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Contents

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"Pretty Good Going"

A VIRILE organisation providing a more comprehensive telecommunications service than ever before. This is the picture portrayed in *Post Office Prospects*, 1962-63, the second annual review of Post Office plans for the future, which reveals that inland trunk telephone traffic is now growing at the rate of 12 per cent. a year and that there has been a marked increase in local calls as well.

To cater for this growth, the Post Office now proposes to increase the number of trunk circuits from about 33,400 to about 37,000 and to add more than 300,000 lines to the local network in the coming year.

The scheme for the complete automatisation of the telephone system by 1970 is going ahead satisfactorily and in the next 12 months 100 more manual exchanges are due to be converted to automatic working, thus reducing manual exchanges to about 600 and increasing the number of subscribers with automatic service to 87 per cent. of the total. More than 500 exchanges serving about one-third of all subscribers in Britain will have trunk dialling facilities by March, 1963, an achievement described by the Postmaster General as "pretty good going".

In the coming year, too, the Post Office plans far-reaching developments in many other fields. The first electronic exchange in Europe to carry public traffic will soon be opened at Highgate Wood; equipment is expected to be installed by the beginning of 1963 in the London radio tower which will carry new trunk and television links; the telephone service to the Continent (beginning with Paris) will be improved by arranging for subscribers to dial their own calls; new submarine cables will be laid from Britain to the United States, Germany and Denmark; the overseas telegraph service will be more highly mechanised; and facilities will be provided for customers using automatic data processing systems to transmit data over the teleprinter and telephone networks.

Nor is this all. The Post Office is playing a leading part, too, in developing communications through the medium of satellites. As this issue went to press the radio station which the Post Office has built at Goonhilly Down was preparing to track with its gigantic space-aerial the first communications satellite—*Telstar*—which will be launched from the United States.

As the Post Office moves even more rapidly into the age of space, electronics and automatisation it can look back with pride on many fine achievements and with justifiable confidence to the future.

Developments in Telecommunications 1912-1962

Sir Archibald J. Gill, B.Sc., M.I.E.E., F.I.R.E.

Engineer-in-Chief 1947-1951

THE transfer of the National Telephone Company to the Post Office on January 1, 1912, described by E. C. Baker in the Spring issue, was the final stage in the concentration of telecommunication services within the United Kingdom. Since then the Post Office has had national control of practically the whole telephone system and today the only exceptions are local systems operated by Hull Corporation and in the Channel Islands.

The Early Years

In 1912 over 80 per cent. of the trunk and junction network consisted of overhead lines but it was recognised that future development would be by underground cables. With the development of air-spaced, paper-insulated cable, the practice of loading and an adequate method of cable balancing, it became possible to plan a telephone cable system for circuits up to 200 miles long. The first major scheme was the London-Birmingham-Liverpool cable completed in March, 1916, the war having led to postponement of most other major schemes. About 1914 the possibilities of the three-electrode valve as an amplifier began to excite interest. The first permanent installation of such equipment consisted of four repeaters at Birmingham on 200 lb. unloaded phantoms in the new London-Birmingham-Liverpool cable.

Before the transfer, the Post Office had placed orders for a number of automatic exchanges of various types. The first was a Strowger exchange at Epsom opened in May, 1912. This was followed by a Strowger PABX at GPO Headquarters, a "Lorimer" exchange at Hereford, a "Rotary" Western Electric exchange at Darlington, and many others. By 1922 there were 16 public automatic exchanges and 12 PABXs in operation.

In 1912 the telegraph service was over 70 years old. The growth of the telephone service was having a pronounced effect on the short-distance telegraph services. As fast as exchanges were installed in rural areas, Wheatstone ABC, morse sounder and single needle instruments were replaced by telephone operation. By 1915 half of the 14,000 telegraph offices were operated by telephone. Important developments were also taking place in long-distance operation. There was competition between automatic high-speed transmission (Wheatstone) and multiplex systems (Baudot), with the latter gaining ground.

Telephone instruments of the day used solid back transmitters fixed in position, either on a pedestal or wall mounted, since this transmitter needs its diaphragm nearly vertical.

In the field of radio, the Post Office had purchased in 1909 the Coast Radio Stations which had been established by Marconi, Lloyds and others. These stations were then either completely reconditioned or replaced by new buildings and plant. At the outbreak of war in 1914 they were taken over and worked by the Admiralty, but as the war continued the Post Office equipped and manned a number of direction-finding stations for detecting and locating illicit transmitters. These stations were also used for locating the position of enemy aircraft approaching the country, and were very effective against the Zeppelin threat.

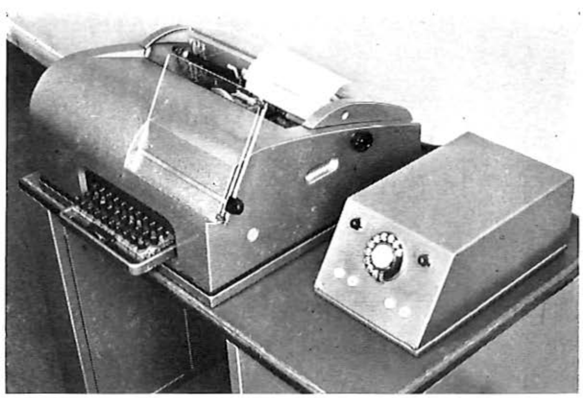
Between the Wars

The underground cable network employing repeater stations expanded rapidly and by 1925 had been extended to Edinburgh. The old heavy gauge cables were now out of date and expansion was based on 20 lb. and 40 lb. cables with 4-wire and 2-wire repeaters. The greater stability of the 4-wire circuit led to its development for long-distance circuits. Eventually, after simple cheap repeaters known as "Units Amplifying" had been developed, the 4-wire circuit was adopted as standard for all new schemes. The last long-distance audio cables, London-Liverpool and Liverpool-Glasgow, were completed in 1935.

The first experiments in carrier-telephony took place as early as 1910, but practical systems had to await the evolution of suitable valves and of network design techniques. Successful systems on overhead lines and on audio type cable were introduced from 1931 onwards and a few are still in use. Experience soon showed, however, the need to provide cables designed specifically for use at high frequencies. Further progress in system design was stimulated in 1934 by the American invention of the negative feedback amplifier which has a very low level of distortion and is remarkably stable. These factors led to the development of the 12-circuit system consisting of separate 24-pair cables for each direction of transmission with repeater stations about 20 miles apart giving a capacity of 288 circuits. The first system was installed in 1935 and was quickly followed by many others. This grew into a network which is now over 3,500 system miles and connects all major centres. About the same time a more advanced system of transmission was introduced. This used coaxial pairs in which one conductor of a pair is a tube about $\frac{3}{8}$ in. in diameter with the other conductor suitably and centrally supported inside. With this construction, crosstalk between adjacent pairs is negligible above a certain low frequency, and there is no limit to the number of telephone channels carried on each pair so long as suitable repeaters are used at sufficiently close spacing. Although the idea originated in America, the first commercial circuits were opened in the United Kingdom in April, 1938, between London and Birmingham. Power was taken from the public supply at certain main stations and carried along the cable to three or more dependant stations on each side and used to energise repeaters spaced seven miles apart.

Experience with several different types of automatic exchange led to the adoption of the Strowger system in the early 1920s as the future Post Office standard. The number of automatic exchanges increased rapidly and by 1930 there

Wheatstone ABC telegraph instrument

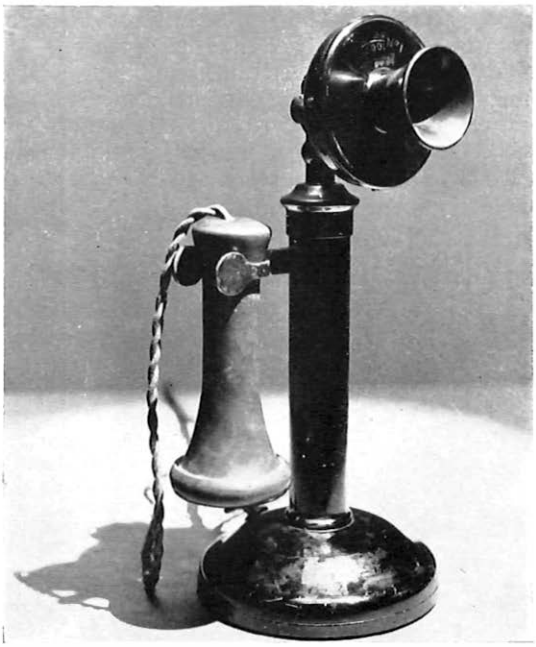


Telex station (Teleprinter 7E) and dialling unit were 307 exchanges serving one-fifth of the telephones. Since about 1926 the number of telephones connected to manual exchanges has remained almost constant, so that the provision of automatic exchanges has no more than kept pace with growth. Another important development was the multi-exchange system for provincial centres and the Leeds area was expanded in 1925 by opening four new satellite exchanges. There still remained the problem of very large areas of high telephone density, particularly London. This was overcome by the development of the director which, when used in conjunction with Strowger equipment, made it possible to call a subscriber using the same dialling code from any exchange in the director area. The first director exchange in Europe was Holborn, opened in 1927. Thereafter, the system was extended throughout London and other large cities. Large-scale application of automatic telephony to rural areas began in 1929 when the Post Office introduced the first standard unit automatic exchange equipment. Between 1929 and 1934, 1,100 such exchanges were opened for service. The present versions of these – UAXs 12, 13 and 14 – were introduced from about 1935. Notable developments in the trunk service were the introduction of the sleeve control board in 1930 and of demand working in 1932-33.

The 1920s saw the introduction of radical changes in telegraph techniques and operation. By 1928 the Post Office had standardised on the Creed No. 3A teleprinter for the inland service. Trials of voice-frequency telegraph systems started in 1925 and by 1931 systems of standard design were beginning to be installed. The VF network introduced great economy and complete flexibility in provision and utilisation of telegraph circuits. In 1932 the Post Office pioneered a switched telegraph service between subscribers – the Telex service.

Great improvements were also made in telephone instrument design. Introduction of the "immersed electrode" transmitter design in 1930 made possible the use of the handset with its benefits of greater convenience and controlled speaking distance. The new telephones – Telephone 162 and so on – were a great advance on their predecessors in transmission efficiency. The next significant change was the introduction, in Telephone 232, of anti-side-tone induction coils which improved the suppression of side-tone without a separate transformer. This was followed by the introduction of the 2P receiver and then, in 1938, by the combined set, typically Telephone No. 332.

Immediately following World War One, the radio stations at Leafield and Cairo, which were under construction at the start of the war, were completed. Shortly after it was decided to provide



Telephone No. 2 (Candlestick)

Telephone No. 706

a high-power long-wave telegraph station with world-wide coverage. A 500 kW transmitting station was erected at Rugby which had an aerial system supported from twelve 820 ft. lattice masts. This station, the most powerful in the world and the first of its kind to have a valve transmitter, was opened on January 1, 1926. A year later a trans-Atlantic long-wave telephone service was opened between New York and London on 5,000 metres (60 kc/s). The transmitter, also housed at Rugby, was designed in America and used the single sideband suppressed carrier technique for the first time. Developments were also proceeding with the use of short waves, 12 to 100 metres, which, now that valves were available, had been found to have a world-wide range. So, in 1924, the Marconi Company was given a contract to provide four sets of telegraph equipment, using sharply directive aerials, to operate to similar stations in Canada, South Africa, India and Australia. At the same time the Post Office went on with the development of short-wave radio-telephone equipment and the first system was opened on trans-Atlantic service in 1928. Thereafter, the short-wave services were extended to cover the world.

