POST OFFICE

telecommunications

JOURNAL

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WINTER 1960

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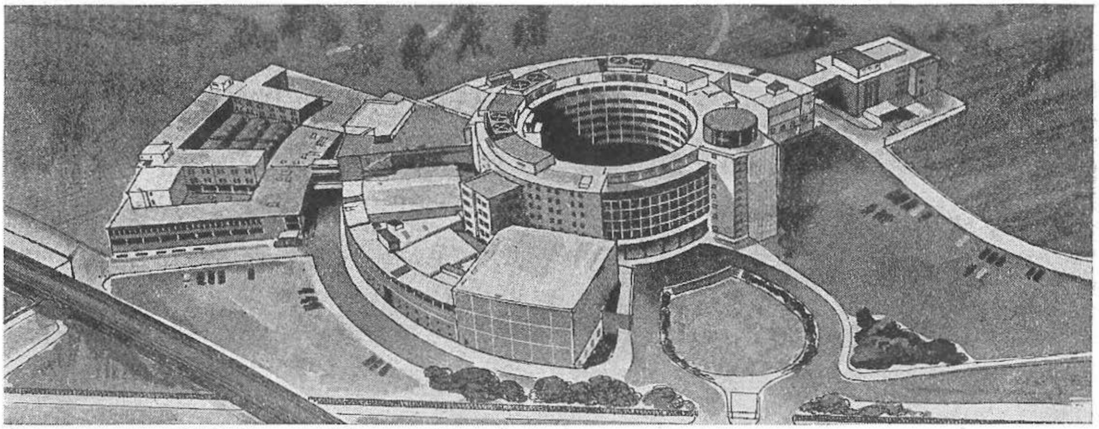

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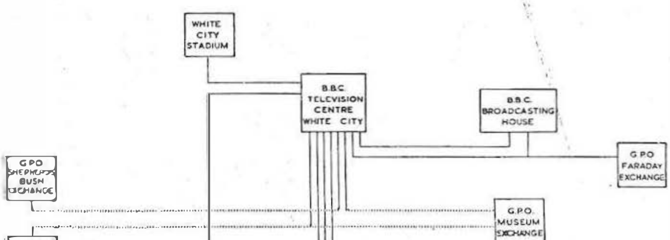

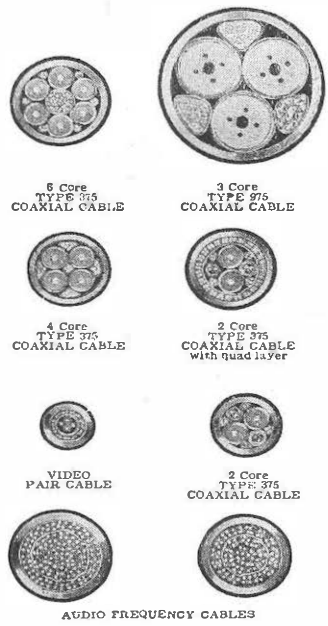

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Post Office Telecommunications Journal

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Vol. 13 *Winter* 1960 *No.* 1

The Figures and the Facts

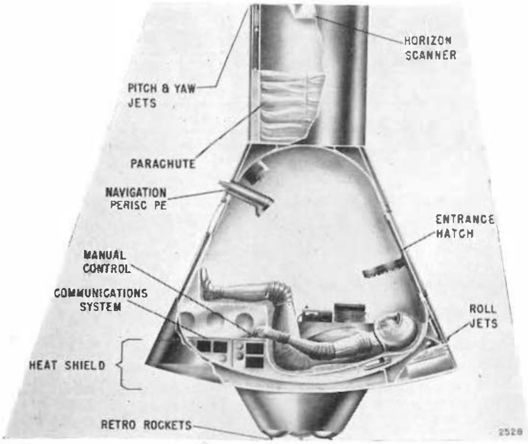
EVERY now and then we celebrate the installation of another million telephones. The latest occasion was on September 26 when the Postmaster General presented the 8,000,000th telephone to Liverpool Parish Church. But such statements as "this is the 8,000,000th telephone" do not tell the whole story of the Post Office effort to increase the number of telephones in the public service.

The installation of the 8,000,000th really meant that, since the Post Office took over the service on January 1 1912, we have installed more than 18,000,000 telephones. The difference is, of course, the difference between net and gross supply. Subscribers may move, for example, and that may involve removing the telephone from their old address and installing another at the new. All this means a lot of work but it does not mean any net growth.

The bare figures of net increase since the end of the war show annual increases in the number of stations ranging from 135,000 to 396,000, but we have in fact fitted about 700,000 telephones annually during the fifteen years; in 1958-59 we supplied 771,000, in 1959-60 930,000, and this year we expect to be well over a million. Further, although since March 31 1959, the number of cases in hand has increased, we have reduced the waiting list from 60,000 to 49,000.

This achievement in a period of restricted capital is a matter for pride. But pride does not mean complacency. As the Postmaster General added at Liverpool, we shall not be satisfied until we are providing telephones freely and quickly for all who want them.

Around the World in Ninety Minutes



D. T. Gibbs, M.V.O., O.B.E., T.D.

THE National Aeronautics and Space Administration (NASA) of America is planning for the first United States manned orbital flight in 1961 and with this project, coded "Mercury", a most comprehensive and intricate network of communications is vital.

The intention is to put a man into orbit around the earth in a capsule released from an Atlas launch vehicle to be fired from Cape Canaveral, Florida. He will be travelling at some 18,000 miles an hour at a maximum height of about 120 miles and will orbit the earth three times, taking some four-and-a-half hours to do so. He will re-enter the atmosphere by the firing of three retro-rockets while the capsule is passing between Hawaii and the United States mainland, to slow down the speed of the capsule and cause it to descend in a long trajectory. At about 60,000 feet a small parachute will be released to stabilize the capsule, and at about 10,000 feet a larger parachute will reduce the speed of fall to 30 feet per second. By these means the astronaut should "land" in the sea off the Bahamas. From the capsule will be released flares, a radio beacon and water dyes, with a special underwater device to assist in recovery operations.

Communication Requirement

The main Mercury Control Centre is at Cape Canaveral and there is a subsidiary centre at Bermuda. The capsule will be launched in an easterly direction and for communications and tracking 18 remote sites have been set up in alignment with the projected track of the satellite to give world-wide coverage. Transmission of data and other messages to and from these sites will be via the Computing and Communications Centre at the Goddard Space Flight Centre at Greenbelt, Maryland, a few miles from Washington, D.C.

Most of the 18 sites have radar facilities for tracking the capsule and sending data into the Computing Centre—normal teleprinter signals sent at the rate of 60 words per minute will be employed. The computers will automatically issue plain messages, containing tracking details, back to each site in advance of the arrival of the capsule. In addition, and throughout the operation, they will cause messages consisting of orbital elements and positional information to be transmitted twice every second over high-speed data circuits to Cape Canaveral where they will be electrically displayed in the Mercury Control Centre.

Shortly after the capsule passes a site—and the maximum period when the two are in radio contact is only six minutes—the site will also send to Goddard Centre a summary of the indications telemetered from the capsule. Some of these data enter the computers and, after being processed, the information is transmitted to the Mercury Control Centre where it is received in display form. Other

Above: The astronaut's position inside the Mercury capsule *(Courtesy, Western Electric News)* telemetry data, such as those relating to the astronaut's physical condition, and administrative traffic, will be filtered through directly to the Mercury Control Centre.

There is also UHF and HF 2-way communication between the capsule and most of the ground sites. This caters for voice transmissions (or morse in an emergency) and 93 telemetry functions.

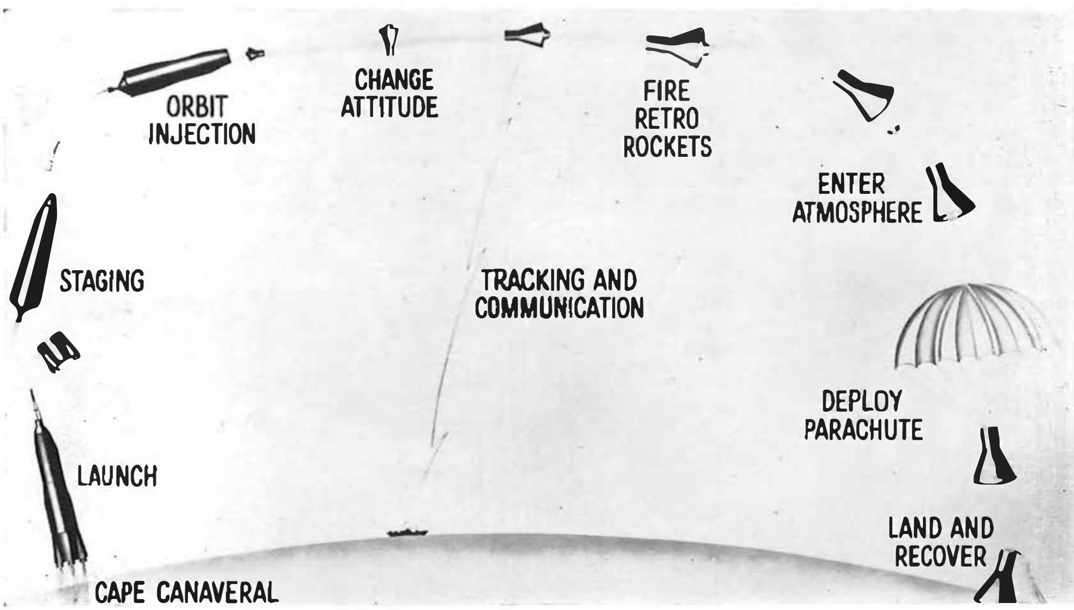
Communication Network

To provide for the interchange of this vast amount of information, a world-wide network was designed and built by an industrial team led by Western Electric Company. Wherever possible standard commercial circuits are leased, particularly within the United States, and in submarine cables to Hawaii and to the United Kingdom. Beyond these points, and including two ships, almost all circuits will be HF radio. Diagram 1 gives a pictorial representation of the network; only routes have been shown and the number of circuits in each route varies according to the function allocated to it. For example, between the Goddard Centre and the Mercury Control Centre at Cape Canaveral there are six voice circuits, eight teleprinter circuits and four high-speed data circuits.

The global ground station network is expected to cost over $30 million and to consist of 88,000 miles of teleprinter circuits, 32,000 miles of telephone circuits and 5,000 miles of high-speed data circuits —a ground total of 125,000 circuit miles.

The system has been designed for a high degree of reliability and flexibility. Operating procedures have to be set up to prevent interruption of service, particularly during the critical periods of satellite launch and orbit, flight simulation or check out tests. The basic circuit used for communication between a site and Goddard Centre is a 60 words per minute duplex teleprinter channel.

Where possible, alternative routing is made available during critical shoot periods either by supplementing the main route by employing additional links or by using secondary routings from existing sites or by providing separate stand-by channels over entirely different routes. For



Stages in the capsule's flight (*Courtesy, Western Electric News*) example, the London-Canary Islands and the London-West Central Africa routes will each be provided with a second radio channel: the Canary Islands–London–New York–Goddard chain of communication can be substituted by a routing Canary Islands–Ship in Atlantic Ocean–New York –Goddard: and for the Australia–Hawaii–Goddard chain, a route direct from Australia via a telegraph channel rented in the existing Pacific telegraph cable to Vancouver and extended by land-line to Goddard will be available.

The initial launch with its Mercury capsule, will be under the control of the normal guidance system installed at Cape Canaveral which will function to bring the capsule into the desired orbit. During this first phase the Mercury tracking and communications system will be used as a back-up; and there will be an interchange of highly complex data between Cape Canaveral and the Goddard Centre.

Bermuda has been set up as a subsidiary control with its own computer equipment for orbital calculations; this station plays a most important part since the capsule will have been inserted into orbit midway between Cape Canaveral and Bermuda. It will have to co-operate with the main Mercury Control Centre in deciding whether the capsule should be returned to earth by firing the retro-rockets either because it has not assumed its intended orbit, or for some other reason. In these circumstances, as the landing must be achieved before reaching the West Coast of Africa, a decision will have to be made within about 30 seconds. To meet this all-important commitment Bermuda will be linked, using leased circuits from the American Telephone and Telegraph Company, the Radio Corporation of America (Communications) and Cable and Wireless Ltd., to the Goddard Centre by one full-time telephone and three full-time teleprinter radio channels into New York—with other alternative back-up radio telegraph channels employing entirely different routings.

The first approach to the Post Office External Telecommunications Executive was made in September 1959 and since then there has been a number of meetings in London with representatives of both Western Electric Company and NASA, including Mr. Rodney M. Goetchius, Western Electric's Mercury Project Manager.

The circuit requirements are to link Las Palmas (Canary Islands), West Central Africa and East Africa via London to the Goddard Centre, using channels in the telegraph system, which the Post Office operates in conjunction with the Radio Corporation of America, in the transatlantic telephone cable. The way in which this is done is shown in Diagram 2, which gives the basic elements only. It will be seen that there are four radio channels, two each to Las Palmas and West Central Africa; one radio channel from each of these two places is switched through special sequencing equipment, installed at Electra House, on to the same cable channel, and the remaining radio channel from each place is linked, directly, to independent telegraph cable channels. All circuits are being leased by NASA.

This switching equipment, provided by Western Electric, is installed in a separate room in Electra House and is being maintained by the Post Office.

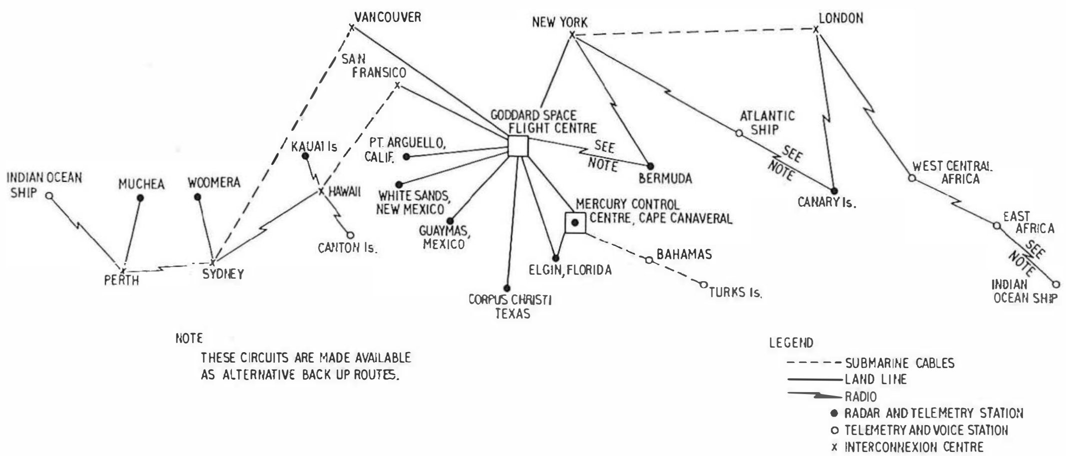


Diagram 1: Ground communications

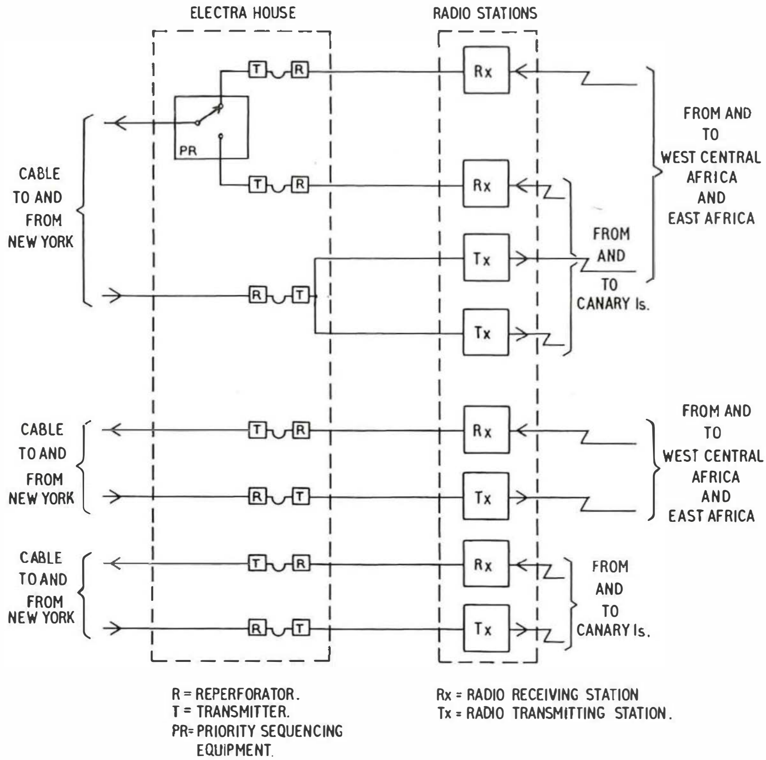


Diagram 2: United Kingdom stations

While the flow of traffic is thus automatically controlled a NASA representative will be in attendance during critical periods of operations should some overall manual control and supervision be needed. On these vitally important occasions, a Post Office engineering maintenance officer will also be present continuously.

To meet the radio requirements, radio systems from London have had to be established. NASA decided to install its own station in West Central Africa and to work directly to London. Existing facilities required expansion in Las Palmas and, in conjunction with Transradio Español, the Post Office has set up a new radio system. In both instances the Post Office is using ISB transmitters and receivers, and frequency division multiplex channelling equipment. The establishment of a direct radio circuit between London and East Africa was also considered but NASA thought that a superior circuit could probably be achieved by providing a radio circuit from East Africa to West Central Africa and thence extending the link on a relay basis to London.

The Post Office has undertaken a considerable amount of work, in collaboration with Cable and Wireless Ltd., to assess the performance of radio circuits and, on behalf of Western Electric, to monitor frequencies in this country to determine the amount of activity and interference on frequencies they had planned to use from West Central Africa. Negotiations are also in train for Cable and Wireless Ltd. to be responsible at the stations in West Central Africa and East Africa for providing the staff to operate and maintain the radio circuits under contract with Western Electric.

Every step possible is being taken to safeguard the continuity of service during "shoot" periods. For example, where emergency AC power generators at radio stations are not designed for automatic start and load transfer in the event of mains supply failure, manual start units will be kept running. Another feature is that spare transmitters and receivers will be tuned in advance of expected frequency fade-outs so that the switching over to the new frequencies can be made with negligible lost time.

Here's wishing every success to Project "MERCURY".

The author would like to record his gratitude to Mr. Goetchius for his valuable help in providing information for this article and to NASA for their permission to publish it.

The Americans have put satellite Explorer VIII into orbit between 200 and 1,000 miles above earth to measure the electrical components of the ionosphere.

Telecommunication as a Social Science

Colin Cherry, D Sc.(Eng.), A.M.I.E.E.

Following are extracts from Professor Colin Cherry's Inaugural Lecture in November 1959 as Henry Mark Pease (Standard) Professor of Telecommunication in the Department of Engineering, Imperial College of Science and Technology, University of London, and are reproduced by Professor Cherry's kind permission. The Lecture has been published by the College. The stars indicate the beginnings and endings of extracts.

Social sciences are those concerning people and their relationships. At least, that is how I shall be using the term. And I shall argue that telecommunication is concerned with setting up relationships between people—or it is nothing else. The purpose of any telecommunication system is social and we judge the merits of any system by its success in setting up social relationships. The function of such systems is purely to remove the constraints of time and distance; the engineer, as engineer, makes his business to change the size and shape of the world.

I shall argue then for the academic treatment of telecommunication in a way which stresses more its social purpose, for three specific reasons. The first is educational; I believe that the subject can make an excellent vehicle for university education (and I should be a poor professor if I did not), but I think that we are not yet taking full advantage of its potentialities.

My second reason is that telecommunication is utterly meaningless without people. (The very word "communicate" comes from *communico*—"I share".) *Tele-communicate*; at present, electronic engineers are too much tied to the *tele* and too little concerned with *communico*.

My third reason concerns research and the future. We now know a very great deal about apparatus and about principles of design but, more and more, we are finding that for real progress we need to know a lot more about human beings; more about the nature of the communication process itself; more about the psychology of speech, hearing and vision; more about the physiology of the nervous system especially that concerned with recognition and learning. With the expansion of our national and global networks, as history closes our ranks, the planning of systems becomes largely an economic-geographical-political matter. We need more and more to consider people's changing habits and social conditions; a host of social factors. To my mind, telecommunication is not an intelligible study if it be confined to electronic apparatus.

* * *

The people of any society are engaged in a great complex of *sharing*: their relationships, one with another, arise from numberless acts of communication and, whether we think only of gossip and daily chatter, or whether we include technical aids such as print, or telephones, telegraphs and the postal services, what is shared is fundamentally the same.

What do we share? Modes of life, social customs, common language? Culture, symbolism, moral codes? Yes, of course, but more fundamentally and within a scientific context we can argue that all this human activity rests upon the use of signs. Signs are really all we have; signs and rules for using signs. All communication proceeds by signs; all communicable knowledge is expressible in signs.

* * *

This basic concept of "signs and rules" needs a little clarification. We must first distinguish between two kinds—languages and sign-systems. A *sign-system* employs rules which are formulated, and inviolate. Mathematics is an example; I could not say $2 + 2 = 5$, at least not as a mathematician.

