone service was reduced to coincide as closely as possible with that of the London Postal District. All sales, operating and traffic staffs came under the Controller, London Telephone Service, and engineering staffs under the Superintending

Engineer, London Engineering District, with fourteen engineering sections. Before everyone had been thoroughly integrated into the organization World War I started. The essential soundness of the organization could be judged by the way it survived severe drains on manpower and materials over four weary years. But development of the telephone in the United Kingdom in the post war years showed the need for unified control of both operational and engineering aspects which led to the present form of organization with telephone managers working to a regional director.

At the transfer John Lee, who later became Controller of the Central Telegraph Office, wrote in *St. Martins-le-Grand Magazine*, forerunner of the *Post Office Magazine*, "we may cast our minds forward a little and think of the London of the immediate future, with one million telephone subscribers. It is no fanciful dream, for the smaller city of New York is even now preparing for two millions. With ten million conversations per day, we can imagine how closely the life of the city will be welded together, and what a social and an economic change will be wrought. Then we must stretch our imagination and think of the toll traffic to the outlying districts, in the progress of which the telephone has been so important a factor. Even then we must let our vision go further a-field and think of the volume of long-distance traffic which will be offered by a million subscribers. Only by so doing can we visualize the importance of the transfer of the telephones to the control of the Post Office".

At the transfer the National Company had 131,506 stations in London and the Post Office 77,315. It was not until 25 years later that the millionth telephone was installed in London.

Many of the ex-National staff were very successful in the Post Office. In 1942, thirty years after, five of twenty Post Office staff engineers started with the Company; ten years earlier the figure had been eight out of twenty three. Today, the last of the National men and women have left us. In their memory let us recall the words of the Secretary of their Company in the final issue of the *National Telephone Journal*, January 1912, of which this journal may claim to be the successor. He wrote: "Through storm and sunshine, good fortune and bad, the National Telephone Company has moved to its appointed end, conscious that at all times it has given of its best . . . often under circumstances of extreme trouble and difficulty . . . it confidently anticipates that the verdict of posterity will be that the National Telephone Company deserved well of the nation".



1884: Middlesbrough Telephone Exchange (United Telephone Company)

New Home for Weather Forecasters

The Meteorological Office communications centre has been at Dunstable for the last twenty-one years and during this time Dunstable has become known as the home of weather forecasting. The centre was housed in temporary buildings and the accommodation became increasingly restricted as the services grew in quantity and complexity. Expansion on the existing site was not possible so, in the interests of efficiency and economy, it was decided to seek a new site big enough to accommodate all Headquarters branches of the Meteorological Office. Such a site was found at Bracknell.

Inevitably the decision to move and centralize raised problems for the Post Office; the large amount of work involved in rearranging the complex communications network without interrupting service called for detailed planning. After many meetings between Post Office, Air Ministry and Meteorological Office representatives, plans for the layout of the teleprinter rooms were agreed and ways were found to carry out the changeover at a set time.

The bulk of the installation work was completed by mid September and the changeover took place at 2 o'clock on September 30, 1961; just four-and-a-half months after installation work started at Bracknell. This work involved wiring 89 teleprinter positions on benches specially designed by the Meteorological Office; four broadcast consoles and six reperforator cabinets; installation of approximately 150 telegraph machines, all positions being wired back to an intermediate distribution frame (IDF); and patching jack field (PJF) in an adjacent room. The broadcast consoles also were designed by the Meteorological Office and have been provided with broadcast facilities for some 180 circuits spread over the four consoles. These facilities called for the provision of 18 broadcasting units and the latest electronic type was installed, together with a back up of electro-mechanical units in case of trouble.

Approximately 120 circuits had to be provided at Bracknell, including 10 facsimile circuits for the Weatherfax Ring, and of these 90 had to be transferred from Dunstable.

To cater for these telegraph circuits, nine multi-channel voice-frequency telegraph systems were provided from Bracknell to the various MCVF terminals formerly serving the Dunstable network. These additional systems enabled Bracknell to be "teed" off the working circuits until the changeover was made, after which the Dunstable links were cut away.

These teeing arrangements permitted the simultaneous reception of information at Bracknell and Dunstable for a week or so before the changeover, and advantage was taken of this situation to train staff at Bracknell and generally run in the new station. In particular, the new broadcast equipment at Bracknell was fully proved by arranging for Dunstable to clear broadcast traffic via the Bracknell equipment. This element of pre-transfer testing and training was a significant factor in achieving a smooth changeover to a full load of some half million groups (words) a day.

The Meteorological Office has expressed its hearty appreciation of the complex task performed by the Post Office. Last minute snags were very few in number and recipients of Bracknell's early transmissions were largely unaware that the new installations had finally been put to the test.

Training Staff

Some staff were transferred from Dunstable and others were recruited locally. For these local recruits nine bench positions fitted with various types of terminal equipment, were provided two months in advance of the changeover in a room set aside for training. This training equipment will be retained to cater for future staff changes.

To the Bracknell meteorological communications centre comes weather information for the whole of the northern hemisphere. Much of the information received is retransmitted over two radio broadcasts, over telegraph circuits covering much of Europe, and over a link with Montreal. In the adjacent forecasting office weather maps and forecasts are prepared. These are transmitted by radio and landline within the United Kingdom and for oversea users, both in a coded version and in facsimile. The land area and shipping forecasts; warnings of gales, frost and snow—familiar to listeners to sound radio and television—originate here.

Dunstable is being retained for the time being as a remote Radio Reception for overseas radio circuits with direct teleprinter circuits into Bracknell.

P. E. Haarer

The Factories Department

POST Office factories originated when the Post Office acquired the telegraph system in 1870. In those days their purpose was to manufacture and repair telegraph instruments—Wheatstone, Baudot, Hughes and the like—batteries and also line plant. With the advent of the telephone, the character of the work changed enormously, particularly when the National Telephone Company was absorbed into the Post Office in 1912 and the factories belonging to that company joined the existing Post Office factories.

Today, the Factories Department has eight establishments employing just under 3,000 staff and it is among the 300 or so "large" industrial concerns in this country. It is organized into three factory groups, each with a Manager, the whole being co-ordinated at Headquarters under the Controller. At Headquarters there are two Divisions—Executive, which is concerned with staff, provisioning, accounting and procedure; and Engineering which is responsible for consultative engineering services, technical liaison with the Engineering Department, and the development of new methods and processes. There are three factories in London, three in Birmingham, a very modern unit in Cwmcarn, Monmouthshire, and a small factory at Edinburgh under the control of the Birmingham Manager.

The Department is primarily concerned with repairing and overhauling all kinds of telecommunications equipment, but there is still some specialized manufacture in its well equipped workshops, particularly of prototypes. The Department is a major user of replacement parts, especially of teleprinter and automatic telephone exchange pieceparts, and it also acts as stockist and supplier of about 30,000 different pieceparts to the Regions.

The Factories Department does not need to repair all the apparatus recovered from subscribers' premises or telephone exchanges, as a great deal of it is suitable for re-use after partial overhaul. This can be done most economically locally, but a large proportion still needs to be returned to one of the factories where it can be thoroughly overhauled to give it longer useful life. This reconditioning is only worth while if it can be done at a lower cost

Left to right: Mr. J. V. YOUNG, Chief Executive Officer; Mr. T. H. SOUTHERTON, Deputy Controller; Mr. W. A. HIBBERD, Controller; Mr. T. F. A. URBEN, Chief Factories Engineer.

than that for new equipment, taking full account of the cost of handling, inspection, obsolescence and the like.

In the year 1960-61, £6.2 million worth of apparatus was repaired at a cost of £3.3 million. Some of the main categories were:—

450,000	Telephones and Bell sets	to a value of	£2,000,000
18,000	Switchboards	do.	£1,100,000
31,000	Teleprinters	do.	£600,000
265,000	Dials auto.	do.	£340,000
25,000	Coin collecting boxes and parts	do.	£110,000

Repairs vary from suites of exchange equipment to jointers' tents: from cable drums to watches: from stamp-selling machines to leather pouches for the Travelling Post Offices.

In general, Post Office policy is to leave manufacturing to contractors. Nevertheless, 15 per cent. of the Department's work is the manufacture of special equipment and pieceparts used in repair. Interesting equipment manufactured by the Department includes the early submarine cable terminations, some early coaxial repeaters, signal generators for the teleprinter switching scheme, and multiplex telegraph equipment for the transatlantic cable. In this type of work, especially at the prototype stage, the factories perform a valuable service, for the work can often proceed from rough sketches where contractors would require fuller information. Regular work includes the assembly of about 200,000 3,000 type relays a year, mainly from renovated parts taken off old relays. For this kind of job the factories have well equipped machine shops, tool rooms, wood mills, cabinet shops, electro-plating and enamelling facilities. About 90 per cent. of the work in the factories is paid on piecework, so that each article made or repaired is given a "Price" (traditional) or an "Allowed Time" (modern) for the job. By this method of costing, the staff benefit from their own industry since, on top of their basic wage, extra payments are made for any part of the Price or Time saved.

The Department has made enormous strides in modernization since the war and is now undertaking a seven-year plan to rationalize its accommodation and to apply flowline methods to repairing apparatus recovered in sufficiently large quantities as to justify continuous flow methods. The stores handling side of the Department's activities is also being overhauled, and the clerical work is greatly assisted by accounting machines in the complicated wages system and for close control of repair costing work.

The industrial part of the seven-year plan is under the general direction of the lively Engineering Division. Spectacular results have been achieved in the application of new techniques to the repair of telephones, dials and cordless switchboards. Progress to date justifies the continued repair of telecommunications apparatus which has not yet become obsolete, and if it continues, there will always be opportunities for the Post Office factories to make a useful contribution to the economy of the telephone and telegraph systems.

Transatlantic Radio Diamond Jubilee

Sixty years ago Guglielmo Marconi became the first to send a wireless signal across the Atlantic. This remarkable achievement with such primitive equipment marked the birth of world-wide communication.

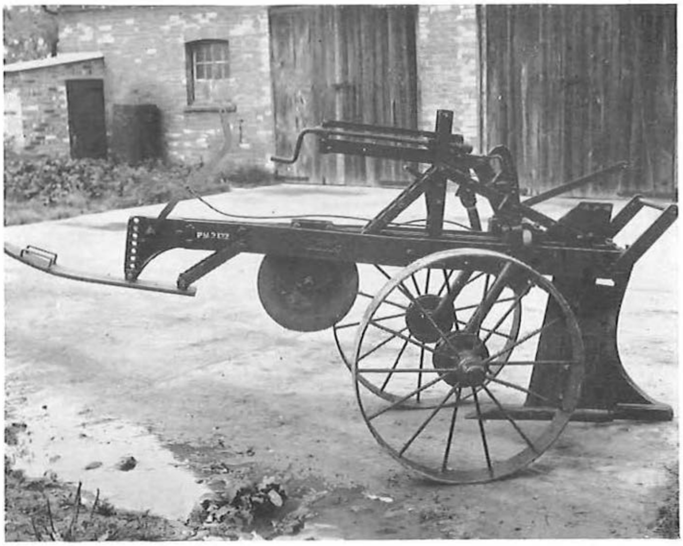
In the spring of 1900 Marconi had succeeded in sending reliable signals from St. Catherines in the Isle of Wight to The Lizard in Cornwall, a distance of 186 miles. This encouraged his belief that, by using larger aerials and far more powerful transmitters, he would be able to achieve transatlantic distances. Scientists were highly sceptical: many said it was impossible because of the curvature of the earth.

Marconi determined to make the attempt. A transmitting station nearly one hundred times more powerful than any previously constructed was built at Poldhu, near Mullion, in Cornwall. Enormous aerials were erected at Poldhu and at Cape Cod in Massachusetts, but both were wrecked in severe gales. Another, less ambitious in design, was put up at Poldhu while Marconi and his two assistants sailed to Newfoundland, where, from the top of Signal Hill, a receiving aerial was hoisted, at the third attempt, by means of a kite.

At 12.30 p.m. (Newfoundland time), on December 12, 1901, Marconi and his assistant, G. S. Kemp, using one of the primitive receivers of the period with a telephone earpiece, heard a faint succession of S's in Morse code. Signals from Poldhu, 2,200 miles away, had crossed the Atlantic.

Laying Telephone Cables by Moleplough

F. L. Best



Ransomes' agricultural moleplough adapted for laying cables. Note disc coulter, round mole and curved guide tube at rear of main coulter.

MANY hundreds of miles of telephone cables are laid quickly and cheaply every year in grass margins and across fields by means of the moleplough.