World War Two and After

The Second World War hindered the expansion of ordinary services and diverted Post Office and manufacturers' efforts to providing communications for the forces and other war services. A large amount of new cabling, and in some instances new exchanges, had to be provided for connection to aerodromes, ports, and service establishments. At the same time repair and replacement of plant damaged by enemy action called for a great effort. On the radio side a new station equipped with one long-wave and eight short-wave transmitters was erected in a secluded area in Wales to act as a standby for Rugby which had important strategic value.

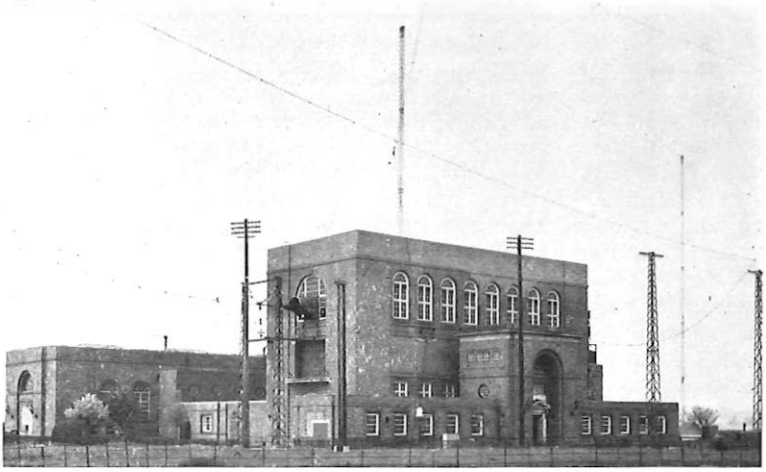
The two small cable ships owned by the Post Office at the outbreak of war and the only large cable ship in Britain – the *Faraday* owned by Siemens Bros Ltd. – were all sunk by enemy action. Fortunately, the Post Office had ordered two new cable ships which came into service in 1940 and it was also decided that the Post Office should build and maintain a large cable ship. This ship, the *Monarch*, was completed in 1946.

The first few years after the war were largely needed for putting existing services into shape, carrying out deferred maintenance and in trying to clear the large waiting list of would-be subscribers.

Since the end of the war the trunk network has increased threefold. Shorter-distance circuits have been provided on audio cables and longer circuits on carrier and coaxial cables. The carrier cable systems, each of which initially carried 12 circuits, have now mostly been converted to 24 circuit working. Coaxial cable systems have been improved both in performance and circuit capacity and modern systems having a capacity of 960 circuits are now the standard method of providing long-distance circuits. In the near future it is expected that microwave radio links will make a substantial contribution to the long-distance circuit capacity.

The first submarine repeater was designed by the Post Office and put in an Isle of Man cable in 1943. Since then the use of repeaters has been extended enormously, first on cables in the shallow waters to the Continent and later, after further research and development, on new telephone cables across the Atlantic. The most outstanding advance of the last decade has been the laying of repeatered submarine telephone cables across the Atlantic. The first link from Britain to Newfoundland used two cables, one in each direction, each containing 51 repeaters of American design and carrying 36 telephone channels – later increased to 48. From Newfoundland to the mainland a single cable works in both directions. This has British designed repeaters and provides 60 telephone channels. A second link with Canada was brought into use in 1961 and this achieves two-way transmission on a single cable. This new design is wholly British. Because of the success of these schemes more systems are projected across the Atlantic and a cable system is to be laid across the Pacific from Canada to New Zealand and Australia.

Television was introduced in London in 1936 but stopped on the outbreak of war. With the return of peace an Advisory Committee recommended that it should be resumed in London and extended to the provinces on the original system. For expansion of television by the BBC and later by the commercial companies the Post Office had to provide nearly all the links between studios and transmitters. Radio links or coaxial line systems similar to those used for telephony are used for long-distance work, while shorter links are provided by video cable systems developed specially for the purpose. The Post Office television

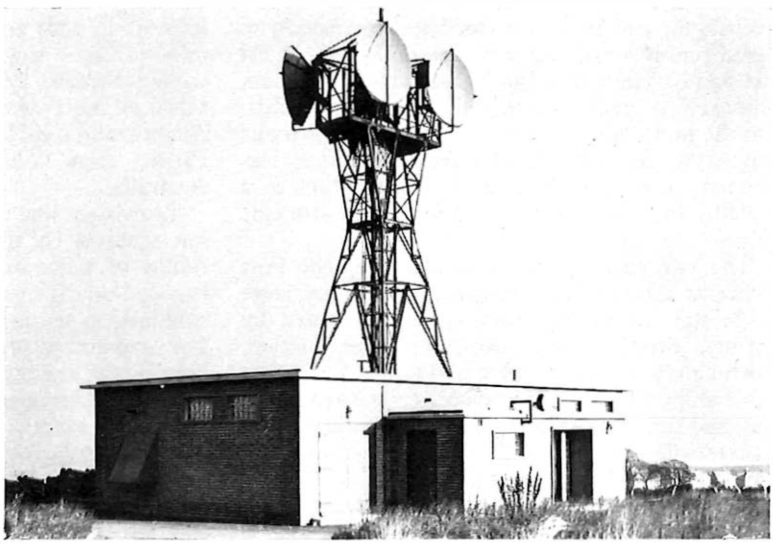


Rugby Long-Wave Radio Station

network now amounts to nearly 5,000 channel miles.

In the field of automatic telephony, considerable progress has been made towards complete automatisation of the system. Over 80 per cent. of subscribers are now connected to automatic exchanges. It was decided that for long-distance calls arrangements should be made at first for the controlling operator to establish calls to automatic subscribers in any part of the country without the intervention of a distant operator. This involved the introduction of a new VF signalling system and provision of trunk automatic exchanges; the first two of these were opened in London in 1954-55. The next stage was to provide facilities for subscribers to dial trunk calls for themselves. The first installation giving these facilities opened at Bristol late in 1958 and they are now available in most of the major towns. Seventeen per cent. of trunk traffic is already dialled by callers. In conjunction with the industry the Post Office has also been engaged for some time in research into the application of electronic techniques to telephone switching; the first all-electronic exchange to

Microwave Radio Station



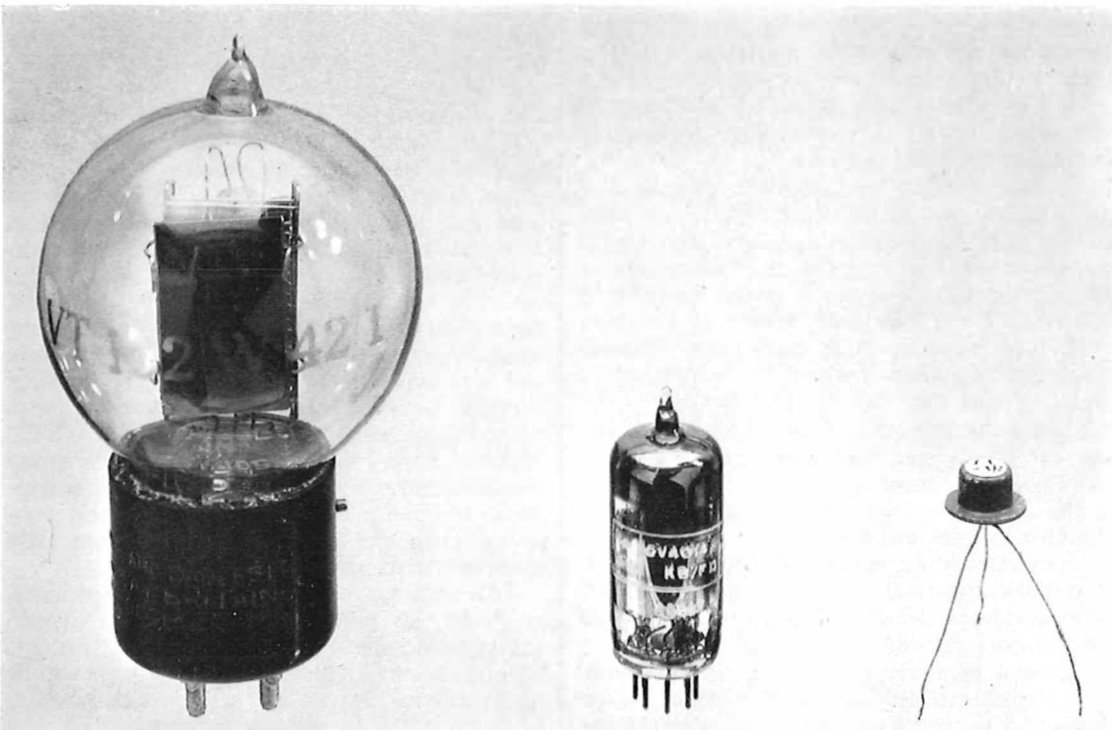
carry public traffic is expected to open later this year at Highgate Wood, London.

Of the many other changes that have taken place, only a few can be mentioned. Among the more important are the introduction of the 700 type telephone with its greater efficiency; the use of cabinets and pillars in the local line network to provide flexibility with consequent economy in use of plant; and, in the telegraph field, conversion of the public network to automatic switching and the introduction of the new Telex service. This, of course, operates over a separate telegraph network and has now been converted to automatic switching.

In 1948 the Bell Telephone Laboratories announced the discovery of the transistor, probably the most important event in telecommunications since the valve was invented. At present the transistor cannot compete with the valve for high powers or for use at high frequencies, but the limits to which it can work are gradually being extended. Since it does not have a heated cathode its power consumption is very low and it operates immediately without warming up delay. As it is so compact equipment can be designed which would be unmanageable if valves were used. An example of this space saving is seen in miniature repeaters for coaxial systems which can be accommodated in manholes. Transistors are already in use for audio repeaters, VF signalling systems, electronic switching circuits, and so on. With a few exceptions all new design work is based on the use of this remarkable device.

The Future

What can we expect in the way of future developments? There will certainly be a vast increase in the demand for circuits for telephone use. From the growing use of computers and the tendency for big organisations to use one central unit to deal with information fed in from many branch offices, a large number of circuits will also be required for data transmission. Such circuit



Old valve *Modern valve* *Transistor*

needs can only be handled by coaxial cables, by very high-frequency radio or, possibly, in the more distant future by wave guides.

We can expect an increasing use of transistors in transmission equipment, in place of valves, and also in switching equipment in place of electro-magnetic devices. Electronic directors have already been tried and there is likely to be a steady increase in their use associated with transistors and magnetic drums.

