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COMMENT

THE POST OFFICE TOOK THE HEADLINES of the national press when the Postmaster General introduced the Wireless Telegraphy Bill at the beginning of November. The Bill has two objects: to bring up to date, extend and make permanent the law relating to wireless telegraphy, and to give the Postmaster General power to deal with the growing problem of controlling wireless interference produced by electrical apparatus.

In 1904, farsighted legislators enacted in temporary form a Wireless Telegraphy Act which gave the Postmaster General the responsibility for controlling the new invention. In 1906 the Act was renewed for a further period of three years and it has been kept on the Statute Book ever since by means of the annual Expiring Laws Continuance Bills.

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IN 1904, THE THERMIONIC VALVE, ON WHICH NOT only radar and television but radiotelephony and broadcasting depend, had not been invented. It is a tribute to the promoters of the Act of 1904 and the legislature that the Act has worked so well until now.

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PART I OF THE WIRELESS TELEGRAPHY BILL clarifies the Postmaster General's powers for controlling wireless telegraphy by licence and regulation. It authorises the Postmaster General to make charges for these licences and to issue certificates and authorities to persons he considers competent to operate certain wireless apparatus. Wireless telegraphy is legally defined. The Bill also lays down that wireless apparatus, anywhere in or over the United Kingdom, on British ships or aircraft registered in the United Kingdom, or carried by balloons and devices released from the United Kingdom or British ships or aircraft, should be licensed. An innovation is that wireless apparatus used for the control of machinery must now be licensed. Otherwise the changes proposed in regard to the licencing of wireless

telegraphy are matters of form rather than substance.

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PART II OF THE BILL BREAKS NEW GROUND HOWever. With the increasing use of electrical apparatus in homes, in industry and for medical purposes, a noise background has become more and more noticeable to all who use wireless telegraphy for communication or other purposes and in some neighbourhoods such "interference" prevents satisfactory reception. Television reception is particularly sensitive to some types of interference; nevertheless for every complaint of interference with television reception, fifteen are received from other users of wireless telegraphy. Electric motors and switches which spark when used, and especially some types of thermostatic switch (used for heat-control in electric blankets and in other heating apparatus) cause much of the trouble. Apparatus designed to generate high frequency energy for medical and industrial heating purposes may be particularly troublesome over wide areas. Unlike other nuisances, interference with wireless telegraphy is not readily discernible or identifiable. For many years the Post Office has investigated complaints and has located the sources of interference. It has then notified the owners of offending apparatus of the trouble they are causing; and they have, in the main, readily agreed to have their apparatus modified so as to reduce the interference to reasonable limits. A few, however, had refused to co-operate and Part II of the Bill has been designed to enable the Postmaster General to deal with this small minority.

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INTERFERENCE IS USUALLY RADIATED FROM ITS source, either directly or via the electricity supply mains, to the aerial of the wireless receiver. The Postmaster General will be able by regulation (made after consultation with an Advisory Committee consisting of experts or representatives of persons whose interests are likely to be affected by the making of the regulations), to prescribe, for classes of apparatus liable to cause trouble, the amount of "interference energy" which may be radiated from the apparatus or injected into the supply mains.

It will not however be an offence to use apparatus which does not comply with the requirements of the regulations and most people will carry on using their apparatus as at present, and cause no trouble. But if their apparatus does cause interference and they ignore warnings, the Postmaster General will be empowered to serve on them a formal notice ordering them to stop using the offending apparatus. If they then have the apparatus modified, all will be well. If the apparatus is still used in defiance of the notice they will risk prosecution for the offence of working the apparatus in contravention of the Postmaster General's notice. A person on whom a notice has been served will be able to appeal to an independent Tribunal against enforcement of the notice if he so desires.

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PART III OF THE BILL PRESCRIBES THE PENALTIES for offences under the Act. It also includes a provision to enable the Postmaster General to obtain from a magistrate authority to enter premises suspected of housing apparatus that does not comply with the regulations, or where there is evidence of the commission of an offence under the Act. This "right of entry" clause has caused most of the criticism so far received about the Bill despite the fact that similar powers in relation to offences exist under the 1904 Act. It has, however, been carefully drafted to safeguard the interests of the public. The Attorney General, when referring to it during the debate in the House, said he did not think he had ever seen a power of entry hedged round and circumscribed by so many safeguards.

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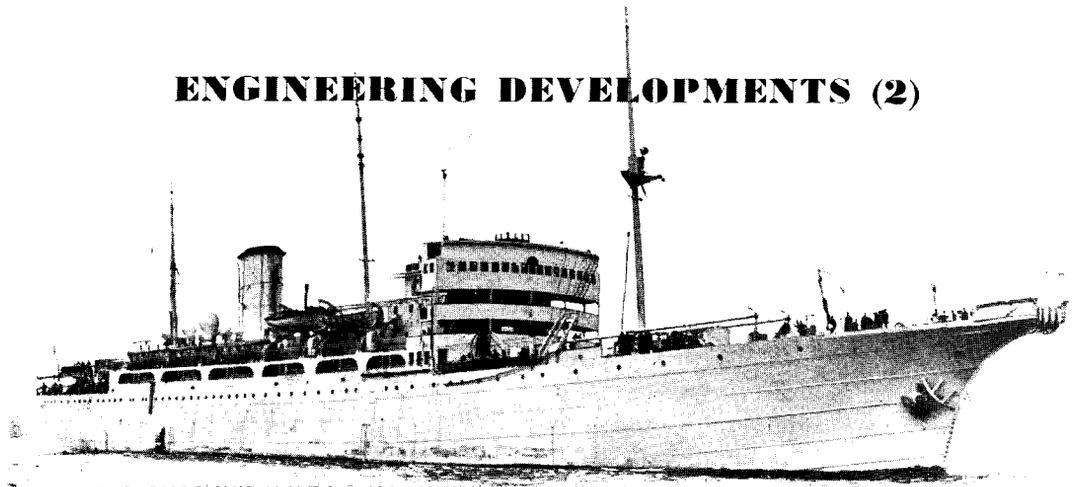
THE NUMBER OF SHARED SERVICE TELEPHONE subscribers now tops the 100,000 mark. This significant development owes much to our engineering capacity for improvisation and to the tactful overcoming by the Sales organisations of the prejudices of both subscribers and applicants. These achievements reflect much credit on all concerned.

Engineering ingenuity has enabled a service to be given which in efficiency falls little short of exclusive line service. The success of the service in practice rests on solid reasons. With two calls a day as the average calling rate from homes, simultaneous calling by those sharing a line is likely to be infrequent. If the Department can solve the problem of the shared account by giving separate metering in automatic exchange areas where it is not at present available and we understand that there are good hopes the service will gain much in popularity. It will thus provide a further valuable and direct contribution to the reduction of the waiting list of applicants for telephone service now standing at over 500,000.

ENGINEERING DEVELOPMENTS (2)



POST OFFICE CABLE SHIP H.M.T.S. "MONARCH"

by A. J. Gill, Engineer-in-Chief

The Atlantic Crossing

DESPITE THE DIFFICULTIES STILL TO BE OVERCOME AND the very great capital expenditure involved, submarine cables equipped with submerged repeaters at intervals seem to be the most hopeful way of increasing telephonic communication between this country and North America on a scale adequate to our community of interests. The maximum number of direct radio telephone circuits utilising what are known as short-waves (i.e. waves between 100 and 10 metres in length) is severely limited because of the world-wide demand for the small number of wavelengths available. A good deal of work has been done recently on a system of telephony in which speech sounds are represented by a relatively small number of simple signals for transmission over a line, and these signals are used to reconstruct speech at the distant terminal. If this system were used, two transatlantic cables, one working in each direction with repeaters, could be made to provide nearly 100 telephone circuits. Two cables, however, would provide no safeguard in the event of a mid ocean fault which it might not be possible to repair for several weeks, and it would be desirable to provide at least four cables, if single way working were adopted, in order to avoid a complete breakdown of service if a fault occurred. The cost of such a provision would be high, probably of the order of £20,000,000 and it would probably have to be a joint British and American project.

Alternative Chain of Radio Links to America

Another conjecturable means of providing a large number of circuits from Europe to America might be by way of a chain of radio links using sharply directional beams on ultra short waves, i.e. waves of one metre or less in length. Such waves can travel only in straight lines and thus the range of each link is about 30 miles. A system of this kind would have to go across Asia to the Behring Straits and then south through Alaska to link up with the American cable system. The political situation, however, hardly favours such a scheme at the moment.

The problem of deep-water telephone repeaters has not yet been given as much attention as we would have wished owing to shortage of staff, but much valuable information will be forthcoming from work which is being undertaken in the design of telegraph repeaters for Cable and Wireless Ltd. As an experimental project, it is proposed to equip the Porthcurno-Bilboa telegraph cable with about four repeaters; some of which will have to work at depths of 2,500 fathoms — roughly three miles.

Telephones and Connection to Mobile Units

The connection of mobile units such as ships, vehicles, etc., to the telephone system can be

of this kind. In the last few months a most important discovery has been announced by the Bell Laboratories of America. They have produced a device resembling the well known crystal detector but fitted with two cat-whiskers instead of one. The device, which has been christened a "Transistor," when connected in an appropriate circuit behaves like a thermionic valve; a weak signal applied between the crystal and one cat-whisker produces an amplified signal between the crystal and the other cat-whisker. The magnification can be of the order of a thousand times in power. Very little power is required to work it and as there is no heating required the transistor is immediately ready for use. It is small, about the size of a flash lamp bulb, and is capable of working up to ten megacycles per second (30 metres wavelength). This new discovery appears to be of outstanding importance and seems likely to affect profoundly the development of telecommunications and allied branches of engineering. For example, it would allow portable radio sets and hearing aids to be made much smaller and much lighter, because the main weight and bulk of such sets is at present due to the batteries. Also in equipments where at present large numbers of valves are used one of the main difficulties is the liability of valves failing. As the transistor operates at normal temperature its life should be very long and an increase in the numbers used should not, in contrast with valves, entail an increase in liability to failure.

The small dimensions of the transistor also makes attractive its employment in electronic switching and other equipments where large numbers of valves would otherwise have to be used, and where large power consumption is entailed and heat dissipation a difficulty. It may even have applications to land and submarine cable repeaters. At the moment the transistor is a laboratory wonder and its appearance as a factory product is eagerly awaited. This discovery is a good instance of a phenomenon existing for years unobserved right under our noses. One wonders what other equally important effects are awaiting discovery by someone with sufficient curiosity to look for them.