The moleplough was originally developed by agricultural engineers over 100 years ago as a cheap and effective method of draining farm land. A bullet shaped piece of steel about 3 inches in diameter and 12 inches long, called a mole, is attached to the bottom of a thin steel blade or coulter and is drawn through the ground by a powerful tractor or winch. The blade cuts a deep narrow slit and the mole forms a round hole with hard smooth sides and bottom by compressing the soil. At the front of the moleplough a disc coulter is fitted. This penetrates two or three inches into the soil cutting surface roots and the turf ahead of the main blade, thus making its passage easier. The depth of the hole or drain can be up to 4 feet, and in some soils a pull of up to 8 tons may be necessary to achieve this depth. In the early years only steam ploughing engines had the power to carry out this work.

These mole-drained channels usually have an effective life of 15 to 20 years and even after 30 or more years recognizable mole drains have been found. Fig. 1 shows the basic layout of the agricultural mole plough. This "long hole", which could so cheaply and easily be formed, seemed an obvious way of laying cables, but there were many difficulties to be overcome before a satisfactory technique could be developed for every day use. The original method was to attach the cable to the back of the mole and as this was pulled through the ground at a depth of approximately 18 inches the cable was drawn into the hole that was formed.

If, however, a lead covered cable is laid direct in the ground it must be protected from corrosion and mechanical damage. This is done by armouring, usually with steel tapes or wires, and impregnating with a waterproof compound. The armouring increases the strength of the cable and also its stiffness and surface roughness, which in turn increases the drag as it is pulled through the ground. Under favourable conditions it is possible to pull in up to 300 yards of cable, but under adverse conditions this length may be drastically reduced. To protect the cable from damage by stretching, which could seriously affect its electrical properties, a mechanical fuse or weak link was introduced between the mole and the cable. When this fuse broke it was necessary to dig to find the end of the cable and to lay a new length from that point. The two lengths then had to be joined.

Under normal conditions the pull required for this type of moleplough is approximately 2 tons and this is beyond the capabilities of agricultural tractors for direct towing, particularly on rough grass or uneven ground. To overcome this a barrel winch is mounted on the tractor and powered by its engine from the standard "power take off" drive. The tractor is also equipped with a large sprag which digs into the ground when a pull is applied and effectively anchors the tractor. The winches can exert a pull of more than 5 tons with a rope speed of up to 85 feet a minute. Employing a winch of this kind gives another, but important, advantage since the moleplough can use a much narrower strip of ground, and even the side of a bank where it would be impossible to drive a tractor.

During the early 1930s a number of junction cables were laid in East Anglia, where soil conditions are favourable and wide margins exist on many roads. Within a few years a new method was devised whereby the cable was led down a tube or guide at the rear of the coulter and mole, as shown in Fig. 2. This method placed no strain on the cable and the lengths laid were limited only by the standard lengths of cable available, or the requirements of the scheme. This development was most opportune since the second world war brought demands for many large military installations with their essential and elaborate telecommunications systems. The installations were designed for a short life and in consequence unprotected lead cables could be used. Thousands of miles of cable were installed at aerodromes and other war establishments the provision of which would, by orthodox trenching methods, have made impossible demands on the already strained labour resources. Cables could be laid, when soil conditions and terrain were favourable, at rates of several miles a day with a team of less than 10 men.

Since the war, polythene insulated and sheathed cables have been developed; as they are light and easy to handle and need no protection from corrosion they are ideally suited for laying direct in the ground. They are cheaper than armoured cables and when used in conjunction with the moleplough they have made it possible to extend the underground system to small and isolated communities which had previously relied on overhead construction. Long lines to farms have been provided, where conventional overhead construction would have been too expensive, and cables have been laid by this method in situations where other methods of construction would have been impracticable. As an example, a few years ago a telephone was needed on an island in an Essex

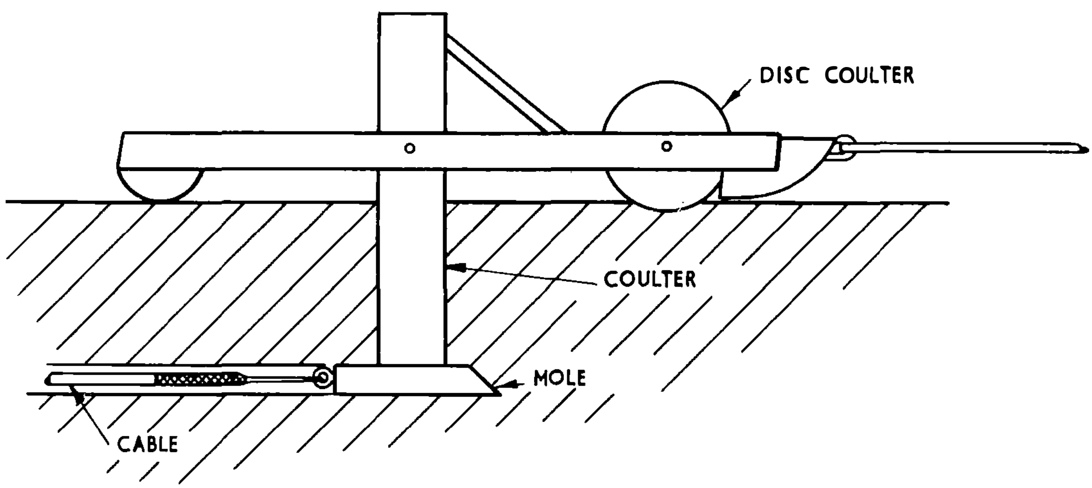


Fig. 1: Agricultural moleplough with cable drawn in behind mole

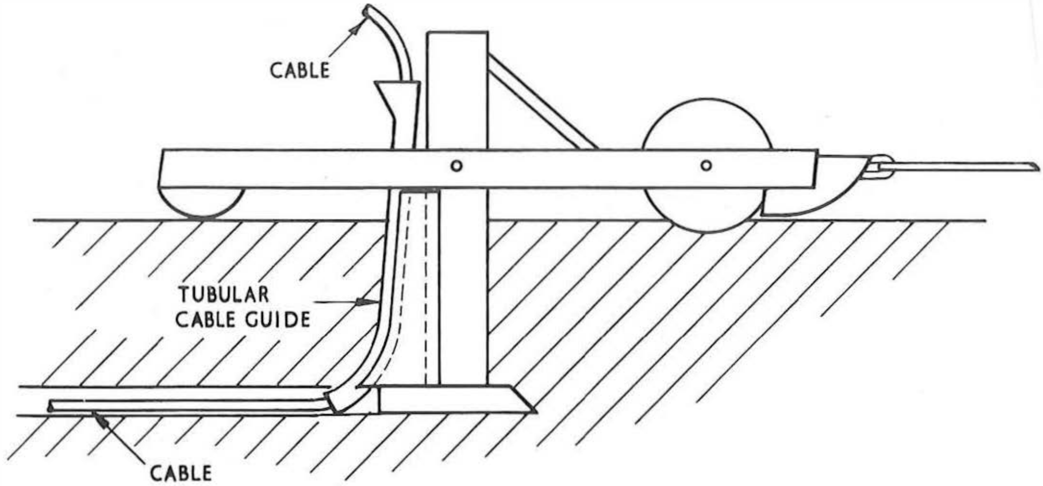


Fig. 2: Modified agricultural moleplough showing tubular cable guide

estuary surrounded by salt marshes and mud flats, and connected to the mainland by a hard gravel causeway. Normal underground construction would have been a costly operation as the tide would seriously interfere with progress and trenching would have had adverse effects on the stability of the hard surface. It was decided to lay the cable by mole draining through the soft mudflats. The standard Post Office machine was modified by the addition of two ex-United States Air Force wing-tip petrol tanks. These did not interfere with operations on firm ground but supported the plough and operator, as it travelled over soft mud.

Present day equipment can lay up to two 100 pair cables simultaneously and will do much to provide a reliable and economic telephone service to rural districts. The agricultural mole drainers, which were modified by the addition of suitable cable guides, were bulky and heavy and because of the scattered nature of Post Office work gave rise to handling and transport difficulties.

It was also found that cable breakdowns were being caused by rodents gnawing through the sheath. These rodents—moles, mice and so on—were taking advantage of the channel left in the soil by the mechanical mole and were using it as a run. To overcome these problems a Post Office standard moleplough was designed with three main aims in view. It had to be light and readily portable, simple to build and repair, and should not leave a channel

Standard Post Office moleplough in use with tractor mounted winch and sprag

The NIAE prototype cable laying plough.
The "C" beam and tooth are clearly shown, and the cable guide. The polished surface of the beam indicates the normal depth of working.

Below: The NIAE plough in use. The operator on the machine is feeding the cable into the cable guide.

along which rodents could run. The first aim was achieved without much difficulty, the final design weighing approximately 3¼ cwt. It could be handled fairly easily in and out of vehicles and along the ground for short distances on a wheel provided for the purpose. The second requirement

was more difficult as the machine had to be strong enough to withstand pulls up to 5 tons, plus shock loads caused by striking underground obstructions. This demanded the use of high tensile alloy steels for the coulter and mole. Several special steels are made which would give satisfactory results but they are not normally available in the sizes required. A considerable amount of research and a number of trials were therefore necessary to find a grade of steel combining as many of the required properties as possible while being readily obtainable.

The third aim was achieved in the Post Office moleplough by using a flat section mole which allowed the hole to collapse and prevent the formation of a rodent run.

Other refinements were also incorporated. The cable guide became a chute instead of a tube as in earlier designs. The guide was fitted behind the blade so that together they formed a wedge which expanded the slit in the soil until it was wide enough to accommodate the maximum size of cable to be laid.

Although the standard Post Office moleplough worked fairly satisfactorily many people felt that there was still room for improvement so the National Institute of Agricultural Engineering were approached for advice. This research organization is developing a much larger machine designed to lay a perforated plastic lining in mole drained channels at depths of up to 4 feet. This lining is stored and handled as coils of plastic strip and is formed by the machine into an edge-locked pipe in the ground. From their examination of the Post Office moleplough they suggested that the method of widening the original narrow slit by forcing the soil sideways was the wrong approach causing unnecessary friction. They also suggested that as the soil has a reduced restraint upwards any displacement should be in this direction. As a result a cable laying plough which used some of the basic principles of their larger machine was designed and built. This machine uses a C-shaped beam which is buried to approximately half its depth in the ground. At its lower end it carries a tooth or pick which is a little wider than the cableguide and presents a sloping face to the ground. This is shown clearly in the illustration. When it is pulled through the ground the soil is lifted and the machine, in effect, produces a narrow trench filled with loosened soil beneath which the cable is laid. This disturbed soil is then consolidated by the roller at the rear, which ensures that there are no empty spaces around the cable to form a rodent run. Trials with the prototype machine were most encouraging and measurements indicated a considerable reduction in the pull required compared with the standard moleplough.

Some of these new ploughs are being used for extended trials in all parts of the country, and the behaviour in a wide variety of soils will be watched with interest. If the initial promise of this machine is fulfilled it will probably permit the use of lighter general purpose winches instead of the present specialised tractor mounted ones. The normal depth of laying is 18 inches but it may be possible to build a larger machine to lay bigger cables at greater depths without exceeding the capacity of the existing winches.

Commonwealth Telecommunications Board

The Tenth General Report and Statement of Accounts of the Commonwealth Telecommunications Board shows that rapid progress is being made towards the provision of the Pacific Ocean cable to connect Canada, Australia and New Zealand. Orders have been placed with British firms for 8,700 nautical miles of submarine telephone cable and 335 submarine repeaters, and much of the raw material for the cable is being supplied by Australia and Canada. A new cable ship, specially designed to assist in laying the new cable, has been ordered by Cable & Wireless, Ltd. The Sydney-Auckland section of the cable will be laid first and made ready for service in 1962. It is hoped to complete the immense project of laying the Pacific Ocean cable by 1964.

Commonwealth telecommunication administrations are taking a keen interest in developments in satellite communication systems and are pooling information. As far as practicable, they intend to take part in the study and testing of such systems.

The telecommunication facilities of the Commonwealth continue to expand. In 1960 international telephone traffic increased by over 14 per cent.; international telex traffic by about 27 per cent., and international telegraph traffic by 4.1 per cent.