Then there are the electronic circuits together with magnetic drums for metering subscribers calls. Already these are undergoing trials and offer many advantages over electro-mechanical meters. In fact, when STD becomes general it is possible that the whole of subscribers accounts will be prepared automatically, thus releasing considerable clerical labour for other work.

Very high frequency radio waves have been used to provide telephone and television channels and it is intended to use radio waves for long range communication by reflecting their beams from satellites.

Signals have already been received from America by satellite but the economics of satellite communications have yet to be worked out. However, this scheme does offer the possibility of exchanging regular live television programmes between Europe and America.

For long distance transmission over a series of radio links it may prove worthwhile to use pulse code modulation in which the signal is converted to a series of telegraph type signals. A description of how this technique works is given elsewhere in this issue. Pulse code modulation may also have application for short trunk circuits and junctions since the equipment is cheap and simple and a high degree of cross-talk can be tolerated.

Finally, new devices may come along which, like the valve and transistor, drastically alter our techniques. There are already some novel devices at the laboratory stage—the maser which is an amplifier without inherent noise so that it can be used to amplify extremely weak signals and the cryotron, a semi-conductor which can be used in a superconducting state as a switching device of extraordinary rapidity.

An even more recent discovery is the optical maser which can produce pulses of light 100,000 times more intense than sunlight. Whether this can be applied to telecommunications is as yet uncertain.

New Post for Mr. A. Kemp, C.B.E.

Mr. A. Kemp, CBE, has resigned from the Editorial Board of the *Telecommunications Journal* on his appointment as Director, Home Counties Region. So ends a unique record of 13 years continuous service as a member of the Board which spans the whole of the *Journal's* life: a record that no-one else can match.

Mr. Kemp has served in Area Offices and has been a Telephone Manager. He has worked in Regional Offices and has been a Telecommunications Controller. He has worked in the ITD and has been in charge of three of its four branches. Before the war he was seconded to Palestine where he organised the conversion of the Jerusalem and Tel-Aviv exchanges to automatic working. Latterly he has been closely identified with group charging and with the introduction of STD in this country. He was chairman of a study group which formulated plans for both of these developments and more recently has been closely connected with the forward thinking about fully electronic telecommunications systems.

This wide range of knowledge and experience, coupled with Mr. Kemp's ability to explain complicated issues in simple direct language, has been invaluable to the Editorial Board. He will be sorely missed. But we are delighted that he has been promoted to such an important post and wish him every possible success and happiness in his new job.

Principles and Possibilities of Pulse Code Modulation

E. C. H. Seaman, B.Sc.(Eng.), M.I.E.E.

THE function of a telephone system is to reproduce, at the ear of a listening subscriber, the variations of air pressure near the mouth of another subscriber who is talking. The speaker's microphone controls an electric current, making it vary in the same manner as the air pressure. In the simplest transmission system this current passes along a pair of wires to the listener's receiver, which reproduces from it the original air pressure variations. The current may be described as an *analogue** of the air pressure, and the simple transmission system mentioned is one example of an *analogue transmission system*.†

The variations of the air pressure and the analogous current with time can be represented graphically, to suitable scales, by the same curve or *waveform*. As indicated in Fig. 1, the current does not jump from one value to another, but varies smoothly over a range of values. Moreover, there are no gaps in time; the pair of wires is in use all the time for the transmission of current.

It has been shown mathematically, however, that to enable such a waveform to be reproduced at a distant point, it is by no means essential to transmit the complete waveform; it is sufficient to transmit *samples* of it at suitable intervals of time. The rate at which samples must be taken depends on the highest frequency-component present, and 8,000 samples per second suffice for telephony if it is accepted that no frequency above 3,400 cycles per second need be reproduced. Thus to enable the waveform of Fig. 1 to be reproduced at a distant point, it is sufficient to convey to that point, by any means that can be devised, information about the value of the current at the points *a*, *b*, *c* – which are 1/8,000 second (125 microseconds) apart.

A simple way of doing this is to transmit pulses of current as shown in Fig. 2, the height of each pulse being equal to the value of the current in Fig. 1 at the same instant. This kind of transmission is called *pulse amplitude modulation*‡ (PAM). At the distant point there will be means for spreading out the pulses to fill up the gaps between them, and theory shows that the waveform of Fig. 1 can be correctly reproduced in this way.

A PAM system is an analogue system, since the pulse height (amplitude) is proportional to the original air pressure.

The pair of wires is not now utilised all the time: between the pulses are gaps that can be used for other purposes. An obvious step is to use these gaps to provide, on the same pair of wires, other PAM channels§ for the transmission of other conversations. Fig. 3 shows how the time could be divided to give four channels on a single pair of wires, the pulses of two channels only being shown to simplify the diagram. The interval of time allocated every 125 microseconds to a particular channel may be called a *time-slot*.

The arrangement illustrated in Fig. 3 is a PAM *time-division multiplex* (TDM) system. Electronic telephone exchanges of the TDM type operate on this principle. It is not practicable to apply PAM

* *The earliest (ancient Greek) meaning of "analogy" was "proportional relationship".*

† *As distinct from a* digital system, *of which PCM will be shown to be an example.*

‡ *Use of the term "modulation" here arises from a slightly different train of thought. It may be supposed that a steady sequence of pulses, all of the same height, is first generated, and that the heights of the pulses are then modified, so that they fit below the waveform of Fig. 1. The pulse amplitudes may then be said to be "modulated" with the waveform.*

§ *A "channel" is a "means of one-way communication". In PAM and PCM systems a separate pair of wires is used for the other direction of transmission, that is, "4-wire transmission" is employed.*

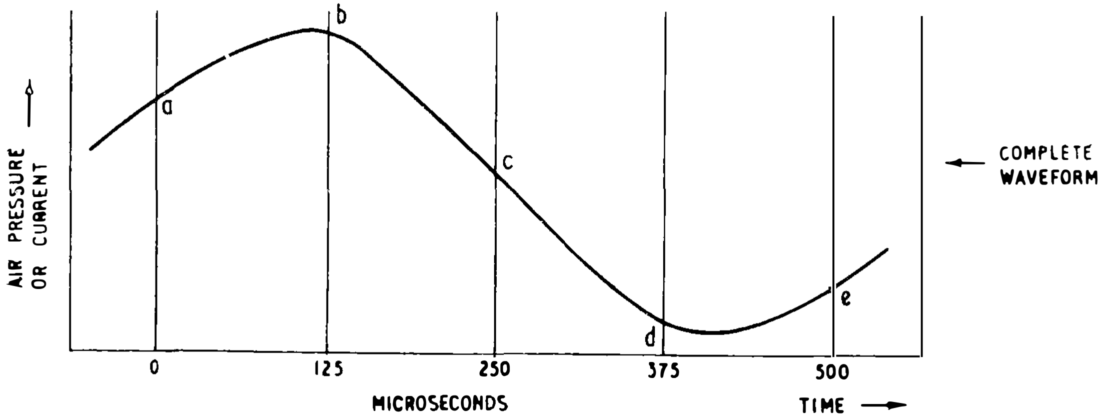


Fig 1: Variations of the air pressure and the analogous current with time represented as a waveform

directly to transmission over lines because of the difficulty of avoiding distortion of the pulses; if one pulse spreads to encroach on the time-slot of another, there will be crosstalk between channels.

Pulse code modulation (PCM) also relies on the process of sampling the waveform, but uses a different method of transmitting information on the size of the samples. In effect, each sample is measured and its size is described by a number. The number is expressed in *binary* form, that is, by a succession of *digits* each of which has only two possible values, 1 and 0. At the right of Fig. 4 the ordinary (decimal) numbers 0 to 7 are shown and beside them the corresponding 3-digit binary numbers 000 to 111. The decimal numbers can be obtained from the binary numbers by giving to "1" in the different positions the values 1, 2 and 4, as shown at the top.

In Fig. 4, the range of sizes covered by the current samples is divided into eight parts, each having a different number. This enables the sizes of the samples at the points *a*, *b*, *c* – to be expressed numerically by the binary numbers shown at the bottom of the figure.

It will be seen, however, that the numbers do not describe the sizes of the samples exactly, but only define certain ranges within which they lie. This feature, inherent in PCM, is called

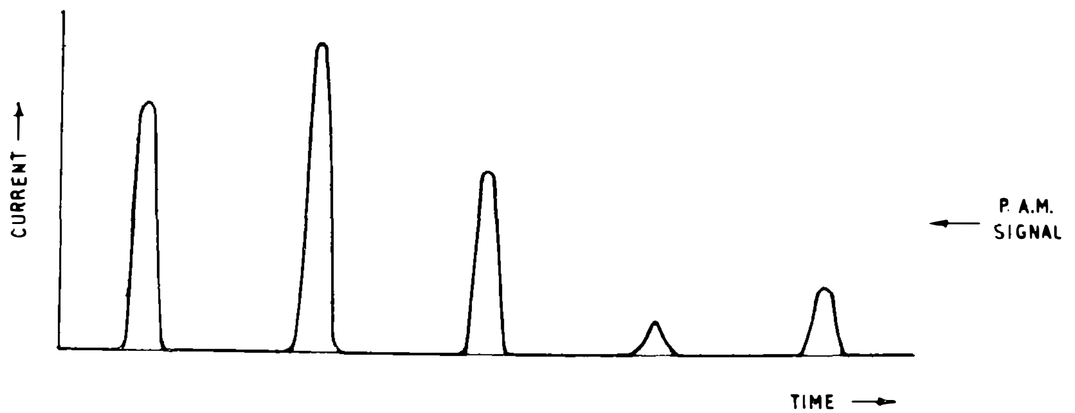


Fig. 2: Pulses of current

quantization; it results in some distortion of the reproduced speech, and the subjective effect is called *quantization noise.*

The use of 3-digit binary numbers, dividing the complete range into eight parts, is of course far too crude. Further digits, having the values 8, 16, 32 – must be added, so that the range may be divided more finely and the quantization noise reduced.

The number of digits needed has to be decided after subjective tests of the quality of the reproduced speech. Seven digits enable the range to be divided into 128 parts and this is the necessary order of precision. An additional digit may be used to provide a separate signalling channel associated with each speech channel.

The next question is how the binary numbers are to be conveyed to a distant point. The method adopted follows telegraphic practice. Still assuming a 3-digit code to illustrate the principle, the time-slot allocated to a particular channel is divided into three parts, in each of which a pulse may or may not appear. The presence of a pulse indicates "1" and the absence of a pulse indicates "0". All the pulses that are present have the same height. The final result – the PCM signal that would be transmitted to represent the waveform of Fig. 1 – is shown in Fig. 5. Time-division is still used to give a number of channels on one pair of wires, as already described for PAM.

Since no physical quantity proportional to the original air pressure is to be found on the line, which carries only coded numerical information, PCM is an example of a *digital system.*

The advantage of PCM, frequently described as "robustness", can be explained by comparing it with PAM. In the latter, the pulse height is used to express the sample size directly, so that distortion of the pulse results in corresponding distortion of the speech. Also, quite small extraneous currents (electrical "noise") will, in effect, alter the pulse heights and produce audible noise when the speech is reproduced.

In Pulse Code Modulation, however, it is only necessary to detect whether a pulse is present or absent and this can be done correctly even if the pulses are greatly distorted or if a good deal of noise is added.