Research Objectives

Research in many different fields of interest to the Post Office holds out the possibility of useful developments. Such research may be carried out by manufacturers, by universities or by research associations or by other Government Departments. Although there has recently been a considerable increase in the research establishment of the Post Office, the engineers and scientists available for research are inadequate in number to enable work to be done in more than a very few of these fields and, in general, it is desirable to select for study subjects which are not under active investigation elsewhere and which seem likely to prove most profitable for exploration. In order to be successful many of the developments will need materials with improved properties, or thermionic valves with special characteristics, and the Post Office will have to allot some of its research effort to work in these subsidiary fields. Provision must also be made for essential work in connection with day-to-day problems of the Engineering Department and urgent short-term projects. In order that the engineering and scientific manpower remaining available for long-term research might not be dissipated by being spread over too wide a field, present practice is to restrict longer term work to a few objectives. Among the telecommunication projects which are being given priority as long-term researches are: (i) the electronic telephone exchange, (ii) submerged telephone repeaters, including those for use in deeper waters, (iii) the modernisation of the subscriber's telephone instrument.

Other Factors

Finally, the adoption of new practices may depend on factors other than research. Changes in manufacturing methods may play their part by so reducing the costs of certain processes as to permit the adoption of systems or methods previously uneconomic. For example, it seems likely that in the future, by the use of large coaxial tubes, wave guides or radio beams, the line cost of long distance trunk circuits may fall to such an extent that the main cost in such circuits may reside in the terminal equipments. In order to reduce the cost of such equipments it may be necessary to seek for cheaper methods of manufacture. If this can be achieved it may mean that the cost of trunk circuits can be reduced sufficiently to allow all calls other than local calls to be charged uniformly throughout the country.

In this connection it is interesting to record that a firm in this country is already manufacturing a simple type of radio receiver by automatic machinery which turns out a complete receiver in 20 seconds. An extension of these methods to more complicated pieces of telecommunication apparatus may be anticipated in due course.

A JOB AT THEIR FINGER-TIPS by H. M. TURNER

Mr. H. M. Turner is the Telephone Manager of the City Area, London Telecommunications Region.

FOR SOME YEARS NOW WE HAVE MAINTAINED in the City Area of the London Telecommunications Region the Piece Part Depôt where recovered exchange equipment of non-standard types has been dismantled and renovated for use in existing exchanges of the same types. Piece parts are not in themselves complete electrical instruments but components, ranging from assemblies such as relays to nuts, relay springs, etc.

The process consists firstly in separating equipment into major components with a selection of usable material, followed by taking apart these assemblies into the smallest possible components, spring sets of relays being completely reduced. Selection then takes place, the parts being sorted into those usable after treatment such as buffing, those requiring factory operations such as re-contacting, and scrap. The components so produced are either despatched directly to exchanges to meet demands for items not in stock, or carried into the Centralised Normal Stock from which demands are normally met. The service covers the whole of southern England and, for some special items, the whole country. Several million parts are stocked in over 10,000 varieties.

In the Piece Part Depôt and Centralised Normal Stock we employ about 120 staff, and, as much of the work is sedentary, war-disabled persons were recruited, but the number offered from the Ministry of Labour was not sufficient to meet our needs. Consideration of the problem revealed that much of the work was within the capacity of blind men, and we commenced an experiment with the employment of such persons.

In November, 1947, with London County Council co-operation, we selected six blind men for employment. In the main they were engaged on assembly work, although they also carried out some of the breaking down processes. After training, each was paired with a sighted man, the blind man assembling relays, etc., from components in accordance with instructions which he had memorised, the sighted man being responsible for the adjustment and testing of the completed assembly.

Our experience with the blind men was so satisfactory that in March, 1948, another six were taken on, and in addition we were able to employ Post Office staff who through the onset of blindness were unable to continue their normal duties and were either being or had been retired. These included three men from postal duties, one from the Supplies Department and one from the Power Section. We have a total of 18 at present, the ages ranging from 20 to 48 and only three have had any previous experience of electrical work. When it is borne in mind that in an experiment of this kind failures were to be expected, the fact that all have adapted themselves satisfactorily to the work must be regarded as a triumph.

The development of other senses to counteract the loss of one is well known, but the sense of touch which some of the blind men possess is uncanny. One of them is able to identify by

Assembling Relay Springs

General View of an Assembly Room

touch alone any of the 90 odd relay springs, some varying in thickness by as little as half a thousandth of an inch. The output and quality of the work of the blind men is in no way inferior to that of similar work done by sighted staff. They are not treated any differently from other staff and they decline any modifications to the normal jigs and tools except in some special cases as, for instance, micrometers which some of them can use quite accurately by sense of touch. Half of the men are totally blind, and the others have such a small degree of sight as to be classified as blind persons. In the latter cases we encourage the men to perform their work by sense of touch alone, so as not to degrade the small degree of sight they have left.

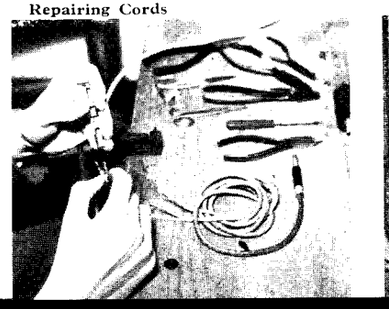
The employment of such a number of blind men in one building is not without its problems, but none is of any magnitude and all are overcome if the supervising staff have understanding. This quality is appreciated by blind people, but they dislike sympathy. The psychological effect of good natural lighting is most marked, and full use is made of bench lighting.

This experiment has been described by medical experts as the most important step in the employment of disabled persons yet undertaken by the Post Office and it has certainly justified expectations. During the next two years, this work will be transferred to the Factories Department in Birmingham, and although, no doubt, blind persons could be similarly employed there, the existing staff will have to be found other duties in London.

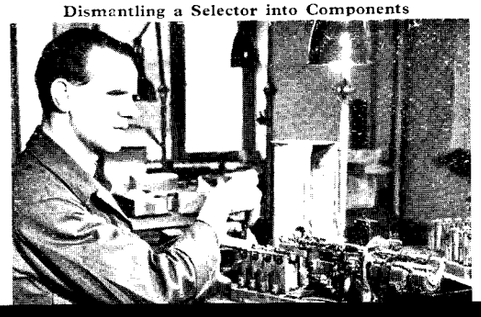
Some of the blind men are being tried on other jobs such as the repair of cords, and with training, a satisfactory product is within their scope. Experience will show the limits of work which can be given to blind men, but there is no doubt that the range of work they can perform is much wider than is generally imagined.

A start is being made with the holding of classes specially designed for blind people, to enable them to acquire some fundamental knowledge of electrical principles, and so help them to develop a deeper interest in the work they perform. Blind people react to monotonous work as do sighted people, and their disability naturally precludes their employment on some of the more interesting work such as adjustment, etc. We feel that much work of a varied character could be found on which blind people could be employed and this short account of the work of the blind men at the Piece Part Depôt has been written in the hope that it will stimulate interest in a real problem, that of helping some of the 80,000 blind persons in the country to make a living by making a useful contribution to society.

Repairing Cords



Dismantling a Selector into Components



Sorting prior to Assembly

Delayed Traffic Problems

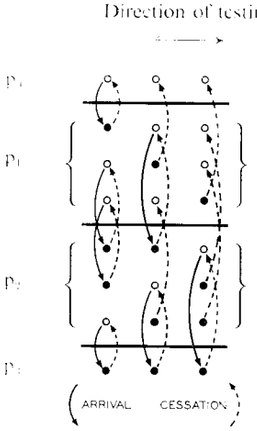
by H. A. Longley

Inland Telecommunications Department, Operations Branch, Headquarters

THE TYPE OF SERVICE WHICH ENABLES CALLS meeting congestion to wait until a channel or operator becomes free is common in telecommunications, and creates traffic problems of great importance. Outside the telecommunications field a topical example is the determination of the relation between the number of landing strips at an airport to the proportion of aircraft likely to have to circle for permission to land, and the probable duration of the delays. Several mathematical solutions of these problems have been published from time to time, but they have in general proved disappointing either in their failure to fit practical experience, or in their complexity. In a recent article* a technique for dealing with traffic problems was described, and applied to the derivation of Erlang's well-known "loss" formula, and to the problem of grading. It is here proposed to apply this technique to some of the better known delayed traffic problems, and, where the results obtained differ from previously published work, to explain the points of difference.

In terms of telephone traffic the main problems are to determine (*a*) the proportion of calls delayed; (*b*) the average delay; (*c*) the proportion of calls delayed for more, or less, than a given time.

Proportion of calls delayed ($p_{>0}$).—In Figure 1 are shown the eight possible conditions of engagement through which a group of three channels may pass. The group changes from one condition to another due to two kinds of event—the arrival of calls and the cessation of calls; the arrows show all possible changes from one condition to another. The number of calls which, by arriving or ceasing create each condition is equal to the number which, by ceasing or arriving destroy the condition; and the equations in the figure express these arrivals and cessations in terms of the probability of each condition—represented by p_0, p_1, etc. These equations apply equally if calls are offered indiscriminately to the channels instead of in order, as shown in the figure.



	Creative			Destructive		
	Arrivals		Cessations	Arrivals	Cessations	
p_1			p_1	Ap_0		(1)
p_0	Ap_0	=	$2p_2$	Ap_1	p_1	(2)
p_2	Ap_1	=	$(3-A)p_3$	Ap_2	$2p_2$	(3)
p_3	Ap_2				$(3-A)p_3$	(4)

Fig. 1. Basic equations for group of three channels, when traffic is delayed during congestion.

The condition when all three channels are engaged (p_3) is created by calls arriving during p_2, and these are equal to $\frac{Ap_2}{h}$—where A is the traffic offered in traffic units or the average number of arrivals in the average holding time, and h is the average holding time. Calls arriving while all channels are engaged tend to prolong condition p_3, and the calls ceasing to terminate the condition are given by the total cessations during the condition $\left(\frac{3p_3}{h}\right)$, less the calls arriving during the condition itself $\left(\frac{Ap_3}{h}\right)$

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as represented in equation (4) in the figure. From the basic equations in the figure we obtain

$$p_1 = Ap_0 \; ; \; p_2 = \frac{A^2}{2!}p_0 \; ; \; p_3 = \frac{A^3}{2!\,(3-A)}p_0 \; ;$$

and as $p_0 = p_1 + p_2 + p_3 + \ldots = 1$

$$p_{>0} (= p_3) = \frac{\frac{A^3}{3!}\frac{3}{3-A}}{1 + A + \frac{A^2}{2!} + \frac{A^3}{3!}\frac{3}{3-A}}$$

In general

$$p_{>0} = \frac{\frac{A^x}{x!}\frac{x}{x-A}}{1 + A + \frac{A^2}{2!} + \ldots + \frac{A^x}{x!}\frac{x}{x-A}} \qquad \ldots(I)$$

where x is the number of channels in the group. For purposes of subsequent discussion it may be noted that

$$p_{>0} = \frac{A}{x-A}\,p_{x-1} = \frac{R}{1-R}\,p_{x-1} \quad \left(\text{where } R = \frac{A}{x}\right) \qquad \ldots(II)$$

merely to bring out the fact that the waiting time of a typical call is made up of a period, less than the average interval between cessations, from its arrival to the next cessation, plus, for some calls, one or more periods equal to the average interval between cessations. When there is more than one channel the duration of the average interval between cessations is equal to $\frac{h}{x}$, whether holding times are constant or variable. Some of the possible types of period between cessations are shown in Figure 3, rearranged in order according to the number of calls waiting at the beginning of each interval, and the number of calls that arrive during each interval. If a_r represents the probability that there are r calls waiting at the beginning of an interval, and b_s represents the probability that s calls arrive during an interval of average length h/x, the probability of r waiting and s arriving is $a_r b_s$, and the probabilities of the various conditions are shown thus in the figure. Now it follows from the pure chance arrival of calls that in any interval when one call only arrives its average wait, till the next cessation, is $\frac{h}{2x}$;

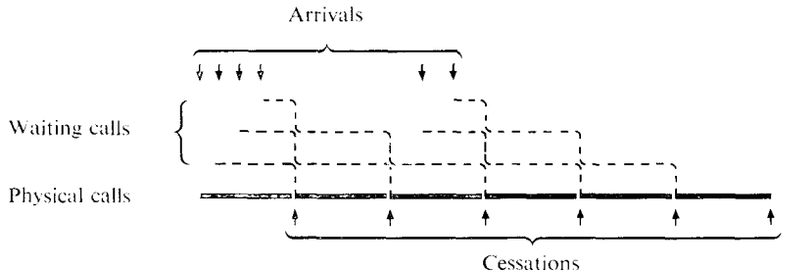


Fig. 2. Period of engagement of a single channel.