Gatwick Airport

Electronic Relay System for Telegraph Traffic

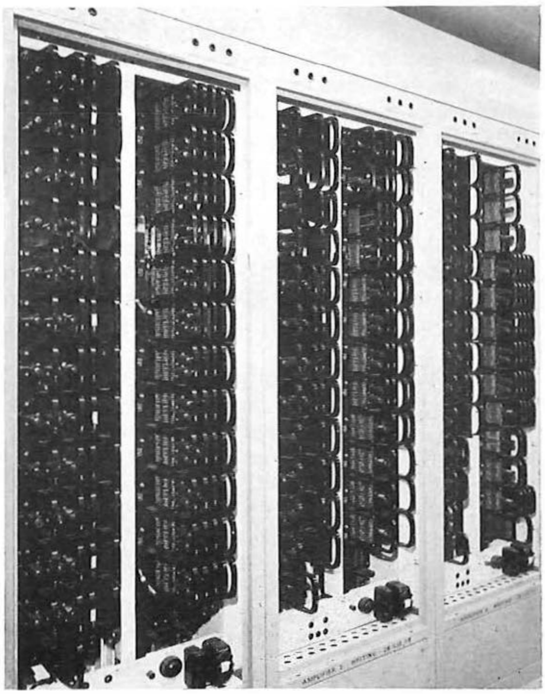
E. L. Bubb, B.Sc.(Eng.), A.M.I.E.E.

GATWICK Airport was designed by the Ministry of Aviation to incorporate the most modern facilities for aircraft and passenger handling. Naturally the telecommunications arrangements, which are vital to the organization of present-day air services, had to be of the same high standard, and the Post Office has worked closely with the Ministry of Aviation to ensure that the special requirements of the airport are met as fully and as efficiently as possible.

Teleprinter communications play an important part in the rapid handling of messages concerning aircraft movements, weather information and air traffic control, and for these purposes the airport has a number of private teleprinter circuits to distant points. The messages originate from or are addressed to a number of teleprinter installations located about the airport. This gives rise to the need for distribution and switching of teleprinter traffic which is met by means of a telegraph relay centre.

The telegraph relay centre has to satisfy internationally agreed standards and to meet these a wholly electronic telegraph relay system designed by a British manufacturer has been provided and is being maintained by the Post Office. It is the first such system to be put into service in the world. As with any pioneering development of this magnitude engineering difficulties have been encountered but valuable lessons have been learned which will enable future systems to be designed even more successfully.

The equipment is based on the STRAD (Signal Transmitting Receiving and Distributing) system designed and manufactured by Standard Telephones & Cables Ltd. but modified to meet the special operating requirements laid down by the Ministry of Aviation. It employs a magnetic drum for the storage of information (messages in course of transmission, outgoing message number sequences, routing instructions and so on), with some 80,000 germanium rectifiers, 5,000 valves, 1,000 transistors and 70,000 resistors and other components to control the acceptance, storage and retransmission of the telegraph messages. The transistors are used solely as switches but current systems use transistors throughout and the elimination of thermionic valves should give advantages both in power consumption and reliability.



(Courtesy STC Ltd.)

Fig. 1: Part of the electronic equipment

The components are mounted in plug-in units to form some 10,000 basic circuit elements which are assembled in cabinet type bays (Fig. 1) arranged for forced ventilation by a common plant in an adjacent room. Wrapped joints are employed within the units as well as for the bay and inter-bay wiring and these have given no trouble in service.

As installed the system is equipped for up to 19 incoming circuits (7 from remote relay centres, 12 from originating traffic points on the airport) and up to 27 outgoing circuits (7 to remote centres, 20 to terminal points on the airport) but the design of the common equipment allows for an expansion of approximately 50 per cent. The designed message handling capacity is 250 messages an hour initially and 400 ultimately, with multi-address routing of approximately 12 per cent. of these in each case. The average message length is 46 seconds.

Operating Procedures and Facilities

The Gatwick installation operates on a semi-automatic basis, that is, the destinations of each message have to be signalled by an operator depressing routing buttons. However the basic design is such that it could be converted to fully automatic operation with the electronic equipment extracting and obeying routing information contained in the message preamble. Messages arriving from a remote station are monitored on a console mounted page teleprinter one of which is shown in Fig. 2. The Gatwick operator reads the address and then operates the corresponding routing button on the console. A lamp adjacent to the button glows to indicate which route has been selected, and after verifying that the correct button has been pressed, the operator momentarily depresses a "Go" button.

This action transfers the routing instructions to the electronic equipment (from temporary storage on a relay set associated with the routing buttons) and as soon as a circuit on the selected route is free retransmission begins. Multi-address routing requires only that the several route buttons shall be operated, simultaneously or sequentially, before operation of the "Go" button. Normal and priority "Go" buttons are provided and messages are retransmitted to each outgoing route in chronological order of the pressing of the "Go" buttons within each priority grading. The incoming messages terminate with a standard NNNN end of message group (temporarily AAAA on selected circuits) and this indicates to the electronic equipment that subsequent characters form the start of a new message.

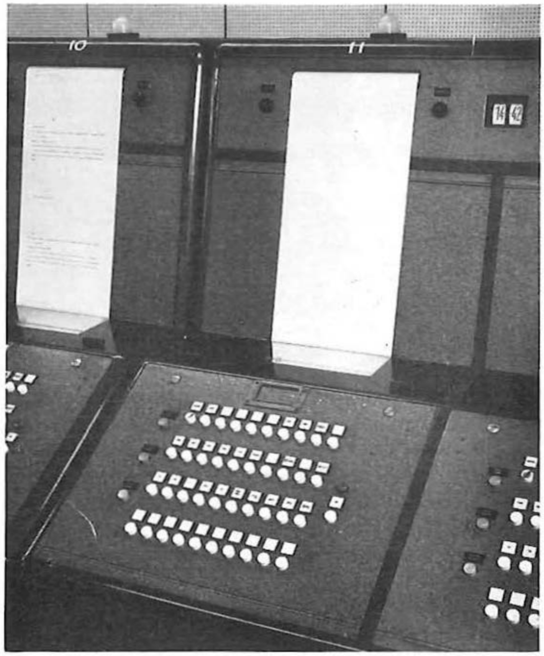


Fig. 2: Incoming trunk console showing the routing and control buttons

Where messages are originated within the confines of the airport, it is economic to transfer the routing control of the message to the originating operator. A routing button panel is provided adjacent to the originating teleprinter and the operator, after typing her message, operates the buttons to instruct the electronic equipment to complete retransmission to the selected addresses. In the case of messages from such local positions the message end pattern (NNNN) is automatically added to the text by the electronic equipment.

To obtain rapid handling of messages within the relay centre the equipment has been designed to initiate retransmission within 5 seconds of the "Go" button operation if a circuit on the selected route is available. Thus retransmission of a message may be started before the whole message has been received.

Fig. 3 is a general view of the Telegraph Signals Centre showing the supervisor's teleprinters, control console and patching jack field in the foreground, with the suite of incoming trunk consoles at the back. The supervisor is seen operating the routing panel of his local originating position.

Retransmission to Outgoing Circuits

The outgoing circuits from STRAD are of several types. On all types a machine start function (a letter shift character) precedes transmission of a message. On local circuits terminating in Ministry of Aviation and airline operators' offices on the airport the message transmission is delayed until an "on-speed" signal is returned over a second wire from the terminating teleprinter. If this signal is not received within approximately 2 seconds the circuit is assumed to be unserviceable, an alarm is given to the supervisor and the message is diverted either to an alternative line in the same route, if one exists, or to an Automatic Overflow position in the signals centre. On long distance circuits, however, it is uneconomic to provide the return path for an "on-speed" signal and on such circuits a pause of 2-4 seconds for the distant machine to run up to speed is introduced between the machine start function and the start of the message. To safeguard messages on such circuits STRAD automatically prefaces each message with a serial number and sends a check message every 20 minutes to all idle circuits.

In addition to the operational outgoing circuits a number of service circuits terminate in the Signals Centre. These comprise the Automatic Overflow previously mentioned, four Key Controlled Overflow circuits which may be switched to act as relief circuits on any routes, a circuit to the supervisor and a "Waste" circuit which is used to dispose of incoming circuit checks and other messages which require no onward transmission.

On circuits terminating on printing reperforators STRAD is arranged to add automatically a 20 letter shift tape feed pattern to each message unless a further message is to follow immediately.

In a tape relay centre incoming messages are recorded as perforations of a paper tape on which the characters are also printed so that an operator can read the address and determine the outgoing

(Courtesy Ministry of Aviation)

Fig. 3: Telegraph Signals Centre

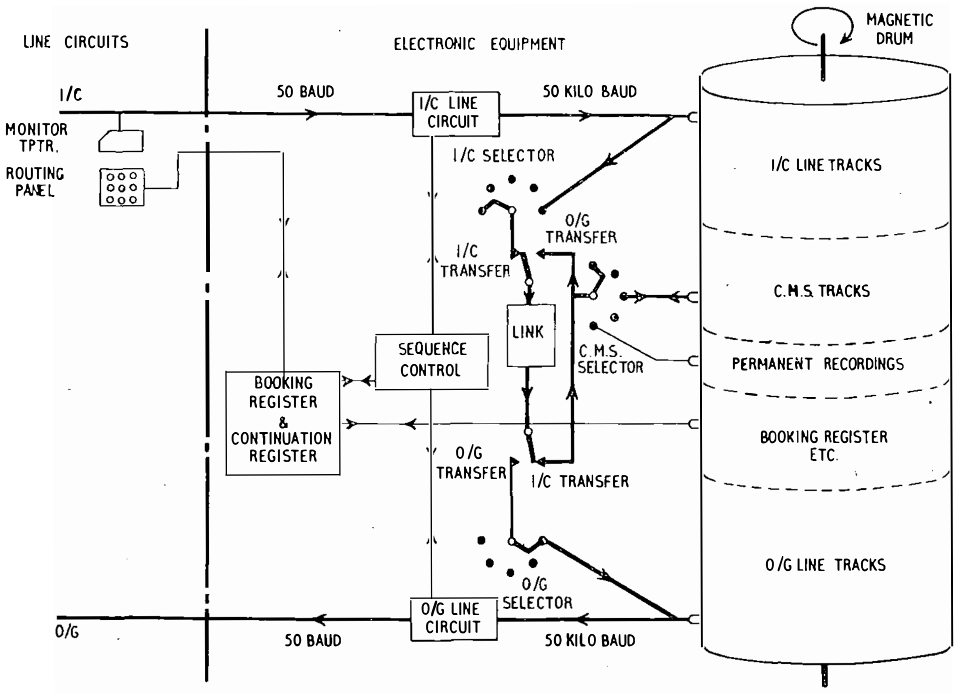


Fig. 4: Simplified diagram of system

route. The messages are then passed to transmitting positions connected to the appropriate outgoing routes and retransmitted. As a line on the required route will not always be available immediately, provision has to be made for temporarily storing the messages in a manner which preserves the chronological order of receipt although allowing high priority messages to jump a queue of less urgent ones.

The STRAD system carries out a similar sequence of operations but stores the messages and the queue records on a magnetic drum, and transfers the messages from one location to another electronically at high speed (300 characters are transferred in 1/25 second). In a semi-automatic system such as that at Gatwick the outgoing routes and priority treatment required by each message have to be determined manually and signalled to the electronic equipment; monitor teleprinters are therefore necessary on incoming lines from originators not provided with their own signalling leads. Because of the high internal transfer speed very little time is lost by placing all messages into a store whether or not a line is immediately available for their retransmission. The destination, priority, and storage location of each message are recorded in arrival order in a circuit known as the Booking Register. As a line becomes free it causes the common control circuits to scan this register for the longest-waiting, highest priority message for it; a copy of the message is then transferred from the queue store to the equivalent of an outgoing transmitter, the destination is deleted from the record of the message and if no further destination remains all recorded details are erased. Fig. 4 is a simplified diagram illustrating the basic elements of the system. The selectors and switches shown are diagrammatic only and in fact consist of transistors used as on/off switches.

Each incoming line has an individual line circuit and drum track on which messages are recorded as they are received character by character. When the message has been received a signal is passed to the common equipment requesting that the message be taken away to the common queueing store (the Central Message Store or CMS) to leave space for a succeeding one which may arrive immediately. The common equipment then arranges for the incoming selector to be set to the requesting line, the CMS selector to be set to the first free CMS track and the Link switches to be set to "Incoming Transfer". The message is copied from the incoming line track on to the selected CMS track and the line circuit is told that this action has taken place. When further characters arrive they are recognised as a fresh message and the line track starts to fill up again from the beginning. Also, as transfer to the CMS takes place, a record is made in the Booking Register that a message from incoming line "A" has been stored in CMS track "S".

When the operator routing messages from incoming Line A operates the "Go" button a search is made of the Booking Register for the oldest entry from line A which has no routing instructions. The instructions, for example that "this message has to be transmitted without priority treatment to outgoing Routes X and Y", are then added to this record. The Booking Register now has a record (on a part of the magnetic drum) that a message from incoming Line A is stored in CMS track "S" and is to be sent, without priority treatment, to outgoing routes X and Y. The information relating to a call is recorded in the first free space on the Booking Register track and when the corresponding message has been transmitted for the last time the entry is erased and all following entries are moved up one space. Thus the Booking Register at all times contains entries corresponding only to messages waiting for transmission and, moreover, contains these in chronological order of message arrival.