* * *

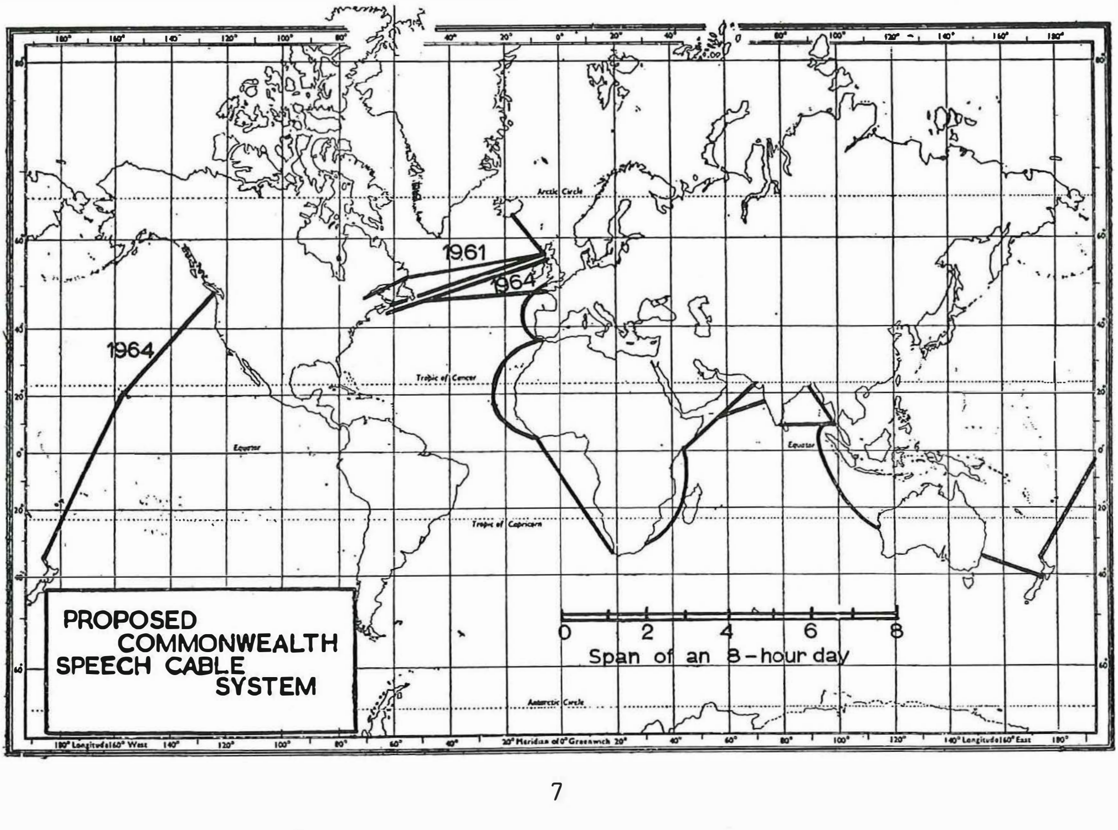
Secondly, the term "rules" should not be taken to imply that they are necessarily known to their users. They frequently are, in sign-systems; but in languages they mostly are not. Rather, rules are "acted upon" by habit or custom; as Hume stressed, "by custom and custom alone". Such rules of language, if formulated, are expressed in a meta-language—we do not, for example, confuse a grammar book with literature; and we can laugh at a joke, without knowing the rules. Only in *sign-systems* are the rules laid down.

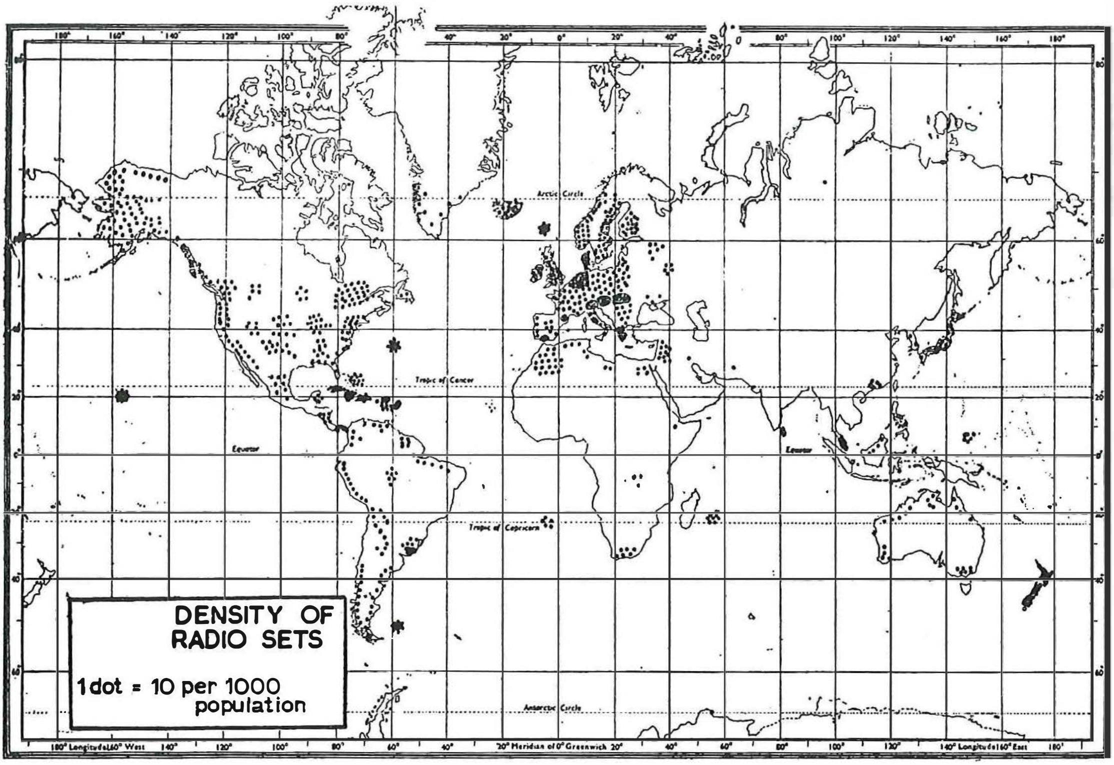
Although any human society is organized upon a basis of many *sign-systems* (like those of law, currency, timetables, and the clock) its humanity derives from its varied forms of *language* (using that word in our present wide sense), for it is only with these open, flexible, universal, modes of communication that personality can express itself.

Telecommunication networks exist in order to extend the range of both—both the systematic and the linguistic. It is true that, as time passes, more and more networks are concerned, not with human speech and writing, but with numbers, coded data of all kinds; with air navigation data, with computer data, with transmission of accounts and, in the future, with forms of data which we can only speculate upon, needed for the defence, supply, control, transport and other factors in a society of increased size and complexity.

But it is in the nature of human society, that its exchanges must include a core of language.

The telecommunication networks used for human speech, vision and other personal communication will also continue to have great human, social importance as our society expands in scale. And these can be steadily improved, made more effectual and made to constrain the less, and





intrude less upon, their users, if the psychological and physical attributes of these human users be increasingly "built into" the design of our systems; and only if the whole social purpose of our science be kept in mind.

* * *

The building of national and global telecommunication networks has removed constraints upon the speed of political action, trade and warfare. It is the explosive increase in the size of societies (that is, areas of mutual dependence and cultural exchange) which is remarkable.

* * *

The North Atlantic is by far the most active long-distance social link in the world.

The inescapable need for closer world integration is stressed by the continual demand for new or extended global telecommunication links, for both speech and data. Further than this, official statistics show that each major innovation (such as the transatlantic telephone, or the new Telex world data-transmission system) itself *creates* fresh business and international trade. The rate of expansion is then highly accelerated, as I shall shortly show.

The diagram (Fig. 1, page 7) shows the Commonwealth telephone-cable system which will girdle the earth by, perhaps, 1965–1970. These tremendous channels of conversation will not follow the traditional trade route from Europe to the Far East, through the Suez passage; the Middle East is politically out of the question.

The layman often asks—why use cables rather than wireless, for global communication? For really reliable day and night service, cables are the only answer, for speech. And it is reliability which is the most important factor of all.

Notice, on this map, the greatly strengthened North-Atlantic speech link; the demand for new channels is unceasing. This network will span the great sea routes and enable the people of the main industrial nations to speak to one another, linking together their national telephone networks. This itself will generate the need for further links.

I should like to inject here another diagram (Fig. 2 above) showing the world distribution of radio sets, as a *density* (radio sets per 1,000 inhabitants). It may seem curious that this distribution corresponds closely to the areas of high literacy, rather than areas of industrialization, but this is so. And there are some surprises; Alaska, for example, has almost the highest number of radio sets, per 1,000 population, of anywhere in the world. There is another strange fact about Alaska; telephonically they are by far the most talkative folk on earth; seven-and-a-half times as much as us in Britain. One wonders why!

* * *

Telegraph traffic both inland and overseas steadily decreases. But the whole situation, with regard to printed messages, is over-shadowed by the explosive growth of the new so-called Telex data-transmission service, to which I shall refer shortly.

With regard to the telephone service we, in this country, have scarcely begun to be telephone-conscious yet. As an expanding industrial exporting nation, we cannot afford but to increase our internal and external telephone capacity many-fold. We have today only $7\frac{1}{2}$ million* telephones in this country (we shall soon have as many cars) though it is true we have a planned expectation of 12 million by 1975. The returns to be expected from such investment are immense.

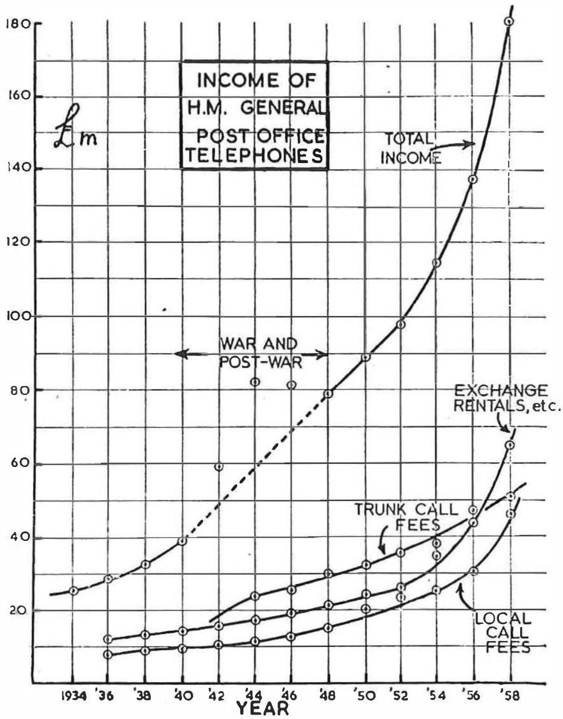
But the curve in Fig. 3 (opposite) shows what is a truly astonishing thing—the rapidly increasing Post Office income from the telephone service. One hardly dares extrapolate this curve into the future! Now I feel it is safe to argue that this income is a measure of the value of the telephone network to our society; it is what we are willing to pay for its use, so that this curve illustrates the accelerating economic importance of the network and of the need to press its expansion. The rapid expansion of long-distance social intercourse is also illustrated by the curves in Fig. 4 (page 10) which show (A) the increase in inland trunk calls, and (B) more interesting from our present point of view, in our Continental telephone calls—more than doubling in ten years.

Even more impressive is the rapid growth of the Telex service, to which I referred just now, a relatively recent introduction by the GPO for the transmission of *data* round the world. Facts and figures, not speech, sent by teleprinter, through a special network of exchanges.

* * *

The explosive growth of the Telex service is illustrated by Fig. 5 (page 11). It has come to cover the globe in some six or seven years, with a ten-fold increase in data traffic in that time.

The capital cost of a telecommunication network is enormous; perhaps £1,000† million is invested already in our own inland telephone system. It is only economic then if the utmost use can be made of it. Of course, we have long had the various "multiplexing" systems for sending several different messages simultaneously over the same wire but, since the last War, a number of new studies

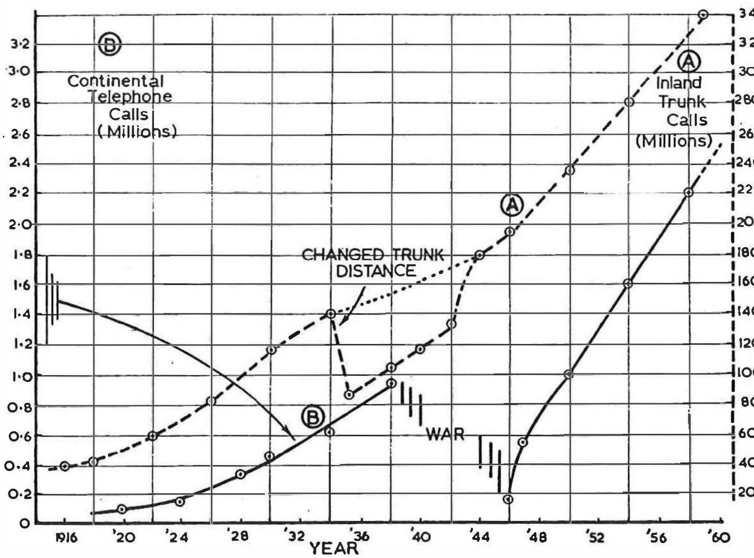


have been forced, concerned with increasing the capacity and use of channels, all of which are basically social in origin—concerning people and their habits—and which have brought the telecommunication engineer into close touch with the psychologist, the physiologist, and linguist and others who study people. I shall mention four fields, in particular: Telephone Congestion Theory, Information Theory, Compression Systems and Speech Assessment.

* *The 8 millionth was provided on September 26; see page 1. The present lecture was written 18 months ago.*

† *Estimated £1,200 million at present costs (historic cost, £800 million).*

GROWTH OF (A) INLAND TRUNK CALLS AND (B) CONTINENTAL CALLS, IN THE UNITED KINGDOM



The Congestion Theory is a sophisticated mathematical theory concerning the probability that telephone exchanges may overload by the chance of too many people ringing up at the same time; a chance depending upon people's habits, the duration of their calls, times of day, etc. Congestion Theory considers also how the probability of lost calls depends upon the type, distribution and connection of exchanges. At present we are used to the idea that, when we telephone someone, we are held connected to them by the one same line. But in the future we may not be, for the line may be changed automatically and irregularly, depending upon demand (perhaps in the middle of a sentence) controlled by computational data which will constantly keep exchanges informed about free or congested routes. But the speakers will not know. In the future our telephone network, with its vastly increased load of speech traffic, will need more to simulate the animal organism and become an adapting system. It will need a memory and be able to learn, so that its behaviour will seem to be more intelligent than at present.

Next, the mathematical Theory of Information. This has been one of the most refreshing breezes that has ever blown through our field. It is of widest implication and has aroused enthusiasm (sometimes excessive) in many other sciences. For it is basic. It might equally well have been evolved within Genetics, for example, or within Linguistics, or as part of Scientific Method, or within Taxonomy. But it wasn't; it was evolved mainly within Telecommunication. It defines the commodity which is bought and sold when a telecommunication channel is used; this commodity is called "information"—information about messages, which is what you pay for. Since the Theory of Information was evolved, interest has been widespread in many scientific circles which previously would have had little in common.

* * *

I think that the reason why Information Theory has been found of value in so many different sciences is that it is really a branch of epistemology, the nature of knowledge. It arises within telecommunication because, when you try to describe precisely the nature of communication, and ask what it is you communicate, how you measure it, and how efficient you are, you are asking some very searching questions.

Although, as I said before, all communication proceeds by signs, telecommunication channels, like your telephone, do not convey these signs. This is common error. They transmit signals giving information about what signs are being successively selected for sending at the source. The source may be human speech, or writing, punched tape or television pictures; it doesn't matter. The information rate of a source is measured in a way which depends upon the probabilities of the signs it uses.

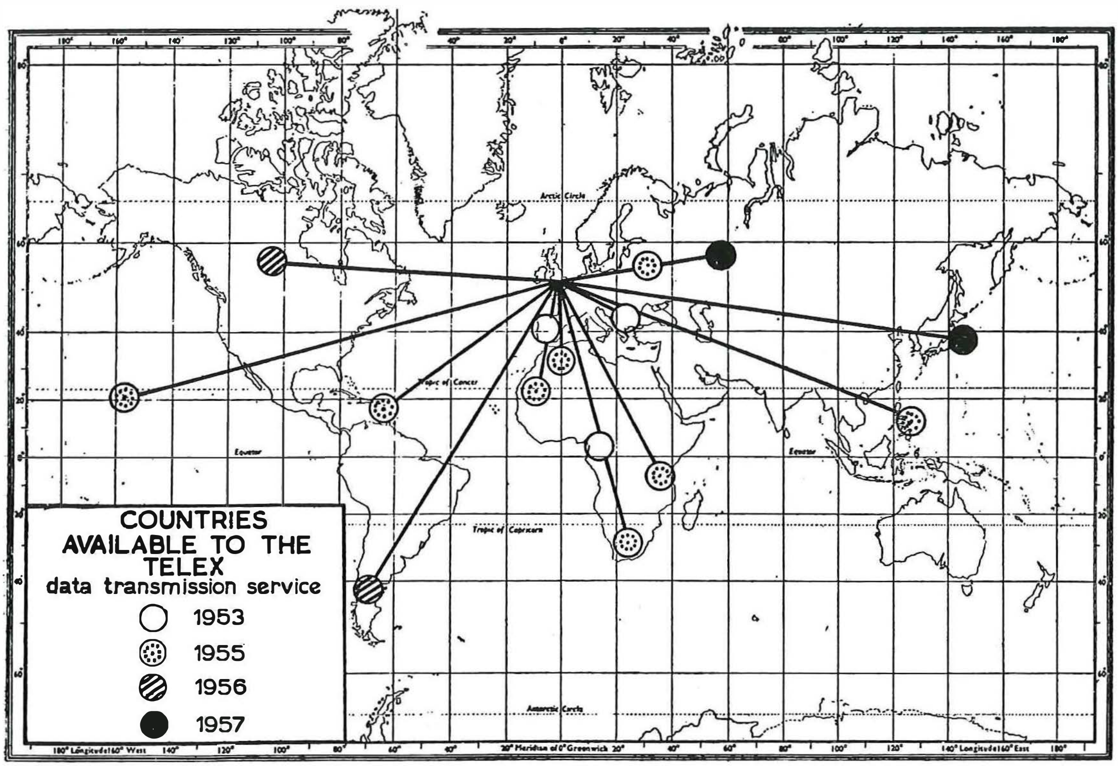
* * *

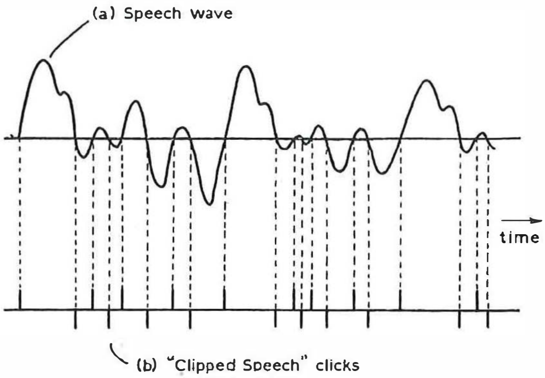
Very few statistical analyses of speech have been made, though I know the GPO have studied the frequency of different words used in telephone speech, showing that when you speak on the telephone you unconsciously change your habits of language, because of the constraints upon you—you cannot, for instance, see your partner. In printed matter the most often used word is *the*; on the telephone it is *I*. Studies of the whole speech-hearing process have received enormous impetus, in particular, from modern telecommunication research. Scientific research upon speech production and aural perception had sailed near to the doldrums after the time of Helmholz but has been taken up again now with new vigour, because we have both the necessary techniques for research and a crying need for understanding. And there is now close co-operation between linguists, phoneticians and people like us.

We began to ask ourselves; what does a communication channel need to transmit? What clues does a listener's brain really use? In the old days the aim was to preserve the sound waveforms accurately (the whole sound fluctuations) but the emphasis has now shifted because people and their needs are considered. Information Theory can tell us how to calculate the redundancy of speech, as a quantity, but not *how* to reduce it. What can be stripped off and what must remain as necessary data for your hearing mechanism is essentially a *perceptual* question, not solely an informational one. In fact we can strip off and deteriorate speech signals to an enormous extent, yet you still recognize what is being said.

(*After playing a record of what is called "clipped speech" Professor Cherry illustrated the process by a diagram: Fig.* 6 (*page* 12).)

Instead of using the whole speech wave—the whole fine fluctuations of air pressure, as in (*a*)—we reduce it to a sequence of "clicks", one click for every pressure wave front, as in (*b*). The speech wave is then torn to shreds, yet the rapid sequence





of clicks gives your brain ample evidence of the speech sounds; and so you hear the speaker, fairly clearly, sounding as though he has a slightly sore throat.