The assumption that traffic arrives in a pure chance manner from an unlimited number of subscribers is reflected in equations of Figure 1 by the fact that the average rate of arrival of traffic is assumed to be unaltered by the engagement of earlier channels in the group. No assumption is necessary about the incidence of cessations, and the solution applies whether holding times are constant or variable.

Average Delay (M).—The average waiting time per delayed call is equal to the total waiting time divided by the number of calls delayed. If the probabilities of 0, 1, 2, etc. calls waiting simultaneously are represented by $p_{x=0}$, $p_{x=1}$, $p_{x=2}$, etc., the average delay is given by

$$M = \frac{p_{x=1} + 2p_{x=2} + 3p_{x=3} + \ldots}{\frac{A}{h}p_x} \qquad \ldots(III)$$

For the purpose of this and subsequent problems it is necessary to determine the values $p_{x=0}$, $p_{x=1}$, etc., in terms of A and x.

Figure 2 depicts a possible period of engagement of a single channel. The holding times are shown as equal

that in any interval where two calls arrive the average wait, till the next cessation, of the first call to arrive is $\frac{2h}{3x}$, and of the second call to arrive $\frac{h}{3x}$; the corresponding periods for an interval where three calls arrive are $\frac{3h}{4x}$, $\frac{2h}{4x}$, $\frac{h}{4x}$; and so on.

The elements of Figure 3 can be equated in terms of conditions $p_{x=0}$, $p_{x=1}$, etc. in three ways. Firstly, equating in terms of the probabilities themselves:

$$p_{x=0} \quad a_0 (b_0 + \tfrac{1}{2}b_1 + \tfrac{1}{3}b_2 + \tfrac{1}{4}b_3 + \ldots)$$

$$p_{x=1} \quad a_0 (\tfrac{1}{2}b_1 + \tfrac{1}{3}b_2 + \tfrac{1}{4}b_3 + \ldots) + a_1 (b_0 + \tfrac{1}{2}b_1 + \tfrac{1}{3}b_2 + \ldots)$$

etc.

Secondly, equating in terms of the number of arrivals and cessations:

$$\frac{A}{h}p_{x=1} = a_0 b_0 \frac{x}{h}$$

$$\frac{A}{h}p_{x=0} \quad a_0 (b_1 + b_2 + b_3 + \ldots)\frac{x}{h}$$

$$\frac{A}{h}p_{x+1} \quad a_0 (b_2 + b_3 + b_4 + \ldots)\frac{x}{h} + a_1 (b_1 + b_2 + b_3 + \ldots)\frac{x}{h}$$

etc.

Thirdly, we can equate with respect to the sequence in which the elements can occur. The number of intervals ending with r calls waiting must be equalled by the number of intervals beginning with r−1 calls waiting ($a_0 b_0$ being the only exception).

Thus

$$a_0 b_1 + a_1 b_0 \quad a_0 (b_1 + b_2 + b_3 + \ldots) \quad Rp_{x=0}$$

Similarly

$$a_0 b_2 + a_1 b_1 + a_2 b_0 \quad Rp_{x=1}$$

$$a_0 b_3 + a_1 b_2 + a_2 b_1 + a_3 b_0 \quad Rp_{x=2} \qquad \ldots(IV)$$

etc.

A general form to these expressions will be noted; it is possible to write a general expression, but it is somewhat lengthy. The above expressions can be expanded into series as follows:

$$p_{x=0} \quad \left(R + \frac{R^2}{2!} + \frac{R^3}{3!} + \frac{R^4}{4!} + \frac{R^5}{5!} + \frac{R^6}{6!} + \ldots\right) p_{x=1}$$

$$p_{x=1} \quad \left(\frac{R^2}{2!} + 4\frac{R^3}{3!} + 11\frac{R^4}{4!} + 26\frac{R^5}{5!} + 57\frac{R^6}{6!} + \ldots\right) p_{x=1}$$

$$p_{x=2} \quad \left(\frac{R^3}{3!} + 11\frac{R^4}{4!} + 66\frac{R^5}{5!} + 302\frac{R^6}{6!} + \ldots\right) p_{x=1}$$

$$p_{x=3} \quad \left(\frac{R^4}{4!} + 26\frac{R^5}{5!} + 302\frac{R^6}{6!} + \ldots\right) p_{x=1}$$

etc. $\qquad \ldots(VI)$

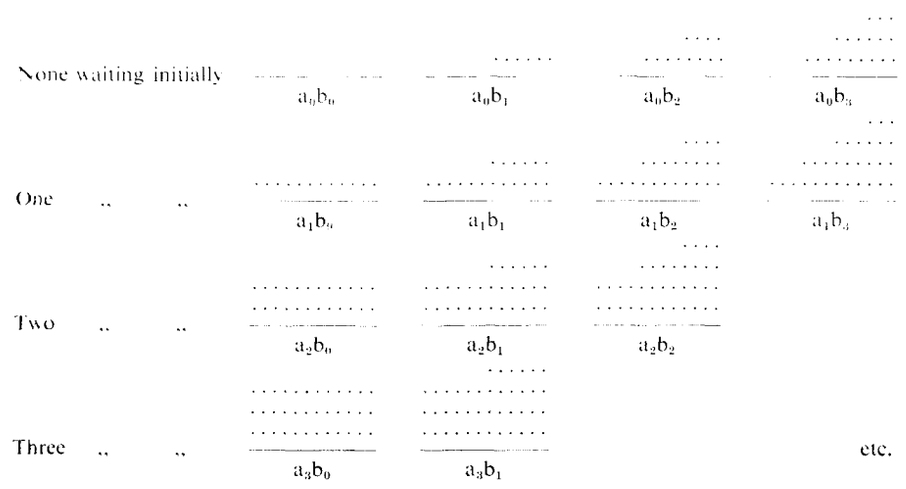


Fig. 3. Types of waiting condition in intervals between cessations.

It may be deduced from these sets of equations that:

$$b_0 = e^{-R} \; ; \; b_1 = Re^{-R} \; ; \; b_2 = \frac{R^2}{2!}e^{-R}; \text{ etc.}$$

$$a_0 = Rp_{x=0} = Rp_{x=1} \; ; \; a_1 = Rp_{x=1} \; ; \; a_2 = Rp_{x=2} \; ; \text{ etc.}$$

From which it follows that:

$$p_{x=0} = \{e^R - 1\}\, p_{x-1}$$

$$p_{x=1} = \{e^{2R} - (1 + R)e^R\}\, p_{x-1}$$

$$p_{x=2} = \{e^{3R} - (1 + 2R)e^{2R} + (R + \frac{R^2}{2!})e^R\}\, p_{x-1}$$

$$p_{x=3} = \{e^{4R} - (1 + 3R)e^{3R} + (2R + \frac{(2R)^2}{2!})e^{2R} - (\frac{R^2}{2!} + \frac{R^3}{3!})e^R\}\, p_{x-1} \qquad \ldots(V)$$

etc.

Substituting these in (III) we obtain:

Average delay on calls delayed $= \frac{h}{2\,(x-A)}$ $\qquad \ldots(VII)$

Average delay on all calls $= p_{>0}\frac{h}{2\,(x-A)}$ $\qquad \ldots(VIII)$

The above formulae for average delay apply whether holding times are constant or variable.

Calls which encounter delay may be served in order of origination or in random order: thus, manual exchange operators normally answer calling signals in order of origination, but, when many calls are waiting, they tend to answer in random order.

The total amount of delay is unaffected by which of the waiting calls is connected when a call ceases; the average delay is therefore the same whether calls are answered in order of arrival or at random.

Proportion of calls delayed more or less than a given time. The values for p_{x0}, p_{x1}, etc. obtained above being independent of variations in the intervals between calls—whether due to a multiplicity of channels or variability in holding times, or both—the probability of a given average amount of delay on a call arriving under given conditions is similarly independent. To obtain the proportion of calls delayed less than a given time, t, we determine the probability of connexion, within this period, of the calls arriving during the average interval between cessations under all possible conditions. It will usually be sufficient to consider only values of t which are a whole multiple of h/x, and the following is for convenience confined to such values, though solutions applicable for any value of t have been developed. When waiting calls are queued, under average conditions, no call arriving to find another waiting has any chance of connexion in time t, if $t = h/x$; no call arriving to find two calls waiting has a chance of connexion in less than t, if $t = 2h/x$; and so on. The proportion of calls delayed less than t is therefore given by:

$$p_{>t} = p_{x0} + p_{x1} + p_{x2} + \ldots + p_{xu} = 1 \qquad ..(IX)$$

where u (a positive integer) $= \frac{xt}{h}$

When calls are served in random order, every waiting call has an equal chance of connexion at each cessation; if R calls are waiting the chance of connexion of any one of them is $1/r$, and the chance of its not being connected is $1-1/r$. If m is the probability that any call arriving in an interval h/x will not be connected at the end of that interval, and n is the probability that any call waiting at the beginning of an interval h/x will not be connected at the end of that interval, then the proportion of calls delayed longer than t (where $u = xt/h$ and is a positive integer) is given by

$$p_{>t} = p_{>0} m(n)^{u-1}$$

From consideration of Figure 3 and the derivative equations (IV) expressions for m and n can be obtained. The proportion of calls delayed longer than t is then given by

$$p_{>t} = p_{>0} Rz\,[1-2(1-R)z]^{u-1} \qquad ..(X)$$

where $z = (\frac{1}{2} p_{x0} + \frac{2}{3} p_{x1} + \frac{3}{4} p_{x2} + \ldots.)/p_{>0}$

and $u = xt/h$

By definition $p_{<t} + p_{>t} = p_{>0}$

Limited waiting period.—In the above discussion it was assumed that the period that a call may wait for a free channel has no limit. In practice, however, a limit is usually imposed by abandonment, suspension or alternative routing, according to the circumstances. If calls waiting longer than a given period T are lost, the traffic carried and therefore the proportion of time all channels are simultaneously engaged is reduced for a given amount of traffic offered. The average delay is also reduced, and now differs according to whether calls are served in order of origination or at random. It is also necessary to distinguish between the proportions of calls delayed and lost, and between the delay on calls effective and ineffective. Interesting and instructive solutions can be obtained to all these problems by applying the principles described above; limitations of space do not admit of their inclusion here, but the following are typical:

When $T = \frac{h}{x}$

$$p_{>0} = Re^{R} p_{x-1} \frac{\frac{A^x e^R}{x!}}{1 + A + \frac{A^2}{2!} + \ldots + \frac{A^x e^R}{x!}} \qquad ..(XI)$$

$$\text{Proportion of calls lost} = p_{>0} \frac{Re^R - (e^R - 1)}{Re^R} \qquad ..(XII)$$

$$\text{Average delay on effective calls} \begin{cases} \text{random service:} & \frac{h}{2x} \qquad ..(XIII) \\ \text{queued service:} & \frac{Re^R - (e^R-1)}{R(e^R-1)} \frac{h}{x} \qquad ..(XIV) \end{cases}$$

Comparison with other results.—Formula (I), for the proportion of calls delayed, is Erlang's well-known "delay" formula, usually called Molina's when applied to constant holding times because he first suggested that it was equally applicable whether holding times were constant or varied "exponentially". The corresponding formula of Pollaczek, which has attracted much attention of recent years, gives lower values than Erlang's, and it has recently been suggested, as a result of tests on working lines in the U.S.A., that Pollaczek's more closely fits practical experience. The effect due to limitation of the period of search, described above, coupled with the smoothing effect which accompanies manual operating would, however, appear to be a sufficient explanation of such a discrepancy between practice and Erlang's theory.

The formula for average delay developed above gives just half the value given by Erlang's "exponential" formula, but corresponds with that given by Thornton C. Fry and Erlang for the case of a single channel with constant holding times; the results obtained with the new formula differ only slightly from those given by the much more complicated formulae of Crommelin and Pollaczek for constant holding times. The fundamental difference between the solutions obtained in this article for average delay (M) and proportion of calls delayed more than a given time, and those of Erlang and derived solutions, arises from employment of the relationship $p_{xr} = R^r p_{x0}$ in the latter work, in place of those given under (VI); the relationship referred to could only be true if it were a valid assumption that the average interval between the arrival of a call and the next cessation were equal to the average interval between cessations, instead of the actuality of half that value.

This point is illustrated in Figure 4, in which the basic equations for $p_{x>0}$, $p_{x>1}$, etc., are shown in a form corresponding to equation (4) of Figure 1. In these equations $p_{x>r}$ represents the probability of r or more calls waiting simultaneously. The average wait in (terms of h/x) from arrival until the next cessation, of a call arriving when r calls are already waiting is represented by g_r. The true value of g_r can be determined from consideration of Figure 3; thus

$$g_0 = \frac{a_0(\frac{1}{2} b_1 + \frac{2}{3} b_2 + \frac{3}{4} b_3 - \ldots.)}{a_0(b_1 + b_2 + b_3 + \ldots.)} = \frac{Re^R - (e^R-1)}{R(e^R-1)}$$

If however g_0, g_1, etc., be assumed to equal unity, solution of the equations in Figure 4 leads to Erlang's formulae for M and $p_{>t}$ with variable holding times (exponential distribution of cessations) and Molina's formula for $p_{>t}$ with constant holding times (binomial distribution of cessations). That such an assumption would be consistent with the so-called exponential theory of holding times suggests that the exponential theory cannot be applied without error to waiting times.

Furthermore, in determining the proportion delayed more than a given time it does not seem to be correct to suppose, as one must to obtain Erlang's and Molina's solutions, that cessations are distributed at random relative to arrivals during specified conditions. For example, a call arriving when no calls are waiting must do so, on the average, in the earlier portion of an interval between cessations, because its arrival has precluded the repetition of the event during such an interval.

It is, however, a major conclusion of the present study that no case exists for distinguishing mathematically between constant and variable holding times in delayed call problems.

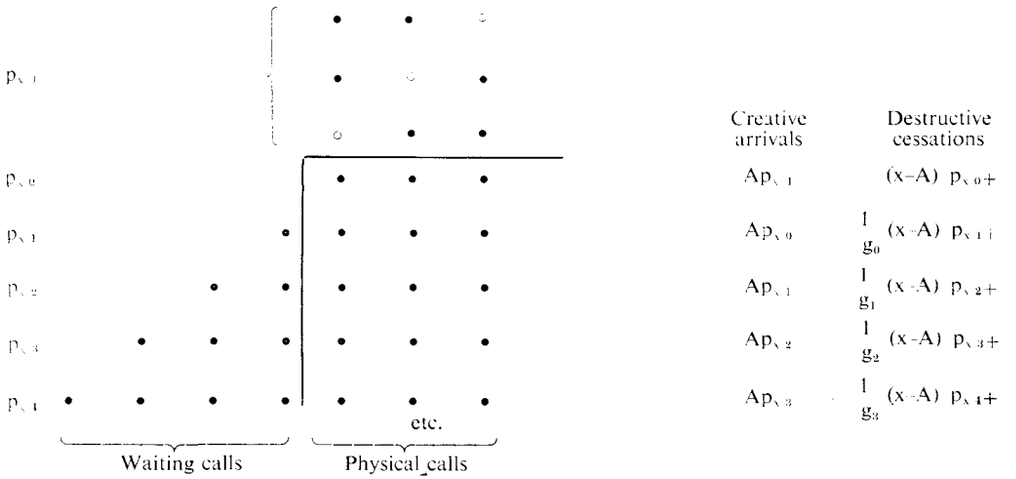


Fig. 4. Basic equations for waiting conditions.

Examples of application.—(1) To compare the proportion of calls delayed and lost, and the average delay per effective delayed call on a group of 6 trunk lines offered 3 traffic units, the average holding time per call being 3 minutes: (*a*) with no sustained search; (*b*) with a sustained search of unlimited duration; and (*c*) with a sustained search of up to 30 seconds.

(*a*) The proportion of calls lost, from Erlang's "loss" formula = .052 (1 in 19). The proportion of calls delayed is nil.

(*b*) The proportion of calls delayed, from Erlang's delay formula (I) = .099 (1 in 10). The proportion of calls lost is nil.

The average delay on delayed calls (from VII) 30 seconds.

(*c*) The proportion of calls delayed (from XI, as $T = \frac{in}{x}$) = .083 (1 in 12).

The proportion of calls lost (from XII) = .018 (1 in 57).

Under normal operating conditions calls are connected in random order, and the average delay on effective delayed calls (from XIII) = 15 seconds.

If it were possible to queue calls offered to trunk lines, and connect them in order (e.g. automatically) the average delay on effective delayed calls would (from XIV) be 16.2 seconds.

This shows that queuing of calls offered to trunk lines would be more expensive of operating time than the usual random order of connexion; it also points to the measure of economy in lines secured by the sustained search.

(2) To determine the average time to answer and the proportion of calls answered in less than 10 and 20 seconds, at a switchboard staffed by three operators, who are 75 per cent. directly occupied, the average operating time being 10 seconds per transaction: (*a*) when the operators answer all calls in the order of arrival; and (*b*) if they answer calls in random order.

Substituting A = 2.25 T.U. and x = 3 in (I), the proportion of calls delayed = .568.

Average time to answer (from VIII) = 3.8 seconds.

Substituting R = .75 in (V), values for p_{x0}, p_{x1}, etc. are obtained which, when applied in (IX) and (X) give:—

Proportion of calls answered in less than

	3.3 *sec.*	10 *sec.*	20 *sec.*
(*a*) Queued service	64%	88%	98%
(*b*) Random service	72%	88%	96%

A small allowance is necessary in the above for the time taken by the operator to observe and answer a waiting call. This example demonstrates a close correspondence between the theory and practical experience.

From left to right: N. R. NUZUM, Senior Sales Superintendent; G. L. WRIGHT, Traffic Superintendent; F. R. PERRIS, M.I.E.E., Telephone Manager; Miss E. E. WALKER, Secretary; N. C. C. DE JONG, A.M.I.C.E., A.M.I.E.E., Area Engineer; R. ARGILE, Chief Clerk.

SWANSEA TELEPHONE AREA

The Swansea Area covering 2,300 square miles, presents sharp contrasts from its giant steel works at Margam, its port of Swansea, through peaceful farmlands to the rugged western coast where stands the ancient cathedral of St. David. There are 128 exchanges, with 21,235 lines and 34,189 stations. Although from this point of view the Area is the smallest in the country, it has, nevertheless, 191,000 miles of underground wire and approximately 40,000 miles of overhead to maintain, for which 644 engineering workmen are employed, together with a fleet of 226 motor vehicles. As the Area is predominantly rural, the provision of service for farmers and kiosks is an important problem.

BIRMINGHAM TELEPHONE AREA

The Area covers over 1,500 square miles with a population of approximately 2½ million and includes the important industrial "Black Country". There are 124,000 exchange lines, over 200,000 telephone stations, 171 exchanges, 987,000 miles of wire underground and 61,000 miles overhead. The total staff, excluding exchange operating staff, is 2,746.

From left to right: W. BELL, Chief Clerk; G. JACKSON, A.M.I.E.E., Area Engineer—Works; J. A. JAMES, Sales Superintendent; J. LOWE, A.M.I.E.E., Area Engineer—Development; S. H. CROFT, Assistant Telephone Manager; H. T. W. MILLAR, B.Sc., M.I.E.E., Telephone Manager; E. H. WILLIAMS, A.M.I.E.E., Assistant Telephone Manager; R. J. STAFFORD, Chief Traffic Superintendent; E. C. C. PIGGOTT, A.M.I.E.E., Area Engineer—Installation; J. GRIFFITHS, G.M., A.M.I.E.E., Area Engineer—Maintenance.

ERRAND BOYS ARE PLENTIFUL by G. H. Taylor, C.B.E.

Late Deputy Regional Director, London Telecommunications Region

IN 1878 ALEXANDER GRAHAM BELL WROTE TO the capitalists of the Electric Telephone Company:-

"At the present time we have a perfect network of gas pipes and waterpipes throughout our large cities.

In a similar manner, it is conceivable that cables of telephone wires could be laid underground, communicating by branch wires with private dwellings, shops, etc., etc., uniting them through the main cable with a central office. I believe that in the future wires will unite the central offices in different cities and a man in one part of the country may communicate by word of mouth with another in a different place."

In the following year, Mr. William Preece (later Sir William Preece) of the Post Office Engineering staff, when asked whether the telephone would be an instrument of the future which would be largely taken up by the public, replied "I think not". Questioned further he said "I fancy the descriptions we get of its use in America are a little exaggerated; but there are conditions in America which necessitate the use of instruments of this kind more than here. Here we have a superabundance of messengers, errand boys, and things of that kind."