Suppose now that line y in route Y becomes free. It signals this information to the common equipment and the Booking Register is scanned to find if there is a message waiting for route Y, and also if any message waiting for the route has a priority rating. The Register is then scanned a second time for the first (that is oldest) entry containing Y and with the highest priority detected on the first scan. When this is recognised the Y mark is deleted and the CMS position of the message is read off. The outgoing line circuit y is told that a message is awaiting transmission and sends the machine start function then pauses and follows this if appropriate with the message serial number. The CMS selector is then set to the track containing the message, the Outgoing Selector to line y, the Link switches to Outgoing Transfer and the message is copied from the CMS to the outgoing line track in one drum revolution. The outgoing line circuit then passes the message to line character by character at 50 bauds. At the end of the message as originally received from line the common equipment will, if appropriate, transfer to the line track a message end pattern and letter shift group which will be sent to line in a similar manner.

Assuming that a message had been put into the CMS and addressed to routes X and Y, the transmission proceeds as described above as a line on each route becomes free. Each transmission is completely independent. The message recorded in the CMS may be copied as often as required but each time a transmission takes place the corresponding route mark in the Booking Register is deleted. When the last routing is made, the whole of the Booking entry is erased and as it is known that the message will not be required again the CMS track is made available for recording a new message.

Any Length of Message

In this description it has been assumed that the message is sufficiently short to be contained on a single track. In fact the message can be of any length. If the message requires a number of tracks to contain it a section is transferred to the CMS each time the line track is filled. The CMS location of the first section is recorded in the Booking Register as already described and the locations of the subsequent sections are recorded in a circuit known as the Continuation Register. The outgoing line is then given the sections of message in the correct order when the time comes for transmission.

Similarly it was assumed that the routing instructions were passed to STRAD after the message had been transferred to the CMS and a partial Booking Register entry made. This again is unnecessary and if the routing instructions are received before message transfer has taken place the originating line designation will be recorded with the instructions in the first free space in the Register. When the subsequent message transfer occurs the CMS location is added to the partial entry carrying the appropriate incoming line designation. Having completed the Booking Register entry, and even if the message has not been completed, transmission will start to the required addresses as lines become free. Any part of the message arriving subsequently will be associated with the initial section by the Continuation Register and its associated circuits.

Components of any type, mechanical, electromechanical or electronic, have a limited life and to obtain reliable, continuous service from a system built of such components requires careful design. Components with a low failure rate must be employed, the components must then be operated within their ratings in circuits which allow them a reasonable tolerance. Finally the whole system must be designed in such a way that even if a component does fail its effect is limited and the service can be restored rapidly. Well designed maintenance techniques may reduce the effect of the limited component lives by detecting and replacing failing units before they react on the system performance but care must be taken to avoid producing additional faults in the process.

The Gatwick STRAD employs electronic components which have proved to have a long life under the conditions of use in this installation. The circuits in the majority of cases operate in an "on" and "off" manner which has enabled the design to allow for a considerable deterioration in the components before circuit operation is affected. Finally, in the system design all circuits which form a part of the common control have been duplicated and interconnected so that both parts are normally operating simultaneously. The individual line circuits are not duplicated since failure here affects only a small part of the system; spare circuits are provided which can be patched to restore service rapidly.

The magnetic drum is duplicated but owing to the very large number of connections involved (approximately 300 recording and reading heads are employed on 250 tracks) it has not been possible to cater for an automatic changeover between the worker and spare. It is anticipated that a drum should have a life of more than five years and that when failure does occur it is likely to be preceded by a clear warning which will enable the changeover to be arranged with the minimum effect on service.

Explosion at Telephone House, Birmingham

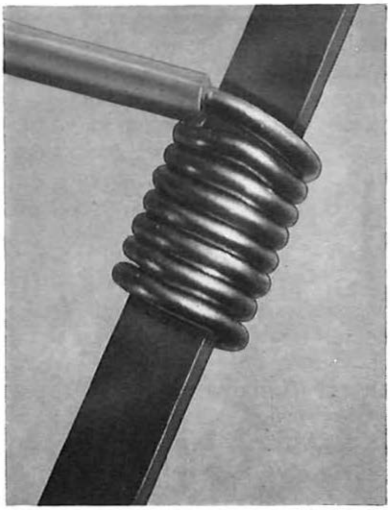
At 8.30 on Thursday morning, January 4, staff on duty at Telephone House, Birmingham, people in nearby buildings, and passers-by were startled by a loud explosion in the basement of Telephone House. Unhappily, one member of the staff was killed and another burnt, and a passer-by was hurled through a wooden fence on the opposite side of the road. There were other casualties and some staff were taken to hospital for treatment for delayed shock.

A gas leak was traced to a fractured high pressure main at a road junction nearby.

Though there was damage to Telephone House building by blast and fire, and many windows were shattered, there was no damage to equipment or cables. This is of interest since the main source of fire seems to have been caused by the pressure of gas from a duct leading into a store room. Flames from the duct were "roaring like a torch". Despite this, two cables in the duct were scarcely damaged; other exposed main cables nearby, were unaffected.

The conduct of the staff at the time of the explosion and afterwards was exemplary. Engineers and others were immediately on the scene and did a magnificent job carrying out rescue and fire-fighting operations. When evacuation of the building was twice ordered—immediately following the explosion, then again at about 11 o'clock—those who left did so in an orderly manner and assembled at a point nearby so that they could easily return. Operating staff and supervisors volunteered to continue the Emergency 999 services.

Ambulance, Fire, Police, Gas and Post Office staff co-operated well. The same co-operation has continued between the staff of the West Midlands Gas Board and the Post Office in trying to find the cause of the explosion. The Ministry of Works did an excellent job, too, and by nightfall the building had been made wind and weatherproof.



Solderless Wire Wrapping

K. W. Hix, A.M.I.E.E.

TELEPHONE calls can be established over a variety of telephone exchange equipments, repeater stations, radio links and submarine cables, but the success of a call on any communication system can be seriously affected by a single faulty connexion.

On a typical telephone path between two subscribers, screw connexions, twisted wire joints, crimped joints, switch wipers, relay contacts, plug and jack contacts, soldered joints and solderless wrapped joints may all be encountered. It is, therefore, of vital importance that each connecting point has a low and unvarying resistance from initial installation to the end of the life of the equipment. Soldering has been the most widely used of all the available methods for connecting telephone exchange equipment, and at the present time several million soldered joints are made weekly by each of the main telephone manufacturers on equipment supplied to the Post Office.

Mass production methods are obviously essential so even the smallest relaxation in the control of soldering materials or operating labour can result in faulty joints at an exchange. The increasing miniaturization of equipment and the introduction of components with a greater sensitivity to heat have made soldering a more difficult operation, while the use of plastic insulation in place of textiles has resulted in some increase in faults due to burnt insulation and solder splashes.

It was the physical difficulty of connecting wires on a number of closely spaced tags which prompted the Bell Laboratories of America to investigate methods of connexion other than soldering, and the development of the solderless wire wrapping method was first publicized in 1952. Following a period of trial and investigation the solderless wrapped joint is now accepted as a production method of proved reliability and it is beginning to challenge the long established pre-eminence of the soldered joint in several fields.

The Wrapped Joint

While it is practicable to make a satisfactory connexion by a simple wrapping action with wiring pliers in a circuit carrying normal operational currents, connexions which have to endure for many years on circuits in which little or no current passes, must be made by a more reliable method. It is necessary to wrap the conductor wire on to the terminal with sufficient force to rupture any surface film and in such a manner that the wire will remain closely bound to the terminal after removal of the wrapping pressure.

Fig. 1 shows a typical wrapped joint with seven turns of the conductor wire wrapped around the tag, while Fig. 2 shows an enlarged cross-section of one turn of a wrapped joint. It will be seen that the wire is indented by contact with the sharp corners of the terminal, and that 24 independent connexion points or parallel paths between conductor and terminal exist. This primary wrapped

Fig. 1 above: Typical wrapped joint

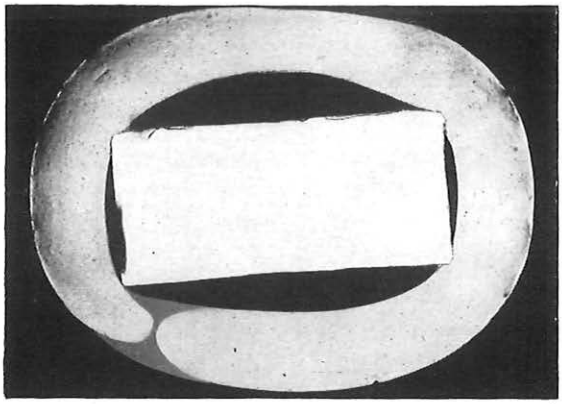


Fig. 2: Enlarged cross-section of one turn of a wrapped joint

joint requires a longer stripped length of wire than is customary in soldering practice but where this length is not available an alternative form of construction can be used. This employs a shorter length of bare conductor wire which is laid along the length of the terminal and a number of turns of a separate wrapping wire bind the conductor to the terminal. This form of joint is referred to as a secondary or bound connexion and in addition to its use for repair work it is also suitable for connecting the wire tails of electronic components and power items, such as silicon rectifiers, to terminals. Fig. 3 illustrates the use of a bound joint for the connexion of printed boards in a modern computer. Tools of special design must be used for all forms of wrapping operations to provide the necessary control which will ensure that an adequate margin of safety exists under all conditions likely to be encountered during the life of the equipment.

Wire Wrapping Tools

A variety of tools has been developed for the application of wire wrapped connexions, from small hand rotated tools to electrical and pneumatically-operated guns similar in size to small electric drills. Fig. 4 illustrates some forms of wrapping tools. The majority employ a wrapping bit with two longitudinal holes side by side, one for insertion over the tag and the other for the insertion of the conductor wire. By rotating the tool by hand or by power the wire is fed from its hole around the tag as the tool is withdrawn along its length. Most tools in present use need to be fed with pre-stripped wire, but the obvious advantage of combining stripping and wrapping operations has been appreciated and tools capable of this dual function have been produced. Fig. 5 shows one such tool at the end of a wrapping operation with the tube of insulation, which has been pushed off the end of the wrapping wire,

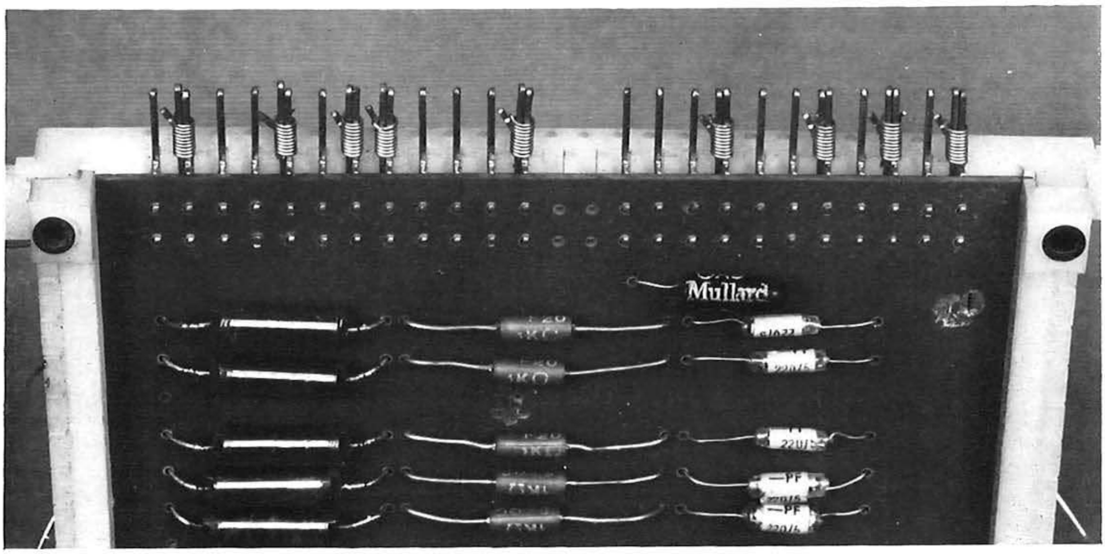


Fig. 3: Bound joints for connexion of printed boards (*Courtesy AT & E Co. Ltd.*)

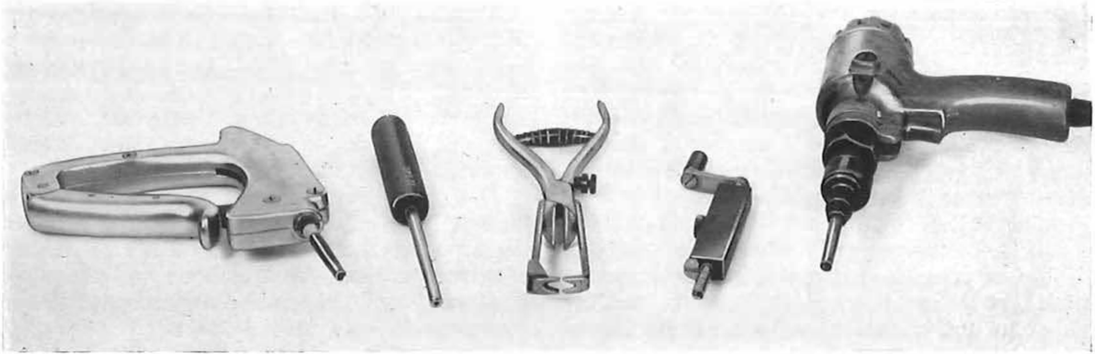


Fig. 4: Left to right: Pistol-grip wrapping tool; direct-action wrapping tool; wire stripping and cutting tool; crank-handle wrapping tool; electric-motor wrapping tool

still loosely held by the retaining collar. The insulation was initially severed by the action of inserting the insulated conductor in the tool.