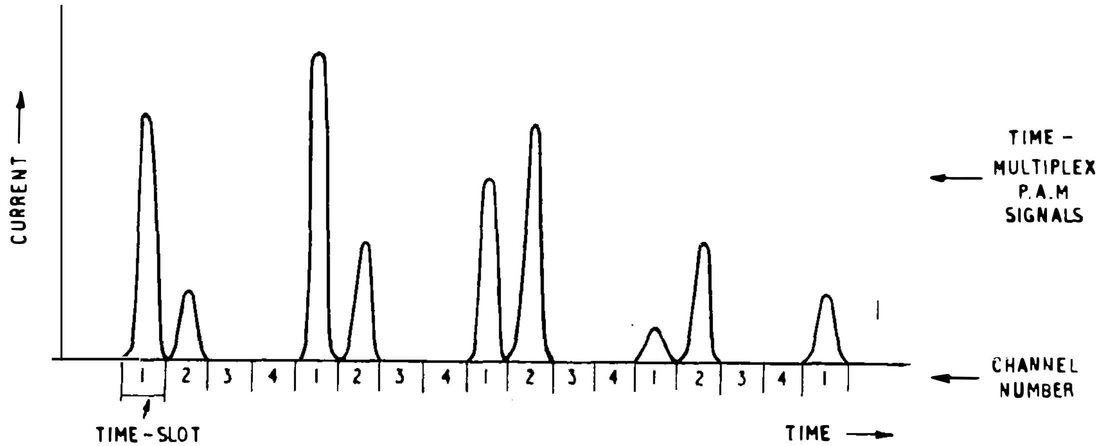


Fig. 3: Time divided to give four channels on a single pair of wires—pulses for two channels only

Digital transmission permits a new point of view in provision of amplifiers (repeaters) along a line. In any analogue system, an amplifier must be designed to "magnify" the received waveform. Small inaccuracies in this process cause audible distortion of the speech and noise is amplified to the same degree as the signal.

In a digital system, where only the presence or the absence of a pulse is of consequence, it is possible to employ regenerative repeaters. These detect the presence of an incoming pulse, even if it is very distorted or partly masked by noise, and then send forward a new, correctly shaped, pulse.

Digital transmission also makes the loudness of the reproduced speech independent of variations of loss in the transmission links. The received pulses may vary in height, but provided that they are correctly recognised, the speech reproduced from the numbers that they represent is unaffected.

PCM does not, of course, give something for nothing. The advantage of a robust system, providing a number of speech channels on a single pair of wires, is obtained at the cost of increased bandwidth. A PCM system providing 24 speech channels occupies a bandwidth of more than 1,000,000 cycles per second, compared with about 100,000 cycles per second needed to transmit two 12-channel groups over a carrier or coaxial system in the well-known *frequency-division multiplex* form.

The cost of the terminal equipment provided for coding and multiplexing operations must be weighed against savings which accrue elsewhere.

Possible Applications of PCM

Further technical development and economic investigation will be required before it is possible to decide whether and where PCM has a useful part to play in the telephone network. It is intended here to do no more than indicate some of the possibilities. Separate parts of the network are first considered and the question of "integrated" systems is then discussed.

The possibility that has received most attention recently is the use of PCM to provide circuits over distances of, say, 10 to 40 miles using pairs in existing audio-frequency cables from which the loading would be removed. For this purpose the "robustness" of PCM would permit multiplex transmission over cables not specifically designed for high-frequency use. Four wires might provide 24 circuits, with regenerative repeaters at intervals of 2,000 yards. If routes are treated individually in this way, there will be equipment for time-multiplexing and encoding and decoding at each end of each route. It is possible that PCM may prove economic in this application, even in the absence of "integration".

A similar arrangement might be used to save pairs in the local line network, between concentrators (line connectors) and local exchanges. It is unlikely, however, that PCM could economically be used solely for this purpose, with multiplexing and coding equipment at each end of a cable connecting a concentrator to a local exchange. Applications in the local line network are more likely to occur as part of an integrated system.

For future long-distance waveguide systems, PCM is a likely choice because of the kinds of distortion to be expected.

As satellite communication involves the reception of weak signals in the presence of electrical "noise", the relative immunity of PCM to noise makes it attractive in this field.

There would be no advantage in using PCM within an exchange if it were not to be used on the lines connected to the exchange. However, if there is to be extensive use of PCM on lines, electronic exchanges can be developed to switch the PCM channels directly, without conversion to

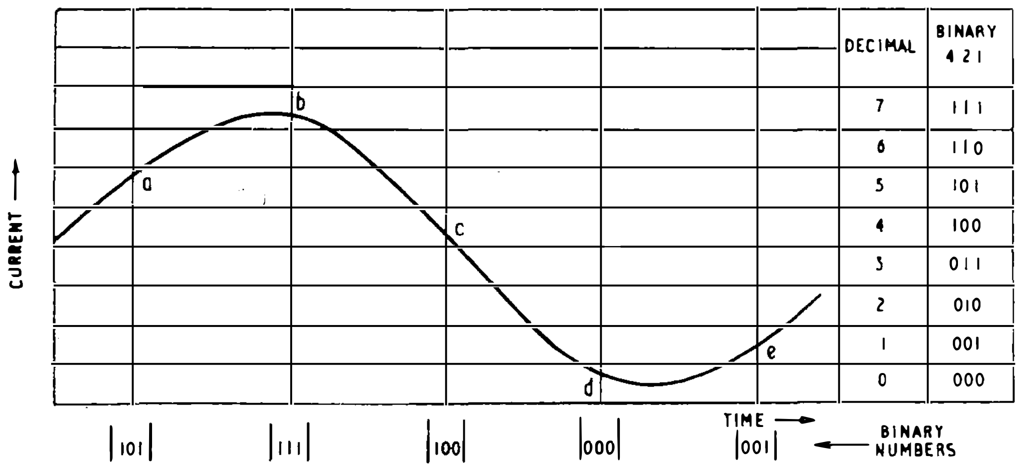


Fig. 4: Pulse code modulation. Sampling the waveform

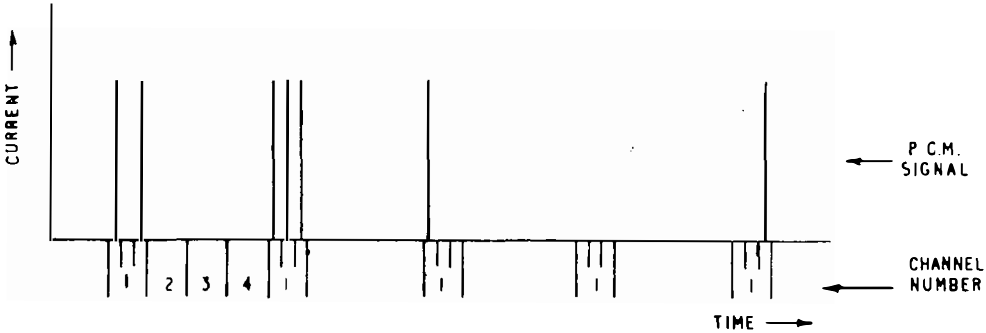


Fig. 5: The PCM signal that would be transmitted to represent the waveform of Fig. 1

audio frequency, and such exchanges may well be cheaper than electronic exchanges of similar size dealing with audio channels. Thus, exchanges handling PCM signals may form part of an integrated system.

As already indicated there are some parts of the telephone network in which piecemeal application of PCM may prove economic. Every such application, however, involves expenditure on encoding and decoding equipment. The advantages of PCM will evidently be more fully realised if the speech can be encoded and decoded only near the ends of connections, transmission elsewhere being in PCM form throughout. This leads to the concept of integrated systems.

Extensive use of PCM on junction routes and long-distance waveguides might result in a system in which encoding and decoding take place at the junction side of local exchanges and transit exchanges would handle PCM signals directly.

The idea of integration has been extended further with the proposal that encoding and decoding should take place at concentrators in the local network, transmission between two concentrators, however far apart, being throughout by PCM.

This could lead to saving on local line plant and to an improved and uniform standard of transmission throughout the network.

Problems yet to be solved to realise such systems include synchronising operations throughout the network, in the presence of transmission delays that will be appreciable and to some extent variable.

As PCM is a digital system, it may well prove practicable to use channels interchangeably for the transmission of coded speech or data. This feature is important in view of the demands for data transmission at ever-increasing speeds. A PCM channel designed for speech transmission can transmit data much faster than can an audio-frequency speech channel.

Ariel in Orbit

CIRCLING the earth every 99 minutes at a height of between 200 and 600 miles, *Ariel* – the first Anglo-American satellite – has been launched into orbit by an American rocket at Cape Canaveral.

Ariel, previously known as UK-1 and S-51, weighs 132 lbs. and is gold-plated. It contains six measuring instruments made by British universities and firms with Government aid and is designed to study the ionosphere – the reflecting layer of the upper atmosphere on which long-range radio signals depend – and its relationship to the sun. It is the first satellite to study the ionosphere and the sun's radiations at the same time.

Sir Harry Massie, chairman of the British Space Research Committee, has said that he doubts if the information collected by *Ariel* will have any immediate practical value but it could possibly help communications experts in predicting radio black-outs due to sun spots. But the main purpose was pure science and no-one could foretell what practical applications may lie in store.

Signals from *Ariel*, described as a "chirruping" sound, were picked up by the British Minitrack station at Winkfield, one of 14 dotted around the world.

Storm Havoc in the North-East

J. Sharp

Courtesy, TheYorkshire Post

The effect of the wind on three new cranes at Middlesbrough docks. One vanished under the waters

IN the early hours of Monday, February 12 and the nights of Thursday and Friday, February 15 and 16, exceptionally severe gales with gusts of up to 100 miles an hour raged in the north eastern part of the country. Some idea of their impact can be gauged from the fact that near Leeds, on the Harewood Estate alone, some 30,000 trees were either uprooted or seriously damaged, and in Sheffield one house in every three was damaged.

Falling trees and debris played havoc with overhead lines and some 55,000 telephones were reported out of order in Bradford, Leeds, Sheffield, Newcastle and York Telephone Areas. Throughout the week following the first gale, the total of carried forward faults in the North Eastern Region was between 12,000 and 14,000 compared with the normal level of 1,500.

Post Office staff, especially the engineers, were faced with a formidable task and responded magnificently. Storm control units were set up and two-men working parties were formed by pairing installation staff and internal maintenance staff with faultsmen. In one Area alone, over 140 such teams were in action. Installation work virtually ceased for conditions were often dangerous, with sustained winds of up to 35 miles an hour. As an example of troubles which had to be overcome, one emergency faultsman had to seek assistance from a four-man gang to get him under way during the early hours of the morning as his garage had collapsed around his van! Road traffic interfered with the job of re-erecting poles and wires, especially in country lanes, and Youths-in-Training from the Regional Training School volunteered to help at weekends by directing traffic.

Help came from many other sources. Gangs were loaned from Midland Region and staff were brought from those Areas in North Eastern Region which were not affected.