* * *

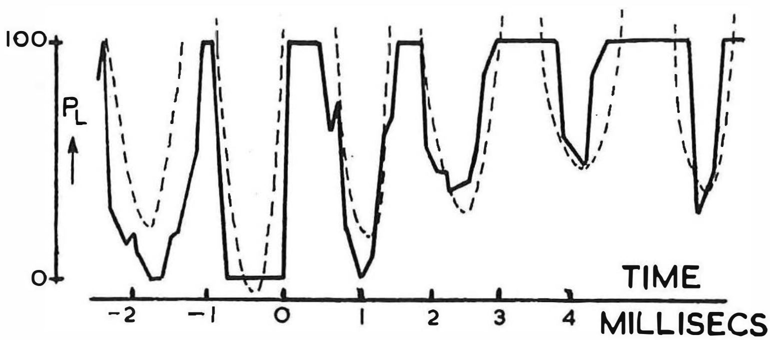
I believe it was Epictetus the Stoic who is said to have made the remark "God gave Man two ears, but only one mouth, that he might hear twice as much as he speaks". However naïve such a stoical view may be, within the field of human wisdom, it is very true on the plane of psycho-physics! For with our two ears we have greatly enhanced powers of sound discrimination. At present, none of our telecommunication systems take any advantage of these faculties. We have two ears, yet we hear only one world; how does the brain examine the sounds reaching the two ears, and then form a single representation out of these, giving one mental image ? Then, having formed one image, how is the *direction* of the source of sound estimated? (For directional hearing is far from being understood.) Again, why does a source of sound appear to stand still as I turn my head? Secondly, if two or more people speak at once, a mêlée of sound falls upon the listener's ears; how does the brain sort out the separate voices so that one speaker appears to be standing over *there* and another over *here*? (What we call the "cocktail-party problem".)

The separation of one voice from another, or from background noise are classical problems in telecommunication. The engineer refers to *cross-talk* and to *signal-to-noise* ratios; he specifies their chance of separation in terms of decibels. But cross-talk and signal-to-noise are essentially psychological problems, not physical, and so long as we leave the human listener out of consideration we are restricting a host of possibilities. Telecommunication systems, at present, make no real use of the fact that we possess two ears—not even the so-called "stereophonic systems"—but such possession greatly assists us to separate voice images and other *gestalten*.

I want to stress that the aim of our psycho-physical studies of hearing is to produce mathematical models.

* * *

It may interest you to see one example of such a calculation, so I have chosen an example from Dr. Sayer's studies of binaural fusion, illustrated by Fig. 7 (below). In his experiments a source of sound (in this case the sung vowel *ah*) is presented to a listener's ears through headphones; a time difference, set at random, between the two phones moves the sound to the listener's right or left side; the solid curve here P_L shows the frequency of the listener's correct guesses, plotted against various interaural delay times. The technical details may not interest some of you, but what matters here is that we can *calculate* as well as mcasurc. Thus the dotted curve shows the predictions of the mathematical model, which are very close to reality. A similar calculation can be done with any source of sound whatever, however complex—even human



Results of a typical psychophysical model. (Solid curves, measured; dotted curves, computed from the mathematical model)

speech. Although the sounds and their spacial locations are private, subjective sensations, this does not place them outside objective science, or even outside calculations. It is a question of good method.

There are endless problems of perception, which can keep us busy for many years; they are largely problems in statistical inference, an exercise at which the brain is singularly efficient.

There is again, the whole field of *theoretical* psycho-physics to be developed—the building of mathematical artifacts (robots) to perform stated classes of stimulus-response activity. This bears the same relation to psycho-physics as theoretical physics bears to physics. It has the identical purposes, which is to suggest experiments.

I would stoutly maintain that all such work can have profound influence upon telecommunication, not only in immediate practical ways, but by altering our attitude and giving us precise understanding of what it is we are trying to do with our systems—and how far off we are from achieving our ideals.

My final remarks will concern "Speech Assessment" and this will return me to my opening theme—the whole social purpose of telecommunication. At present it is customary to assess the properties of a channel in terms of certain easily-measurable factors—bandwidths, signal-to-noise ratios, etc., all based upon sine-wave technique. Such factors are properties only of the apparatus itself—of the lines, amplifiers, and so on, but make no reference whatever to its true *communicative function*.

Certainly a great deal of empirical assessment is made of the qualities of telephone channels, using linguistic material—"test words" or "test sentences"—designed with considerable objectivity, making use of word probability tables and so on. But we must go the whole way and emphasize the *purpose* of the channels, which is to set people into certain relationship to one another. We must treat the whole matter within the context of behavioural science and set up objective measures of the degree to which the relationship between the partners in communication is still inhibited by the presence of the apparatus itself.

A very big step towards this ideal end has been made by the British Post Office, who have devised tests which keep the social purpose of channels constantly in view. For example, some tests require the execution of certain tasks involving co-operation between the partners, such as the solving of visual puzzles. These tests are "open" ones, with free use of language—the partners converse freely with one another. We need to go much further in this direction and learn more from the experimental psychologists. The importance of such methods of assessment lies in their emphasis upon the social purpose of channels; the technique of such "open" tests places no constraints upon the partners except those imposed by the channel itself—what is observed is their manner of adaptation to this sole constraint. The problem is to set up measures of their success.

* * *

That is all. Perhaps what I have said could be summed up in the motto: "telephones do not communicate—people do". But this motto is not yet written over the doorways of our laboratories.

Direct Telephone Cable between Britain and Sweden

A direct telephone cable between Britain and Sweden was opened on October 11, when the Postmaster General spoke over it to Sweden's Minister of Communications, Mr. Gösta Skoglund. The cable is a joint undertaking of the British Post Office and the Royal Swedish Board of Telecommunications.

The new cable, the first direct cable to link the two countries, will provide twenty-four more telephone circuits between London and Stockholm by which operators in each country will be able to dial subscribers in the other. Later, subscribers will be able to do their own dialling direct to subscribers in the other country. Telex and public telegraph circuits will also be provided.

Until this cable was opened telephone circuits between the two countries were routed through the Netherlands and Denmark, or Northern Germany. The new cable provides a third route for telephone and telegraph contacts with Scandinavia.

Laid by H.M.T.S. *Monarch*, the new cable cost £1½ million and is of similar coaxial construction to that being used on the shore ends of CANTAT, the cable to be laid next year between the United Kingdom and Canada. Twenty-eight rigid repeaters are used at about 18-mile spacing, and a new type of valve is employed which reduces the power-feeding voltage needed on the cable.

An average of 500 telephone calls a day is made between Britain and Sweden.

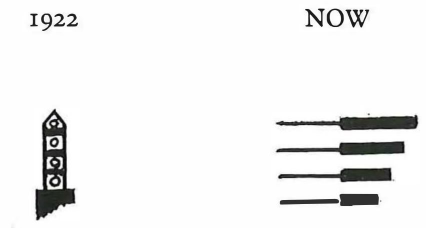
Graphical Symbols for Telecommunications

H. J. S. Mason

IN preparing drawings for the production and maintenance of equipment and for the illustration of articles and reports, the telecommunication engineer is probably one of the most prolific users of symbols to represent the various components in his equipment. Thousands of drawings are prepared annually and many are seen not only by people in this country but appear in periodicals circulated all over the world. The advantages of a standardized system of symbols and conventions which can be understood both nationally and internationally are obvious.

In this country the body charged with the standardization of engineering and industrial practice is the British Standards Institution, which is the national standards organization and issues the British Standards specifications. For the electrical engineering industry the BSI publish two standards giving symbols for use in power and telecommunication drawings respectively. These standards are BS 108 (1951) *Symbols for General Engineering Purposes* and BS 530 (1948) *Symbols for use in Telecommunications.* The Post Office has always maintained close connexion with the BSI and indeed, the BSI publication *Fifty Years of Standardization* records that shortly after the first Standards Committee was set up in 1901 to study standardization in the steel industry it was Sir William Preece, then Engineer-in-Chief of the Post Office, who persuaded this Committee to widen its terms of reference to include standardization of electrical plant.

The first attempt to set up a national list of graphical symbols for the electrical engineer was made in 1922 when the BSI published BS 108 (1922) *Graphical Symbols for Electrical Purposes.* In the introduction to the standard it is stated that "The use of symbols being now almost a necessity and the application of electricity so varied it is not surprising that several Public Departments, Manufacturers' Associations and Engineers have their own list of symbols. The object, therefore, of this standard is to draw up a British Standard list of symbols acceptable to every branch of the industry." One section of the standard was devoted to telephone and telegraph symbols and contained some 95 symbols, the vast majority of which had been contributed by the Post Office. Many of the symbols were the same or very similar to those in use today. Others had a more Victorian air and must have taken a considerable time to draw. For example, the symbol for a telephone plug was virtually an illustration of the device, and the symbol for a wall telephone was almost identical with an elevation drawing of the instrument even including a small circle to represent the head of a fixing screw for the bell.



Symbol for operator's plug

The rapid expansion of the electrical industry led to the need for a revision of BS 108 and in 1930 the Post Office was asked to undertake the preparation of a list of graphical symbols for telegraphy and telephony. This work was done by a committee (known as the Post Office Nomenclature and Symbols Committee) which had earlier been formed to do similar work in connexion with a glossary of terms for another British Standard. The results of the committee work were included after slight modification by BSI in a new standard, BS 530 *Graphical Symbols for Telephony, Telegraphy and Radio*, published in 1934. The original BS 108 was also revised and reissued being now confined to symbols for power engineering.

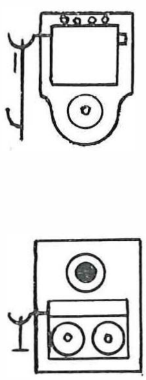
Internationally, the first attempts to achieve standardization were made in 1904 when Colonel Crompton read a report on electrical standardization at the St. Louis Exhibition and as a result an international body known as the International Electrotechnical Commission (IEC) was formed in

1906. Thirty-five countries are now members of the Commission which is organized on the basis that each country shall have its own IEC National Committee and in this country the BSI is the recognized representative. Minutes of the IEC meetings show that the Post Office has always been represented.

The aim of the IEC is, of course, standardization in the whole field of electrical engineering, but one of its many technical committees is charged with standardization of graphical symbols. In 1931 the IEC issued the first international list of symbols for what is now generally regarded as "telecommunications". This was known as *IEC Publication* 42, *Graphical Symbols for Weak Current Systems.*

Shortly after BS 530 was published the IEC invited its constituent national technical committees to make proposals for revising Publication 42 to cover all branches of telecommunications. The invitation was extended to include the three advisory committees of the International Telecommunication Union—the CCIT, CCIF, and CCIR. The Post Office was asked to represent the BSI at the various conferences. As a result of these meetings a second edition of IEC Publication 42 was issued in 1939. Concurrently with this work the Post Office Nomenclature and Symbols Committee reviewed the then current BS 530 in the light of the IEC discussions and their proposals for the revision of the standard were largely accepted by the BSI.

It has always been Post Office policy to follow BSI drawing standards and, to achieve this end, the 1934 edition of BS 530 was published in the Technical Pamphlet series, and the 1937 edition appeared in the Educational Pamphlet series. After the war BS 530 was again revised and by arrangement with BSI a special Post Office edition was prepared and widely distributed within the Engineering Department at the end of 1947. Since then five supplements and a number of amendments to the Standard have been published and copies have been distributed to holders of the original BS.



Symbol for Wall Telephone BS 108 1922 edition

The Post Office Nomenclature and Symbols Committee (now known as the Post Office Terms and Symbols Committee) has continued to operate throughout the years and provides a channel through which any branch of the Engineering Department can make representation on matters concerning symbols and provides a means by which changes in the practice of outside organizations, can if desired, be introduced into Departmental practice.

The ever increasing pace of development in the telecommunication field results in the production of many new devices and techniques which require new symbols or amendments to existing ones and these should be standardized as soon as possible. However, many interests have to be consulted before any recommendation for a new symbol can be made by BSI and considerable care must be taken in deciding on the form of the symbol to allow for developments in the device being represented.

The symbol for a transistor is a good example of the difficulties in devising a symbol which will meet with general approval, yet is easy to draw and allows for future development. The first transistors were point contact types and an obvious symbol was three lines for the collector, base and emitter respectively sprouting symmetrically from a short thick line representing the semi-conductor material.

However, the point contact transistor was soon superseded by the junction type and it was clear that techniques were developing rapidly for producing new devices based on the original transistor but perhaps requiring new symbols. While some people continued to use the original symbols for junction transistors a number of new ways of representing the device rapidly began to appear. Each of these symbols had to be examined and it took some years before BSI could issue any standard which it was felt could reasonably be regarded as reflecting the most common usage in the electronic industry both in this country and abroad. Even so, the many developments taking place in semi-conductors have revived interest in new types of symbols and fresh proposals were recently discussed at an IEC meeting in Paris although no decision has yet been made as to whether there shall be any change in the present symbols.

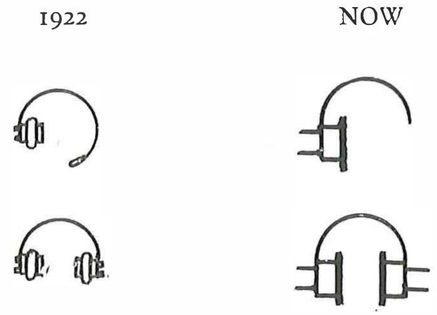
In a large organization like the Post Office drawings must be as consistent as possible and recently the Terms and Symbols Committee decided to issue an Addendum to the Post Office edition of BS 530 which will show all changes or additions to the BS 530 which have been agreed for Post Office use. Symbols and rules in the Addendum are provisional until such times as they are agreed or amended by B.S.I.

As previously mentioned, there are at present two British standards for graphical symbols in electrical engineering and there has been a tendency for the power and telecommunications engineers to go their separate ways in devising symbols for new applications. A similar procedure was adopted by the IEC before the war, but they have now gone over to the principle of a single list and the American Standards Association in collaboration with the Institute of Radio Engineers has recently done the same. A similar procedure is being adopted in this country and work is now proceeding on the merger of BS 108 and BS 530.

The need for the change lies in the growth of new techniques which cannot be described as either power or telecommunication engineering: for example, remote control of machinery, needing drawings showing both power and telecommunication components and equipment and where the use of different symbols for the same class of item could lead to confusion. In carrying out the merger the opportunity is being taken to revise both volumes and in doing this close attention is being given to the work which has already been done or is going on in the international field.

It will probably be many years before everyone accepts a completely standardized international system of symbols, but the work of the past 50 years has not been without avail and on the whole there are surprisingly few variants (and none of major importance), considering the large number of countries and interests involved. This has not been achieved without some penalties. Two examples which have occurred in the past may be of interest.

For many years the usual German representation of a battery consisted of a short thick line for positive and a long thin one for negative, which was the opposite arrangement to that adopted in other countries. To conform with international usage German engineers agreed to face the inconvenience



Symbol for headphones

of reversing their practice to bring it into line. In Britain it had been the practice up to 1937 to indicate a slow to operate relay by a shaded end and a slow to release one with a cross. Internationally the practice was the reverse and with the issue of the 1937 edition of BS 530 the Post Office undertook to adopt the internationally agreed convention.

These are two isolated examples of the difficulties which can arise if there is not close co-operation and it is to be hoped that with the close co-ordination both nationally and internationally which has grown up during the years such extreme difficulties will not arise in the future.

In concluding this short summary of the way in which the present standard list of symbols has grown up it might be useful to indicate the basic principles used in devising suitable symbols. These are, briefly, that the symbol should be simple in form, self-explanatory and unambiguous. Its primary purpose is to indicate the electrical function or operation of the component or device, mechanical construction is of secondary importance, and no attempt should be made to produce a pictorial drawing of the item. A box with a letter inside should be avoided if at all possible, since such a symbol can rarely, because of language differences, be adopted internationally.

The Institution of Post Office Electrical Engineers announces five prizes and five certificates of merit to be awarded for essays submitted for the year 1960-61. Technical accuracy is essential but a high technical content is not absolutely necessary for an award.

Closing date for entries is December 31 1960 and further information will be given by the Secretary, IPOEE, GPO, 2-12 Gresham Street, E.C.2.

Post Office Work for Outside Broadcasts

B. H. Moore

In our Summer issue Mr. Cheetham outlined how the Post Office helped the BBC to televise the Grand National for the first time—an outstanding example of "outside broadcasts" (OBs). Below Mr. Moore describes the general work involved in OBs.

WHILE THE PRODUCTION AND TRANSMISSION of a broadcast is the responsibility of the broadcasting authority concerned, the programme will normally have to be sent from studio or outside broadcast site to the transmitter, possibly via a switching or control point, and this will frequently involve an extensive use of lines which the Post Office provides and maintains. The studios, transmitters and so on are linked by a permanent network of circuits which have been provided over a number of years but, in addition, Post Office circuits are used to link outside broadcast points possibly at very short notice and for a very limited period.

The first circuit provided by the Post Office for an outside broadcast was from the roof of St. Stephen's, Westminster, to Savoy Hill. This was used by the British Broadcasting Company (the predecessor of the Corporation) in 1923 to relay the sound of Big Ben to "2 LO" (the broadcasting station) familiar to older readers. Since 1923 the number of circuits has grown rapidly and during 1958 in the London Telecommunications Region alone, more than 3,000 circuits were provided.

Before World War II the BBC was the only general renter of these circuits, which were used mainly in connexion with sound outside broadcasts. A few, however, were provided for what was then the new television service and the most notable event was the BBC's televising of the coronation procession of King George VI in 1937—the first television outside broadcast.

The BBC television service was reopened after the war but there was no great increase in the demand for circuits until 1948, when the Corporation covered the Olympic Games extensively with both sound and television. The extension of television transmission hours and the opening of new transmitters throughout the country increased Outside Broadcast activity and brought fresh demands for circuits. So many memorable events have been broadcast during these years—up to Princess Margaret's wedding—that it would be difficult to list them all.

Although the number of circuits set up for the Queen's coronation in 1953 made this one of the largest outside broadcasts, the two events which tested the Post Office most in preparing OB circuits were the deaths of King George VI and Queen Mary. The coronation date was fixed well in advance and planning was steady and progressive; and although many changes were made in the plans, there was reasonable time to get the work completed. Death gives no notice and plans for televising a funeral have to be drawn up quickly; the Post Office must get all the circuit work completed so that tests and perhaps camera or sound rehearsals can take place before the event. When the Independent Television Authority network was opened in 1955, there was a fresh demand on the Post Office for OB circuits from the programme contractors.

Circuits

The number and types of circuits required for an OB depend on whether it is for a sound or television transmission, and on the event to be broadcast. When it is some royal occasion or has international interest, a greater number of circuits will probably be required. For a royal occasion the vision and sound circuits may be duplicated and alternative routing given as reserve circuits against any possible failure. For events of international interest additional circuits may be required to provide direct communication to the country concerned for each foreign commentator. There is also the broadcast made up of contributions from a number of OB sites; one example was the General Election in October 1959. For this type of broadcast additional circuits may be required to "cue" the producers into the programme. There may also be "feedback" or "talkback" circuits which help the producers at all the sites to maintain continuity of the programme as a whole.

A few typical examples of circuit requirements for sound for various types of outside broadcasts are given in Table 1.

Planning and Routing the Circuits

When an OB is being planned, the broadcasting authority asks the Post Office whether the proposed site can be linked by circuits to their particular programme or line centre. The plant available, and the lines and equipment to be provided must be thoroughly investigated and the enquiry answered as quickly as possible. Records are made of all OBs and the circuit performances are carefully filed. This information plays an important part in dealing quickly with any future enquiry.

Broadcast producers and engineers must solve many problems before a broadcast can be said to be "ON". It is therefore the exception rather than the rule that full details of the circuit requirements are given well in advance of the date of the event. This means that the Post Office must provide the circuits quickly to meet the specified date. Although these circuits are temporary and may be used for one transmission only, their performance must be the best possible within certain prescribed limits.

Table 1 shows two types of circuit, control and sound. The control circuits are bothway speech circuits of normal telephone quality. They are used for the Producer and the Engineer-in-Charge to maintain contact with their programme and lines centres throughout their stay at the site. These circuits are usually provided by connecting through spare cable pairs at successive telephone exchanges on the route. When the circuits are very long they will probably be routed into a Post Office trunk centre and extended via other trunk centres on trunk circuits to give good transmission and signalling facilities.