Terminals and Wire

Wire wrapping can only be carried out on equipment having suitable terminals and cannot be used, therefore, on such items as standard relays. The tags used for solderless wire wrapping must be longer than normal soldering tags to allow for the six turns which are applied, and have sufficient cross-sectional area to give rigidity. They must also have reasonably sharp corners. A typical terminal to accommodate three wrapped joints would be 1″ long, with cross-section $\frac{1}{16}'' \times \frac{1}{32}''$, although smaller tags can be used where only a single wrapped connexion is needed. The tag material must be reasonably hard; nickel-silver and brass are typical choices and the same protective tinning is normally used on both tags and wire as is employed for soldering operations. This enables a reconnexion to be made at any time by soldering if desired, and also helps to seal the contact points against corrosive agents. The normal size of single wires (.020″ diameter) used for telephone exchange connexions gives just sufficient strength to stand up to the forces involved in wrapping operations, but larger diameter wires can be wrapped with suitable tools.

The first exchange installation to use wrapped connexions in this country was at Brixton, South London, in 1955. Other trial installations at Kidderminster and Springpark exchanges followed, and solderless wire wrapped equipment has now been installed in many automatic exchanges throughout the country. The application was limited initially to wiring on connexion strips but as new items are designed the possibility of using wrapped joints is considered.

An example of a new design which incorporated terminals suitable for wire wrapping is the interception unit fitted on the new main distribution frame (MDF) which was described in the Autumn 1961 issue (*Electrical Protection of Telecommunications Plant*, S. J. Little). The electronic equipment provided for the STD register translators at Bristol included some wire wraps and in general it can be said that while the re-design of existing electromechanical equipment to permit wire wrapping is rarely justified, the technique is readily applicable to electronic equipment practice. There are indications that it may be used extensively in the electronic exchanges of the future.

It has already been applied to equipment for telegraphs, line transmission, computers and radar. The communications equipment installed at

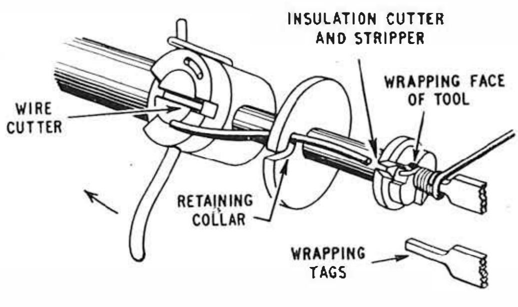


Fig. 5: Combined stripping and wrapping tool

Gatwick airport for the Ministry of Aviation employs large quantities of bound connexions and several years of operational experience have now justified the early confidence in these joints. Conversations over the transatlantic cable are dependent on a considerable number of wrapped joints on the speech interpolation-TASI-equipment at Faraday Building. Wire wrapping is used as an alternative to plugs and sockets in a recently introduced computer, and the long-term reliability of the method together with its advantage for maintenance has resulted in it being used in important equipment for the Service Departments.

After 10 years, solderless wire wrapping is well past the experimental stage and increased use is being found for the method. The need to redesign terminals on standard components, such as relays, has prevented its more rapid adoption, and the specialist nature of the tools, until recently imported, has also handicapped expansion.

The rising popularity of the technique and interest in other developments, such as crimped joints, suggest that soldering as the normal method of wire connexion for telephone and electronic equipment will be increasingly challenged in the future.

Telecommunications Statistics

	Quarter ended 30th September, 1961	*Quarter ended 30th June* 1961	*Quarter ended 30th September* 1960
Telegraph Service			
Inland telegrams (excluding Press and Railway) ...	3,421,000	3,056,000	3,523,000
Oversea telegrams:			
Originating U.K. messages	1,615,789	1,611,180	1,623,920
Terminating U.K. messages	1,622,570	1,589,335	1,670,199
Transit messages	1,304,383	1,326,267	1,367,896
Greetings telegrams	898,000	757,000	860,000
Telephone Service			
Inland			
Gross demand	107,711	149,296	135,144
Connexions supplied	108,606	129,428	111,699
Outstanding applications	155,449	174,007	155,181
Total working connexions	5,141,041	5,014,344	4,889,308
Shared service connexions (Business and Residential)	1,139,407	1,145,757	1,129,928
Total inland trunk calls	118,714,000	114,100,000	107,282,000
Cheap rate trunk calls	30,432,000	27,633,000	26,858,000
Oversea			
European: Outward calls	861,864	843,376	751,773
Inward ,, ...	823,000	802,987	763,654
Transit ,, ...	3,682	3,885	3,745
Extra-European: Outward calls	71,395	74,737	70,517
Inward ,, ...	87,724	85,314	80,584
Transit ,, ...	18,432	19,115	17,314
Telex Service			
Inland			
Total working lines	7,885	7,476	6,459
Calls from manual exchanges	*	*	422,000
Manual calls from automatic exchanges (including Assistance and Multelex) ...	2,500	2,000	266,000
Metered	17,176,000	‡17,197,000	6,515,000
Call to Irish Republic	19,000	18,000	†
Oversea			
Originating (U.K. and Irish Republic) calls ...	1,007,312	‡911,602	712,653
Transit calls	22,300	‡22,100	12,979

* Conversion to automatic working completed December, 1960

† Included in calls from manual exchanges

‡ Amended figure

International Subscriber Dialling

C. J. Maurer, C.G.I.A., B.Sc.(Eng.), A.M.I.E.E.

and

H. Eggleton, B.Sc.

In this issue J. M. Harper reports on three years of Subscriber Trunk Dialling. C. J. Maurer and H. Eggleton look to the future and the introduction of International Subscriber Dialling.

ALL public telephone calls from United Kingdom subscribers to subscribers in European countries are controlled at the Continental Manual Exchange in London, and from this exchange there are direct circuits to the major European cities. Some of these circuits are signalling circuits, operator to operator, while some are equipped to enable the operator in one country to dial directly—by key sender—to subscribers in the other.

In 1950 the total outgoing traffic to Europe from this exchange was approximately one million calls and this increased to approximately three and a half million by 1961. Assuming that this rate of increase continues it is estimated that by 1970 more than three thousand operators will be required at Continental Exchange. The difficulties of recruiting staff, especially linguists, to meet the present needs are well known and it would be quite unrealistic to assume that a staff of this size could be maintained in central London. One approach to this problem would be to arrange to control at least some of the Continental traffic at exchanges outside the London area, but this would increase the cost of providing the service since at least two-thirds of the traffic originates in the London City and Centre Telephone Areas. Clearly, the ultimate solution to this problem is to arrange for subscribers to dial their own Continental calls.

Originated Traffic

Traffic originating from subscribers in the London director area accounts for approximately 80 per cent. of the total outgoing traffic. Of the remaining calls, amounting at present to approximately 14,000 a week, some 4,000 originate from the five provincial director centres. Further analysis of the traffic shows that 3,500 calls a week originate from the twenty-two next largest centres, and the whole of the rest of the country—which will be served by about 330 group switching centres—produces only 6,500 calls a week or an average of less than 20 per group switching centre. The very marked differences in the calling rates at the various centres must influence the priority of development, and since so great a proportion of the relief to the manual board load will be obtained by introducing subscriber dialling of Continental calls in the London director area this development will be given the first priority.

Destinations of Outgoing Traffic

Outgoing traffic to the major European countries expressed as a percentage of total traffic is shown in Table 1. To each of the countries marked * circuits equipped with a 2 VF signalling system specified by the International Telegraph and Telephone Consultative Committee (CCITT) will be in use by the time that International Subscriber Dialling is introduced.

Table 1

Destination	Percentage
*France	27.10
*Germany	17.60
*Netherlands	17.50
*Switzerland	9.60
*Belgium	9.50
*Italy	5.90
*Denmark	3.30
*Sweden	2.80
*Norway	2.00
*Spain	1.30
*Austria	1.00
Portugal	0.31
*Finland	0.30
*Poland	0.29
Czechoslovakia	0.26
*U.S.S.R.	0.24
Remainder	1.00

The distribution of traffic within certain of these countries—France, Denmark and Sweden—follows a similar pattern to that of incoming traffic in the United Kingdom, since the vast majority of calls are for subscribers in the capital city area. In other countries, such as Germany, Holland and Switzerland, the traffic is more evenly distributed to two or three major cities, and direct circuits to these cities are provided.

Subscriber Charging

The method of charging for an International Subscriber Dialled call from the United Kingdom will be the same as for an inland trunk call under STD; that is, by periodic single operations of the calling subscriber's meter, at intervals depending on the destination of the call.

For operator controlled calls subscribers are charged on the basis of chargeable time. The chargeable time for calls lasting three minutes or less is three minutes, and for longer calls the actual conversation time is rounded up to the next whole minute. Examples of current charges for three minutes are given in Table 2, and the intervals between meter pulses which would be needed to give the same three-minute charge at 2d. per unit are also shown.

The meter pulse rate for an international subscriber dialled call will be determined by a register translator at the originating group switching centre from an examination of the country code dialled by the subscriber. It would be expensive to provide the full range of pulse rates at all group switching centres and the present intention is to simplify the tariff structure by charging a single rate to all zones of a country, and by reducing the total number of charge steps required.

Table 2

	Present Charge for 3 minutes	Period for 2d. which would produce the same charge for 3 minutes
France (Zone 1)	6/-	5 seconds
Belgium, Netherlands	7/-	4 2/7 seconds
Luxembourg	8/-	3¾ seconds
France (Zone 2)	9/-	3 1/3 seconds
W. Germany, Switzerland	10/-	3 seconds
Denmark	12/6	2 2/5 seconds
Italy	13/6	2 2/9 seconds
Norway, Sweden	16/-	1⅞ seconds
Austria, Czechoslovakia	18/-	1⅔ seconds
Poland, Spain, Gibraltar	18/6	1 23/37 seconds
Hungary, Yugoslavia	20/-	1½ seconds
Finland, U.S.S.R.	21/-	1 3/7 seconds
Portugal	22/-	1 4/11 seconds
Bulgaria, Rumania	24/-	1¼ seconds
Greece, Malta	30/-	1 second

International Accounting

For international services the charges collected from the subscribers have to be distributed to the various administrations concerned in establishing the connexion. At present, information for this purpose can be obtained from the tickets completed by the controlling operator but when ISD is introduced this will no longer be possible. International accounts will then be settled on the basis of records taken by measuring equipment installed in the International Automatic Exchange. This equipment will be mainly electronic and will use magnetic drum storage techniques. It will record the conversation time of subscriber-dialled calls to each country, and where more than one routing is available a separate total of conversation time will be recorded for each routing. The equipment will also be capable of recording traffic in separate totals in accordance with geographical divisions or zones of the destination country, so long as that country can be suitably divided in terms of the first or the first two digits of its significant numbers. Thus, if a country is divided into three zones and the traffic to each zone is divided between three routings, the conversation time will be recorded in nine separate quantities to which different international accounting rates can be applied if necessary. If a country is not divided into zones and only one routing is available a simple record will be taken of the total conversation time to that country.

Spare storage capacity of the magnetic drum equipment will be used to obtain other important traffic statistics; for example, total busy-hour traffic on out-going routes and distribution of conversation times.

With the expansion of Subscriber Trunk Dialling throughout the United Kingdom each exchange will be given an STD code and this, together with the telephone number of each subscriber, will constitute a system of national numbers for dialling inland trunk calls. The majority of European countries have also developed national numbers for their own Subscriber Trunk Dialling schemes and in Europe two types of national numbers have developed depending on whether the published number in dialling code lists, official directories or on subscribers' letter-heads includes the trunk prefix.