Telephone exchange staff also were called on to make extra efforts. The level of traffic at some of the larger exchanges was 30 per cent. higher than normal, and several thousand "999" calls were handled during some nights.

Post Office people suffered damage to their homes, ranging from missing slates and blown-away greenhouses to completely demolished roofs. True to tradition, however, there was little absence from duty.

Engineers who design, erect and maintain Post Office plant and all those who helped throughout the emergency can feel proud that conditions were nearly normal within a fortnight.

Nonetheless we are glad that so much plant has been put underground during the past decade.

Telephone Exchange Relays

G. F. Machen, B.Sc.(Eng.), A.M.I.E.E.

ALTHOUGH defined as "a device, operated by an electric current and causing by its operation abrupt changes in an electrical circuit", a relay can include a valve, rectifier or transistor. The most generally known, however, is operated by electro-magnetism and it is this type and the various forms of electro-magnetic relays used in telephone switching which will be briefly described.

Permanent magnets, consisting of the natural "lodestone" (oxide of iron), were known before Roman times. But it was not until batteries, giving steady current, were constructed in the early nineteenth century that much progress was made in the study of the magnetic effect of current flowing in a wire. With this development came rapid advances in understanding electro-magnetic effects. When the telephone began to be recognised as an essential part of commercial and social life, the problems of signalling between large numbers of telephones and exchanges led to the development of the electro-magnetic relay, basically in its present form.

The combination of electro-magnet and contact springs which make a relay took many forms. Some used gravity to pull the contacts apart when the current was disconnected but it was not long before the elastic effect of springs was almost universally used.

Soon after World War One electrical methods of communication became popular and the automatic method of setting up a telephone call part of normal life. It was not long before the Post Office decided it needed a "standard" product from all manufacturers so that all telephone exchange equipment would be similar, irrespective of origin. The well known Post Office 3000 type relay was standardised in the early 1930s as, later, were the more complicated exchange mechanisms. Hundreds of millions of this type of relay are in use throughout the world and it is still being produced in very large quantities – a tribute to the engineers who designed and developed it.

Special purpose relays have since been introduced where the need for greater speed, sensitivity and longer life justified the necessary development work.

The aim of relay design is to attain a specified performance for circuit functioning at minimum cost of manufacture, testing, installation, use and

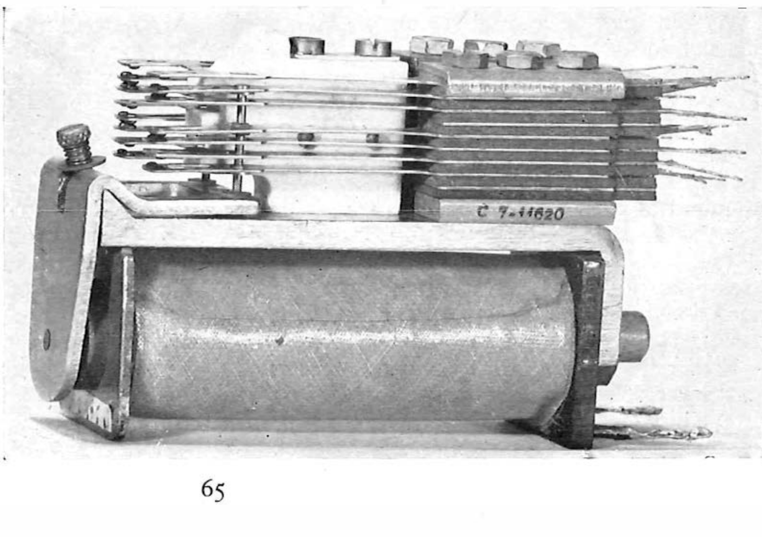


Fig. 1: 3000 type relay with two make, one break and three changeover contacts

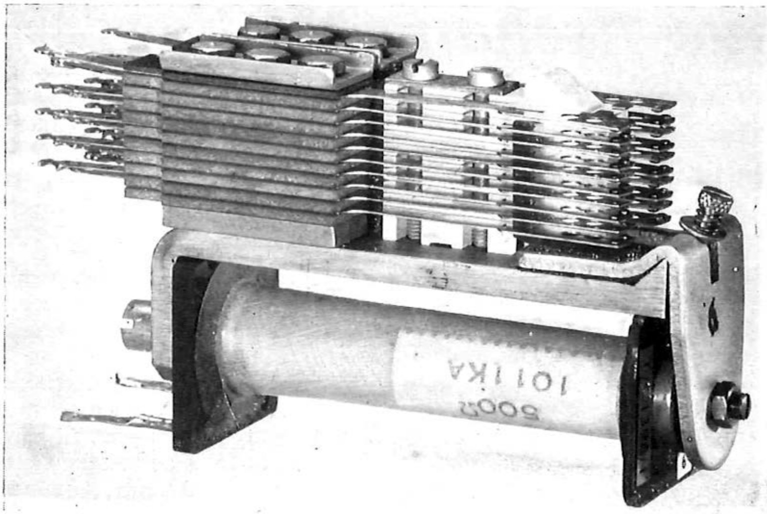


Fig. 2:
Type 10 relay with ten make contacts

subsequent maintenance. Inherent in all this are consistency – that is, small differences between samples intended to be functionally identical – stability and reliability. But none of these is needed for its own sake. The relay need only be as stable over the years as the circuit performance requires, so that to spend money to achieve more than this is wasteful. Today, relay windings are very reliable but it is noteworthy that this part of a relay is hidden from view and is perhaps the most delicate part. A typical winding has half a mile of fine copper wire with an even finer coating of insulating enamel on it. Elsewhere on the relay the parts are larger and the materials more robust and open to inspection.

As the relay is a combination of an electro-magnet and a contacting system, it is convenient to consider these two parts separately.

Electro-magnet

The electro-magnet is a simple form of motor. Its armature does not rotate continuously but is required to rotate only a small distance – termed the travel – about a hinge usually in the form of a knife-edge wedge under the influence of the energised winding. Then it returns in the reverse direction when the current through the winding is cut off.

Generally, the return is controlled by a flat cantilever spring. The armature is made of soft iron and the rest of the magnetic circuit is usually of the same material. As iron tends to retain a little magnetism even when the current through the winding is removed an air gap, formed by a non-magnetic "residual" stud, is left in the magnetic circuit to assist the demagnetisation of the iron. The residual stud is attached to the armature and when the relay is about to operate the magnetic field has to bridge not only the gap caused by the residual stud, but the travel gap as well. The armature needs to be free to rotate, and the knife-edge suspension is used to reduce frictional force and the magnetic reluctance.

Contact Systems

There are many contact systems in use today, each suited to its particular application. The most common form consists of flat springs clamped together between insulating material. One end of each spring is wired to the electrical circuit and the other has a noble metal tip added to it which makes contact with a similar one when the relay is actuated. The most commonly used metal for the contact is silver but where additional cost is justified platinum is used. Various alloys are used for special purposes.

The force with which the two contacts press against each other is an important factor in determining the reliability of the contact but, as the force available from the electro-magnet is limited, great care is necessary in design and manufacture to obtain the best performance. A typical value of contact force is half an ounce. One effective way of improving the reliability of contacts is to make them in pairs so that if one momentarily fails the other carries the current. In practice this arrangement gives a marked gain in reliability although the contact force on individual pairs of contacts is halved by this twin arrangement. When contacts part and the electrical circuit is broken the distance of separation is of great importance. Where the currents and voltages are low this distance can be small – say five-thousandths of an inch – but where currents are more than an ampere wider spacing and special contacts are necessary.

Sensitivity and Timing

The current at which relays are required to operate varies over a wide range and is dependent on the circuits in which they are used. In a telephone exchange the range is usually from about one-thousandth of an ampere (one milliamp) to an ampere or so. For the smaller currents – a few milliamps – polarised relays are used but the rest of the range is covered by the 3000 type relay.

In some circuits relays need to be as fast as possible; in others slow operation or release is required.

3000 Type Relay

When the Post Office standardised the 3000 type relay (Fig. 1) it was usual for every relay to require special adjustments depending on its use. The 3000 type was a great advance as it standardised not only the parts from which it is assembled but also subsequent adjustments. The spring tensions, armature travel and so on, were all fixed. Production adjustment was simplified and – very importantly for the Post Office – so was the subsequent maintenance in the telephone exchange since staff were able to adjust relays without reference to detailed instruction sheets. It also meant that uniform results could be obtained by design engineers working independently of one another. Another important feature was that twin contacts were used throughout and the contact material was either platinum or silver.

There are some exceptions to this ideal state. For example, when the 3000 type relay is used for sensitive pulse repetition applications special adjustments are necessary. The distinction between simple and special applications is indicated by the coloured label on the front of the relay – white or green for simple and red for special.

An essential function of some relays is to remain held-operated for a certain time after the current is cut off. This timing function can give a release lag of from, say, 50 to 500 milliseconds, according to design, and is achieved by fitting a thick tube of copper round the core. An operate lag of up to 100 milliseconds can be obtained by similar means.

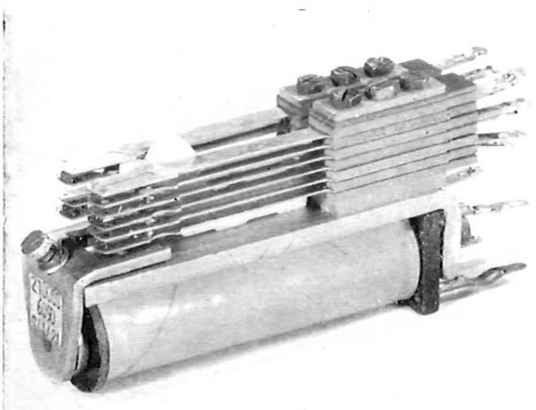


Fig. 3: 600 type relay

Remanent Relay

The 3000 type relay can easily be modified so that it will remain operated after the operating current has ceased. The modification is to the magnetic core on which the coil is wound and to the armature. The core material is made of a low carbon steel – instead of soft iron – which becomes a "permanent" magnet after energisation. The armature has the residual stud removed so that the magnetic circuit is completely closed when the relay is operated.

Having operated the relay and removed the operating current the contacts remain held by the permanent flux due to the steel core. Magnetism of the core can be destroyed by sending a pulse of current through the coil in the reverse direction to the operating current, thus releasing the relay.

Type 10 Relay

The type 10 relay is similar to the 3000 type and is shown in Fig. 2. It utilises many of the parts in the 3000 type but some are modified in shape and material to give a longer fault-free life.