We should say now that Graham Bell had foresight and that Mr. Preece lacked it. Likewise some would say that lack of foresight is the reason why many of our telephone exchange buildings are too small to suffice for the period planned, as mentioned by Mr. Bradburn in his letter in the first number of this Journal. It is easy to be wise after the event but I wonder whether lack of foresight is the primary reason for the premature exhaustion of our buildings.

The first Telephone Company in Great Britain was floated in 1878. At the end of 30 years there were rather more than half a million telephones in use in this country. Another 40 years have now passed and the number of telephones in use has increased nearly ten fold. But what a difficult 40 years they have been!

A telephone exchange building is conceived some seven to ten years before it is required, and if it has to suffice to carry the development for 20 years, its size has to be determined nearly 30 years before the planned date of exhaustion. A period of 30 years is a long time to look ahead and with relatively stable conditions the most intelligently thought out forecast may well prove to be wide of the mark. But during the last 40 years there has been no 30-year period of relative stability; I doubt whether there has been a period of even ten years which can be so regarded.

Let us review the last 40 years and refresh our memories of the many things which have had a material bearing on telephone development.

On January 1, 1912, the control of the telephone service passed into the hands of the Post Office. This involved a complete change in the direction of the service. But in anticipation of the change, provision for development had been restricted despite a number of schemes agreed upon between the Post Office and the National Telephone Company. Thus in 1912 buildings and plant were tight in many places.

From 1914 to 1918 we were involved in a World War; telephonically this was a catastrophic event at a time when there was so much to be done to provide for future development.

Some ten years later we entered a trade depression which was world wide, and though telephonically it did no more than restrict the development in this country, it caused heavy losses of stations in those countries most highly developed telephonically, particularly in the United States. After another ten years we heard the rumblings of World War number two, and now another decade has passed, and we are still in a state of unrest.

These factors of themselves were more than enough to upset the most intelligent of forecasts. But in addition from 1922 onwards we were faced with rate changes at relatively short intervals, all of them, until the outbreak of the second war, favourable to the subscriber; and there has also been the change in the value of money. The importance of this last factor can well be seen from the following comparison of rates:

In 1912 a residential subscriber in the London Telephone Area outside the County of London

paid £5 10s. 0d. a year rental, including 360 penny calls. A call to another subscriber on the same exchange cost one penny; calls to other exchanges in the London Area cost twopence.

At the present time the same subscriber, if outside the ten mile radius, pays £5 7s. 4d. for his rental and 360 unit calls, and the unit fee covers very much more than calls on his own exchange.

(But the contemplative pipe can no longer be filled with tobacco at sixpence an ounce and smoked while one reads the halfpenny evening paper).

Is it to be wondered at that with so many changes, buildings which were planned in the years between the two wars have often proved inadequate to meet the requirements of the present day, and can we believe that our own estimates of the future development will prove to be any truer than those of the past? They may, of course, be over optimistic; but that can be as grievous a fault as underestimating.

We could not have been expected to allow for war several years ahead when we were making our long term forecasts and the effect of two wars on telephone development is something that we now have to accept. But the effect of the depression in 1930 and thereabouts is perhaps another matter. Telephone development cannot be expected to follow a smooth curve; in times of prosperity it is likely to be at a more rapid rate than the average; when depression looms ahead the rate of development is depressed also. But in our development forecasts we have no alternative but to assume the smooth curve and our buildings are provided and the plant is installed on that basis. The result is that when depression comes there is greater delay before new plant becomes revenue earning. Interest and depreciation, and to some extent maintenance charges, have, however, to be met whether or not the plant is earning revenue and if the normal margin of revenue over expenditure is small it is likely to become a deficit in bad times. A deficit always invites criticism, whether in Parliament or at a shareholders' meeting. A business concern insures to some extent against such an eventuality by building up reserve funds during the better days; (in many cases the reserves have been adequate to maintain normal dividends during bad times).

In the Telephone Service there was no form of reserve fund to fall back upon when the depression came, as the profits of the earlier years had gone to the relief of taxation. It was important however to avoid a deficit if at all possible and, therefore, other financial devices, including the restriction of capital expenditure, had to be adopted. The rate of increase in the number of subscribers fell appreciably, which offered scope for short term economies, but the financial structure of the Post Office was such that more was necessary and one of the results was a restriction in the long term provision for telephone development, and this meant smaller buildings. Thus, not only was a deficit in the Telephone Account avoided but the margin of profit began to rise within a few years and it became possible to make substantial rate reductions in 1934 and subsequently. Then came a period of rapid growth. During the five years from 1934 to 1939 the net increase in stations approximated to the net increase in the previous ten years. And our buildings began to be congested.

Now we are faced with another problem arising out of the second war, the effect of the changes in the housing of the people. Changes in the telephone rates and the trade depression affected all telephone areas in the same manner, though to different degrees, but the effect of the present housing situation is very different. Exchanges which serve areas in which the proportion of higher grade residences is high, are developing much more slowly than the exchanges which serve primarily smaller residences. In the latter type the development is often well ahead of forecast, and there is a tendency to regard the high rate of penetration into the lower grades of residences as an indication of the rapid development of the telephone habit among the more lowly paid sections of the populace. Some of this penetration is due, no doubt, to this factor but we always provided for a measure of such development which the war may have accelerated. It is important, however, to obtain the right perspective on this question and we must not forget that there has been virtually no building of new residences in the higher categories. The inevitable result is that many are now living in small residences who would have moved into larger houses if the opportunity had offered. In 1938 it was possible, within reasonable limits, to relate the income of the occupants with the rateable value of the premises, and though we classified the residences in our studies, we were in effect grading the occupants into income levels. Now we are unable to do so and care must be taken not to be

continued on page 47

1928 1948

20 YEARS OF TELECOMMUNICATIONS

20

Some figures to think over

			MARCH 31 1928	MARCH 31 1938	MARCH 31 1948
CAPITAL INVESTMENT IN PLANT, BUILDINGS, etc.	TELEPHONES	£	105,000,000	195,000,000	333,000,000
	TELEGRAPHS	£	10,600,000	2,900,000	4,200,000
REVENUE	TELEPHONE (INLAND)	£	18,624,000	31,986,000	78,526,000
	(OVERSEAS)	£	251,000	663,000	1,130,000
	TELEGRAPH (INLAND)	£	3,540,000	3,269,000	5,346,000
	(OVERSEAS)	£	1,471,000†	710,000	1,508,000
TELEPHONE EXCHANGES	MANUAL		4,206	3,104	2,197
	AUTOMATIC ..		111	2,559	3,840
CALL OFFICES	—		23,998	48,168	52,098
TELEPHONE STATIONS	—		1,643,648	3,050,012	4,652,704
TELEPHONE CALLS	INLAND		1,070,500,000	2,059,300,000	2,681,000,000
	TRUNKS		102,206,596	105,838,286	216,614,671
	OVERSEAS		702,000	1,887,000	1,702,600
TELEGRAMS	INLAND, OVERSEAS AND TO SHIPS		60,722,000	58,382,000	58,283,000
SPEECH CHANNELS	OVERHEAD ..		Not available	719,305	966,340
	UNDERGROUND ..		Not available	6,433,205	11,820,494
	SUBMARINE ..		23,100 (physical)	23,200 (physical)	43,700 (physical)
TELEPHONE DENSITY IN GT. BRITAIN & N. IRELAND	PER 100 PERSONS		3.6	6.4	9.3
	PER SQUARE MILE		17	32	48

† Includes revenue for beam services and cable to Canada, transferred subsequently to Cable and Wireless Ltd. in 1929

HUMAN REACTIONS TO TECHNICAL IMPROVEMENTS

by Elizabeth M. Anderson, M.D.(Durh.)
Personnel Department, Training and Welfare Branch

THE DEVELOPMENT AND EXPANSION OF THE telecommunication service has been accompanied by interesting problems from the medical and social point of view. The staff which has been called upon to acquire new techniques or to use new apparatus has displayed varying degrees of adaptability to change. The only certain factor in the changing scene appears to be that the human responses will be unexpected.

Modifications in working conditions and techniques are, of course, frequently made. The majority are small and do not demand from the staff much adjustment. Many improvements have been introduced by stages and the planning staff devotes great care and thought to technical improvements and perseveres with them in spite of some disappointments and much criticism.

During the years when I was a medical officer in the former Post Office medical service there were, however, a few major alterations which attracted attention because they demanded much adjustment on the part of the operational staff.

One of the most radical changes in my experience occurred on the telegraph side when morse operating was superseded by teleprinter and phonogram working. The response to these new conditions was unfavourable and for a time the medical department was overworked as a consequence. Telegraphists came to it in droves, complaining bitterly of the new demands made upon them, particularly of the difficulty of learning to typewrite. For the members of the older generations I felt a great deal of sympathy as they had, through long years of practice, acquired much skill at the difficult work of morse operating, and felt the pride of skilled operators in their jobs. They were then required to learn a completely new job, and were for the time being placed in the position of novices. In some cases, adaptation followed swiftly, but in others difficulty persisted and caused loss of mental equilibrium, pride of craft, and sighing for the passing of the good old days of morse and baudôt. The resulting disappearance of telegraphist's cramp was not, of course, appreciated at the time.

Another technical improvement in services which came forcibly to my notice as a medical officer was due to the introduction of the public facility for calling police, fire or ambulance by dialling "999." During the experimental early stages, an audible signal could be heard by all operators in one telephone switchroom. The intention of the signal was to attract attention by an urgent note, evoking instant response from the telephonists required to answer the calls. The signal did its work so effectively that all telephonists leapt literally leapt from their seats whenever the clarion call sounded. The public, having been offered a new facility, used and misused it lavishly, adding to the confusion.

Behind the scenes in the medical waiting room it speedily became apparent that yet another improvement had resulted in unforeseen human responses. For the next few days, telephonists trooped into this room, wailing "It's that 999 again." Whilst unprecedented amounts of bromide were being administered by the medical officer, upstairs in the switchroom first-aid measures were adopted also. Ably assisted by a helpful cleaner, who willingly loaned her dusters in the emergency, a courageous supervisor dealt with the signal on scientific lines. She suppressed the noise at the source by blocking the mouthpiece with dusters. The clarion call diminished to a plaintive bleat and normal work in the switchroom was gradually resumed.

The next human response was less unexpected and came from the operational branch concerned when the news reached it of the unauthorised modifications in the signalling device effected by the sufferers.

At another stage in telecommunication development, the old international switchroom was the target for fierce criticism by its occupants. Bitter complaints of insupportable noise were made and listened to sympathetically by supervisors, operational planners and medical officers alike. Eventually the first soundproofing of a telephone switchroom ceiling was undertaken at great expense, and

it was hoped by this method to obtain a contented staff. Within a few days of the acoustic treatment being applied, the number of telephonists from this room attending the medical department had become greater than ever. They now complained even more bitterly of insupportable quiet, of the deathly hush in the switchroom, and of inability to work in such an abnormal environment.