Provision of a sound circuit can present many problems. The circuit is unidirectional in transmission and is required to transmit the effects, commentary or music from the OB site to the broadcasting Lines Centre. The circuit requires a frequency bandwidth of approximately 50 c/s to 8,000 c/s when a full orchestral concert is being broadcast. There is no great difficulty in providing

Table 1

Type of Broadcast		Subject	Number of Lines		
			Sound	Control	
				Production	Engineering
A	Sound Broadcasts (ordinary)	(*a*) Church service (*b*) Dancing (*c*) Workers Playtime	1	1	1
B	Sound Broadcasts (Royal occasions)	(*a*) H.M. the Queen attending Mansion House (*b*) Royal Procession (per site on route)	2 2	1 1	1 1
C	Sound Broadcasts (overseas)	(*a*) Wembley F.A. Cup Final (*b*) Wimbledon Lawn Tennis Championships	4 5	4 5	3 2
D	Television (ordinary)	(*a*) Ice Skating (*b*) Theatre OB	1 1	1 1	1 1
E	Television (Royal occasions)	(*a*) Opening of Parliament (four sites) (*b*) H.M. the Queen attending Guildhall	12 2	5 1	8 2
F	Television (and Eurovision)	(*a*) Wembley F.A. Cup Final (*b*) Wimbledon Lawn Tennis Championships	7 11	7 11	4 2
G	Television (A number of OB sites contributing to one programme.)	(*a*) "Summer Song" eight sites (*b*) General Election. London only, 19 OB sites	8 28	16 165 Controls	9

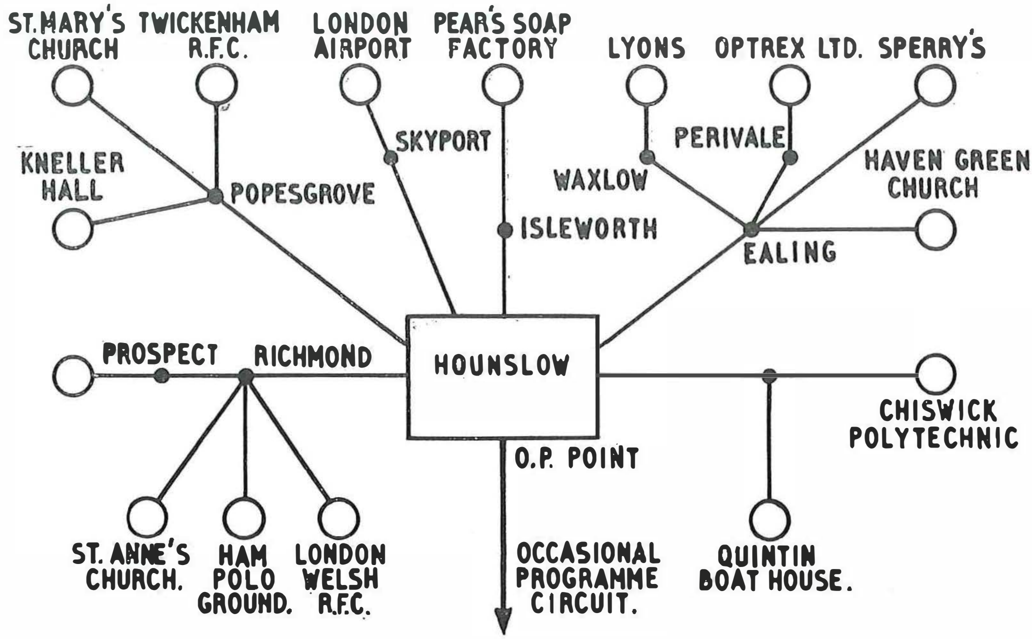


Fig. 1 : Typical use of an occasional programme circuit

these circuits in the centre of London or any big city as the telephone exchanges which cater for greater density of telephone users, serve smaller areas, and are relatively only a small distance apart. In the more residential districts the telephone exchanges cater for a larger territorial area of telephone users and are consequently further apart. The junction circuits between the exchanges will probably be loaded: that is, have added inductance. While this improves transmission efficiency for ordinary telephone purposes, it means that the circuits have a limited frequency bandwidth and there is a "cut-off" for all frequencies above those required for normal speech. Certain methods are used to overcome this "cut-off" effect but this worsens the noise disturbance level.

Occasional Programme Network

The cross connecting of circuits through successive exchanges on the route takes time, and staff have to be withdrawn from other work for occasional programmes which have to be prepared for quickly. It has been found in practice in London that there are many advantages in having a few zero loss highgrade circuits set up from selected exchanges in London Telecommunications Region and terminating at the London Repeater Station in Faraday Building. These circuits being of known quality and performance form a backbone network for circuits required from OB sites in the outskirts of London.

Each of these circuits, known as an Occasional Programme (OP) circuit, covers a wide area. Fig. 1 gives an example showing how one circuit has been used for transmissions (on different dates) from a large number of OB sites.

The network of occasional programme circuits does not solve all the problems. There are times when the circuit from the OB site to the nearest point on the occasional programme network is too long for the varying transmission losses at different frequencies to be equalized by special equipment installed at the end, or where the signal/noise ratio is unacceptable. For these occasions a portable music amplifier/equalizer is installed at some convenient exchange, usually about midway along a circuit. This, which is shown in Fig. 2, consists of a terminating unit, a variable equalizer, and two mains-operated amplifiers, one acting as a reserve.

The sound circuits set up using the OP network are routed into London Repeater Station and terminate on a Special Services position of Trunk

Test. The individual circuits can be connected through as required to permanent local end pairs set up between this position and the premises of the broadcasting authorities in London, or they can be extended to the provinces via other Post Office trunk centres.

The London Trunk Test position deals with all incoming and outgoing broadcast circuits and handles some 13,000 connexions a year. Fig. 3 shows the connexions set up for the General Election broadcast in October 1959.

The shorter length circuits from OB sites in and around the centre of London are routed into the Museum TV Network Switching Centre, where they can be equalized and amplified and connected through via permanent circuits to the premises of the broadcasting authorities. Fig. 4 shows the "patching" racks with the variable equalizers and the test equipment.

For televising the coronation procession of King George VI in 1937 the Post Office provided a network of special low loss cable. The BBC rents this. Since 1937 the cable network has been extended and the various terminations have been modified, until it now forms a backbone network

Fig. 2 : Portable music circuit amplifier equalizer

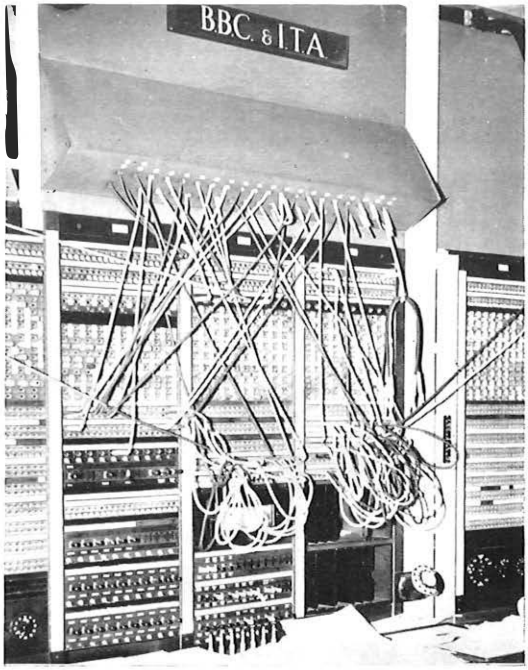


Fig. 3 : Connexions for General Election OB at London Repeater Station

for relaying vision signals from a number of exhibitions and concert halls and other OB sites. The network is shown in Fig. 5.

Experiments were made before the war using ordinary telephone cable pairs to transmit television pictures. A very wide frequency bandwidth of approximately 50 c/s to 3 Mc/s is needed but although there are very definite limitations, the Post Office uses such circuits regularly. In London alone in 1959 more than 500 television transmissions took place over this type of circuit and about 1,000 vision repeater points were operated. The distances between vision repeaters on these circuits range from three-quarters of a mile to two miles and depend on the gauge and type of cable used.

It will be appreciated from these few brief details that provision of this type of circuit is limited to the centre of London where (as already remarked) telephone exchanges are only a short distance apart. Fig. 6 shows a video repeater and test equipment.

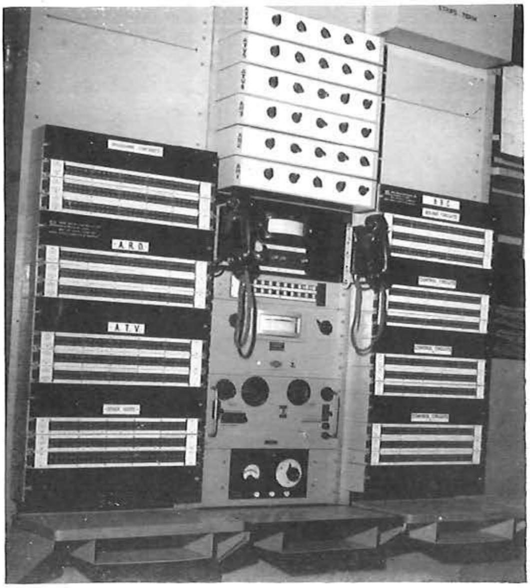


Fig. 4 above : Connexion rack at Post Office London Television Network Switching Centre

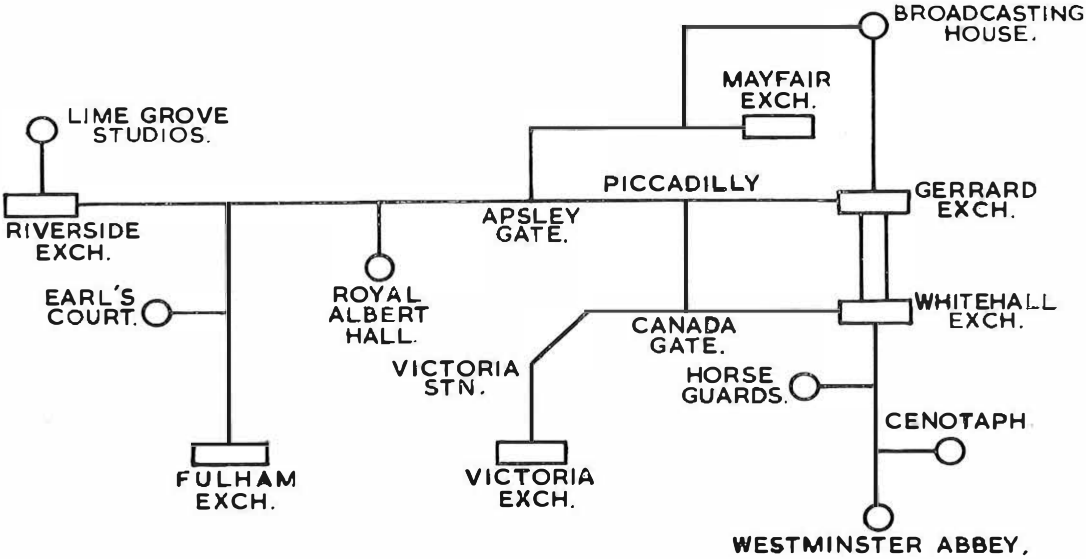
There have been occasions when cable pairs have been brought out at some convenient point along a route to a mobile repeater station mounted inside a vehicle. These occasions are exceptional as there is the problem of parking the vehicle and of obtaining mains power.

Outside broadcast vision circuits at video frequency or carrier frequency are also set up on spare coaxial cables when available. Such a circuit is provided each year for the BBC for the Wimbledon Lawn Tennis Championships broadcast. This circuit is about 16 miles in route length. The first two repeaters are provided on ordinary telephone plant at video frequency and then the signal is used to modulate a carrier frequency which is sent over some 12 miles of coaxial cable with four intermediate equalizer/amplifier points on the route.

A similar circuit has been set up on two occasions between London and Brighton. This circuit had a route distance of about 60 miles, and 17 miles were operated at carrier frequency and the remainder at video frequency using a total of fourteen repeater points.

Provision for closed circuit broadcasts is another Post Office service. The most notable of sound

Fig. 5 below : Vision Outside Broadcast network



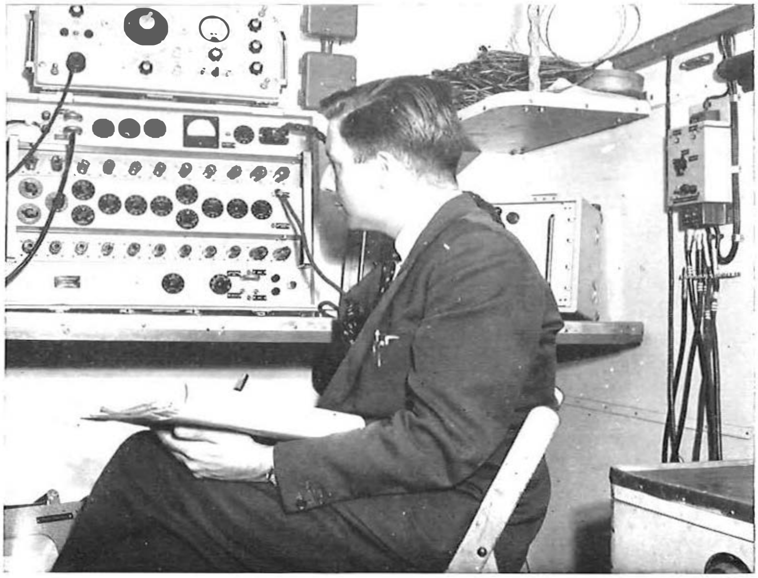


Fig. 6 : Video repeater equipment

closed circuit broadcasts were those set up for the "Billy Graham" transmissions. Wherever a meeting was held it was invariably relayed over Post Office lines to many other towns and cities in the country.

Circuits have also been provided for closed circuit television. Some have been used for Post Office publicity; for example, the inauguration of ERNIE, the Premium Savings Bonds prize selector at Lytham St. Annes in 1957, when the pictures were relayed to the Radio Show Exhibition at Earl's Court. As shown in the Spring *Journal*, closed circuit television is provided for the Stock Exchange. Other interesting transmissions have been made for the Smith, Klyne and French Research Institute, these being over a number of circuits from various hospitals to meeting halls. Live transmissions of surgical operations in colour have been relayed and displayed on a large screen to an invited audience of the medical profession. Sound circuits are also provided to enable questions to be asked and answered while an operation has been in progress.

While these transmissions must prove of immense teaching value to the medical profession, they do not always make easy viewing for the Post Office staff monitoring a circuit during the transmission!

Telephone and Telegraph Society Programme

The Post Office Telephone and Telegraph Society of London opened its winter session on October 10 with an address on "Fire Communications in Surrey" by Mr. A. H. Johnstone, Chief Officer, Surrey Fire Brigade, and Mr. E. N. Jack, of South West Area, London Telecommunications Region, who described the teleprinter system, used by Surrey Fire Brigade, in our Summer issue.

On November 29 Mr. T. A. O'Brien, CBE, Post Office Public Relations Officer, will speak on "Public Relations and You". On December 19, Mr. C. R. Smith, Clerical Mechanization and Buildings Department will talk about "The Electronic Office", and on January 20 Mr. T. H. Bridgewater of the British Broadcasting Corporation will speak on "TV Outside Broadcasts". Mr. W. Hadfield of the Ministry of Transport will talk on "Control of Road Traffic" on February 28, and on March 13 after the Annual General Meeting, Mr. D. Smith, Inland Telecommunications Department, will end the session with an address on "Twopenny Telex".

All the talks will be given in the Lecture Theatre of the Institution of Electrical Engineers, Savoy Place, W.C.2, beginning at 5.15 p.m.

Producing more circuits from the transatlantic cable

J. C. Billen, A.M.I.E.E.

DURING the past year two major changes have taken place on the United Kingdom-Canada-United States telephone cable system (TAT1), both intended to provide additional circuits to meet the ever-growing traffic demands and to improve the service on the transatlantic route. These changes have been made possible by the co-operative efforts of engineers of the American Telegraph and Telephone Company and the British Post Office.

The Post Office contribution has been to replace the original 4 kc/s spaced channels by 3 kc/s spaced channel equipment, thus making more efficient use of the frequency spectrum available on the cable. The Bell Telephone Laboratories at the same time developed a time assignment speech interpolation system (TASI for short) which approximately doubles the number of circuits working on a given number of cable channels. Agreements between the American company and the Post Office in 1958 ensured that the TASI and 3 kc/s equipment would be compatible. It was further agreed that the American company would be responsible for developing and providing TASI and the Post Office for developing and providing the 3 kc/s spaced channel equipment. Both these developments have been applied to the United Kingdom–United States circuits in the cable only. Additional capacity will become available to Canada next year when the CANTAT cable comes into service; in the meantime other arrangements have been adopted temporarily to provide additional circuits to Canada.

The transatlantic cable was originally equipped to provide 36 channels between the United Kingdom and North America. The 36 channels were used to provide 29 circuits between London and New York (White Plains) and six between London and Montreal. The remaining channel was split to provide voice frequency telegraph facilities between London and Montreal and between London and White Plains.

The telephone circuits were provided by using conventional 4 kc/s spaced channel equipment of the type normally used on land carrier or coaxial cable systems. This equipment uses each 4 kc/s of cable frequency spectrum to provide an audio channel of 300–3,400 c/s nominal band width. Such channel equipment permits an economical electrical design and is widely used in national and international carrier and coaxial cable systems. It is not, however, very efficient because only about 78 per cent. of the available bandwidth is effectively used.

The 3 kc/s spaced channel equipment developed by the Post Office provides audio channels of 300–3,150 c/s nominal bandwidth each requiring 3 kc/s of cable frequency spectrum. It is thus much more efficient than 4 kc/s spaced channel equipment because it effectively uses about 95 per cent. of the available bandwidth. As a result 16 channels spaced at 3 kc/s can be provided in the basic group bandwidth which normally provides only 12 channels spaced at 4 kc/s. Using such channel equipment the number of London–New York circuits on the transatlantic cable system has been increased by one third.

It is important to realize that although each speech channel takes up only 3,000 c/s of the cable frequency spectrum, the band effectively transmitted is 300 to 3,150 c/s, by comparison with 300–3,400 c/s for conventional 4 kc/s spaced channel equipment. Subjective tests have shown that the loss of 250 c/s at the top end of the audio band does not noticeably affect the quality of the speech transmitted.

The design of the equipment is naturally more complicated than that of conventional channel equipment and uses double modulation processes in conjunction with very steep sided filters to achieve the separation of channels in the restricted space between adjacent channels.

The conversion of the transatlantic cable system from 4 kc/s to 3 kc/s spaced channels was not just a simple matter of replacing the channel equipment but posed a number of problems. First, 3 kc/s working is not possible over the inland plant between London and Oban and Sydney Mines (Nova Scotia) and New York (White Plains), since 4 kc/s equipment used on the common plant of the inland systems gives rise to spurious tones at 4 kc/s intervals. This is normally of no consequence because the spurious tones fall between channels; with 3 kc/s spaced channels these spurious tones would cause whistles in the channels. In addition the inland plant would impair the quality of transmission on those channels at the edge of the group band. The 3 kc/s spaced channel equipment has therefore been installed at the submarine cable terminals at Oban and Sydney Mines so as to provide the maximum number of good quality voice channels. The voice channels are then extended via standard 4 kc/s channels to New York and London. This break up of the original London –New York through groups, which had no intermediate voice frequency interconnexions, necessitated extensive changes in the pilot arrangements by which the engineering maintenance of the circuits is assured. Each of the three group paths, London–Oban, Oban–Sydney Mines and Sydney Mines–New York is now provided with its own section pilot which is automatically regulated to within close limits. Furthermore a change in level in excess of prescribed limits on any section results in an alarm condition, which is automatically extended over an alarm reporting system to London and White Plains. This automatic alarm reporting is particularly important with the introduction of TASI, because faulty channels must rapidly be taken out of service.

The 3 kc/s channel equipment at Oban and Sydney Mines is mounted on racks 9 feet high and each rackside accommodates the equipment for 16 channels. The rackside is self-contained and includes its own power supply panels which are energized from a regulated AC power supply.

The decision to equip the transatlantic cable with 3 kc/s spaced channel equipment and TASI was taken at discussions between the American company and the Post Office in July 1958. The 3 kc/s equipment was manufactured in this country, shipped to Sydney Mines in late 1959, and installed by the end of December. The conversion from 4 kc/s to 3 kc/s working was completed during January 1960. This complicated operation was carried out with minimum of disturbance to the

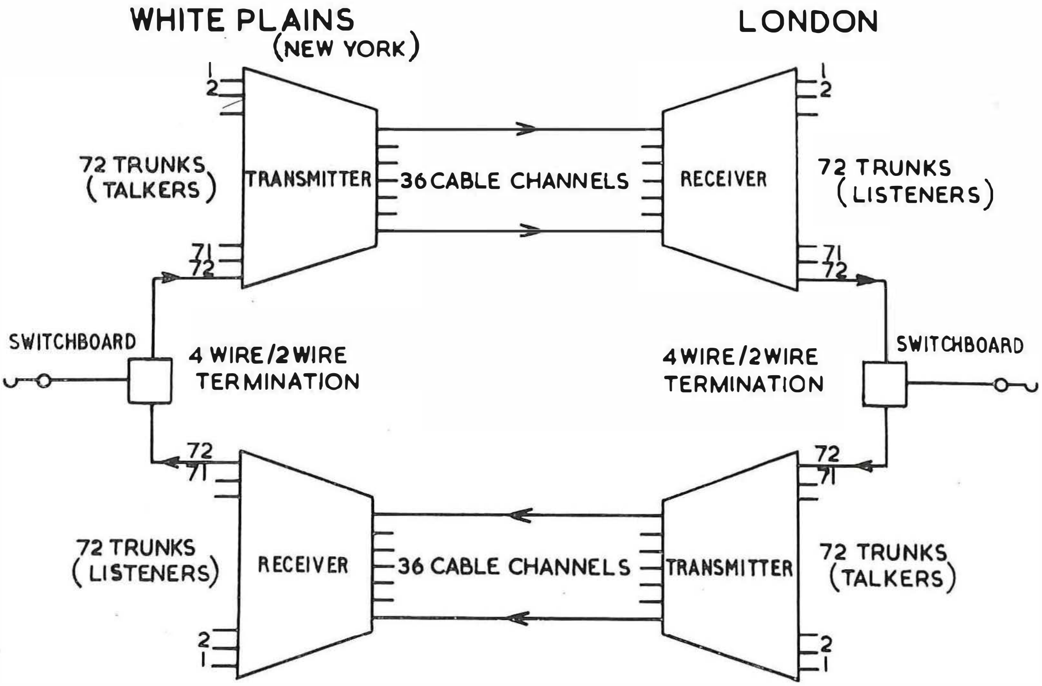


Fig. 1: Basic TASI arrangement for 72 trunks with 36 cable channels

working system, which had to be kept going to maintain the service on the route. It entailed arduous and long hours of duty, usually at night, by engineers on both sides of the Atlantic. Post Office engineers working at Sydney Mines and Oban were responsible for commissioning the 3 kc/s channels on the submarine cable. In addition to the 3 kc/s equipment itself, the Post Office was responsible for providing new pilot equipment and the alarm reporting equipment. This was all manufactured in the United Kingdom, installed in White Plains and Sydney Mines under Post Office supervision, and thereafter tested and put into service by Post Office engineers. In all, 22 racksides of equipment provided from the United Kingdom were installed in North America. Complementary equipments were installed in this country.