The brass lifting pins and keramot lifting studs used in the 3000 type relay have been replaced by combs made of synthetic resin-bonded paper and the studs on the armature used for stopping it at

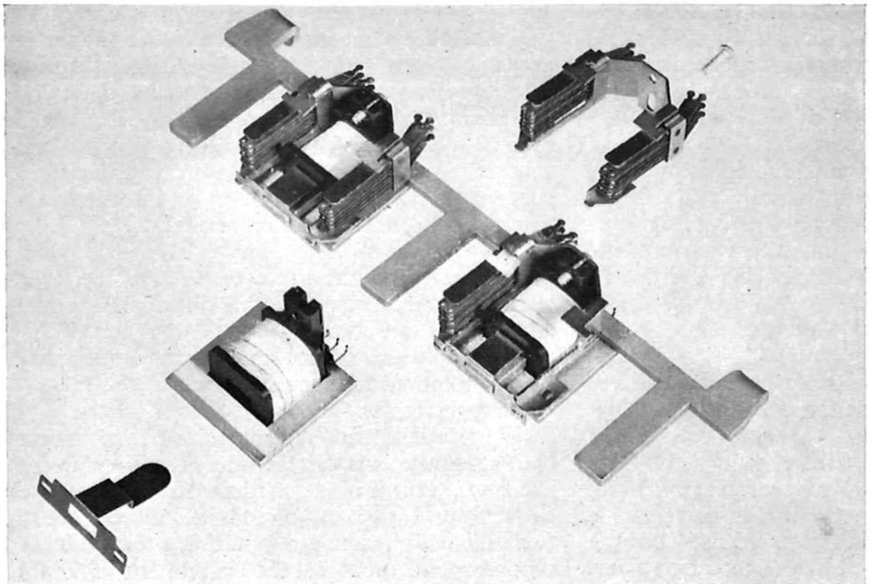


Fig. 4: Type 12 relay. Part exploded view (Courtesy of Ericsson Telephones Ltd.)

the extremes of its travel have been enlarged and re-shaped.

In some applications some of the moving parts of the 3000 type may show distinct signs of wear after a few million operations but the type 10 will operate satisfactorily after one hundred million operations. The type 10 is used in register translators in the STD network and in other heavily worked circuits.

600 and Type 12 Relays

One of the circuits in which relays are employed in large numbers but receive relatively little use, is that directly associated with the subscriber. Every subscriber has a line relay and a cut-off relay at the exchange which is for his use alone. It was considered that the use of ordinary robust, adaptable relays for this purpose was unjustified and a smaller and cheaper version of the 3000 type relay, the 600 type, was developed (see Fig. 3).

When line finders were re-introduced some years ago it was recognised that the circuit requirements were such that the associated subscribers relays could be built on an even simpler basis than the 600 type and that one built on a multiple basis should prove cheaper to manufacture.

The type 12 relay (see Fig. 4) was developed for this purpose. It is made in units of five identical

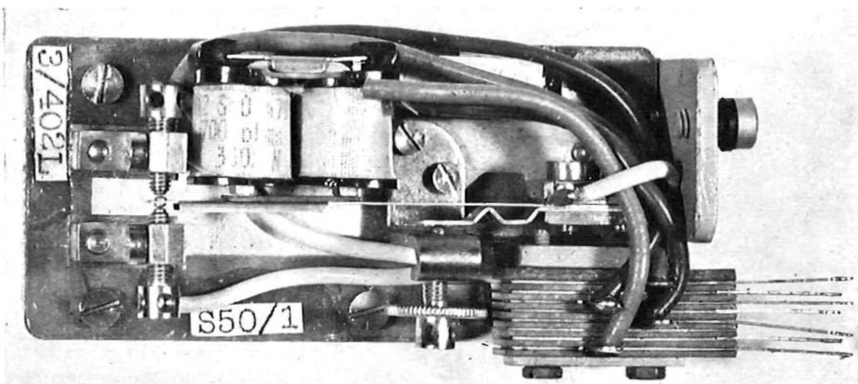


Fig. 5: High speed relay with one changeover contact

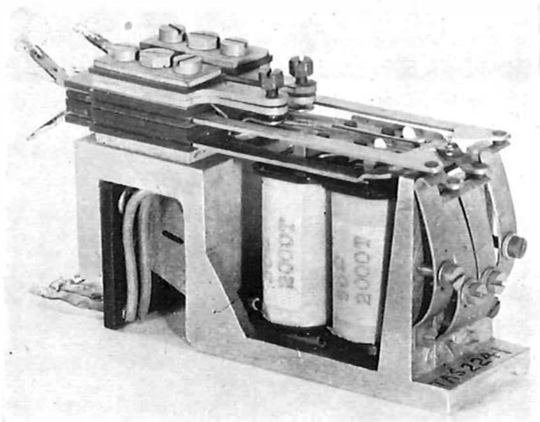


Fig. 6: High speed relay with two changeover contacts

relays. The metal parts are simple stampings, and plastic is used for the more complicated shapes. The plastic bobbin for the winding, for instance, is not only a space to wind the wire but also locates the hinge point of the armature, controls the armature travel and locks the spring sets in position. The number of screws and tapped holes used in this relay is an example of the simplification achieved. There is only one screw for each relay which locks into a spring nut. The relay it supersedes has about 12 screws for each relay, all located in tapped holes. The unit of five relays uses five screws and two fixing screws, instead of 60. Other important design details reduce initial production and installation costs. It is anticipated that this relay will require no maintenance attention on the circuits for which it has been specifically designed.

Single Contact High-Speed Relay

The single contact high-speed relay, which has one platinum changeover contact and was standardised by the Post Office in the late 1930s, is about ten times faster than the 3000 type and is used whenever quick operation or release is required by the circuit. It will be seen in Fig. 5 that the coils, magnetic parts and armature and the distance the contacts move – four-thousandths of an inch – are all much smaller than the 3000 type equivalents.

Another important feature not obvious in Fig. 5 is the magnetic circuit cross-section, that is the plane at right angles to the direction of magnetic flux. This cross-section is rectangular with the long sides very much greater than the short. The reason for this is the same as when similar rectangular shapes are used for transformer laminations to reduce circulating currents in the magnetic material induced by the changing magnetic flux. In a transformer such currents cause heating losses. In a relay heating losses are insignificant, but the currents delay the release of the relay.

As the relay has such a short travel and the residual setting is vitally important the contacts are adjustable on a fine screw thread. The tension can also be adjusted by screw thread so that performance can be accurately set; the relay will operate or release in less than 1 millisecond.

Double Contact High-Speed Relay

A high speed relay with two platinum changeover contacts was standardised in the Post Office about 1950. This double contact high-speed relay, shown in Fig. 6, has more contacts and as it is more sensitive it is slower than its smaller predecessor. Although the basic parts are larger a new layout permits it to be mounted in one 3000 type relay space.

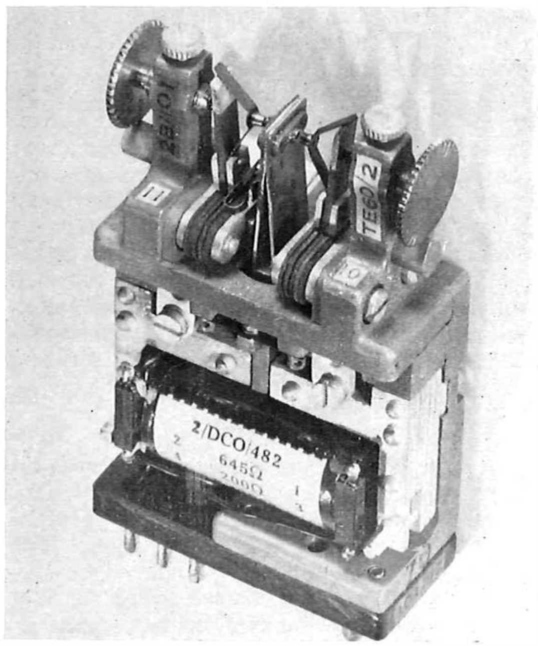


Fig. 7: Polarised relay with one changeover contact

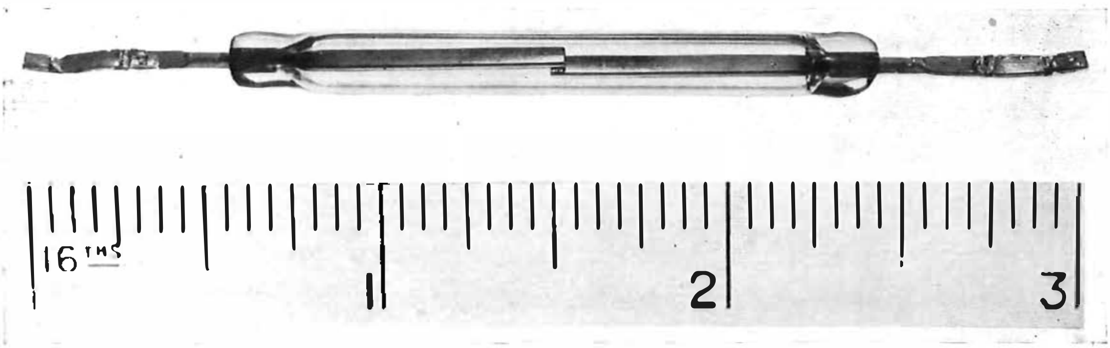


Fig. 8: Reed relay unit

Where accuracy of setting, speed and extreme sensitivity are required the choice is for a relay having a permanent magnet in the magnetic circuit, that is a polarised relay as shown in Fig. 7.

Polarised Relays

These relays have one changeover contact of noble metal with a contact spacing of less than five-thousandths of an inch. Unlike other relays the centre spring of most polarised relays remains on the side of the changeover contact on which it was last resting when the energising current ceased. It is held in position by the magnetic flux of the permanent magnet.

Reference was made to the rectangular cross section of the magnetic circuit on high-speed relays and the similarity to transformer cores. Polarised relays usually have part of their magnetic circuit made up of laminations for the same reasons. However, as may be expected, there is a limit to the speed of response and this is set by the bounce of the contacts when they come together. Special precautions are taken to reduce contact bounce and if present the time is about 0.1 millisecond. A recent development in this field is a polarised relay with two changeover contacts.

Reed Relays – Types 14 and 15

The least reliable part of a normal relay is the contact, which may be affected by atmospheric conditions, dust and fibre particles between contact pairs and suffer chemical attack. This "mechanical separation" is thought to be adequately covered by twin contacts in all but the worst environments, but twin contacts cannot be used on fast relays where the contact opening is very small.

The contact unit of a reed relay (Fig. 8) overcomes these problems by placing the contacts in a glass envelope. The contacts consist of two reeds of magnetic iron, held at opposite ends of a glass tube and overlapping one another at their free ends in the middle of the tube, but ten-thousandths of an inch apart. The overlapping ends are gold plated and form the contacts. Magnetisation of the reeds by a coil outside the glass causes the reeds to attract one another and come together with a toggle-like action. The resulting contact forces are, in general, higher than those on open type relays.

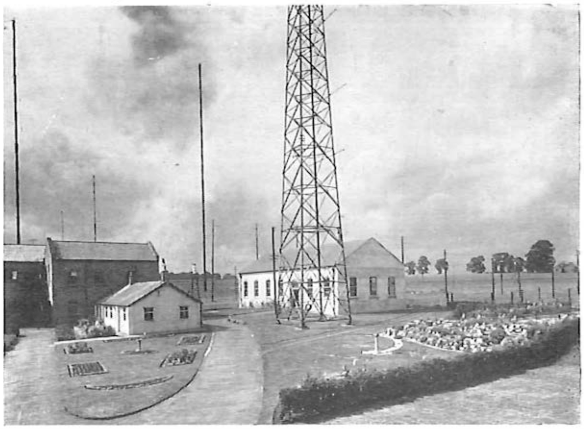
Coil bobbins are plastic and mountings for these relays are available for assembly into existing standard mountings or on to printed circuit boards. Up to four contact units fit into one bobbin.