In the United Kingdom the trunk prefix is "0" and, as in most Continental countries, the prefix is included in the national number to simplify dialling code presentation. Thus the national number of a London subscriber ABC 2345 would be 01ABC-2345. The digit "1" identifies London and the number 1ABC2345 is known as the "significant" number since it is the combination of digits necessary for the selection of a subscriber from a trunk exchange in his own country. In France, however, the trunk prefix is "16" but the national number of a Paris subscriber SEG 2345 would be published as 1SEG2345, the digit "1" in this number being the trunk code for Paris. Countries such as France, where the trunk prefix is not included with the trunk code, have the same significant and national numbers.

Calls to Other Countries

Calls to other countries will be dialled by preceding the national number with an access code for the country required; these access codes are generally referred to as country codes. Codes for calls to other countries could be allocated arbitrarily by each outgoing administration, but, to facilitate transit switching and for uniformity, the International Telegraph and Telephone Consultative Committee has allocated two-digit country codes for all the countries of Europe and many of the countries in the Near and Middle East. The addition of the allotted two-digit country code to a national number produces an international number for each subscriber in the linked numbering area. For example, the country code allocated to the United Kingdom is "44" and to France "33". The international numbers of the London and Paris subscribers previously mentioned are then 4401 ABC 2345 and 331 SEG 2345 respectively.

To set up an international call subscribers must first dial a code to obtain access to equipment capable of routing the call to the required subscriber and in the United Kingdom this code is "010". The initial digit "0" is the STD prefix digit, the remaining digits "10" form the trunk code for London Faraday International; hence a subscriber in the United Kingdom requiring connexion to Paris/Segur 2345 will dial 010 331 SEG 2345.

An exchange area must, of course, have STD facilities if it is to have ISD, since some of the equipment provided for STD is also used for ISD calls. The first digit "0" of the code "010", which will be dialled for an ISD call from this country, will give access to the STD equipment serving the originating exchange. The next digits "10" will tell the STD equipment that an international call is required and bring in the additional facilities needed for ISD calls.

National and International Routing

In non-director STD areas it will be necessary to install auxiliary ISD registers to handle the longer ISD numbers and auxiliary call timing equipment to provide a greater range of meter pulses than is needed for STD calls. In director areas, however, where STD register translators using magnetic drum storage techniques have been installed at central points, the equipment already provided can be arranged to give the additional register translator and call timing facilities required for originating ISD calls.

In both cases the principles employed in setting up ISD calls will be the same. When "010" has been dialled the equipment at the originating group switching centre will receive the country code and the national number of the wanted subscriber. The equipment obtains from a translator the routing information necessary to route the call to the international exchange in London and the meter pulse rate appropriate to the country concerned.

When a connexion to the international exchange has been established, the country code and the national number of the wanted subscriber will be repeated to an international register at the international exchange. Direct access will be provided between the London STD centres and the international exchange and possibily between the provincial director centres and the international exchange. All other ISD traffic will most probably be routed to the international exchange through the new transit network.

At the international exchange the incoming circuits will terminate on relay sets having access to international registers capable of routing the call to the country required. When the international register has received the first five digits it will signal these digits to a translator to determine the outgoing route and to obtain signalling and accounting information. The five digits extended to the translator are the country code and the first three digits of the national number. In many cases the country code will suffice to determine the routing but where a country has more than one international centre—for example, Frankfurt, Dusseldorf and Hamburg, in Germany—traffic in-intended for each will, if a free circuit is available, be routed to the appropriate centre. The CCITT recommendation on routing is that it should be possible to determine the centre required by an examination of the first two digits of the significant number. These digits will be the third and fourth or the fourth and fifth digits of the international number, depending upon whether a single digit trunk prefix is included in the national number. The translator will indicate to the register the outgoing route required and will also pass information relating to the signals that are required to set up the international connexion. In addition. for international accounting the translator will indicate the zone of the country and the route taken.

All the outgoing routes to the Continent will be equipped with the CCITT international 2 VF signalling system and connexions between the access relay sets and the outgoing circuits will be made by a marker controlled link switching system. This system will provide rapid switching of the connexion and will also permit 4-wire switching. The CCITT signalling system used on the outgoing circuits includes certain check signals relating to the transmission of the digital information. If these signals are not received at the appropriate times the international register at London will automatically release the connexion and make a second attempt. Should the absence of the check signals be due to a faulty line the line circuit will automatically be busied out of service and a fault indication will be given to the international maintenance centre.

Incoming Calls dialled by Subscribers Abroad

The present design of international 2 VF signalling equipment installed at London caters for incoming calls which are operator controlled or subscriber dialled. The difference is indicated by the receipt of language digit "0" on a subscriber dialled call in place of the normal language digit "1—9" received on an operator dialled call. While it may appear unnecessary to indicate to the incoming terminal that the call is subscriber dialled this signal performs two important functions. First, it permits steps to be taken to prevent access being given to operators' services in the incoming country, and, secondly, it informs the incoming terminal that there will be no "end-of-pulsing" signal, such as is given on an operator dialled call.

It is a cardinal principle of International Subscriber Dialling that access should not be given to operators in distant countries, since this could lead to language difficulties and to the calling subscriber being charged for an unsuccessful call. An indication that there will be no "end-of-pulsing" signal is important in the United Kingdom, since subscribers' national numbers may consist of eight, nine, or ten digits, and on a subscriber-dialled call it is necessary to delay the release of the incoming register equipment for a few seconds to ensure that no further digits are received. If all national numbers had the same number of digits, incoming register equipment could be released automatically when a full quota of digits had been received. It would have been too costly, however, to secure this degree of uniformity in the STD system for the United Kingdom.

Interim ISD to Paris

To provide some relief to the Continental operating staff quickly the possibility of introducing International Subscriber Dialling to the Paris Area in advance of the main ISD installation is being examined. If this service is introduced it will be limited to STD subscribers in the London Director Area and it will be provided in a different manner from the standard ISD service described in this article. It is proposed to provide a direct route to Paris from a selector level at the London centralized STD centre, and to make special arrangements to obtain information for international accounting.

The rapid increase in traffic to Europe and the difficulties of recruiting suitable operating staff to provide for this growth make it essential that automatic access to European centres be available to subscribers in the United Kingdom as soon as possible. As a first step, consideration is being given to providing subscribers in the London Director Area with STD facilities automatic access to subscribers in the Paris area. A major installation of equipment to provide International Subscriber Dialling facilities is now being planned, and this should be available for service early in 1964. This unit will provide an automatic service for subscribers in the London Director Area and from the unit it will be possible to establish connexions to any country to which circuits equipped with CCITT 2 VF signalling system exist.

If full advantage were taken of the facilities to be provided, the introduction of subscriber dialling to Paris should reduce the load on the Continental switchboard in London by about 14 per cent. and the reduction of manual board traffic would probably be as much as 50 per cent. on the introduction of the full ISD scheme in 1964. The extent to which language assistance provided by operators is essential for setting up a Continental call is not clear, but it is quite certain that the reduction in the manual board traffic will approach the figures quoted above only if subscribers can be persuaded largely to abandon the personal call facility now demanded on almost 50 per cent. of the calls to Europe.

A further reason for caution in assessing this reduction of manual board traffic is that there is a distinct possibility that the improved dialling facilities will result in a general stimulation of traffic. For some years to come it seems likely, allowing for the rapid growth of traffic, that ISD will do no more than enable the expanding Continental telephone service to be given more cheaply and speedily without calling for any great increase in the present number of operators employed.

High Power VLF Radio Station

To augment the communications facilities of the North Atlantic Treaty Organization, work has started on building a high power very low frequency (VLF) radiotelegraph station on the coast of Solway Firth, Cumberland.

Reliability of communications is the prime need for this station and, accordingly, high power and very low frequency will be used, ensuring that the transmissions will be as immune as possible to the effects of ionospheric disturbances. Moreover, to avoid interruptions caused by failure of valves or other equipment, the transmitter will be built of duplicate sections which can be worked individually or in parallel, and the aerial system will be protected against mechanical overloads.

The site, which is a disused airfield between the villages of Anthorn and Cardurnock on the Solway Firth, is particularly suitable for a VLF station. It has an area of some 700 acres at the extremity of a peninsula in a region of fairly flat land of low resistivity, the subsoil is capable of supporting heavy mast loadings without undue difficulty, transport facilities are reasonably good and an adequate public power supply is available nearby.

The transmitter will be at the centre of the site, and the acrial, which will consist, of six radial rhombic-shaped sections suspended from thirteen masts 600—740 feet high, will cover practically the whole site. This arrangement of the aerial will enable each section to be lowered to the ground for maintenance without fouling mast stays or any other obstructions. The aerial will be built of cadmium-copper-conductors about one inch in diameter, to enable it to withstand the working voltage (120 kV) under adverse weather conditions, and also be strong enough to support a heavy coating of ice. Should the ice loading on the conductors increase beyond the designed maximum value, halyard-tension-limiting gear will cause the winches to lower the aerial and prevent the conductors and supporting structures being overstressed. Twenty miles of conductor, weighing some 100 tons, will be required. The aerial will be insulated by strings of compression-type insulators so that failure of any unit insulator will not result in collapse of the aerial.

The galvanized steel masts will be of conventional design, triangular in section, stayed in three directions at intervals of about 150 feet and pivoted at the base. The posts will be of solid round section to minimize wind loading, and will, in the worst case, transmit a maximum thrust approaching 1,000 tons to the foundation. 1,800 tons of structural steel and 25 tons of pre-stressed steel wire rope will be required for the masts and stays. Each mast will be provided with normal aircraft obstruction lighting and a track for a self-propelled hoist.

Our Contributors

E. C. BAKER ("The Transfer") was appointed Post Office Archivist in 1948. He has written or produced the material for many publications on postal and telecommunication history; is a member of several historical societies and of the Society of Archivists.

F. L. BEST ("Laying Telephone Cables by Mole-plough") is an Executive Engineer in the External Plant and Protection Branch of the Engineer-in-Chief's Office. He joined the Post Office in 1938 as a Probationary Inspector and was employed as Inspector and Assistant Engineer on general maintenance and external development duties in the Colchester area. He was appointed Executive Engineer in 1959 to his present post which is part of a group responsible for the development and provision of mechanical aids.

E. L. BUBB ("Electronic Relay System for Gatwick Airport Telegraph Traffic") is a Senior Executive Engineer in the Telegraph Branch, Engineering Department. He began his career in 1936—as a Youth-in-Training—with the London Test Section, transferring to R. Branch in 1939, and was promoted Inspector in 1944. Appointed Executive Engineer in 1948, he worked in the electronic switching group which was responsible for ERNIE, and then transferred to Telegraph Branch in 1957. He was promoted to his present rank in 1960 and is concerned with automatic telex relay systems.

H. EGGLETON (joint author, "International Subscriber Dialling") is a Senior Telecommunications Superintendent in the External Telecommunications Executive. He entered the Post Office in Birmingham in 1936 as an Assistant Traffic Superintendent and moved to London Telecommunications Region in 1950. In 1954 he joined the Inland Telecommunications Department and in 1958 moved to ETE. He is at present concerned with the traffic aspects of international subscriber dialling.

R. J. HALSEY ("CANTAT") has been Director of Research since 1958. He is also a director of Cable & Wireless Ltd.

J. M. HARPER ("STD—The First Three Years") is a Principal in the Inland Telecommunications Department, Telephone Mechanization Branch. He contributed "STD—The First Three Centres" to the Autumn 1960 *Journal* and his career is outlined in that issue.

K. W. HIX ("Solderless Wire Wrapping") joined the Post Office in 1937 after an apprenticeship and design experience with Ericsson Telephones. After several years in the Telephone Branch of the Engineering Department, he escaped from Harrogate to join the Lines Branch War Group and was subsequently concerned with repeater station power supplies. Area experience at Oxford from 1949-1952 was followed by three years with the Australian Postmaster General's Department. Since 1955 he has been engaged on physical design duties in Telephone Exchange Standards and Maintenance Branch.

C. J. MAURER (joint author, "International Subscriber Dialling") is an Executive Engineer in the Engineering Department. He joined Exeter Telephone Area in 1938 and was transferred to the Engineering Department as an Assistant Engineer in 1949. In 1956 he was appointed Executive Engineer in the international signalling group.

Post Office Report and Commercial Accounts 1960-61

The Post Office Report and Commercial Accounts for 1960-61—the last year before Post Office finances became largely independent—show that there was an overall surplus of £24.3 million. Of this £18.4 million came from the telegraph and telephone services. Following are some of the main telecommunications trading results.

Telegraphs

During the year 13,567,000 inland telegrams were sent. This was 260,000 or 1.9 per cent. less than in 1959-60. Greetings telegrams made up about one quarter of the total and nearly half of all greetings telegrams went at de luxe rate on special forms. An additional design was added to the de luxe range.