How TASI Works

Expensive equipment and facilities are commonly shared between users of the telephone service. When we make a call from a manual exchange we share the services of the switchboard operator with other subscribers; a caller on an automatic exchange shares the equipment and switches at the exchange with others on the same exchange. In the same way, when we make a call to another exchange we are given the use of a junction or trunk circuit from a group of such circuits for the duration of the call we wish to make; at other times the junction and trunk circuits are used by other telephone users. An extension of this idea of time sharing is the underlying principle of TASI equipment recently put into service on TAT 1.

Long-distance telephone circuits require amplifiers at intervals in the cables used to provide the circuits. These are fundamentally unidirectional devices. For this reason modern long distance circuits provide two individual transmission paths (usually referred to as channels) one in each direction, between the two ends of the circuit. Two subscribers engaged in conversation on a trunk call are therefore given the exclusive use of a circuit comprising two unidirectional channels, one for each direction of transmission. By the very nature of normal conversation one person listens while the other talks, so that for at least half the time of a two-way conversation, one or other of the channels is idle. By using channels while they are idle in this way, it should clearly be possible to make more effective use of the plant and carry more traffic on the same amount of cables and equipment. The TASI equipment does this and so enables more circuits to be provided. When one subscriber is talking to another TASI equipment assigns a channel to him in the talker-listener direction every time he speaks. He does not use the same channel each time, and when he is listening the channel he has been using for speaking is assigned to other users.

In discussing this subject it is necessary to distinguish between the trunk circuit (trunk, for short) which appears on the switchboards at London and New York, and which is connected to the two subscribers making a call over the cable, and the channels, which are the unidirectional communication paths over the cable itself. TASI is interposed between the cable channels and the trunk ends on the switchboards and functions to ensure that channels are assigned to talkers and listeners to meet their conversational needs. Fig. 1 indicates in a simple way the basic TASI arrangement and shows the association of 72 trunks with 36 cable channels.

The diagram shows a TASI arrangement capable of doubling the traffic handling capacity of a 36-channel cable system so that up to 72 conversations can be carried on 36 channels. When a talker starts to speak TASI connects him to the distant listener over an idle channel in the cable. TASI is a reasonable machine and once a connexion is established it is not disturbed unless the channel is required by another talker, so that while there are fewer talkers than channels, interpolation—that is, interleaving of other conversations on the one channel—does not take place. When there are more talkers than channels, interpolation starts automatically. As talkers become silent they are rapidly disconnected from the channel they are using, which is then assigned to an active talker who requires a channel. As soon as they become active, disconnected talkers are rapidly connected to other free channels. The whole process of connecting an active talker to a free channel is so rapid that it has no noticeable effect on the users' conversation.

It will be appreciated that the switching of talkers to free channels and their connexion to listeners at the far end has to be carried out very rapidly, since some speech will be lost (clipped) while the connexions are being made. The TASI design enables the connexion to be made in about 17 milliseconds which results in an initial clip of this duration for each speech burst when the traffic loading is such that interpolation is taking place.

It will be realized that with more talkers than channels there is the risk that a talker will not find a

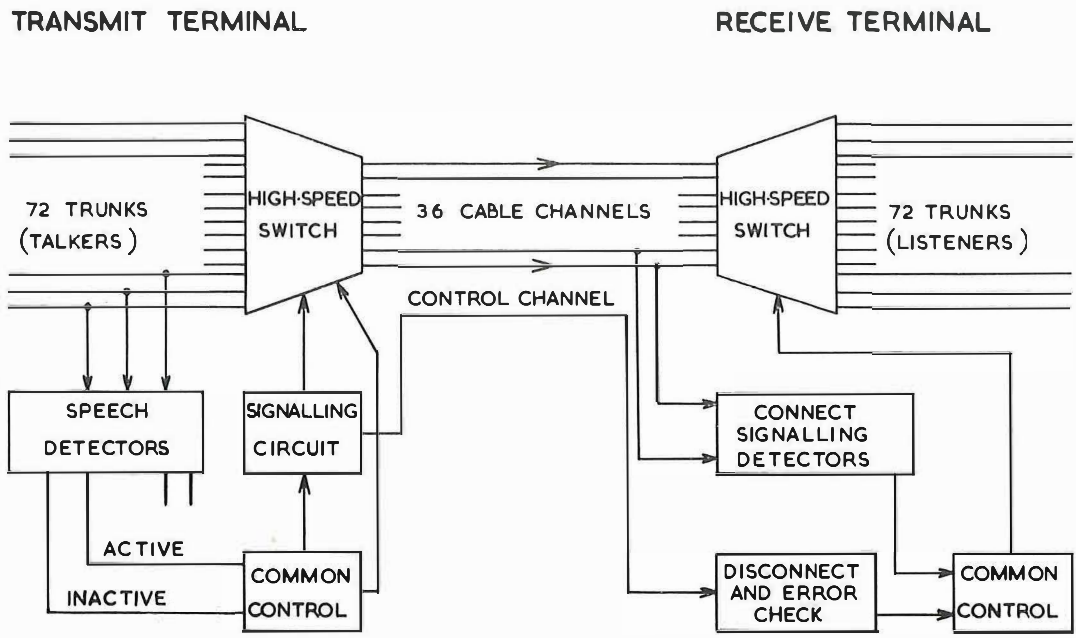


Fig. 2: Simple block diagram of TASI arrangement. Opposite direction of transmission requires exactly similar equipment

free channel at the moment he needs it. This risk would obviously be quite high if we attempted to use the speech interpolation idea with too few channels; for example, it would be impracticable to attempt to make two simultaneous conversations on one channel because the risk of two talkers both requiring the one channel at the same time would be too great. With larger groups of channels, however, the situation becomes more favourable and the chance of not finding a free channel is greatly reduced, so that the advantage to be obtained by using TASI increases with the number of channels available. Even so the more trunks we attempt to use with a given number of channels the greater the risk of an active talker not finding a free channel when he needs it. When this occurs some part of the talkers speech burst will be lost; this situation is referred to as " freeze out". Subjective tests have shown that small percentages of "freeze out" can be tolerated by subscribers using the cable and at present TASI on the transatlantic cable is operated so that, on average, the total loss of conversation will not exceed 0.5 per cent. This level of freeze out is barely perceptible even to trained observers.

The increase in the number of circuits which a TASI system can give depends primarily on three factors:—

(i) The number of channels available.

(ii) The average activity of talkers (including telephone operators)—that is, the percentage of time they talk during a conversation.

(iii) The degree of freeze out which can be tolerated.

With a unidirectional average speech activity of 40 per cent. and with 36 channels, a gain of slightly more than two to one will result in a freeze-out of 0.5 per cent. This degree of freeze-out is quite acceptable and enables 72 trunks to be provided with 36 cable channels. A clearer impression of the significance of 0.5 per cent. freeze out may perhaps be gained by stating that for this amount of freeze out about 1 per cent. of the talk spurts will be frozen out for 0.08 seconds or longer. A freeze out longer than 0.08 seconds will occur on average about four times during a 10-minute call. Less than one talk spurt in 10,000 will be frozen out for as long as a quarter of a second, and this will occur only once in about 30 calls during the busy hour.

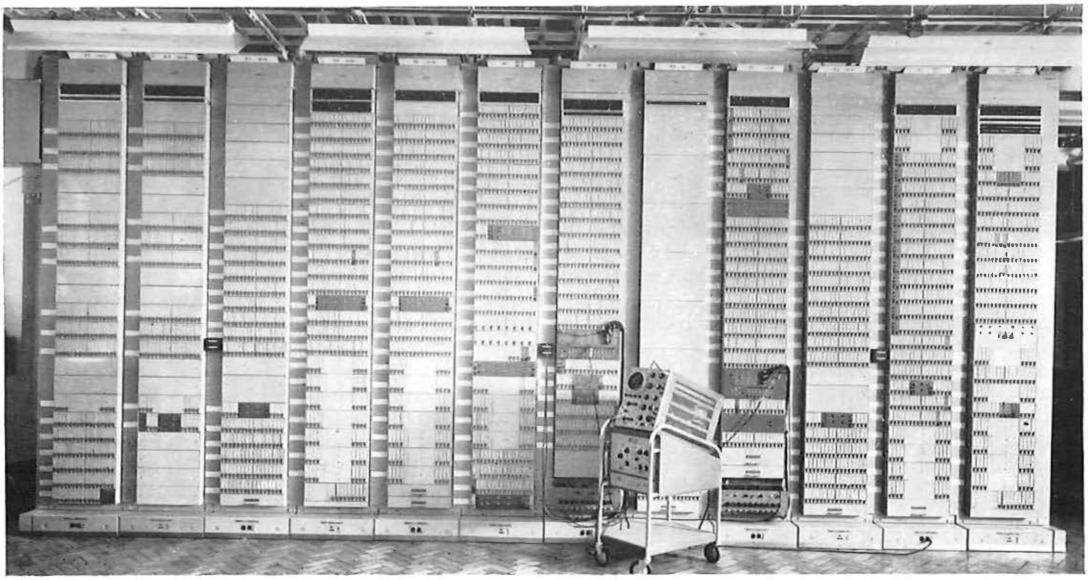


Fig. 3: General view of London TASI terminal

For comparison it is worth noting that the average syllable length is about 0.125–0.25 seconds, so that 0.5 per cent. freeze out will result at worst in the loss of one or two syllables in about 30 calls. It is emphasized that all these remarks apply to a 0.5 per cent. freeze out condition, which will occur only at times of peak traffic; at other times negligible freeze out occurs.

As a result of present requirements for special circuits (telegraph circuits and private wires) in the transatlantic cable, only 25 channels are available to TASI, which enables the provision of 47 trunks. In addition to the channels used for speech a further channel is required between the TASI terminals for control purposes, the function of which is described later.

Basically the TASI equipment consists of a transmitter and receiver for each direction of transmission (see Fig. 2). The transmitter has four major parts:

(i) The speech detectors
(ii) A high speed electronic switch
(iii) A signalling circuit
(iv) Common control equipment

The major items of the receiver are:

(i) The connect signalling detectors
(ii) A high speed electronic switch
(iii) Disconnect and error checking equipment
(iv) Common control equipment

Stated briefly the operation of connecting an active talker to a listener over a free channel is as follows. The speech detector detects the presence of speech from the talker and as a result the control equipment assigns a free channel to him. Instructions in the form of coded signals are sent over this channel to cause the TASI receiving terminal equipment to connect the channel to the corresponding listener. All this takes place in about .017 seconds—far less time than it has taken the reader to read the first word of even this very abbreviated statement of the operation—in fact, even before the first syllable has been read. Once set up the connexion is not disturbed unnecessarily. However, when the traffic rises to the extent that less than two free channels remain, TASI disconnects unwanted channels as soon as talkers become inactive. To do this it is no longer practicable to transmit signals over the channel to be disconnected, since the callers would hear such signals. Disconnect signals are therefore sent over a separate control channel and these result in unwanted channels being freed ready to be assigned to other active talkers. The control channel is in use only to transmit disconnect signals for a small fraction of the time. At other times it is used to transmit signals between the transmitting and receiving terminals which continuously check the correct association of trunks and channels at the two ends and rapidly correct any errors which may have occurred.

Each trunk is provided with a speech detector at the outgoing end which serves the important purpose of deciding whether the talker is active or not. It must be able to detect the presence of speech over a wide range of levels and be sufficiently sensitive to detect the presence of speech from a low level talker. It must not, however, be so sensitive that it operates to low level noise, which is always likely to be present, as this would result in the trunk appearing active and unnecessarily engage a channel, thus defeating the whole object of TASI.

The high speed switch which connects active talkers to free channels operates on the time division multiplex principle. The speech on each line is sampled 8,000 times per second and the resultant pulses pass via a common highway to channel gates. These gates are opened in sequence to allow the pulses from individual talkers to enter the channels which have been assigned to their use. The original speech waveform is restored by passing the samples through a low pass filter. By sampling the speech 8,000 times per second the original waveform can be reconstructed with virtually no distortion.

A free channel having been selected at the outgoing end, instructions to connect this channel to the correct trunk at the receiving end are sent ahead of the speech, in the form of a multi-frequency signal.

The high speed switch at the receiving end operates in a similar manner and connects channels in the correct sequence to the required trunks.

The common control equipment is the "brain" of the system and uses the pulse and digital techniques of modern computers. Its function is to scan the speech detectors continually to determine whether talkers are active or inactive and to note their identity. This information is used to connect the proper signalling code to an available channel and to associate the active talker with the selected channel via the high speed switch. The talker/channel assignments are stored in a delay-line type memory.

The TASI terminal equipment in London is installed in Faraday Building and is shown in Fig. 3. The equipment, not surprisingly, is complex and costly but it is a worthwhile investment for use on a long submarine cable system such as the transatlantic cable. There are altogether 16 racks of equipment including maintenance and test racks (Fig. 4). The construction and design uses the most modern techniques. About 9,000 transistors and 20,000 diodes are used in this terminal equipment. Most of the circuits are on printed circuit boards; a typical board extended from the rack for testing is shown in Fig. 5. The whole of the equipment has been developed in the Bell Telephone Laboratories and manufactured in the United States by the Western Electric Company.

The TASI equipment for the London terminal was received in this country during the last week of 1959 and was installed by engineering staff of

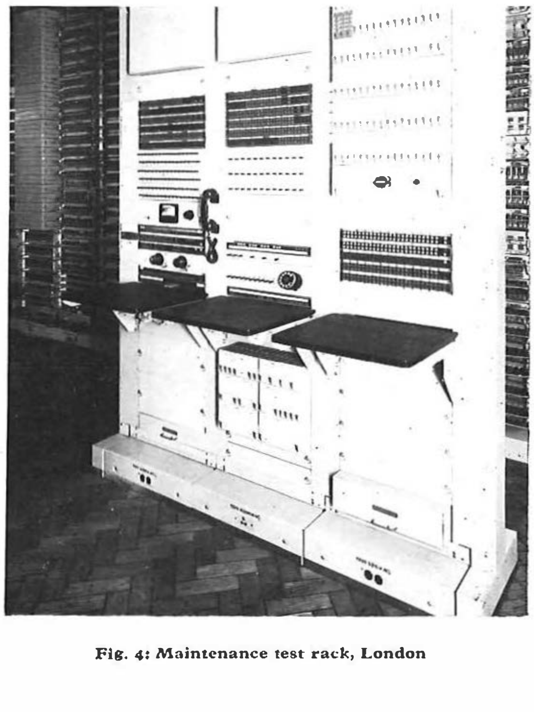


Fig. 4: Maintenance test rack, London

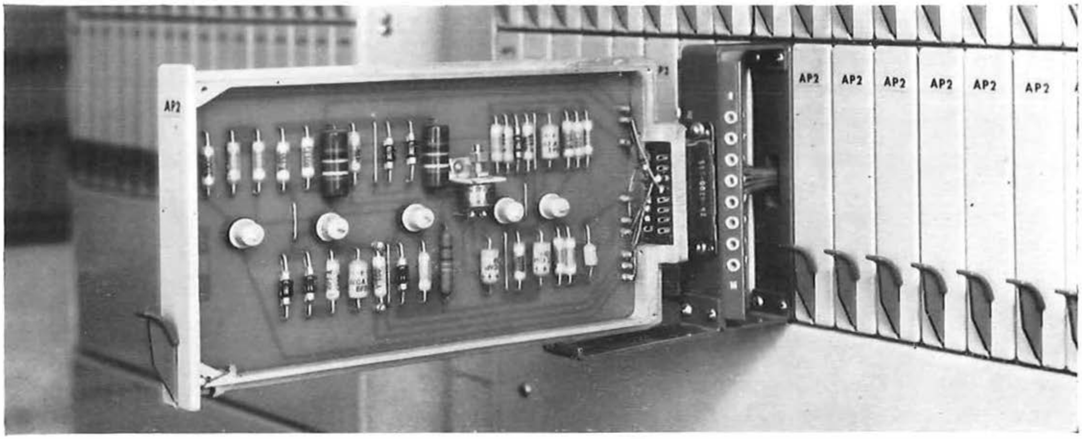


Fig. 5: TASI: printed wiring board, extended for test

London Telecommunications Region Long Distance Area. A team of Bell Telephone Laboratories engineers started testing early in February 1960; during the same period installation and testing work was going ahead at the White Plains terminal at the United States end of the system. Early in April TASI was pressed into service at short notice during a cable fault on the transatlantic route to make the greatest use of a limited number of cable channels. Though not fully tested it performed very satisfactorily and provided additional circuits which were much needed at the time. TASI went into full time service on May 1 although engineering tests continued until June. As mentioned previously only 25 channels are at present available to TASI and 47 trunks are being derived from these channels.

The additional trunks provided as a result of TASI have enabled speedier service by reducing delay in connecting calls on the London–New York route.

The successful completion of the work of providing more circuits on TAT1 is yet another example of the excellent co-operation between the American company and the Post Office. The engineers of each partner have contributed their best designs and developments without duplicating effort, and this has enabled us to carry a complicated programme through successfully to meet an exacting time-table.

Acknowledgement is made to the American Telephone and Telegraph Company and the Engineer-in-Chief of the British Post Office for permission to make use of the information contained in this article. The author gratefully acknowledges the published information by the Bell Telephone Laboratories, on which he has freely drawn.

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Time Assignment Speech Interpolation (TASI): C.E.E. Clinch, Post Office Electrical Engineers' Journal, Vol. 53, *p.* 197, *October* 1960.

The new edition (October) of the London (Postal Area) Telephone Directory (A–D) contains the new-style preface used in December 1959 for Stoke-on-Trent directory, slightly revised.

The Post Office Inland Telecommunications Department revised and shortened the text, which London Typographical Designers laid out in the new style. Text is now in Times New Roman, and headings are in Perpetua Bold.

The new preface will now be used for all new Area directories.

In future, commercial advertisements will not appear on directory covers, the space being used for Post Office publicity only.

The Contracts Department

THE Post Office Contracts Department is responsible for arranging contracts for the supply of stores and executing works and non-personal services required for the operation of Post Office telecommunication and postal services, other than carrying mail and erecting buildings, and for selling surplus and scrap stores. The Department is also responsible for supervising and guiding contract work carried out in the Directorates and Regions and other Post Office departments. The staff of 390 covers the work of four main Purchasing Branches, and the work appropriate to the Sales, Production, Advisory Service to Regions, Procedure, Establishments, Accountancy and Technical Costing branches.

Purchasing methods fall under three categories—long-term agreements, competitive tendering and, exceptionally, non-competitive tendering. Supplies of telephone exchange equipment, telephone apparatus, telephone cables and loading coils are purchased under long-term agreements. These agreements also provide for laying cables and installing exchange equipment.

Prices are negotiated with the various groups of firms concerned after the Department's professional accountants have ascertained the actual costs of manufacturing selected items, and the other items are subsequently priced by technical costs officers. Prices hold good for the period of the agreement subject only to adjustment for variations in the rates of labour and price of materials. Stores and works to a value of approximately £28 million were ordered under the agreements during 1959–60.

For purchasing stores and executing works not covered by the long term agreements the normal method of purchase is by competitive tender, which for stores requirements cover specified quantities to be delivered at a specified rate, or estimated quantities spread over a period of 12 months or more to be delivered as required, depending on the requirements of the department using the goods.

Lists of approved tenderers for each of the various classes of items are maintained. More than 1,000 applications were received during 1959–60 from firms wishing to be placed on the approved

Left to right: Mr. R. OLIVER, Assistant Director; Mr. G. H. ARNOLD, Assistant Director; Mr. C. T. MEREDITH, CBE, Director; Mr. P. J. MAPPLEBECK, Deputy Director; Mr. E. WILLIAMS, Assistant Director; Mr. T. J. TAYLOR, Assistant Director; Miss E. M. L. LANGFORD, Secretary.

lists. Where there is no competition the Administration's approval is sought for placing high value contracts, and satisfaction on price is obtained by technical or accountancy investigation of costs of manufacture.

The range of items purchased and the works executed outside the long term agreements are extremely wide; for example, overhead and underground stores, teleprinters, radio links, oils and paints, postal stamps and stamped stationery. In fact, Post Office requirements bring the Contracts Department in touch with most trades. During 1959-60, 5,500 separate contracts valued at £37 million were placed outside the agreements, while sales of scrap materials realized more than £3 million.

The Production Branch, operating from both London and Birmingham, progresses contracts for the supply of engineering stores to ensure that contractors maintain their delivery terms. Reports from this Branch on the performance, reliability and capacity of contractors are taken into account when tenders are being assessed; at this stage the Engineering Department is consulted on technical matters when necessary.