Although the relays briefly described here all depend on electro-magnetic action for their operation, they differ individually in many important respects – in speed, sensitivity, contact capacity and life. Availability of this range of types supplemented by the Ratchet Relay (*Journal* Summer 1959, pages 121 and 122) has provided flexibility and economy in circuit design and made it possible to meet the requirements of mechanisation successfully.

Electromagnetic relays are unlikely to play any large part in electronic exchanges of the future since devices such as the cold cathode tube and transistor provide the basic relay function and operate at far higher speeds. Nevertheless, a vast number of electro-magnetic relays will remain in service for many years and, based on past experience, with continuing reliability in performance.

The End of an Era at Leafield

D. E. Watt-Carter



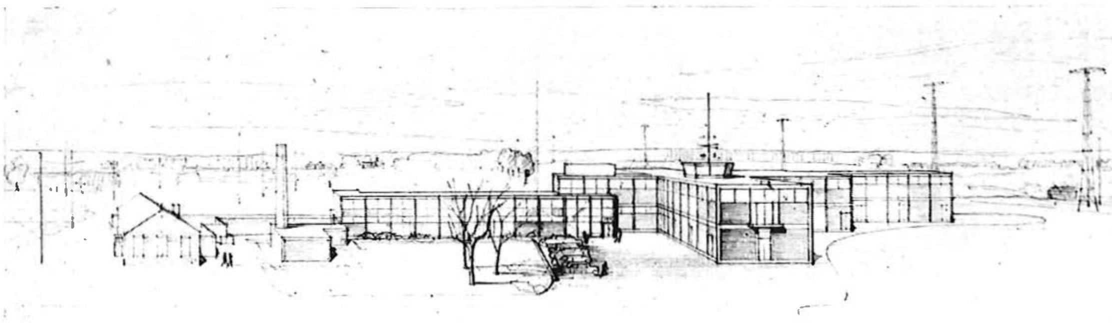
Leafield Radio Station today

THE Post Office Radio Station at Leafield in the heart of the Cotswolds dates from the pioneering days of radio communications. Originally it was built in 1912 as part of a chain of ten long-wave radio stations which were to be erected in various parts of the British Empire, but which, because of the First World War and the subsequent rapid developments in short-wave radio, were not completed. It was acquired by the Post Office and began commercial operation in 1921. The first transmitter used the Poulsen Arc System, but after 1928 was succeeded by three-valve transmitters. These transmitters were used to send Press telegraph traffic overseas.

Since those early years much of the telegraph traffic, both Press broadcast and point-to-point, have been carried by the more economical short-wave systems which have grown in importance. The original long-wave site was extended in 1932 to accommodate high-frequency aerials and four transmitters working in the frequency band 5–25 Mc/s were installed. By 1942 the number had grown to eight, and today there are ten.

Now the long-wave era at Leafield has come to an end. Early in 1961 the remaining long-wave services were transferred to other stations and the transmitters ceased operation after some 30 years of continuous service. Today's need is to raise the efficiency of the high-frequency services by employing high-power transmitters and improved aerial systems, and to increase the traffic handling capacity of the point-to-point telegraph services by exploiting modern multi-channel techniques using high stability independent sideband transmissions. Virtually the whole of the present installation, comprising both long-wave and short-wave transmitters and aerials, is to be dismantled and replaced by equipment of up-to-date design housed in a new building.

Work on the new building began in January, 1961 and is already well advanced. When completed it will house 18 transmitters in three wings radiating from a central area containing the station control position. In this respect it follows the lines of its predecessor at Rugby, except that a two-storey arrangement has been adopted, with the radio frequency amplifiers on the first floor and the power supply and air cooling equipment underneath. Twelve of the transmitters will occupy two wings and will be capable of a peak output power of 30 kW. The third wing will house six 85 kW transmitters intended for commercial Press services. Both types of transmitter, which are very similar in design, will be among the most modern of their kind anywhere in the world. They will be capable of tuning themselves automatically to any frequency in the 4–27 Mc/s band in less than a minute on receipt of the necessary command signals, and will be connected to the appropriate low-power drive equipment and aerial arrays by means of remotely controlled radio frequency switching matrices. An important part of the installation will be a number of frequency-synthesizers, one to each transmitter, permitting operation at any desired frequency in steps of not more than 500 c/s in the 4–27 Mc/s band. A master oscillator system, in which three 100 kc/s crystal-oscillators will be kept continuously running in boreholes 30 feet below the building, will control the synthesizers and maintain their output frequencies. The frequency stability of the carriers

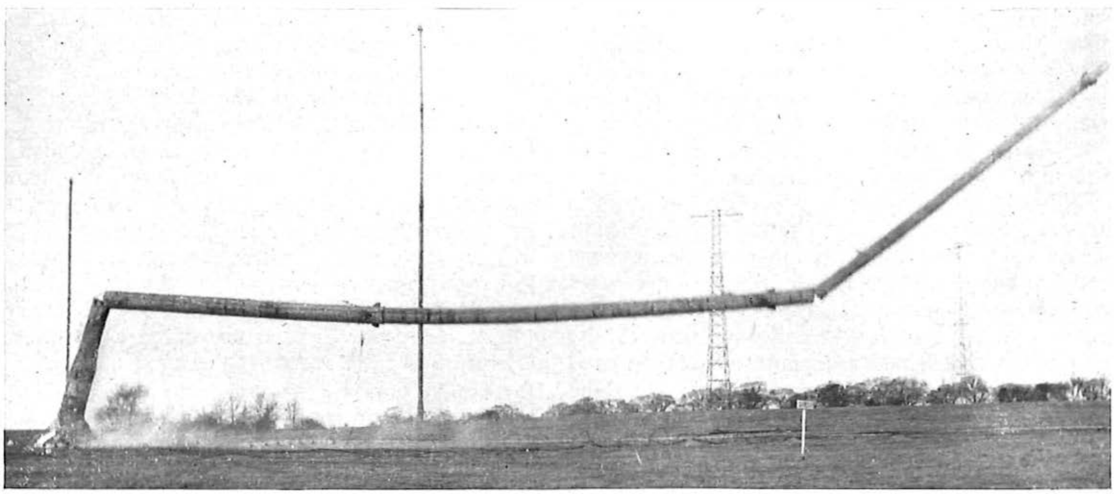


An architect's drawing of the new station Courtesy, Ministry of Works

so achieved will, for the first time, permit the operation of independent sideband systems without the need for automatic frequency control at the receiver.

The complete installation will be controlled from a central position in the station. For this purpose the transmitters will be arranged in three groups of six and a number of services, say four or five, will share a group. Control will be on the basis of services rather than transmitters since all transmitters will be interchangeable in each group. Such a system will have a number of advantages; in the event of a fault developing on a transmitter a second transmitter is immediately available to take over without the need for time-wasting manual intervention by engineering staff. Also, it is necessary to change frequency several times each day on most overseas routes, and at such times a second radio channel can be established alongside the first to effect an orderly transfer of traffic without service interruption. This facility is very important in modern multi-channel telegraph systems carrying a mixture of public, telex and leased circuits. This new conception of station control should be a major contribution towards greater efficiency in the use of plant. Every effort is being made to build a high degree of reliability into the equipment of the station so that it may eventually become possible to transfer its control to a central office in London and even operate it partly unattended.

The site will contain a mixture of high-gain rhombic aerials for the point-to-point services, and broadside arrays designed for the particular



Looking like a gigantic spider's leg, one of the 305-ft. high masts at Leafield crashes to earth requirements of the Press broadcast services. Many of these aerials will be supported by 300-foot multistayed steel masts of welded construction – the highest structures yet used by the British Post Office for aerials in the high-frequency band.

Work on clearing the long-wave aerials from the existing site is already well under way. Among the more imposing features are the ten 305-foot tubular steel masts which date from the original installation. These were built up from rolled semi-cylindrical sections, but were encased in a 6–8 inch shell of reinforced concrete in 1942 as a safeguard against corrosion. They now weigh about 75 tons each. The illustration shows one of these masts in the process of being felled.

When the station is completed – it is hoped by the end of 1963 – it will form a valuable addition to the long distance radio resources of the Post Office. The many novel features being introduced into its design and the emphasis being placed on flexibility and reliability should place it in the forefront of transmitting station developments in the high frequency band over the next decade.

Telecommunications Statistics

	Quarter ended 31 *December*, 1961	*Quarter ended* 30 *September*, 1961	*Quarter ended* 31 *December*, 1960
Telegraph Service			
Inland telegrams (excluding Press and Railway) ...	2,869,000	3,421,000	3,054,000
Overseas telegrams:			
Originating U.K. messages	1,622,639	1,615,789	1,675,586
Terminating U.K. messages	1,625,191	1,622,570	1,660,963
Transit messages	1,408,856	1,304,383	1,245,752
Greetings telegrams	691,000	898,000	733,000
Telephone Service			
Inland			
Gross demand	106,254	107,711	138,683
Connections supplied	99,141	108,606	123,256
Outstanding applications	145,985	155,448	156,724
Total working connections	5,170,710	5,141,041	4,958,536
Shared service connections (Business and Residential)	1,130,447	1,139,407	1,133,504
Total inland trunk calls	118,454,000	118,714,000	106,199,000
Cheap rate trunk calls	26,934,000	30,432,000	23,982,000
Overseas			
European: Outward	838,741	861,864	764,983
Inward	825,257	823,000	747,412
Transit	3,352	3,682	3,681
Extra-European: Outward	77,991	71,395	76,775
Inward	97,653	87,724	81,000
Transit	17,970	18,432	17,400
Telex Service			
Inland			
Total working lines	8,274	7,885	6,749
Calls from manual exchanges	*	*	319,000
Manual calls from automatic exchanges (including Assistance and Multelex)	2,500	2,500	203,000
Metered units	19,459,000	‡17,649,000	8,971,000
Calls to Irish Republic	20,000	19,000	†
Overseas			
Originating (U.K. and Irish Republic) ...	1,131,356	1,007,312	766,299
Transit	28,205	22,300	13,070

* Conversion to automatic working completed December, 1960.
† Included in calls from manual exchanges.
‡ Amended figure.

International Telex Subscriber Dialling

E. E. Daniels

A. E. T. Forster, A.M.I.E.E.

With the opening of London (Fleet) exchange in December 1960, the conversion of the inland telex service to automatic working was completed. This prepared the way for the introduction of new facilities which will enable subscribers in this country to dial international calls. To provide these international dialling facilities, a specially designed switching unit was installed in Fleet exchange which was brought into service, stage-by-stage, during 1961. About 85 per cent. of all outgoing international telex calls are now being dialled by subscribers. This article describes how the service was provided.