The problem of medical certification was a thorny one. Should I certify them as suffering from "ingratitude", "noise deprivation" or coin some hybrid term such as "hypovibrationism"? I was deterred from this rashness by the fear that the sufferers might, on seeing the name of their unusual complaint, cease to be curable. Also the sick absence duty would almost certainly query whether sick absence benefit should be paid for an ailment not listed in the schedule of recognised disorders, or, more tersely, might return all certificates in despair with the comment "regret certificate indecipherable, please use block capitals." The patients were therefore given a label well-known in the Post Office, "nervous debility" itself, by the way, not mentioned in the Royal College of Physicians' nomenclature of diseases. Medical textbooks offer no help in crises such as these; although there are a few hints on the treatment of excessive noise I could find nothing about the treatment of excessive quiet. I contented myself with making soothing promises to the effect that the patients would soon get used to the change.

The planners were much disappointed when their enlightened efforts to improve the telephonist's lot were received so critically, but they also introduced some soothing noises into the quietness and the switchroom gradually became less peaceful physically and more peaceful mentally.

I was puzzled by this episode and could find no explanation to satisfy me about it till, much later, I discussed it with a psychologist. He had for some years been dealing with the responses of aircraft pilots to visual and auditory signals. His theoretical explanation was that prior to the introduction of soundproof ceilings, the telephonists who received training would subconsciously associate certain operational processes with certain noises. As they became proficient, the various operations to a large extent resolved themselves into a mechanical routine carried out smoothly with a certain harmony and subconscious check at each stage. When the well-trained telephonist continued operating in a room from which all the familiar noises were removed, the harmonious rhythm was interrupted. She became confused, wondered what she had omitted to do, and had to concentrate on each process. This interruption of her normal routine had the effect of reducing her again to the slower pace of the novice, or of requiring increased mental exertion to maintain her old speed and efficiency. Since fatigue is followed by depression, complaints of inability to work would follow inevitably.

This theory seems to me to have the merit of probability and is supported by the fact that at a later stage, groups of telephonists trained in rooms where acoustic treatment of ceilings had become standard practice, experienced no discomfort but appreciated the quiet surroundings.

In the nerve-shattering din of a large factory where many machines are running at speed, the skilled worker can at once detect any unusual sound, or the cessation of a usual one, so that his attention is immediately and unerringly given to the faulty machine.

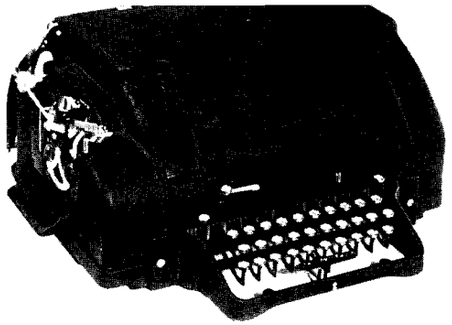
The examples I have quoted are largely a matter of conditioned reflexes. In a machine-minded age, nature's slow methods of evolution have to be remembered, with the necessity for adapting the machine to the worker or, alternatively, paying the price nature demands for insistence on the worker being adapted to the machine.

The coming installation of cordless switchboards has the great merit that the mechanism can be planned with the operator's needs in mind to an extent never possible before during the rapid evolution of telephony, and the planners are taking full advantage of this fact.

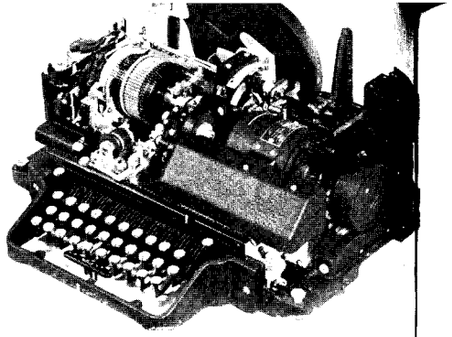
ERRAND BOYS ARE PLENTIFUL

(continued from page 44)

led into false assumptions about the development of the telephone habit. Though we have crashed through the development forecasts in some exchanges we are far behind in others and in the aggregate, after allowing for the ineffective applications for exchange lines which are on the waiting list, we are somewhat short of the pre-war forecast. But where we have crashed through the forecast we have advanced the date of exhaustion of the exchange building, and present day housing conditions are thus part of the answer to Mr. Bradburn's question.



THE NEW TELEPRINTER



by D. T. Gibbs, O.B.E., Inland Telecommunications Department.

THE FIRST TELEPRINTERS NO. 11A, KNOWN BY Messrs. Creeds as their No. 47 Tape Model, were brought into operation on the Inland Service in January. These machines are being operated for the present on certain point-to-point circuits only, but No. 11B machines will be used universally on the new automatic switching scheme referred to in the first issue of the Journal. The No. 11B machine will differ from the No. 11A by the inclusion of such features as the paper failure alarm, tape-wheel brake and WRU contacts.

The Teleprinter No. 11 is a start-stop machine, using the International Telegraph Alphabet No. 2, and the speed of operation is normally set for 50 bauds. Since the Teleprinter No. 7, which is the machine supplied to private renters, has the same transmission characteristics also, these two types of machines are suitable for interworking; this will not be possible with the Teleprinter No. 3 the tape machine at present employed by the Post Office on the inland manual switching network.

Appearance

The photographs above shew the new machine with, and without, the dust cover. The cover, which is fixed to the main base by shock-absorbing mountings, can easily be removed. A small message tray, which has two sections and includes a docket holder, is held in position on top of the cover, by a locating hole and a screw head projection on the cover itself. Experiments with covers finished in grey-green have been carried out but their initial attractive appearance was soon lost owing to their liability to show marks. A black "ripple" finish has therefore been adopted.

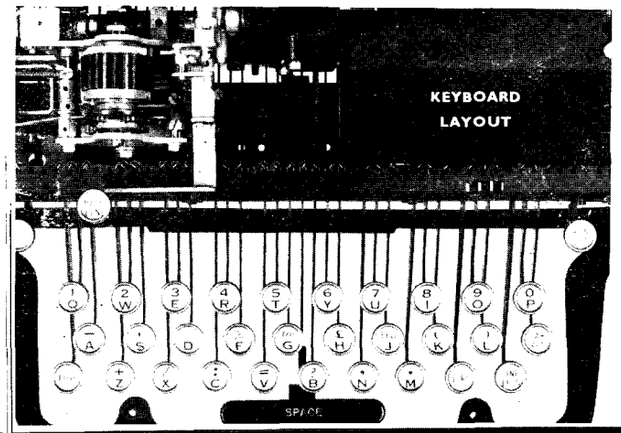
Internal Layout

The Teleprinter No. 11 retains the basic principles of the Teleprinter No. 7 but several important new features and improvements have been introduced. The keyboard, transmitter, motor and governor, electro-magnet, type-head and answer-back unit are all so arranged that they can be replaced without difficulty. Considerable use has been made of oil-impregnated porous bronze bearings these are saturated with oil during manufacture and should need very little attention.

Keyboard Assembly

The locking-bar action on the Nos. 3 and 7 Teleprinters is not altogether satisfactory, as there is a tendency towards sluggish keyboard operation, with consequent dropping of letters, mutilations, etc. These difficulties have been overcome on the new teleprinter by the use of combination bars cut so as to give saw-tooth projections. The operation of a key causes the under edge of its keybar to be pressed downwards against the slopes of the saw-teeth. The directions of these slopes determine whether each individual combination bar is moved to the right (Marking) or to the left (Spacing). This technique gives a much "freer" keyboard, with a more uniform touch.

The layout of the keys is similar to that of the Teleprinter No. 7, except that the WRU, "Here is" and "Run out" facilities are given on three additional keys. The "Here is" key trips its own answer-back unit, thus allowing the calling office to announce its identity to the called station; the WRU key causes the identity of the called station to be received on the sending machine.



Advantage is taken of the fact that the combination bars remain in the position they have taken up until the next key is depressed, to provide a "Run out" key which, on depression, will transmit continuously the character of the last key operated. A new type of key top consisting of a label sealed between two discs of celluloid is proposed This change would obviate the difficulties arising from the discoloration of the old type key labels and breakage of protecting glass discs.

Printing and Tape Feed Unit

This unit is an interesting new feature. The printing point is close to the tear-off position and the whole of an answer-back signal is visible without feeding the tape by hand. Ink ribbon, with automatically reversing ribbon feed, is used and can be renewed without moving the dust cover. A paper failure alarm mechanism is fitted and the alarm which, by the closing of contacts can be made to give both visual and audible warnings, operates instantly if the paper breaks, is exhausted, or fails to feed forward.

The whole unit is hinged at the bottom and can be swung clear without moving the dust cover. Easy access is thus given to the ribbon, alarm mechanism, and to the printing type.

The tape roll holder is at the rear of the machine and replacement of a tape roll is a simple operation which also can be made without removing the dust cover. The tape is brought through a brake on the holder (which prevents an over-run of the roll) via tape wipers, the jaws of the paper failure alarm, to the platen and tape feed roller.

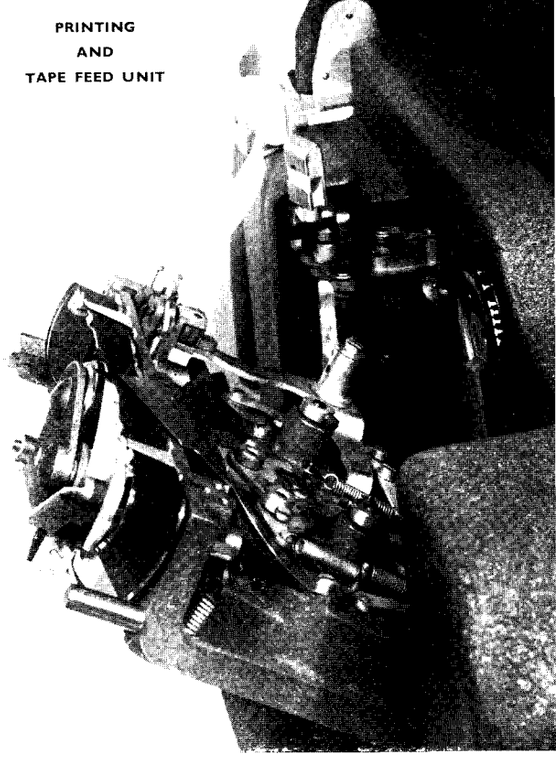
Similarity between the actual typed characters which might arise if they are badly printed has been safeguarded by slight alterations in shape, or by the use of serifs. In size the type is a compromise between those used on the Nos. 3 & 7 Teleprinters.

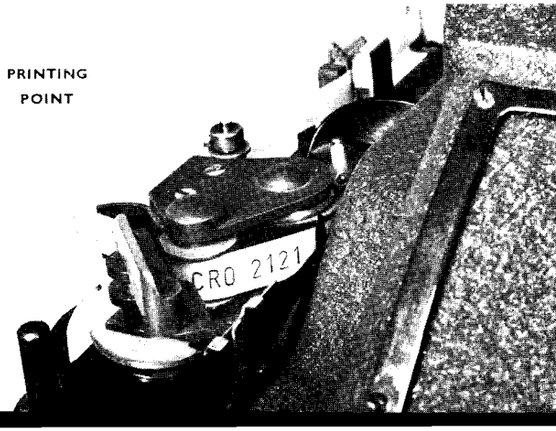
Other New Features

An orientation device facilitates check of the adjustment of the receiving mechanism after overhaul. Orientation is effected by means of a lever, movable across a graduated scale.