The Technical Costs Branch advises oversea administrations on prices for telecommunications equipment, while purchases are also made on behalf of other Government Departments—for example, for the supply and repair of hearing aids for the Ministry of Health. Research and Development contracts are placed to improve the service offered by the Post Office both for telecommunication and postal items, and responsibility rests on the Department for the commercial exploitation of any patents or registered designs which may arise from such contracts or from development work within the Post Office itself.

Contracts Department's work is essentially commercial and its objective is to meet the needs of the telephone, telegraph and postal services with the minimum of expenditure consistent with the specified standards and delivery required. Nevertheless, as part of a Government department, it uses procedures and follows policies common to other Government purchasing departments; for example, in the treatment of Priority Suppliers—organizations with disabled personnel—and in the preference accorded to firms in Development Districts. The Department is represented on the various Contracts co-ordinating committees set up by the Treasury.

New "Alert" is Launched

H.M.T.S. *Alert*, fourth of her name, was launched by Mrs. Bevins, wife of the Postmaster General, on November 7.

Designed primarily as a cable repair ship the new *Alert* is also capable of laying up to 900 nautical miles of submarine telephone cable incorporating rigid repeaters. She will be based at Dalmuir on the Clyde, since her main task will be to maintain the long-distance transatlantic cables, but a programme of cable laying expeditions has been planned, starting with the St. Lawrence section of the CANTAT cable (which is to be laid next year) between Corner Brook, Newfoundland, and Grosses Roches, Quebec. She will then lay a cable between Manahawkin, New Jersey, and Bermuda.

Her overall length is 418 feet and her gross tonnage 6,200. She has a propelling power of 4,400 b.h.p. and her service speed is 15 knots maximum and 12 economical. Her range is 7,000 miles, and net coiling capacity is 64,660 cubic feet.

Alert incorporates many novel features for a cable ship. Her propelling machinery is diesel electric. The propulsion motors can be directly controlled from the cable control stations either forward or aft. To aid manoeuvrability on the cable ground and when berthing, an athwartship thrust unit of 200 b.h.p. is fitted in a tunnel forward, below the waterline.

The normal practice in laying long cables is to lay over the stern. The machine for this purpose, situated aft, is the 5-sheave paying out machine developed by the Post Office Research Branch for laying telephone cables that incorporate rigid repeaters. With conventional paying-out machinery the ship would have to be stopped while paying out a rigid repeater but with the 5-sheave machine she can carry on without interruption. There will be two independent cable picking-up and paying-out machines forward for use in repair operations and when laying shorter lengths.

The new ship will have a complement of 131, including supernumerary technical staff. The accommodation is in conformity with the best modern practice, with mechanical ventilation.

Telephone Accounting Developments

A. M. Jones

THE Postmaster General, announcing in July the tariff changes recorded in our Autumn issue, said "I also intend to restore quarterly accounting to all telephone subscribers. This will require a phased programme over the next four years. I believe the public will welcome a return to quarterly telephone accounts." This reintroduction of quarterly accounts is one of a number of changes which have been made recently, or will be made in the near future, in telephone billing.

Just over 5,000 staff in Telephone Area offices are employed on telephone and telex billing work; they prepare and despatch nearly 10 million bills a year, deal with the payments and answer the queries that arise. The methods they use have been given much attention in recent years, and while some of the resulting changes have reached most Areas, others are only now beginning to spread. The overall effect on Clerical Divisions is considerable, both as regards the way in which the work is organized and the number of staff needed, and the process is one which seems likely to continue.

Just before World War II the Post Office changed from a manual ledger system of accounting to the use of the add/lister accounting and addressing machines which produce the form of bill we all know. In 1943 quarterly was replaced by half-yearly accounting to save manpower, paper and machines. This was described at the time as one of the largest single sources of savings of this kind made by the Post Office during the war. Although plans to reintroduce quarterly bills were made in 1946 they had to be cancelled because of manpower restrictions. The pattern of telephone billing procedure now being altered is therefore one which has existed with little change for a good many years.

Developments in accounting methods have been approached from two main directions, a desire to simplify procedures and the parallel aim to mechanize work. Both are intended to eliminate drudgery, to achieve greater accuracy, to reduce process costs and to meet the needs of a service growing in size and complexity. Sufficient progress has been made in recent years to show that quarterly billing can be restored without additional staff by taking the fullest advantage of the fall in ticket work resulting from Subscriber Trunk Dialling and of the mechanized systems which have been developed. The most impressive change is the introduction of punched-card methods, but there are a number of others which deserve notice; indeed it is doubtful whether the full effect of what has been, and is shortly to be, done is generally recognized.

Telephone Accounts Groups

For many years the standard method of dividing accounts work in Area Clerical Divisions was on a functional basis. Three main sections were concerned with this work, known as Rentals, Fees and Ledgers. The arguments for and against splitting a complex operation into specialized functions are probably well known; in telephone accounting it has been shown that although with functional working a well-planned rotation of staff over the various duties could ensure that they knew how other sections operated, better results are obtained by making small teams responsible for all aspects of the accounts of a group of subscribers.

The possibility of combining an Area's Rentals, Fees and Ledger work on a territorial basis was first successfully demonstrated by an experiment started in Coventry Telephone Manager's office in 1954. Six further Areas went over to the new organization in 1956 and the results were so favourable that it was adopted as the standard arrangement for Area accounting. The introduction of the Telephone Accounts Groups system—familiarly known as TAG—involved a considerable training programme and rearrangement of staff and accommodation; the changeover had to be very carefully planned and spread over a period. Usually any other changes during the period had to be avoided.

Mechanized Local Call Accounting

The machine accounting system introduced 20 to 30 years ago left many operations to be done manually, including the assessment of the charges for local calls. Meter readings, whether made by exchange, clerical or engineering staff, were entered by hand in the columns of a meter book. The numbers of ticketed local call units were counted and entered at appropriate intervals, credits (refunds and engineering test calls) were allowed for, and the old meter reading deducted from the new reading; the residence free call allowance and the business (small user) rate were further complications. The resulting total of chargeable units was then evaluated to produce the local call charge to be included in the account.

A well-kept meter book was a joy to see but the system was very vulnerable to error when figures were hastily entered or were in various hands, and the degree of accuracy depended entirely on standards of mental arithmetic. Several Areas used "plus-adders" to improve the system but substantial improvement came only with the use of an accounting machine with "live keyboard" facilities; these enable all the various calculations except the final evaluation to be done mechanically, with most of the figures neatly recorded on cards which replace the meter books. This method of accounting for local calls, known as the "Cambridge" system because it was developed in that Area, is now used in most Areas.

Tariffs

Maintenance of records of subscribers' installations, the preparation of bills and the treatment of enquiries are made easier by simple tariffs. But tariffs are not designed solely to meet billing requirements and simple charging arrangements do not necessarily meet the needs of subscribers or of the service generally. Nevertheless, much can be done if tariff features which have outlived their usefulness can be dropped. A number of examples occurred during the tariff revision in October 1957, when the residential free call allowance, the business (small user) tariff and the sliding scale of charges for extension rates were all abolished. Such simplifications can at least go a considerable way to offsetting the extra billing work caused by the introduction of new services and facilities and of such new variations as the recent reduction in the residential subscribers' local call charge.

Counterfoil Bills

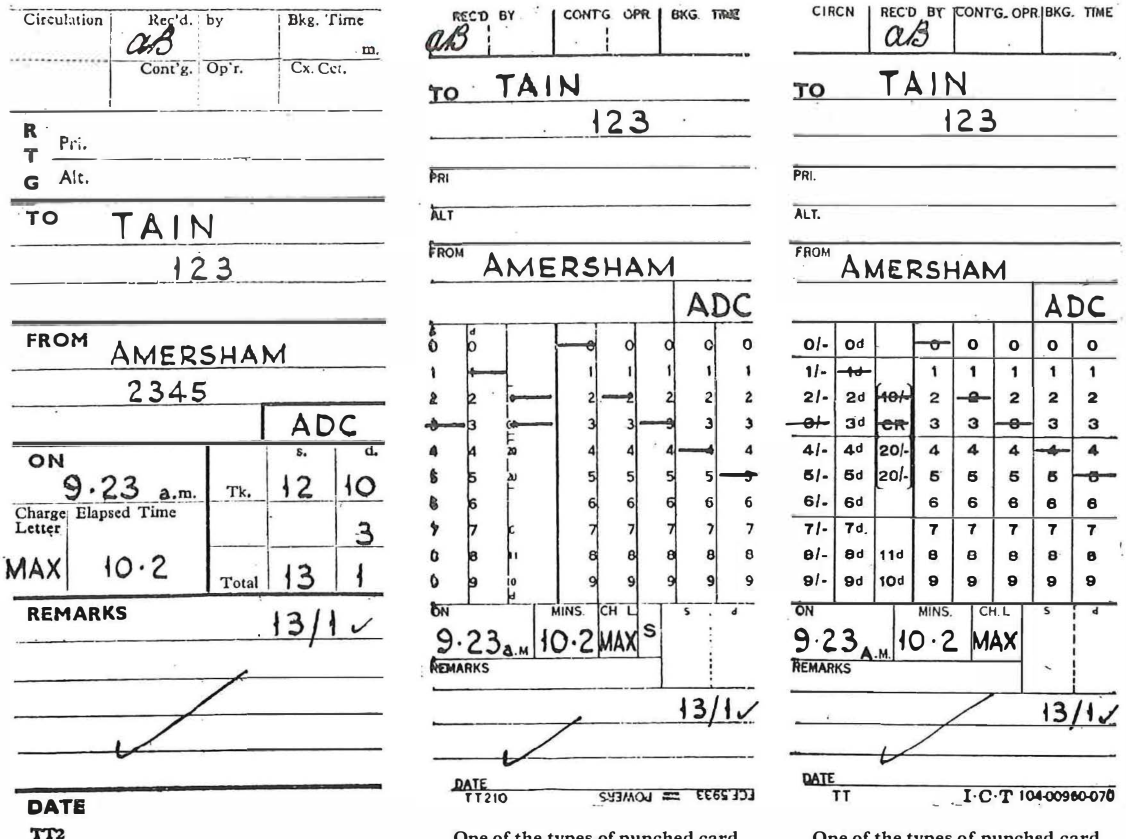
Until 1958 the standard telephone bill consisted of two portions—the bill sent to the subscriber and the ledger sheet retained in the Area Office. When the subscriber paid his bill, either at a Post Office or direct (usually by cheque) to the Area Office, a receipt was prepared in manuscript and sent to him with his bill, an under-copy of the receipt being used for internal accounting. In an endeavour to reduce the amount of work involved, a trial was carried out at Belfast of a bill which included a counterfoil in the portion sent to the subscriber; the receipt was given on the bill and the counterfoil detached and used for the internal accounting processes.

The passing of the Cheque Act, 1957, increased the practice of paying bills by cheque and not requiring a receipt, thus reducing work on the part of both payer and payee. However, unless such a customer paying by cheque is sent a bill with a counterfoil he is liable to keep the bill for his own records and the arrival of a large number of cheques without any direct indication of which accounts they refer to can be confusing. A telephone bill with a counterfoil which could be returned with the cheque was therefore needed and the experimental system tried in Belfast was adopted nationally. This was not altogether an easy matter because, with the machines then normally used for bill preparation, both the counterfoil and the ledger sheet had to be carbon copies of the main bill and a number of difficultics had to be overcome before a satisfactory form layout was achieved. There were also a few complaints from subscribers who objected on principle to any change and thought that the desire of the Post Office to avoid writing out a receipt for a cheque payment was some sort of dark plot. The new system, now it has settled down, is a great improvement because it means a reduction of work, both at the Post Office counter and in the Area Office.

Mechanical Accounting for Telephone Service (MATS)

The use of punched-card methods for telephone billing has quite a long and interesting history, many aspects of which have been recorded in two *Journal* articles—The Mechanization of Trunk Fee Accounting (August–October 1954) and Going Over to MATS (Winter (November) 1958). The sorting of telephone call tickets to subscribers' numerical order and tabulating trunk calls on trunk statements has always required the employment of a large number of staff on work which has often been described as monotonous and soul-destroying.

The first large scale use of punched-card equipment for dealing with telephone tickets began in the Canterbury Area in 1948, with the two aims of



A standard paper ticket

One of the types of punched card ticket used in recent years

One of the types of punched card ticket to be used in the future (printed in red)

Fig. 1

eliminating this monotonous work and of giving on all subscribers' trunk statements more detail than the date and amount of each call. Tickets for trunk calls were prepared in exchanges in the usual manner, but instead of a paper ticket a stiffer card, suitable for punched-card treatment, was used. In the Area Office the tickets were key-punched with the calling number and the called exchange name so that they could be sorted and tabulated by machinery.

The monotonous task of hand-sorting had, however, been replaced by the equally monotonous task of hand-operated key-punching. This led to the development by the Post Office Research Station of the automatic mark-scanner punch; the exchange operator makes a mark against each of the appropriate digits and these are used by the optical system of the scanner to punch the appropriate holes in the ticket for the sorting operations. Despite the remarkable advance represented by this machine the punched-card system was found to cost more than the equivalent manual system; most of the extra cost was due to the additional detail given on the trunk statement, since this still involved hand-punching. The potentialities of the punched-card system were so great, however, that a decision was taken to extend the experiment and in 1956 the Canterbury installation began to handle local call tickets and preparation of subscribers' bills. A second installation was opened in Edinburgh which also did both call ticket work and the preparation of the periodic bills, though here the standard form of trunk statement, showing only the date and charge for each call, was normally given.

The next stage in the development of the punched card accounting system was the opening of Regional ticket processing centres intended eventually to process centrally all the tickets of a Region. By this time plans for STD were well advanced and ticket volumes were expected to reach a peak just before STD became available in a number of the larger cities in 1961. The aim was therefore to provide the Regional centres with enough machines to handle the ticket volumes expected by about 1963. The areas with the earliest STD programmes would be the first to have their ticket work taken over by the units; then, when the number of their tickets decreased, the work of other Areas in the Region would be added, thus ensuring full use of the equipment for most of its economiclife. This approach also had the advantage that the removal of ticket work released accommodation for the staff needed to deal with the quarterly bills for the STD subscribers.

The first Regional unit opened in Birmingham in October 1958, and the second at Manchester in July 1959, both originally intended to deal with some 70 million tickets a year; the third—a somewhat smaller installation—opened at Oxford in January 1960. While these units were being set up it was decided that they should also prepare trunk statements, using new tabulators cheaper than those originally used at Cambridge and Edinburgh. Four further units are to be opened and the Edinburgh unit expanded (as recorded in the Autumn 1960 *Journal*) so that eventually the ticket work of all Areas will be done by mechanized units. As a further development the provision of additional machines will enable all these units to undertake the preparation of periodic bills.

Fig. 1 shows the standard paper call ticket used in exchanges in Areas without the mechanized system, one of the types of punched-card tickets used in recent years, and one of the types of ticket to be used in the future, which is printed in red. The latest model of the mark-scanner has an optical system which filters out the red printing. This enables the use of an improved ticket design with larger figures; the operator can make a mark through the figure instead of at the side and an extra column can be introduced for exchanges with six-figure numbers.

Figs. 2 and 3 show the mark-scanning punches and a tabulator at the Manchester unit. The mark-scanners are the first machines the tickets are put

Fig. 2: Mark-scanners at the Manchester mechanical ticket processing unit *(Courtesy, ICT Ltd.)*

through on arriving at the unit from exchanges; the tabulator is used to produce trunk statements from tickets which have been mechanically punched and can also be used to prepare subscribers' bills.

Staggered billing

With the pre-war system of quarterly billing, Areas sent a bill to each subscriber every January, April, July and October; when half-yearly billing started, half the accounts were sent out in January and July and half in April and October, exchanges being divided into the "J" and "A" categories for this purpose. This arrangement produced a number of peaks in the various stages of bill preparation and despatch, reminders, payment work and subsequent processes.

The plans made in 1946 for the resumption of quarterly billing envisaged that billing work would be divided into three categories, one third of the total bills being prepared and despatched each month. When these plans had to be abandoned the general feeling was that the change in accounting periods necessary to go over to six-monthly staggered accounting would irritate subscribers and that the benefit to the Post Office was insufficient to justify the disturbance involved.

The introduction of mechanical tabulation of subscribers' trunk statements and the need to render quarterly bills to subscribers with STD lines brought the need for some form of cyclic billing to the fore again. Billing work could be divided so that a set number of bills were sent out each week (or even each day); the gas and electricity authorities, whose billing arrangements are partly determined by the perambulations of their meter readers, often adopt such a procedure. Monthly despatches will suffice for present Post Office purposes and give the even flow of work in the mechanized units necessary for the economic use of machines. The idea of "staggered" billing proved to have unsuspected appeal to Chief Clerks, despite remarks passed about the term and, instead of Areas changing over to staggered working only when the imminence of mechanization or a large STD programme made it necessary, as had been visualized, the majority decided to change to the new system as quickly as possible.

STD quarterly billing and MATS

With STD subscribers are given quarterly bills. This policy was adopted for two reasons; it provided an attraction to set against the bulk billing of dialled trunk calls and it started the Post Office on the trail back to quarterly billing generally. It could be done because the reduction in ticket work with STD saves staff and lowers billing costs. It is quite feasible to provide quarterly billing for a reasonably small proportion of an Area's subscribers while keeping half-yearly billing for the remainder, but when the position was reached that over half an Area's lines had quarterly bills, the maintenance of some half-yearly billing could be difficult in practice. Even if Areas changed over entirely to quarterly billing when half an Area had STD some half-yearly billing would still have been in force until about 1970. This would have been difficult to defend publicly, especially in the era of a more commercially-minded Post Office. Full quarterly billing was seen to be possible by taking advantage of mechanization, and the Postmaster General decided to add to the policy of quarterly billing for exchanges given STD facilities a programme for complete quarterly billing Area by Area, spread over four years. This will be done by arranging for Regional mechanized units to take over main bill preparation for those Areas for which they sort tickets. As an Area's bill preparation work is transferred to MATS, quarterly billing will be introduced for all the lines in that Area that are not at the time receiving them as a result of the introduction of STD.

Multi-register accounting machines

The quarterly bill provided for STD lines shows separate amounts for dialled calls, for trunk calls via the operator and for local calls via the operator. The dialled-calls item includes a statement of the number of metered units—an extra facility provided partly so that renters of private meters can see how their charges line up with the readings on their meters. The MATS system can give this extra entry but the accounting machines hitherto provided for telephone bill preparation cannot do so except by a subsequent operation; the figure could be typed in, of course, but this would also involve two operations. Modern multi-register machines are now in use in many TMOs for payroll work and these have been used for preparing STD bills at Bristol ("Charging for STD Calls", Winter 1959 *Journal*). Less expensive machines than those used for payroll work are now available which give all the facilities needed for STD bills and these are to be used mainly in those Areas with substantial early STD programmes for which MATS will not be available in time. The system used with these machines includes a number of interesting features; one is that the local call ticket posting and metered call calculation operations are combined with bill preparation, which may allow these items to be taken up to a later date than that now possible.

Negative Posting

One useful facility available in connexion with the MATS system, which can also be provided by the new multi-register accounting machines, is that known as "negative posting". Reference has already been made to the production of accounts in three portions—the bill proper, the counterfoil and the ledger sheet, the last two being obtained through the use of carbon patches on the form. Both the new machine systems produce accounts in two-part forms; the top copy consists of the bill and counterfoil side-by-side, with the appropriate entries on each, and the bottom copy of the ledger sheet and a stub. When payments are received the relative ledger sheets are date-stamped and the stubs are detached for cash reconciliation. With "negative posting" time need not be spent extracting ledger sheets and then refiling them after posting; in addition the presence or absence of a stub readily shows the state of the account.

The bills used with both the MATS and new accounting-machine systems are on NCR ("no carbon required") paper which does away with the extensive carbon patching hitherto needed on bill forms.

Meter photography

Several times during the past 30 years the photographing of meters, to give a more accurate record than that obtained by entering meter readings into meter books or cards by hand, has been suggested but none of the various attempts to solve the problems involved seem to have got very far. Recently, however, a trial has been made in the Edinburgh Area of some Swiss equipment which is used by a number of telephone administrations. A photograph is taken of a block of meters by a simple arrangement of a flash camera and a large metal hood, a hundred meters being photographed at a time. At the accounting unit, the film is passed through a very ingenious machine which scans each meter reading in the correct sequence and projects a magnified image on a glass screen (see Fig. 4). The operator key-punches the readings to cards. A machine then compares these with the punchings for the previous reading and calculates the metered and local call charges. The use of meter photography in conjunction with MATS

Fig. 3: A punched-card tabulator producing trunk statements at the Manchester ticket processing unit *(Courtesy, ICT Ltd.)*

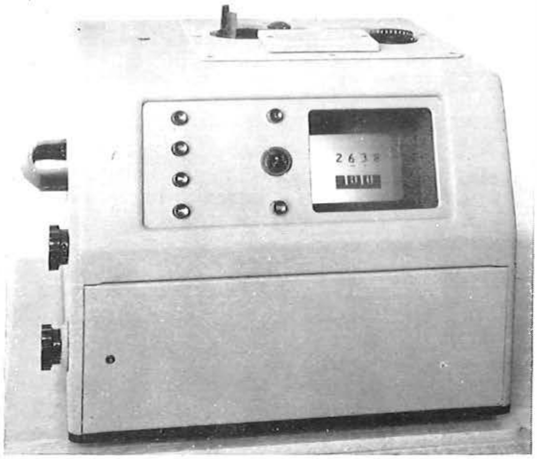


Fig. 4: Alos "autoscope" for photographed meter readings

should produce greater accuracy; for instance it should lead to the virtual elimination of the need for requests for second readings. Meter photography is unlikely to be economic except with a centralized MATS system and it will be introduced only in Areas whose main bill preparation is undertaken by centralized units. The machines used in the Edinburgh experiment did not fully meet the different arrangements of meters which exist in the Post Office system and with the need to produce specifications and get new machines manufactured, any large scale extension of meter photography is not likely to start before the end of 1961, when the MATS programme will be well advanced.