Oversea telegrams declined slightly, 20,022,000 being sent compared with 20,384,000 in 1959-60. Ship-shore telegrams (839,000) also showed a decrease of 1.6 per cent. on the previous year.

On the other hand telex traffic continued to rise and completion of the conversion of the inland system to automatic working (subscriber-to-subscriber) brought a rise of 2.6 million in the number of dialled calls. Manually operated calls fell by 1.6 million, and total calls (5.3 million) increased by 24 per cent. The proportion of dialled calls was 63 per cent. compared with 16 per cent. in 1959-60. By March 1961 there were 7,089 subscribers—an increase of 20 per cent.

Telex services were available to 53 Commonwealth and foreign countries, and subscribers in four, and operators in a further eighteen, European countries were able to dial calls directly to subscribers on automatic telex exchanges in the United Kingdom.

Telephones

4,300 million local telephone calls were made, 400 million more than in 1959-60. In addition, 39 million more trunk calls brought the total number of trunk calls to 422 million.

The telephone service earned £223.4 million against an expenditure of £203.1 million, giving a surplus of £20.3 million. The main contribution to this surplus (£14.7 million) came from inland trunk calls.

The number of exchange connexions rose during the year above 5,000,000 and by the end of the year there were 8,280,000 telephones—more than in any other country in the world except the United States.

From September 1 1960 the cheap rate trunk charge for calls connected by an operator, up to 35 miles, was reduced from 1s. 0d. to 9d. for three minutes; for calls of more than 125 miles the reduction was from 2s. 6d. to 2s. 0d. for three minutes. The local call charge of 3d. was reduced to 2½d. for calls from residence subscribers' lines.

During the year STD was considerably extended and installations serving 57 exchanges with some 192,000 lines were brought into service. Subscribers having STD continue to exploit it to the full and are making more calls than they did before it was introduced.

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New Year Honours

Mr. D. A. Barron, Deputy Engineer-in-Chief, and a former member of the *Journal's* Editorial Board, headed, with the CBE, the Post Office people in the New Year Honours List.

Mr. L. L. Tolley, Chief Regional Engineer, Midland Region, and Dr. R. A. Brockbank, Staff Engineer, Research Station, were honoured with the OBE. Dr. Brockbank contributed *British Submerged Repeaters in the Transatlantic Telephone Cable* to the Summer 1956 issue.

Post Office telecommunications staff who received the MBE were Mr. J. H. Broadhurst, Senior Executive Engineer, Engineer-in-Chief's Office (author of *The Post Office Circuit Laboratory*, Autumn 1961); Miss P. L. K. Mann, Superintendent, Central Telegraph Office; Mr. D. H. S. Simpson, Chief Telecommunications Superintendent, Oxford.

The BEM list included Miss E. Hopwood, Senior Chief Supervisor, Salford; Mr. G. Simons, Telephone Mechanic, Factories Department, Edinburgh; Miss E. D. Riley, Chief Supervisor, Hanley, Stoke-on-Trent; Mr. R. Johnson, Supervisor, Bedford; Mr. F. W. M. Richards, Technical Officer, Long Distance Area, London Telecommunications Region; Mr. E. P. McManus, Cable Foreman, H.M.T.S. *Monarch*; Mr. B. C. A. Stone, Technical Officer, Brighton and Mr. F. Greensides, Technician IIB, Cambridge Telephone Area.

* * *

New Training School at Harlow.—A new Engineering Training School is to be built at Terlings, an estate on the outskirts of Harlow, Essex, which it is hoped to have ready for occupation by 1965.

* * *

Volume 14 begins with this issue and all future volumes will begin in February, thus enabling the four issues to be published in the same calendar year. Readers are reminded that, in consequence of this change, Volume 13 has five issues—Winter 1960 to Winter 1961—and the index to that volume is included in the Winter 1961 issue.

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

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

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

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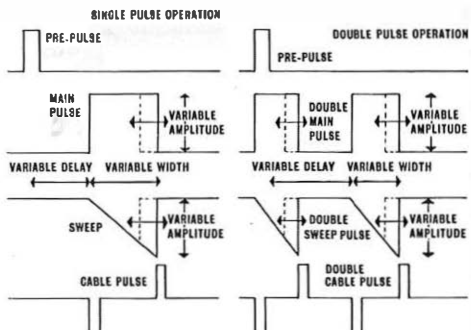

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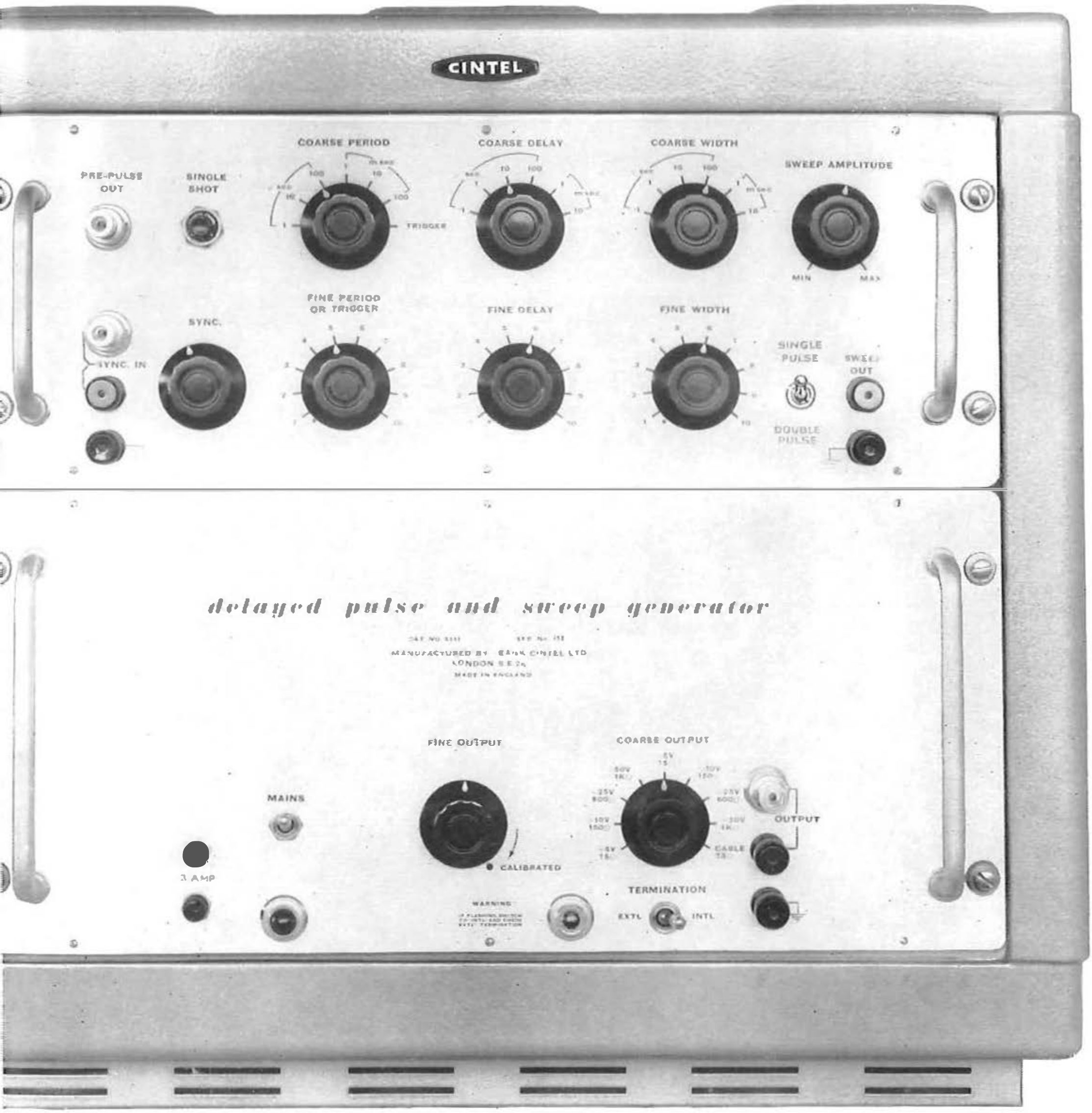

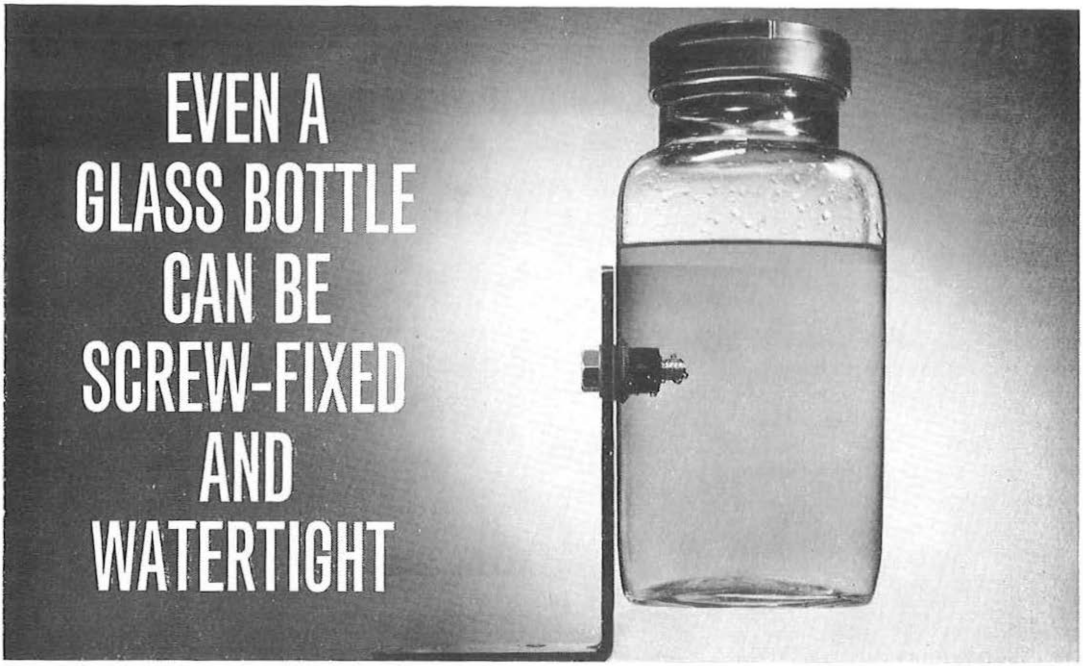

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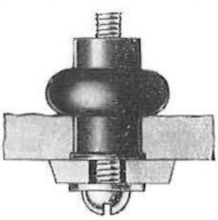

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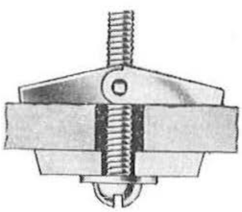

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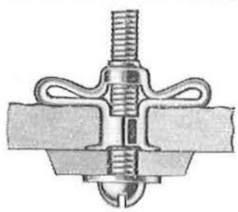