The typehead clutch is of a simple shock-absorbing type of a new design which should give improved efficiency with negligible maintenance. Much attention has been paid to the question of noise. The design of the main base, the mountings of the motor and the dust cover, and the arrangement of the gearing should result in a considerable reduction. Further, under automatic switching, circuit conditions are such that the teleprinter motors will run only during the transmission and reception of messages. This will be a welcome change in Instrument Rooms where normally No. 3 Teleprinter motors are running continuously. Instead of having cord and plugs permanently attached to the machines as at present, the cords are part of the position equipment and will be plugged into connectors on the machines.

Two minor but novel features are the rigid support at the rear which enables the machine to be upturned to give easy access to the underbase components, and the hand grip on each side which replaces the present rather cumbersome handles.





BOOK REVIEWS

B.B.C. HANDBOOK 1949 (BRITISH BROADCASTING CORPORATION, 3 6)

AS PRICES ARE IN THESE DAYS, THIS Handbook is full value for money. It opens with a chapter written by Sir Ernest Gowers on Radio English. "Everyone listens to the News and its material comes mostly from sources specially susceptible to temptation from the Press that finds the lure of the picturesque neologism so hard to resist and from Officialdom that likes to wrap up awkward truths in the cotton-wool of verbiage so as to lessen the pain and the reaction to pain that is produced by the sharp edge of precision." He praises the B.B.C. for changing "adverse meteorological conditions" into "bad weather" and "service personnel" into "troops."

The story, typographically well set out and well illustrated, is simply told. There are, for instance, some picturesque features on the troubles of "the poor producer" and the descriptions of the build-up of the popular programmes make lively narratives.

As regards television, the year was one of experiment and consolidation. Outstanding technically was the introduction of the highly sensitive C.A.S. Emitron camera, first used for the Royal Wedding scenes outside Westminster Abbey. Improved mobile television equipment was used for televising the Olympic Games from Wembley.

In the international field, reference is made to the proposals for the European medium and long wave broadcasting bands. The successful outcome at the Copenhagen Conference on these proposals evidently came too late for publication in the Handbook.

Electrical interference to both sound and television reception still remains a problem. Reference is made to the services, in this connection, of the Post Office Engineering Department. We are also told that the B.B.C. engages in daily listener research. It maintains, in addition, a voluntary listening panel comprising several thousand members. The Listening Panel gives a qualitative appraisement on the programmes thus supplementing the quantitative results of the daily survey.

SCIENCE NEWS, No. 8 (PENGUIN BOOKS, 1 6)

This number of *Science News* features an article on "Demography—Science and Administration" by R. R. Kuczynski. He pleads for the immediate taking of a fertility (or family) census as an indispensable prelude to a serious study of the population problem, and an overhaul of the machinery for the collection, assembly and publication of statistics. There is no field in which Science needs the co-operation of Administration so much as in the demographic.

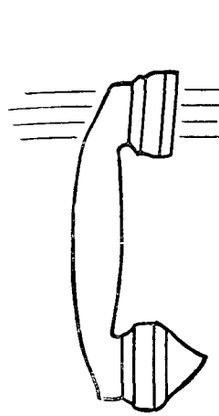
BOOKS RECEIVED

BRITISH TIME. D. de Carle (Crosby, Lockwood, 15/-)

The story of Time as told by clocks. A book for the non-technical reader; it contains chapters on G.M.T., Big Ben, TIM, Kew Observatory, the Time Signals and a brief explanation of the Quartz Crystal Clock. The TIM pages reproduce articles by Messrs. L. E. Magnusson, Dr. E. A. Speight and O. W. Gill, contributed to the January 1937 issue of the *Post Office Engineering Journal*.

THE ELECTROLYTIC CAPACITOR. Alexander M. Georgiev (Crosby, Lockwood, 15 -)

The author describes the design, construction, manufacture, function and testing of dry and wet electrolytic capacitors.



NOTES AND NEWS

Conference in Mexico City - Trunk Mechanisation - Tribute - Production of Private Telephone Equipment - Colour of Telephone Kiosks - Post Office Exhibition - etc., etc.

Conference in Mexico City on High Frequency Broadcasting. The High Frequency Broadcasting Conference now being held in Mexico City is dealing with short-wave broadcasting frequency allocations in the various bands between 3.9-4 and 5.95-26.1 megacycles per second. The Conference is the first to attempt the production of an agreed world plan for the allocation of such frequencies. The United Kingdom delegation is led jointly by Mr. H. Faulkner, Deputy Engineer-in-Chief, and by Mr. T. C. Rapp, H.M. Ambassador to Mexico. The other Post Office representatives are also members of the Engineering Department. The Conference opened on October 22, 1948, and is expected to finish sometime this month.

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Post Office Cables on Railways. The British Railways Executive has been asked to agree to the placing on railways of Post Office cables supported on short concrete posts. A recent investigation showed that this method of construction was practicable on sections of the steam railways between Ely and Downham Market and between Skipton and Grassington for distances of 19 and 9 miles respectively.

It is proposed that the Post Office should instal and maintain the cables. The project would be experimental in character and the experience gained should enable a decision to be taken whether or not the practice could be extended.

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English Speaking. Seven out of ten of the world's telephones are in English-speaking countries.

Trunk Mechanisation. The Mechanised Trunk System Working Party has been considering the initial and ultimate objectives of a mechanised trunk system. Based on a traffic analysis, it has been decided that, initially, a mechanised trunk system for the inland service need only cater for two trunk links in tandem but would have to be capable technically of extension to three or more trunk lines in tandem. The question whether the extension of operator dialling beyond two trunk links in tandem is economically justified will need very careful consideration. It has, of course, been a fundamental policy of the Working Party throughout its investigations that any system of operator trunk dialling must be capable ultimately of providing for subscriber subscriber trunk dialling.

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Kiosks. About 2,500 new kiosks were brought into use during 1948.

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TIM is Growing. The Speaking Clock known to London Telephone users as "TIM" (from the dialling letters for the service), is now over 12 years old. Since the service was introduced in London in July, 1936, Londoners have made 265,000,000 calls to the clock. Analysis shows that the clock is mostly used between 8 a.m. and 9 a.m., when, no doubt, people are anxious to know the exact time in order to catch their trains. The popularity of the Speaking Clock, which was designed and constructed in the Post Office Engineering Research Station at Dollis Hill, increases week by week. In London on an average 700,000 calls a week are made. The speaking clock

service has been extended to Manchester, Birmingham, Edinburgh, Glasgow, Belfast, Bristol, Leeds, Newcastle, Sheffield, Nottingham, Leicester, Plymouth, Swansea and Bradford. Since the service began "TIM" has been asked nearly 400,000,000 times for the correct time.

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Television. At the end of December, 1948, 92,800 television licences were in force.

Televising Elmer Rice's "The Adding Machine", with Stanley Maxted. *(By courtesy of the B.B.C.)*

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New Overseas Exchange. It is 22 years since the inauguration of the first transatlantic radiotelephony circuit between London and New York. The new Overseas Exchange at Wood Street, London, E.C.1, opened in November, 1947, handles exclusively the large and rapidly growing traffic from Britain and the Continent to all parts of the world, by means of radio circuits. This exchange is an offshoot of the International Exchange at Faraday Building. By this segregation the Overseas and Continental services have been provided with sufficient accommodation to accept the surge of post-war expansion. A further development is the contemplated introduction of demand working in the Continental service.

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Tribute. The following warm tribute to the Continental service has been received at Post Office Headquarters: "I would be grateful if you would express my thanks and appreciation to your Continental services and more especially your Italian services with whom I have been dealing this week. They have greatly impressed me by their courtesy, efficiency and the infinite trouble that they are prepared to take to help people like myself. Incidentally, I don't know their names, and I have only come into contact with them through the fact of telephoning fairly frequently to Europe. The attention I received this week saved me time, money and trouble."

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Telegraph Facilities for the Ministry of National Insurance. Late in 1947 the Ministry of National Insurance notified the Post Office that when the National Insurance Scheme came into operation, July 5, 1948, it was estimated that each day 2,000 telegrams over the public telegraph system would be sent from or received at the Ministry's Headquarters at Benton, some three miles from the centre of Newcastle-on-Tyne. The telegrams would be to and from the 1,000 local offices of the Ministry throughout the country.

The Post Office decided therefore to set up a telegraph office at the Ministry's Headquarters to be staffed by Post Office telegraphists. Normal circulation of the telegrams would have involved teleprinter working between the Ministry's office and Newcastle Head Post Office, but in order to avoid retransmission at Newcastle of such a large number of telegrams the new office was connected to the teleprinter manual switching network. The choice of accommodation available in the Ministry's premises was limited. During the next three months, with close co-operation between the staff of the Telephone Manager and Head Postmaster, accommodation was provided; batteries, power equipment and 14 teleprinter positions with manual switching facilities were installed; all miscellaneous equipment, furniture and stores were supplied and circuits to the six teleprinter switchboards were provided and tested. Staff had already been recruited and put in training and on July 5 the office was available to meet all requirements. The actual traffic experienced initially was below the estimate quoted but is expected to increase as more people become entitled to National Insurance benefits.

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Improvements in Standard Unit Automatic Exchange (U.A.X.) Buildings. An improved type of floor and cable trench construction is being introduced in U.A.X. buildings types A, B and B1 to minimise the penetration of damp. The concrete floor will be put down in two layers with a damp-proof membrane between them. The cable

trench will be similarly waterproofed, the floor being constructed in two layers of concrete and the sides in two skins of 4½in. brickwork. Other general improvements in the construction, design and finish of these buildings are in preparation.

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B.B.C. Outside Broadcasts. Circuits for 3,914 outside broadcasts were provided for the B.B.C. during 1948, compared with 3,731 for 1947.

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Production of Private Telephone Equipment. The firms manufacturing public exchange equipment also make private telephone equipment giving internal telephone service without access to the public telephone network. It is necessary to ensure that the manufacturing capacity released by the Post Office's reduction in demand for public exchange equipment should be wholly diverted to export, and that an undue proportion of output should not be concentrated upon private installations. Agreement has, therefore, been reached with the five manufacturers of telecommunication equipment who are contractors to the Post Office, on a low level of production of internal telecommunication equipment for the home market something less than that obtaining in 1938. This is estimated to be slightly more than is necessary to maintain and extend existing installations, and there is accordingly only a small amount of such equipment available for essential new installations.