Conclusion

In about five years, when the plans mentioned above have been fulfilled, all ticket processing and periodic bill preparation will be done by Regional punched-card units, meter photography will be extensively used and much of the work done in Areas will have been altered to conform with this pattern. In addition there will be other changes which are on trial or contemplated but which I have not mentioned, such as the mechanization of private wire accounting.

There will, however still be scope for mechanizing and improving processes not so far dealt with. The Headquarters Central Organization and Methods Branch and the Engineering Department are not likely to cease producing ideas on these subjects, either proposals for using new machines which become available or, as has happened on more than one occasion, ideas which lead to the development of new machines. Several important developments in telephone accounting have originated in Areas and Regions and there will certainly be no lack of suggestions for the improvement of billing work from these sources.

Taking a longer view, the plans for telephone billing in the future must some day result in the use of electronic computers which will be able to undertake even more complex operations than those done by the present machinery; there are also prospects of electronic meter-pulse recording systems. These developments, which will no doubt furnish material for future *Journal* articles, seem likely to guarantee the continuance of enough activity in the telephone accounting field to make it quite unsuitable for anyone who is interested only in a quiet life!

The Post Office Report and Commercial Accounts, 1959-60, presented on November 9, show an overall surplus of £20.9 million, including £16.9 million surplus on telephones.

The overall surplus was larger than had been expected, says the Report, because the steep increases in traffic, arising from the buoyant state of the economy, generally made use of existing means of communication and the additional expenses incurred were thus proportionately lower.

The £21 million surplus, however, represents only 5 per cent. of Post Office expenditure or 2½ per cent. of the net assets employed (£830 million). The full return on those assets (taking into account profit before contribution in lieu of taxation, interest and supplementary depreciation) was about 8½ per cent. The corresponding return for private enterprise generally would be nearly double that figure.

A public enterprise carries, of course, social obligations which rule out a precisely equal performance. But a concern like the Post Office, with capital requirements of some £100 million annually, can hardly be said to be paying its way unless it provides a return not too remote from that in the private sector, and one which will enable it to plough back a satisfactory proportion of its own capital. These conditions appear to call for a return on capital of at any rate not less than 8 per cent.

Telecommunications in Iraq

G. J. Alston, A.M.I.E.E.

WE who are directly concerned with telecommunications in this country and in others equally advanced may be inclined to overlook the very great problems existing elsewhere where so little has been accomplished in the past and so much remains to be done in the future. Great strides have been taken since the last war in helping such countries to develop.

Progress depends largely on sharing material resources and technical "know how". Assistance may concern the development of food and agricultural resources, education, health, communications and so on. The extension of the means of communication is a basic need for any country which proposes to develop its resources and improve its standard of living under the control of a centralized government.

Throughout the world the spearhead of this overall assistance to countries in need of development has rightly been the United Nations Organization. The operation concerned is known as "The Expanded Programme of Technical Assistance for Economic Development of Under-Developed Countries". This co-ordinates and directs the activities of the Technical Assistance Board and seven specialized agencies for International Labour, Food and Agriculture, World Health, Education, Science and Culture, International Civil Aviation, International Telecommunications, and World Meteorology.

The technical assistance work of the International Telecommunication Union is only one aspect of its responsibilities, and is a relatively new one. This article gives an account of such work in Iraq.

Iraq was admitted to the League of Nations as a Sovereign State in 1932, having been a mandated territory under Great Britain since World War I ended. Previously the territory, then known as Mesopotamia, had been ruled by the Ottoman Empire for nearly four centuries, and it lagged greatly in the many developments which were taking place in the West.

Above: Baghdad and the River Tigris

The country consists of 172,000 square miles and has about 5,000,000 people, 90 per cent. of whom are Moslem, 10 per cent. Christian. It is known as the "Land of Two Rivers". The important part is centred on the rivers Tigris and Euphrates, which meet to enter the Persian Gulf below Basra. There are a few large cities and the ancient capital, Baghdad, on the Tigris, is the centre of government and administration.

Central Iraq has one of the driest and hottest climates on earth; temperatures in excess of 120°F. are quite common in the long summer months. Fine dust storms occur from time to time, discomforting and disturbing to the lady of the house, as the dust penetrates every little corner. Spring and autumn climates are delightful, but there is a certain amount of rain in the winter, when it can be quite cold.

The southern part of Iraq, bordering on the Persian Gulf, is rather humid but three-quarters of the country is barren desert. In the mountainous regions of the north, bordering on Iran, Turkey, and Syria, much of the climate is similar to that which Britain experiences in a good summer. There is plenty of rain, good crops are grown, and some of the area is well wooded.

The main economy is founded on oil, which is normally found in the north of Iraqi territory. There are heavy oil-bearing strata to the south of Iraq, but these are operated in adjacent Abadan (Iran) and Kuwait. The large oil companies operate their own communications systems between the wells and refineries. The oil centres of the north have pipelines extending right across Iraq, Syria and Lebanon to the Mediterranean. These have suffered from time to time as a result of political disturbances in one country or another.

That Iraq was the site of the biblical flood can well be imagined by any one who has experienced the difficulties of the country. For hundreds of miles the banks of the Tigris and Euphrates are contained by continuous embankments of earth (bund) 12–14 feet high, built over the years as a protection against floods. During melting snow or continuous heavy rain in the north water is released at a tremendous rate across barren land with hard, fine soil and no vegetation or tree roots to arrest its progress. Flooding and devastation was the lot of the inhabitants of the past.

In recent years this has been largely rectified by constructing huge barrages across the rivers at suitable points. The combined effect of the numerous barrages on the two main rivers is to give controlled flow of the water throughout the year, husbanding the overflow to be used in the dry season for irrigation purposes.

The responsibility for communications in Iraq is vested in a Government department under the control of the Minister of Communications and Works. The Directors General for Railways, Air, Works and Posts and Telegraphs operate in this Ministry.

The Director of Posts and Telegraphs is permanent Head of his department and responsible for telecommunications, including the technical side of radio broadcasting. Administrative Headquarters are in Baghdad and the country is divided into five regions, each under a Director/Divisional Engineer. These are based on the cities of Mosul, Kirkuk, Baghdad, Hilla and Basra.

Typical temporary line construction depôt


Baghdad automanual switchboard with enquiry positions in foreground

Much of the present telecommunications system in Iraq was built in the mandate days and subsequently developed by the Department of Posts and Telegraphs. A few British engineers have been employed in the Department for many years but the needs of a rapidly developing Iraq required more than that, and the Government was glad to have United Nations assistance.

Two basic needs had to be met—improving and augmenting the long distance communications in Iraq, both national and international, and developing local communications, particularly in the provincial towns. Though the larger cities like Baghdad, Mosul and Basra had a fair telephone service, there were many waiting applicants. The smaller towns, however, were relatively worse off and there was a very great need for real development based on sound planning for these centres, many of which have populations of well over 50,000.

In 1955 one United Nations expert was appointed, to improve the trunk lines, with both advisory and executive responsibilities, and in 1957 a second expert took up duty to develop exchanges and local line network in the provincial towns with similar responsibilities.

The Iraqi Department of Posts and Telegraphs employed a British firm of consulting engineers and most of the contracts for telecommunications equipment have been placed in Britain in the past. The principal cities have automatic systems.

Except for a few British engineers from the General Electric Company, who supervise maintenance on a contract basis, these automatic exchanges were maintained by local Iraqi staff. A number of them had had training in Britain, partly with General Electric and partly with the Post Office, though there appeared to be much greater need for training on maintenance than on manufacturing. A small training school had been established for general training in telecommunications technique, but had not developed as well as expected, and actual school training had come to a standstill.

There seems to be a sound case for a joint training school shared among the Arab countries of the Middle East, all of whom have this training problem. Recent information indicates that such a school is to be set up in Cairo.

Apart from the principal cities, most of the large towns in Iraq depended on manual exchanges, mostly in urgent need of expansion and renewal. It was not uncommon for towns of 60,000 to 80,000 inhabitants to depend on a two-position magneto switchboard, but, of course, telephone penetration is low. A bold expansion programme is in hand to replace these antiquated manual exchanges by modern CB types, most of which had been manufactured in Britain. They will be in new buildings which combine a Post Office, telephone exchange, an engineering depot and a Postmaster's residence. It is best to have purely manual switchboards in these centres in view of the large amount of operator assistance traffic involved and because of the isolation of some of these cities and the not infrequent interruptions of their long distance communications.

One difficulty was that the operating staff, mostly men of indifferent type, were poorly paid and generally were not good enough to guarantee satisfactory service.

Girls operate the Baghdad auto-manual board during the daytime. I always found them efficient and as helpful as the language difficulties would permit. Quite a few spoke English. The illustration shows most of the operators wearing European type dress, but it was customary for them on leaving the exchange to put on their black abbayas, the traditional overdress of Iraqi women.

The local cable network in Iraq consisted of armoured cables laid direct in the ground, which generally gave fairly good service, though they were inadequate for the increasing telephone needs. The installation of new exchanges was always accompanied by a comprehensive local line development scheme opening open-wire DPs to serve localities in need of telephone service.

The long distance national and international circuits presented many problems which differed somewhat from those met in Britain. The remoteness of the towns from each other and the comparatively low level of traffic have been met in the most economic way by providing overhead trunk lines. Construction was similar to that in Britain, except that sheet steel poles were used.

For some years past the traffic carrying capacity of the routes has been increased by introducing overhead carrier systems. About four years ago there were 15 such carrier systems, mostly using 1 + 1 and 1 + 3 carrier equipments and providing (when they were all working) a total of 36 speech channels. About this time, experiments were conducted with a 12-channel carrier system between Baghdad and Kirkuk, a distance of about 200 miles, with one repeater station approximately half way. However, transmission was often far from satisfactory owing to the indifferent lines, difficulties with maintenance and so on. Frequencies of the order of 30 kilocycles and above suffered from extreme attenuation due to poor line characteristics common in Iraq.

Arrangements are now being made to introduce 37 voice-frequency telegraph channels suitable for teleprinter operation. When I left Iraq, none of these systems was actually operating, though some had already been installed. The existing telegraph system within Iraq is the obsolescent DC morse working, which barely caters for the rather limited present inland telegraph traffic. New telegraph systems to be made available are intended to provide alternative landline channels, as against radio, for the Civil Aviation network, airlines, oil companies and other interested operators, in addition to public telegraph needs. The systems will permit the operation of teleprinters, using either English or Arabic characters.

Climatic conditions cause considerable dust deposit on insulators. At certain times of the year, moisture deposits on line insulators, already coated with very fine dust, ruin the insulation with a consequent deterioration in line characteristics and the loss of channels on the carrier network.

In international telecommunications the outlets from Iraq were partially overhead carrier, partially radio. The former included line communications to Syria, Turkey, Iran and Jordan. These routes were being augmented and improved, particularly those to Turkey, Iran and Jordan, in view of the participation in the Baghdad Pact at that time. I understand that these plans have now been suspended indefinitely since the Republic of Iraq was formed, but it is hoped that, for normal commercial interests they will soon be carried out. Among the radio circuits, the outlet to London is open for traffic each day between 07.15 and 10.15 and 13.00 and 15.00 GMT at the cost of £1 a minute. The service is reasonably good.

As can well be imagined, one of the greatest problems in the remote parts of Iraq was to provide suitable and reliable power supplies to ensure the successful working of telecommunications equipment, particularly carrier equipment. Most of the modern equipment is designed for working with AC mains operation. However, many municipal power supplies were either DC or most unreliable AC which were subject to considerable overloading and breakdown.

The Government had an ambitious programme of building new power stations to rectify this trouble but until this matures it was found necessary to make local arrangements to improve the power facilities within the communications network.

Various expedients were adopted; for example, standby power facilities using lead batteries charged from the uncertain mains supply and used in turn to operate rotary converters which would produce the necessary alternating currents during periods of power failure. Unfortunately, maintenance difficulties prevented this from being satisfactory.

In view of the importance of the trunk network it was decided that carrier terminal stations should have their own diesel electric standby installations with all the latest automatic and regulation controlling facilities that we are now accustomed to in this country. The problem of training enough staff to operate and maintain this equipment adequately is being given the greatest consideration. The equipment manufacturers provide comprehensive maintenance instructions.

A major development now nearing completion stages, being carried out under auspices of the Development Board of Iraq, is the installation of a power generation system and distribution network to serve the requirements of Northern Iraq, including important oil fields. Power will be generated by gas turbines, using gases which are a by-product in the Kirkuk Oil Fields and which were previously wasted. This area is illuminated at night by the glowing sky reflecting the blazing gases which are a landmark for many miles around.

It is proposed to use carrier equipments on the power lines, which will provide telecommunications channels to the main northern cities Mosul, Arbil, Kirkuk and Sulaimaniya. The average number of channels between each centre will be six.

Rebuilding overhead carrier route across the desert to Jordan

A second national power-generation and distribution project is also planned for central and southern Iraq.

Quite a major problem in maintaining long distance telecommunications network in Iraq is the necessity to supply, equip, and staff with suitable personnel, trunk test control positions. Much expensive equipment had been installed already; much had still to be provided, but the selection and training of suitable staff was lagging behind requirements, though measures were being initiated to overcome this difficulty. However, the large number of impedance regularities and incorrect circuit conditions, which are a great feature of the existing lines, prevent the successful application of some of the more modern fault localizing techniques—for example, electronic pulse testing. The difficulty of locating faults accurately by measurements and calculations still further emphasizes the importance of completely overhauling the overhead trunk line construction throughout Iraq.

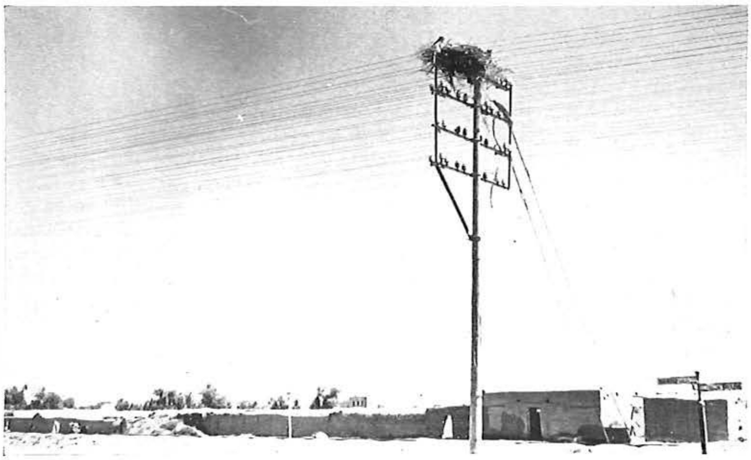
An outline of the problems associated with the satisfactory operation of the trunk carrier network would not be complete without mentioning the frequent difficulties experienced by the interference with such transmission lines by members of local populations and Bedouin tribesmen. Line insulators provide an excellent target for rifles and stones, and aiming at them appears to many to be a fascinating pastime to pass away the long hours while shepherding their flocks! Also, quite frequently, sections of wire are cut away overnight for their metal content. On some occasions the theft of the wire has been accompanied by complete dismantling of the line, involving the removal of the steel section posts, steel cross arms, and all fittings! However, as most of these lines are adjacent to desert tracks, fast being converted to first class roads, accompanied by more regular and effective road communications with increased police patrols, this type of marauding should rapidly diminish.

While travelling round Iraq on telecommunication service I enjoyed many unusual experiences. Among them was one which proved to me, more than anything else, the willingness of Iraqis to work very hard and efficiently in an emergency. This was at the opening of the new Khanaqin Telephone Exchange and Post Office. Khanaqin is on a large tributary of the Diyla river. A fine new building had been erected to cater for Telephone Exchange, Post Office, Engineering Centre and Postmaster's living accommodation, surrounded by an eight foot wall. Iraqi engineers had installed a modern Ericsson CB Telephone Exchange with a complete cable development scheme.

Overnight I stayed at the Oil Company Refinery, some 10 kilometres away, to be awakened by the Manager in the morning complaining that he could get no reply from the new exchange. There had been torrential rain and on leaving the residence I discovered that the river had overflowed, isolating the refinery and preventing any of the staff coming to work. Farther down the river, part of a mud-built village had been washed away, the river having risen 20 feet during the night.

By wading through water almost up to my waist, crossing the river on a wreck of a bridge and traversing the several kilometres on foot, mostly under water, I arrived at Khanaqin to see a scene of desolation.

The river had poured through the town, destroying houses, washing away the surrounding wall of the Telephone Exchange and leaving the switch-room with 21 inches of water completely ruining all leading-in cables and immersing the tag blocks and leading-in cables in the rear of the switch-board. Not a telephone in the town was working, nor could any reply be received on the outgoing carrier circuits to Baghdad. There was no electricity, the power station by the river being under 6 feet of slime, the river having then dropped with amazing suddenness by many feet from its overnight peak.



Stork nesting on overhead carrier route from Baghdad to the South

Eventually a reply was received from the adjacent exchange at Jalawla, 50 kilometres away, where the operator could just be heard, though faintly (it transpired that the pole route in the desert had collapsed, but some wires were still protruding from the water in places!). By using a lineman's telephone and tapping the overhead route, the call was finally extended to Baghdad, when the Kaymaham (local Governor), standing knee-deep in water, was enabled to pass the word of the disaster to the authorities in Baghdad. Many people and cattle were drowned and thousands rendered homeless by the flood.

Service was restored that day to the essential users (hospital, railway, Governor, police and oil company), using the old magneto switchboard, and work started immediately on clearing the water, removing the slime, drying out and restoring the new exchange. Great credit must be given to the Iraqi lineman, jointers and exchange construction staff, who worked day and night, first to give temporary service and then to restore the main exchange, which they successfully did four and a half days after the flood.

Nearby in the desert the Iraqi army did a first-class job by providing temporary hutting for the homeless villagers and townsfolk within a few days of the catastrophe. Nurses attached to the World Health Organization came immediately to the villages to help those in need and did wonderful work with local Iraqi doctors in a field hospital.

It was my experience that the average Iraqi held Britain in great esteem and was most appreciative of the excellent work we had done in their country. They were often critical of mistakes we had made, in their opinion, but nevertheless our prestige was high and benefits that Iraq had achieved through its close union with Britain were recognized.

I would like to express my appreciation of the assistance I have received in preparing this article from the Technical Assistance Section, ITU, Geneva; from my colleague in Iraq, Mr. Winston R. Prattley of the New Zealand Posts and Telecommunications Department; from my many colleagues and friends in the Directorate General of Posts and Telecommunication, Iraq, and from the Iraqi Embassy in London for the photographs accompanying this article.

Microminiaturization

J. R. Tillman, D.Sc., Ph.D., A.R.C.Sc.

SEVERAL distinct developments are hastening the entry of electronics into more and more industries and into commerce. Thus, many of the physical quantities met in industry—for example, temperature, pressure and velocity—can be reliably converted into proportional (analogue) electric signals and subsequently expressed in digital form. There is now a wide range of electronic computers which can process this digital information—whether it represents physical quantities or commercial data—at high speeds and with adequate accuracy, in accordance with instructions also presented in digital form. Electronic machines can be made to simulate huge industrial plants, nuclear reactors and defence systems as well as to solve hitherto intractable mathematical problems and to handle commercial accounts. Their first cost is often very high, but they save manpower and office accommodation and enable management to assess a complex situation much more rapidly.

Bigger machines are justified for some purposes, but two interrelated technical factors, other than cost, limit their size as measured by complexity and number of parts. The first factor is their physical size and the second is their reliability; different applications may stress each differently, but both occupy much attention today in the laboratories of the electronics industry. They are clearly also of importance in determining the extent to which electronics can be used in weapons and space vehicles. Fortunately the problems to be solved in reducing physical size and increasing reliability are eased because the signal levels used throughout the greater part of the industrial and commercial machines are low, involving little power consumption and hence little self heating.

The size of conventional electronic components has steadily been reduced by the use of better materials and processes and the elimination of wasted space. Miniature components have become commonplace and work on microminiaturization has been greatly increased. Microminiaturization recognizes that often the vital part of a component —for example the thin carbon or metal film of a resistor—occupies only a very small part of the total volume of the component compared with that taken up by the support or housing. It recognizes also that conventional wiring and even printed wiring limits the density with which components can be packed together.

Micromodule Method

One approach to microminiaturization, called the micromodule method, concentrates on very efficient stacking of components; each component is formed or mounted on a thin ceramic plate about one-third of an inch square. The method thereby permits close spacing, easy assembly and simple (though considerable) wiring; two or three hundred components might occupy only one cubic inch.

It was a small step in ideas to put several components and their interconnexions on one plate to produce microcircuits which also can be stacked to give densities of one thousand or more components per cubic inch. The circuit designer can then think in terms of plates to perform functions—to amplify, to generate pulse trains, to carry out logical functions—rather than in terms of individual components; but he will no doubt need re-educating before accepting standard ranges of plates as his starting blocks. We may expect these two techniques (micromodules and flat plate microcircuitry) to find some uses in telecommunications in the next few years, particularly where space and weights are at a premium.