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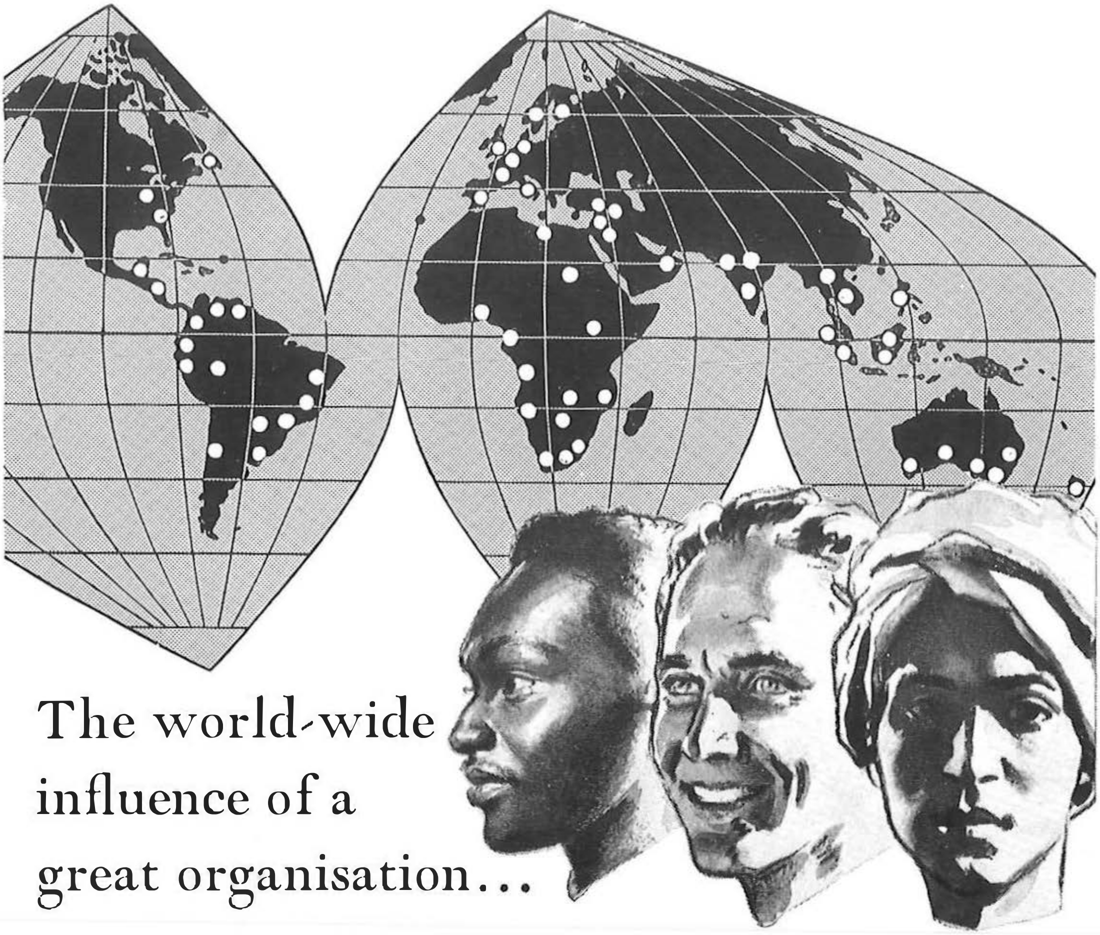

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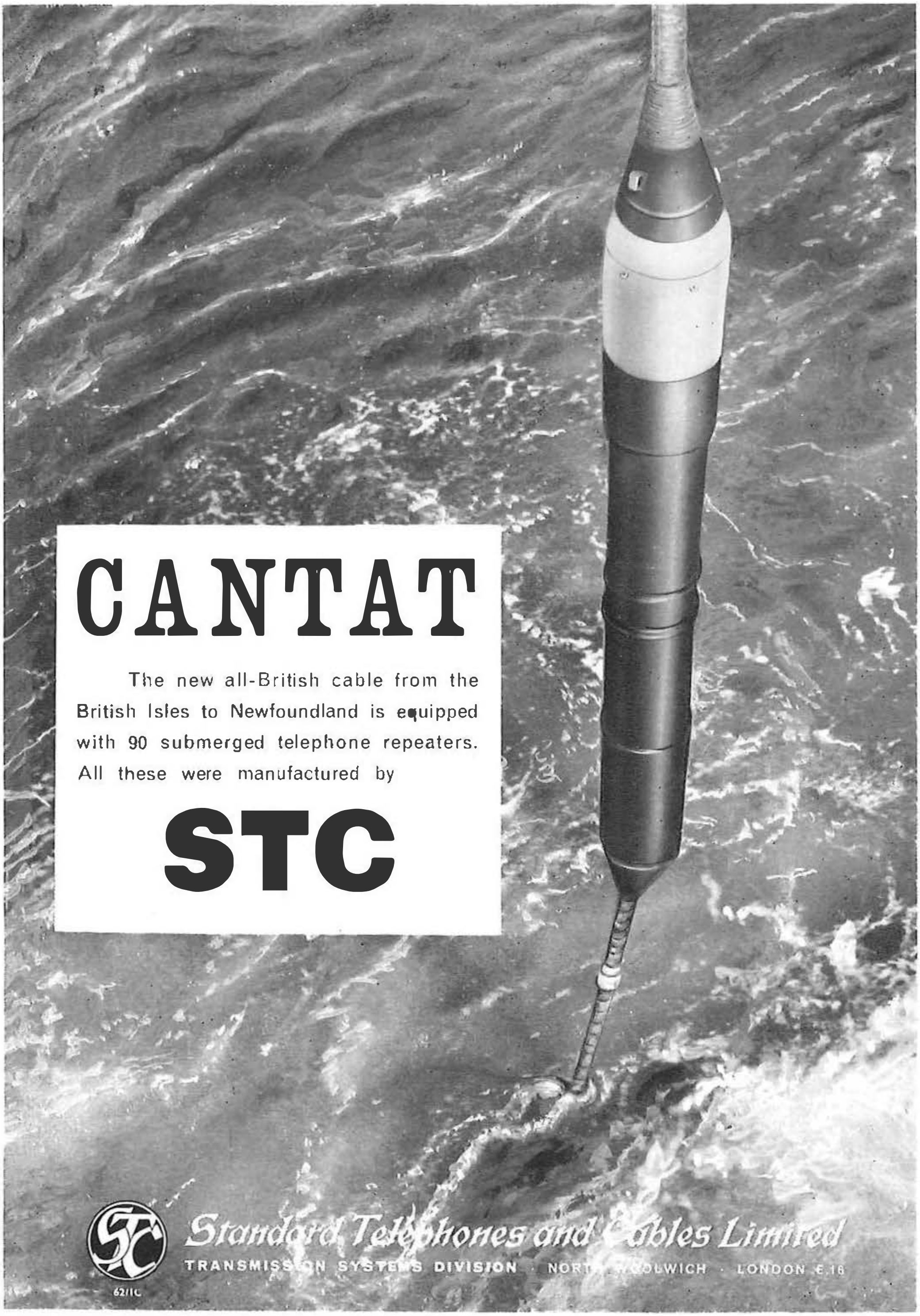
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The new all-British cable from the British Isles to Newfoundland is equipped with 90 submerged telephone repeaters. All these were manufactured by
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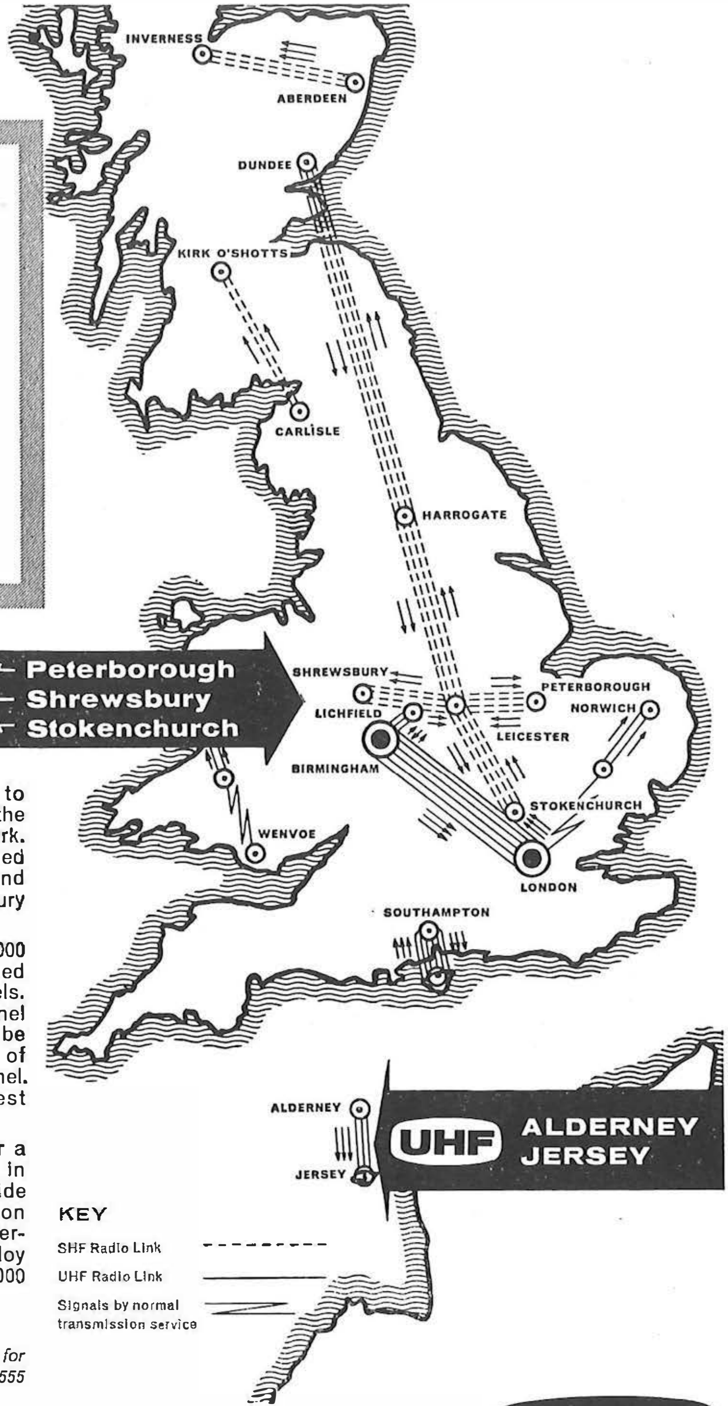
BROADBAND RADIO EQUIPMENT once again chosen by the BRITISH POST OFFICE

SHF LEICESTER — Peterborough / Shrewsbury / Stokenchurch



GEC has been awarded contracts to supply and install further extensions to the national broadband microwave network. Two SHF radio channels are to be provided in each direction between Leicester and Peterborough, Leicester and Shrewsbury and Leicester and Stokenchurch.

These systems will operate in the 6000 Mc/s frequency band and can be extended by the addition of further RF channels. One RF channel acts as a standby channel to several working channels and can be switched in automatically in the event of failure or degradation of a working channel. The equipment conforms to the latest CCIR recommendations.

A contract has also been received for a UHF link between Alderney and Jersey in the Channel Islands. This link will provide three unidirectional channels for television (video plus sound) in the direction Alderney to Jersey. This system will employ GEC radio equipment operating in the 2000 Mc/s frequency band.

UHF ALDERNEY JERSEY

For further information, please write for Standard Specification SPO 5555

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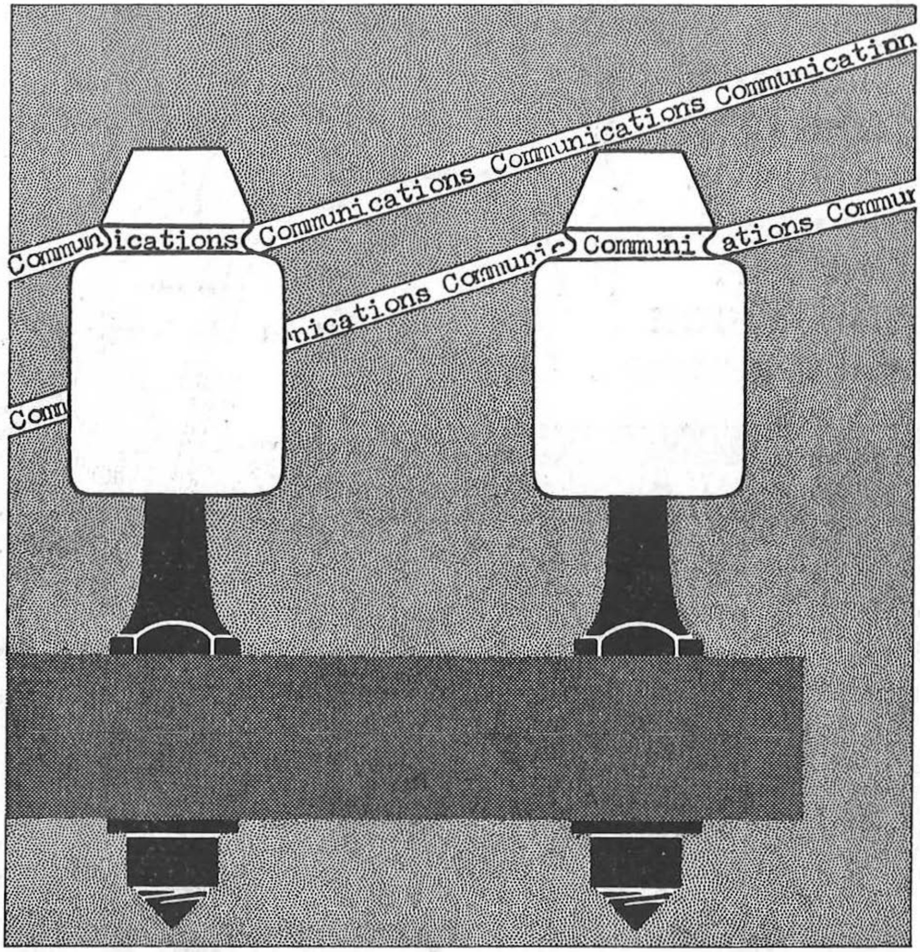
COMMUNICATION



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