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Exchange Capacity Statistics. The total capacity of existing exchanges at September 30, 1948, was 3,300,006, made up as follows:

Director and non-director exchanges	1,794,997
Manual exchanges	1,104,139
Unit auto exchanges	400,870

The total increase in capacity for the first six months of the present financial year was 92,284 lines as against 99,171 lines for the same period last year. The percentage of spare to total capacity has increased from 10.2 at the end of June to 10.7 at the end of September, this being the second successive quarter in which a slight improvement has been recorded.

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Telephone Waiting List. On December 31, 1948, the number of outstanding applications for exchange lines was 481,902 as compared with 478,105 at the end of November. A further 38,246 lines were in course of provision.

The Young Idea. American children are telephoning more than they did pre-war. When school holidays are on, there is a sudden jump in calls. Some of the companies have had to run advertisements addressed specially to boys and girls to make these calls shorter. Recently the president of one of these companies received a letter from an adolescent who said his social life was hampered by lack of a telephone: "The girls cannot reach me by 'phone and they are also complaining." The president wrote him a nice letter and then added, "P.S. When I was 16 I didn't have a 'phone either."

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Post Office Capital Investment. In April last the Investment Programmes Committee invited the Post Office to prepare an estimate of its capital investment in 1949-50, and a tentative programme for the years 1950-53. Subsequently the investment proposed for 1949-50 was approved, and the Engineering Estimates for that year will be based on that authority.

The Post Office has now been invited by the Investment Programmes Committee to review the programme for 1950-51 onwards in the light of developments which have taken place since the original estimates were furnished, and to produce a firm estimate of investment for the year 1950-51.

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Stags. Even stags play their part in telecommunications and some of our engineers wish they didn't. Dundee engineers report that stags have caused a deal of "wear and tear" to telephone poles in Scotland. The animals use the poles as scratching posts, and it has recently been necessary to replace a number of poles on the Moor of Rannoch because they have been worn dangerously thin by the constant rubbing. The engineers have brought in a piece of worn pole to convince the sceptical.

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and Woodpeckers. Attacks on telephone poles by woodpeckers have long been a source of trouble to our engineers. Apparently the humming of the wires encourages the birds to attack the poles. The humming may not be audible to human beings, and why it should attract the woodpeckers is a problem for an ornithologist. But the remedy is simple and practical. The wires are silenced by damping the vibration by means of a spiral lapping of "lead-strip," bound around line wires and insulator in three spiral turns and lapped along the wire for a distance of ten inches.

It is the "Large Green" and the "Greater Spotted" woodpeckers who are most likely to cause damage to wood poles. The third of the woodpecker family, the "Lesser Spotted," is described as "small, very shy and seldom seen in this country."
The damage is recognised by holes varying from one to five inches deep which appear in apparently sound timber. After they are found, the holes are plugged with a special compound and the surface coated with tar.

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Printing Reperforators. A new type of telegraph instrument, known as a Printing Reperforator, in which telegraph signals are recorded not only in the form of perforation, but also as printed characters on the same tape, is now being delivered. The first supply of these new instruments will be for use by the Services.

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Olympiad XV, 1952. There can be little doubt that the arrangements for telecommunication services in connection with the Olympic Games, Olympiad XIV, held a most important place in the organisation of the Games. The planning would justify a more lengthy and detailed description than is possible in these notes. The XVth Olympiad will be held in Finland in 1952, and it is interesting to note that, before the Olympic Games in London began, representatives of the Finnish Postal and Telecommunication Administration arrived in London to study the arrangements made.

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Colour of Telephone Kiosks. The Postmaster General, after consulting the Ministry of Town and Country Planning, the Royal Fine Art Commission and the Councils for the Preservation of Rural England and Wales, has decided to maintain "Post Office Red" as the standard colour for kiosks. For places of exceptional beauty one alternative colour scheme dark battleship-grey with the glazing bars picked out in red may be adopted after consultation with the Ministry of Town and Country Planning.

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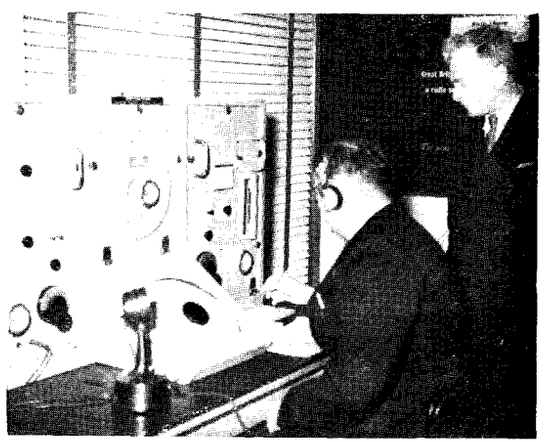
The Teleprinter Manual Switching Scheme. A teleprinter manual switching centre is being set up at Brent Building, London, to relieve the centre at the Central Telegraph Office. It is hoped to complete the installation work during the early part of this year.

The Assistant Postmaster General Visits the Post Office Exhibition.
The exhibition has been shown in London and Birmingham. It will visit several provincial cities and Scotland during this year.

The Assistant Postmaster General, Mr. C. R. Hobson, sends a souvenir telegram. This exhibit was designed to stress the need for the use of block capitals in telegrams. The operators are Misses Boxall, Hawke and Eden of the Central Telegraph Office.



Mr. W. M. Dunell, of the North Foreland Radio Station, demonstrating to the Assistant Postmaster General the handling of a distress call at a Coast Radio Station.

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Telegraph Typewriters. The provision of typewriters with a keyboard layout similar to that of Teleprinters No. 11 is being considered. Messrs. L. C. Smith have modified a No. 8A typewriter to give the required layout, and this machine is now undergoing tests in the Central Telegraph Office, London. In addition, the Imperial Typewriter Company have been approached regarding the prospect of supplying either a robust portable or commercial model with an international keyboard layout.

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Colour and Finish for Telephone Switchboards. We noted in our last issue the experiment at Wembley in connection with the moves to improve the appearance of switchrooms. A further detail is that the woodwork of the switchboard to be installed in the new exchange will be bleached mahogany, instead of the normal dark mahogany. The keyshelf will be of the standard red fibre. The Ministry of Works architects particularly wished to have the switchboard finished in a light wood in order to fit into a special scheme of decoration which is planned for Wembley. Another experiment will be made at the new Gainsborough exchange, where the wood will be light oak and the fibre will be dark green.

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Acknowledgments. We owe a debt of gratitude to our colleagues in the Supplies Department and to our local correspondents and organisers for their most helpful collaboration. Not least in this category of indebtedness are our Stationery Office friends. They have had to contend with the clamant demand for print of all kinds, in a world of paper shortage, labour difficulties and adverse conditions in the printing trade. Social legislation has raised for them printing problems of the first magnitude. The Stationery Office has striven, notwithstanding all the other preoccupations, to help us to provide a worthy publication.
Generally criticism has been favourable. From outside the Department there have been many tributes. From within the Department there has been, amidst commendation, measured and helpful criticism of the right kind. We shall do our best to act on the suggestions made. The dominating difficulty is that of paper. We assure our readers that every possible step will be taken to enlarge the Journal without undue delay.

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The Journal. Inevitably much more remains to be done with the Journal. When the ship takes to the water the building process is far from complete. The main point is that the launch has been achieved. Like all launches it has had its embarrassing moments. Not the least of these was the continually rising demand. In the upshot twice as many copies as the most optimistic forecast had indicated were printed. The Journal was sold out on publication and a reprint was necessary.
The Journal was planned to appear in 1945 but adverse fate defeated all efforts to go ahead. The paper shortage, the fuel crisis, the dollar famine and the manpower problem successively beat all the reiterated attempts to go ahead. One consequence of these difficulties is that the Journal appears as a quarterly and not as a monthly.

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Sir Archibald J. Gill

The New Year's honours list contained the name of Mr. A. J. Gill, Engineer-in-Chief, General Post Office, amongst those to receive a knighthood. His fellow members of the Editorial Board offer him their congratulations.

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Mr. G. H. Taylor

With the retirement of Mr. G. H. Taylor on December 31, 1948, the Editorial Board of the Journal lost a valued member. We feel our readers will be with us in thanking Mr. Taylor for his help in shaping the Journal and we wish him and his wife a long and happy sojourn together in the days of retirement.

Some aphorisms of Frank Lloyd Wright, the American architect

The safety of the soul depends on its courage.

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The long view is the cool view.

★

Tolerance, experiment and change give a culture strength.

★

Life always rides in strength to victory, not through internationalism or through any other isms, but only through the direct responsibility of the individual. It bears a royal characteristic called initiative. Where individual initiative is active, strong and operative, there you may see the mainspring of life in abundance, operating. Nature herself places this premium upon individuality. And it applies to nations. Nations are only the individual raised to a common power which should act as a check to idiosyncracy. The fact that a nation does not so act is the weakness of the nations.

★

Saying of Sinan, Ottoman architect of Agra, quoted by Wright: "Keep the young generations in health and bequeath them no tumbled house."

Letters to the Editor

Dear Mr. Editor,

Far be it from me to add to your burdens as Editor of the delightful *Telecommunications Journal*, but there is a somewhat premature reference on page 25 of the November issue to the burial rites in Northern Ireland of the last morse circuit in public service. In point of fact, these obsequies are not likely to be performed for a few years to come.

The absence of electricity supplies in much of the Hebrides still necessitates the maintenance of a morse circuit of about 80 miles between Stornoway and Lochmaddy. From Lochmaddy there runs another morse circuit about 70 miles in length to Grogarry, Lochboisdale, Creagorry and Castlebay. Traffic is substantial, particularly during the lengthy fishing season. Greetings telegrams have also achieved popularity on the occasion of weddings and other anniversaries, and in order that the good wishes of those sponsoring the messages may be closely associated with the events—a very human and reasonable sentiment it has long been customary for the telegrams to be handed in only shortly in advance of the functions. In due time the Hydro-Electric Board will fulfil its function of supplying electric power to Lochmaddy and when that auspicious moment arrives, the last morse circuits will be decently interred. Then will follow joyful celebrations honouring the introduction of a teleprinter service, but I am not prepared to hazard a guess concerning the date of this doubtful event; nor will anybody else. Meanwhile, the offices remain loyal to morse and the staff engaged in the prosaic occupation of dots and dashes read their messages in the long, dark winter days by means of acetylene gas lamps. As regards delivery, there are a few islands in the remote parts where the receipt of a telegram at the local Post Office for someone living on the island is announced by means of smoke signals or, in some cases, flag signals.

Nothing of greater antiquity than morse can now be found in public telegraph service in Scotland. The last single and double needle instruments and A.B.C.'s disappeared about 1944 but the British Railways at Waverley Station, Edinburgh, still transmit daily with single needles and these bizarre contraptions reside immediately alongside modern teleprinters. Morse is also in use at many railway stations. Edinburgh, for instance, still employs this method of communication to Newcastle and there seems to be no immediate intention of scrapping this particular type of service.

Let me congratulate Northern Ireland on the recovery of their last morse circuit. We would fain copy their example but are perforce compelled to be patient pending development of measures beyond our own control.

Yours sincerely,

Headquarters, Scotland. P. S. SIMPSON

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