Break with Tradition

The next step is a greater break with traditional component design and assembly than anything previous. It arises in part from the more successful methods of making transistors, in which heterogeneity is introduced, under close control, into a block of homogeneous semiconductor (germanium or silicon); thus the processes of diffusion, masking, evaporation of metals, ultrasonic cutting, electrolytic etching, alloying and thermo-compression bonding, are coming widely into use and can be adapted to the making of resistors, capacitors, insulators and diodes.

Very pure silicon is such a poor conductor of electricity that it may well prove an adequate insulating substrate for metal films deposited on it to form resistors; less pure material (of much higher conductivity) can form the starting point for a capacitor; either a junction diode can be made in it, by diffusion or alloying, and operated under reverse bias, or its surface can be oxidized and a metal film deposited to produce a more conventional parallel plate capacitor.

The aim of the new approach to microminiaturization is to produce, as one block of solid material, a sub-system which performs the same electrical operations as an assembly of up to 100 separate components. Because refrigeration and thermo-electric generation of power using semiconductors are now practical possibilities, some sub-systems may incorporate parts doing one or other of these functions. Although the component parts can be considered, in the abstract electrically, separate from one another, the interconnexions between them are made during the fabrication of the block and cannot be considered separate for the purpose of replacement or adjustment, and usually not even for routine measurement.

New Terms

Several terms have been coined for these advanced techniques (the whole subject of microminiaturization abounds in new terms). One, "Semiconductor Networks", stresses the important role of the semiconductor; "Solid Circuits" and "Integrated Circuits" stress the circuit side; while "Molecular Electronics" implies, as yet without much justification, that each molecule used has some predetermined necessary job to do. "Microelectronics" does no more than suggest microminiaturization of electronic equipment.

Claims are made that component densities of 20,000 per cubic inch are possible, even allowing for the interconnexions between blocks and the mounting of groups of blocks with some external connexions, though nothing much more than 5,000 per cubic inch has been demonstrated so far; much more development may be needed before the two other claims, that production yields can be adequate and reliability can be high, are substantiated.

It is too early to predict cost (which will depend considerably on the scale of production required, because some very expensive machines are used) or to foresee equipment designers' problems: for example, of avoiding interference between blocks and finding economical testing and maintenance procedures. Molecular electronics may ultimately lead the electronics industry to concentrate most attention on a smaller range of materials and processes and will avoid the many separate connecting operations now in use—all with greater expectations of reliability. The advantages of having many components in good thermal contact may, however, be more than offset at the moment by the greater temperature dependence of some parts than of their conventional counterparts.

The digital (switching) fields of electronics, in which the Post Office has an ever increasing interest, are likely to be the first to be able to take advantage of the new method of producing complete circuits. Conventional line transmission systems which tend to call for tight tolerances for a moderate proportion of components, may have to wait for much closer control of the processes used in making solid circuits before they too can benefit (and even then only if they have not been largely superseded).

Four Post Office men are among a British team of telecommunication experts who went to the United States in October to discuss the use of communications systems via earth satellites. They are Captain C. F. Booth, CBE, Deputy Engineer-in-Chief, Messrs. W. J. Bray and F. J. D. Taylor, OBE, of the Engineering Department, and Mr. H. Leigh, External Telecommunications Executive. They will visit technical installations of the National Aeronautics and Space Administration, the Defence Department, and private firms.

Telecommunications Statistics

	Quarter ended 30 *June*, 1960	*Quarter ended* 31 *March*, 1960	*Quarter ended* 30 *June*, 1959
Telegraph Service			
Inland telegrams (excluding Press and Railway) ...	3,086,000	2,852,000	3,194,000
Overseas telegrams			
Originating U.K. messages	1,593,251	1,278,323	1,198,124
Terminating U.K. messages	1,555,448	1,304,579	1,208,828
Transit messages	1,399,936	1,401,611	1,352,719
Greetings telegrams	725,000	704,000	740,000
Telephone Service			
Inland			
Gross demand	123,022	134,883	111,551
Connexions supplied	108,415	110,359	100,668
Outstanding applications	145,432	143,717	140,757
Total working connexions	4,835,104	4,784,005	4,643,206
Shared service connexions	1,129,676	1,130,911	1,135,847
Total inland trunk calls	100,918,000	96,498,000	93,106,000
Cheap rate trunk calls	22,700,000	19,718,000	21,201,000
Oversea			
European: Outward	753,375	734,638	682,037
Inward	719,950	702,487	642,650
Transit	3,325	3,224	2,838
Extra-European: Outward	69,082	65,342	62,190
Inward	77,073	76,196	66,725
Transit	17,055	17,121	17,142
Telex Service			
Inland			
Total working lines	6,181	5,923	5,226
Calls from manual exchanges	487,000	576,000	704,000
Calls from automatic exchanges	264,000	292,000	217,000
Metered units from automatic exchanges ...	5,073,000	3,706,000	937,000
Oversea			
Originating (U.K. and Irish Republic) ...	648,142	671,379	554,174
Terminating (U.K. and Irish Republic) ...	607,574	523,875	529,598
Transit	11,577	9,781	6,135

OUR CONTRIBUTORS

G. J. ALSTON ("Telecommunications in Iraq") is Telephone Manager, Swansea. He entered the Post Office as a Youth-in-Training in Liverpool Internal Section in 1927 and became a Probationary Inspector in 1933. After further service in Liverpool, he became the first Officer-in-Charge of the North West Regional Training School in Manchester in 1936, returning to Liverpool as Chief Inspector, on External Planning and Construction, until 1940 when he was appointed Post Office Liaison Officer to the Commander-in-Chief, Western Approaches, for telecommunications associated with the Battle of the Atlantic. At the end of the War, he became Executive Engineer, Trunks, Telegraphs and Training, Liverpool. In 1950 he was promoted Area Engineer, Shrewsbury and, subsequently, Deputy Telephone Manager, London East Area in 1957. Later that year, he was appointed Telecommunications Adviser to the Iraqi Government in Baghdad under the auspices of the United Nations. He came back to his previous work in London late in 1958 and was appointed Telephone Manager, Swansea, in 1959.

J. C. BILLEN ("Producing More Circuits from the Transatlantic Cable") is an Assistant Staff Engineer in the Submarine Cable Section of the Engineering Department Main Lines and Development Branch. After ten years in South Western Region and Wales and Border Counties, he came to Main Lines Branch in 1940 and worked on the development and provision of line transmission systems. Later he was engaged in the restoration of communications to Europe following the invasion; he has since been concerned with the provision of submarine cable systems on the route around the British Isles and to the Continent. Since 1958 he has also been associated with the engineering of communications on the transatlantic cable routes.

COLIN CHERRY ("Telecommunication as a Social Science") has been Professor of Telecommunication at Imperial College, London since 1958. He began his scientific career in the research laboratories of the General Electric Company doing researches mainly on television and, during the war, on various centimetric radar systems. From 1947 to 1949 he was Lecturer at the Manchester College of Technology, and later Reader in Telecommunication at Imperial College. His present researches are mainly in the psychology of hearing and speech and in various studies of signal and information analysis.

D. T. GIBBS ("Around the World in Ninety Minutes") wrote "HMY *Britannia* Called from the Antarctic" for the Winter 1957 *Journal*, and his career was outlined in that issue. Since that time he has taken charge of the International Meetings and Defence Division of the External Relations Branch, External Telecommunications Executive.

A. M. JONES ("Telephone Accounting Developments") joined the Post Office as a Clerical Officer in 1936. After service in several London Telecommunications Region Area Sales Offices, and six years in the Royal Artillery, he was promoted to Executive Officer in the Inland Telecommunications Department in 1948 and to Higher Executive Officer in 1953. In recent years his duties have included call charge matters (including the introduction of group charging) and telephone accounting.

H. J. S. MASON ("Graphical Symbols for Telecommunications") is a Senior Executive Engineer in the Local Lines and Wire Broadcasting Branch of the Engineering Department. He entered the Post Office in 1938 as a Probationary Inspector. After seven years in the Radio Branch he moved to Main Lines Branch and in 1950 transferred to Local Lines Branch. He has been Secretary of the Post Office Terms and Symbols Committee since 1956.

B. H. MOORE ("Post Office Work for Outside Broadcasts") is an Executive Engineer in London Telecommunications Region. He entered the Post Office in 1919 as a Youth-in-Training and after a number of years in Centre Area was transferred to Regional Headquarters in 1949 to take charge of the Television Outside Broadcast Group.

In the early days on the Group the work took him to most of the large cities and towns in the country to set up TV OB circuits, until 1952 when groups were set up in four other Regions.

J. R. TILLMAN ("Microminiaturization") is a Senior Principal Scientific Officer in the Research Branch of the Engineer-in-Chief's Office and has charge of a division primarily concerned with transistor electronics. He joined the Post Office in 1936 having previously carried out research in atomic and nuclear physics at Imperial College.

CORRECTION

We regret that in reporting the tariff changes ("Local Residential Call Charges Cut") in our Autumn number some wrong figures were quoted. The second paragraph should have read:

> From September 1 the charge for timed trunk calls up to 35 miles will be reduced from 1s. 0d. (1s. 3d. from a call-box) to 9d. (1s. 0d. from a call-box) for three minutes. A corresponding reduction will be made for calls over 125 miles, from 2s. 6d. (2s. 9d.) to 2s. 0d. (2s. 3d.)

In the fourth paragraph, Private Automatic Branch Exchanges Type No. 2, the new charge for 25–35 automatic extensions should have read: £280.

The last paragraph should have shown that from August 1 charges for calls in the service area of the South Lancashire car radiophone service were reduced from 2s. 6d. to 1s. 3d. for three minutes.

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This telephone incorporates the latest type induction coil and rocking-armature receiver, providing a transmission performance superior to that of other Magneto instruments.
Side tone is maintained at a satisfactorily low level.
Normally, this instrument employs a 5000 ohm bell and under favourable working conditions operation of 10 telephones per line is possible.
Advantage has been taken of the 6-volt source required for the generator to supply the telephone transmitter via a resistor. This feature prevents damage to the transmitter during any circumstance of low transmitter resistance.

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Automatic Telex Network Completed

With the opening in December of the new automatic telex exchange for London, the two-year programme to convert the whole of the inland network to automatic working will be completed. The Shoreditch automatic telex exchange, opened to serve part of London temporarily when automatic telex was inaugurated in 1958, closed on November 12.

The telex exchange equipment occupies two floors in the new Fleet Building which will eventually also contain the new international exchange switchboards, two telephone exchanges, the telegraph voice-frequency channel terminal for London, the new central telegraph office, administrative offices for London Telecommunications Region's City and Long Distance Areas, and an engineering depot. Mr. J. Bellew wrote in our Summer 1958 issue about the planning of Fleet Building and we hope to publish a further article about it shortly.

The auto-telex exchange will open with some 3,600 subscribers: 3,200 in London and 400 in the Home Counties—subscribers in the Brighton, Canterbury, Colchester, Guildford, Luton, Norwich, Oxford, Portsmouth, Reading, Southend and Tunbridge Wells charging areas being included. Equipment has been provided in the first place for 5,600 subscribers, but ultimately some 20,000 will be served.

Fleet will be the largest automatic telex exchange in the world. Planned, with the whole of the automatic telex system, jointly by the Post Office Inland Telecommunications and Engineering departments, it has been equipped by Ericsson's at a cost of nearly £1,000,000. Installation began in May of last year.

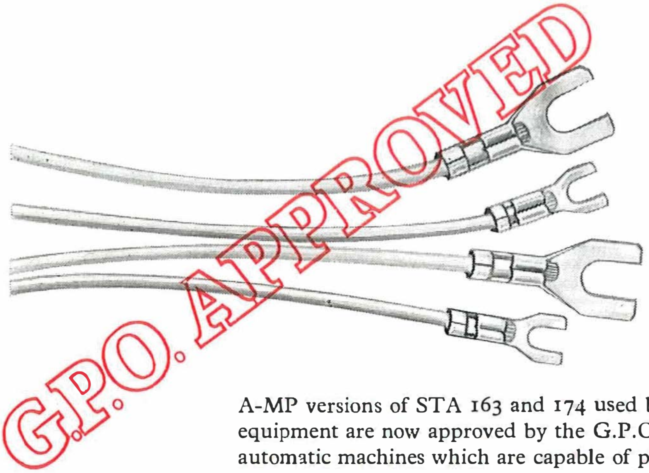
Inaugurating **Subscriber Trunk Dialling** at Wrexham on October 19 the Postmaster General said that by the end of March 1961, 72 exchanges with a quarter of a million subscribers will have STD; by the end of March 1962, the figure will rise to 340 exchanges and one million and a quarter subscribers. By 1970, 90 per cent. of subscribers will have STD.

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

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

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

GPO



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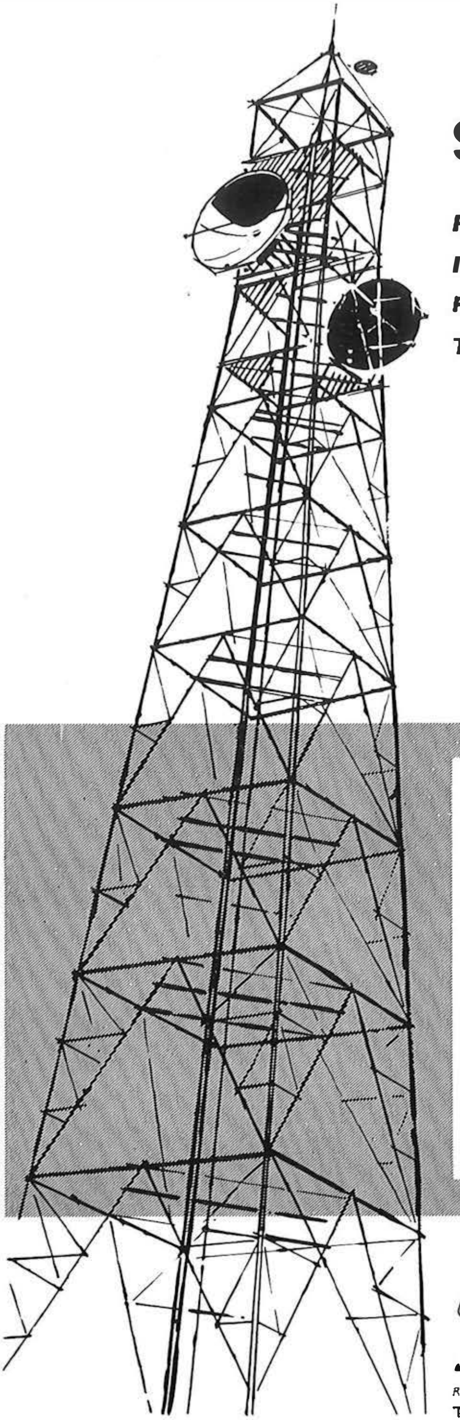

Radiotelephones by ATE—a vital service for isolated localities

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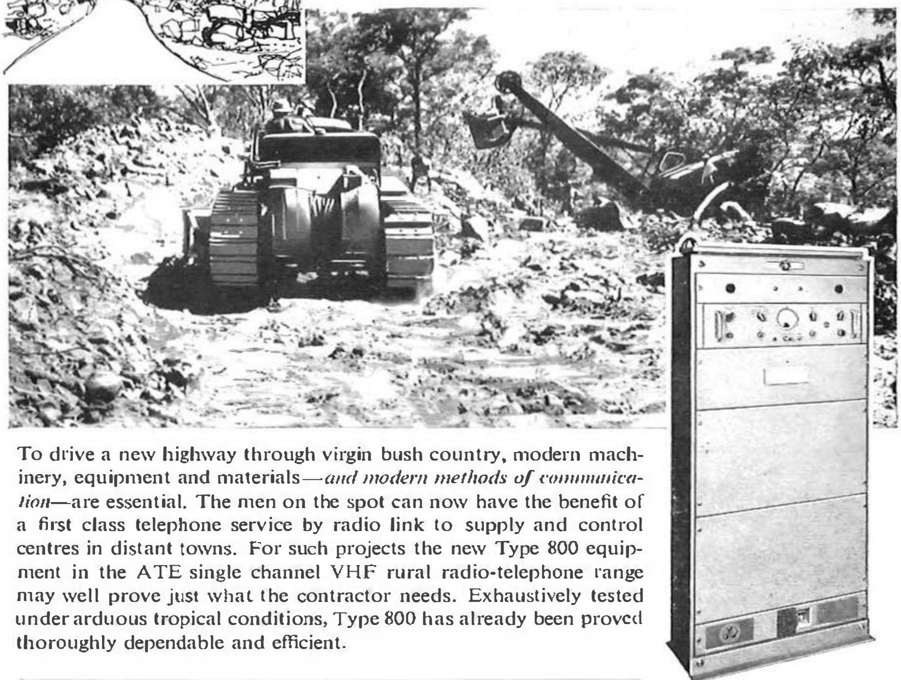

To drive a new highway through virgin bush country, modern machinery, equipment and materials—*and modern methods of communication*—are essential. The men on the spot can now have the benefit of a first class telephone service by radio link to supply and control centres in distant towns. For such projects the new Type 800 equipment in the ATE single channel VHF rural radio-telephone range may well prove just what the contractor needs. Exhaustively tested under arduous tropical conditions, Type 800 has already been proved thoroughly dependable and efficient.

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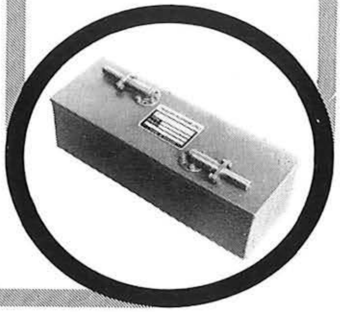

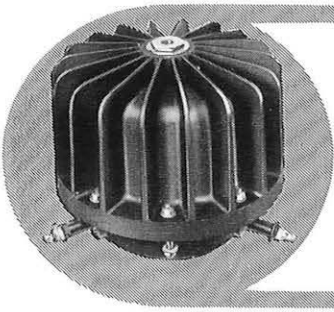

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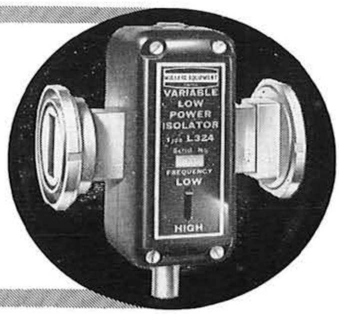

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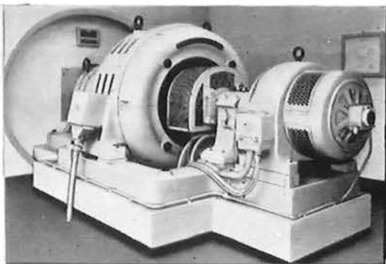
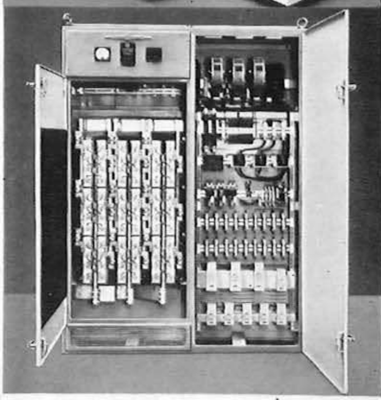
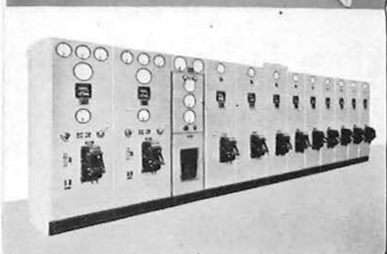
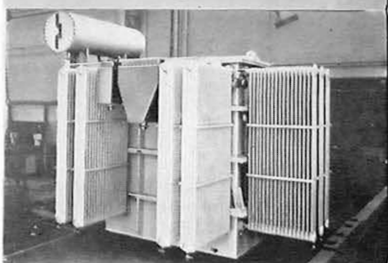

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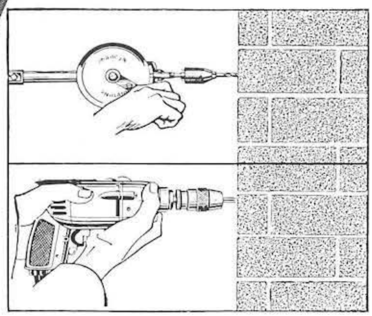

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Time Measurement

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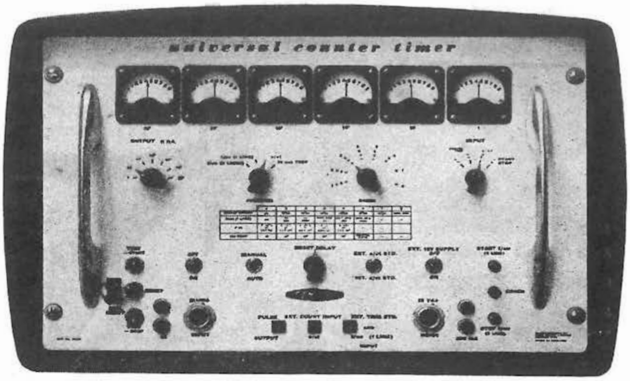

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