BECAUSE of the rapid growth of the international telex service since the war it has become essential to employ automatic switching methods. Most countries use switching mechanisms and techniques similar to those in their national telephone networks and this has resulted in a variety of switching principles in the various telex networks. For example, some administrations chose register systems while others preferred non-register working. Again, some register systems are controlled by dials; others use the teleprinter keyboard to signal the required number. Then, the method of indicating ineffective calls is not uniform; some systems use teleprinter signals, others a simple signal such as starting and stopping the teleprinter motor. The introduction of international automatic working has made it necessary, therefore, for the International Telegraph and Telephone Consultative Committee (CCITT) to consider how the various systems should be interconnected.

The solution to this problem is based on the standardisation of two basic ranges of signals – designated Type A and Type B respectively – corresponding to the two main systems used in national networks. In addition, when interconnecting two switching systems using different techniques the equipment at the outgoing end of a circuit of one system should conform to the requirements of the incoming circuit of the other system. This simplifies interconnection of similar systems, and shares the cost of conversion equipment between two countries where systems are dissimilar.

The two ranges of standardised signals provide the same signalling functions, the differences being mainly in the detailed signalling condition used to transmit a particular function. For selection signals either dial pulses or teleprinter signals may be used. Although the use of the teleprinter keyboard for selection makes it possible to use letters in subscribers numbers, this has not been standardised because of difficulties with calls originated in countries with dialling systems. The CCITT has decided that only figures shall be used for selection over international trunk circuits. For signalling ineffective calls it has recognised the use of teleprinter signals or functional pulses. These signals are always followed by a clearing signal, both to ensure that lines and equipment are not unnecessarily held and to avoid charging for ineffective calls on metering systems. The

Table 1

NA	— Barred
NP	— Spare line
ABS	— Absent
OCC	— Busy subscriber
NC	— Busy trunk
DER	— Faulty line

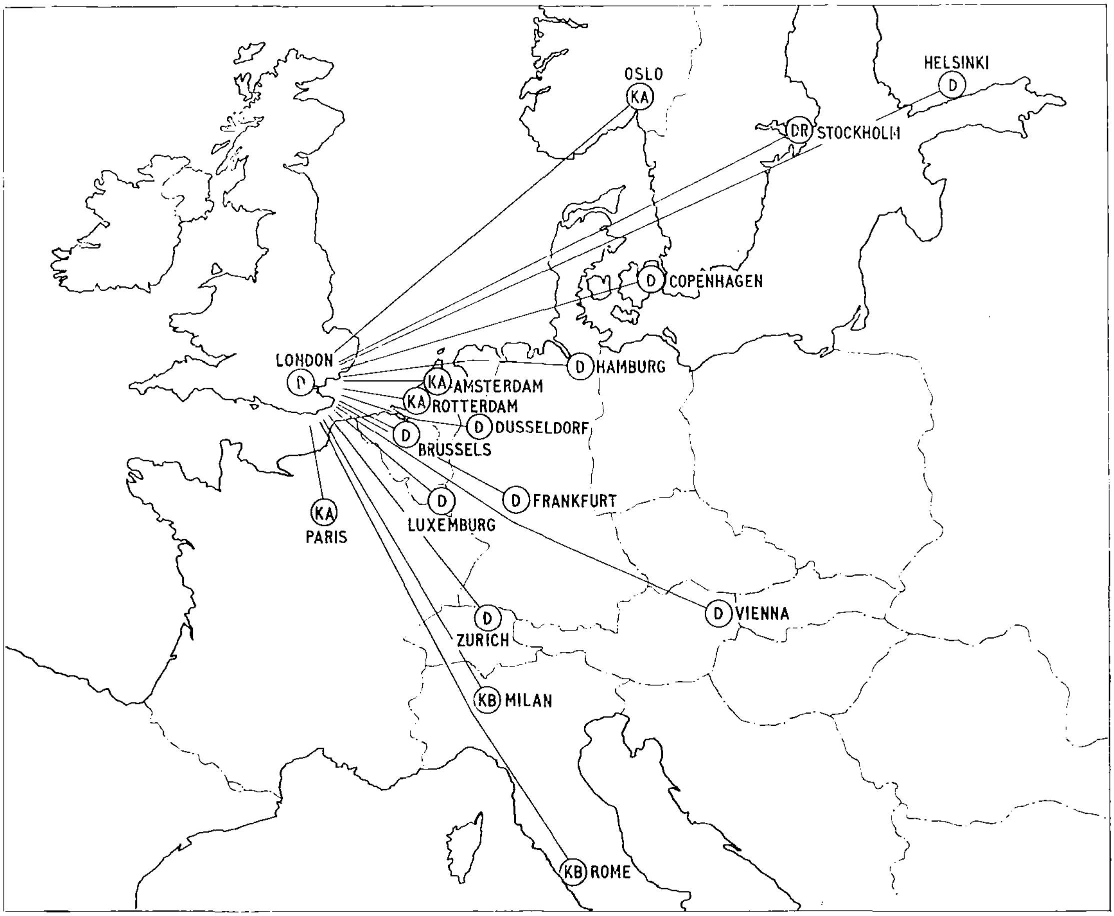


Fig. 1: Subscriber dialling telex routes from London to Europe (1961)

D. Dial selection, non-register
DR. Dial selection, register
KA. Keyboard selection register (CCITT signalling type A)
KB. Keyboard selection register (CCITT signalling type B)

teleprinter characters for signalling ineffective calls have been standardised, although there are several detailed differences in the ways in which they are used. The principal signals are shown in Table 1.

The CCITT recommendation that outgoing equipment in the calling country should be adapted to suit the system of the called country makes it unnecessary to provide any special conversion equipment for incoming traffic in London. The incoming international circuits, therefore, terminate directly on 1st selectors in the Fleet international telex exchange.

However, since the equipment carrying outgoing traffic from this country must conform to the requirements of the distant system, it has been necessary to develop a range of outgoing equipment. The range has been reduced as far as possible by dealing with the conversion of backward and forward path signals separately. Facilities for the former are included in the trunk relay sets, while conversion of forward path signals, where necessary, is carried out in outgoing register translators. Register translators are necessary for working to distant register systems because of the need to store selection signals. It is profitable, therefore, to take advantage of this to introduce translation when required in the forward path signals.

When an international call is made by a subscriber in this country the code 20 is dialled to obtain access from the inland system to the international exchange. This is followed by a code of one or two digits to identify the distant country, and then by the number of the called subscriber. The code of each destination country depends on the method of access to it and is called the "country code". Trunking of the international switching unit is shown in simplified form in Fig. 3.

Calls to Dial-Selection Non-Register and Register Systems

To obtain access to dial selection non-register systems having only one route from this country, trunk circuits are taken directly from the selector level corresponding to the country code. The call is then set up without the use of registers. This is possible because the dials used in this country conform to the CCITT standards and telegraph circuits allow dial pulses to be transmitted without significant distortion.

So that calls can be routed to more than one entry point in dial-selection non-register systems, routing translators are provided similar to those used in the inland service. This arrangement allows for discrimination on the initial digit of the called subscriber's number. Where the trunk route carries traffic with only one distinctive initial digit it terminates on second selectors in the distant country. If a trunk route carries traffic with more than one distinctive initial digit, calls pass through a routing translator in London to restore the initial digit and allow the trunk route to terminate on a 1st selector in the distant system.

Calls to distant dial-selection register systems are routed through an outgoing register-translator. This permits the digits dialled by the calling subscriber to be stored while a register is being connected in the distant system.

When access to such systems is required a 2-digit country code is allocated, and the outgoing register-translators are reached through access relay-sets. These are connected to the selector level corresponding to the first digit of the country code. The access relay-set then accepts the second digit of the country code while the register translator is being connected. This digit is subsequently transferred to the register, which then receives the digits of the subscriber's number direct. The register-translator starts to transmit the routing digits as soon as the first digit of the called subscriber's number is received. The first part of the translation consists of one or two digits to control the outgoing selectors in this country to select the outgoing circuit. When the trunk relay-set receives the "proceed-to-select" signal from the distant system the register-translator transmits the digits of the called subscriber's number directly into the distant system. The register normally releases when either the "call-connect" signal or a service signal is received over the backward-signalling path. A forced release facility is included as a safeguard against incomplete dialling. The register-translator can discriminate by examining the initial digit of the called subscriber's number and so produce distinctive translations which enable calls to be correctly routed to systems having more than one entry point.

Calls to Keyboard Selection Systems

The outgoing register-translator can route calls to keyboard selection systems. Translator operation is similar to that for calls to a dial register system except that the second part of the translation is sent in the form of 5-unit teleprinter signals instead of dial pulses. The first part of the translation may be transmitted on receipt of any pre-determined number of digits; the second part again requires a "proceed-to-select" signal from the distant system. Any auxiliary signals required by the distant system are added by the register-translator.

International and Subscribers Accounts

Introduction of international subscriber dialling has made it necessary to record automatically the information for international accounting.

Meters are provided for each international trunk circuit to record the value of the traffic carried so that data can be prepared for exchange with other administrations. Each outgoing circuit has two meters; one recording the number of chargeable calls and the other the aggregate chargeable time in units of one minute. Facilities are provided for avoiding metering on calls dialled from selected service points, from the international switchboard, and on calls transit-switched in this country.

It is intended that information which enables the revenue on transit calls to be apportioned amongst the administrations concerned will be recorded in the originating country.

Metering facilities are not provided on incoming international circuits.

Charges for dialled international calls are recorded on the subscribers' meters and included with inland call charges. The time zone metering equipment installed in the inland exchanges includes facilities for metering international calls and is designed to distinguish the international access code 20. It then examines the following two digits to identify the country and select the appropriate pulse rate.

The method of metering international calls is the same as that used for inland telex calls, namely, one meter pulse is applied when the connection is established, after which pulses fed from a common pulse machine are connected at regular intervals. The first periodic pulse is suppressed so that the interval between the initial pulse and the next periodic pulse fed to the subscriber's meter is never less than the time shown as available for 2d. in the published tariff. The metering system is designed to provide metering in 30 steps, up to a maximum rate of 120 pulses a minute.

The traffic rates at present in use to Europe are shown in Table 2. This also shows the dialling codes used by subscribers in the United Kingdom to make calls to the countries concerned.

Signal Conversion Facilities

The inland telex system in the United Kingdom is designed so that the calling subscriber automatically receives the answer from the called party

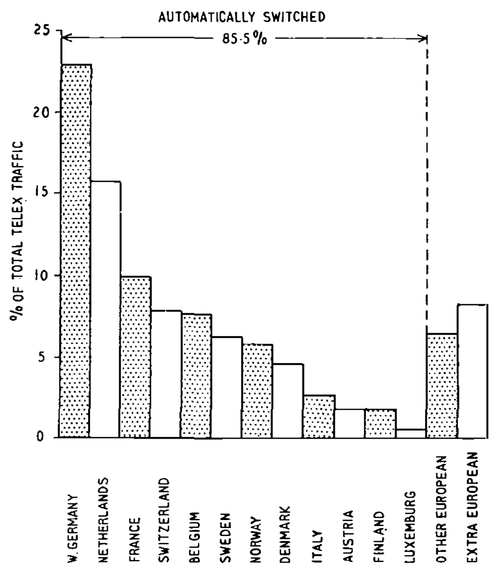


Fig. 2: Distribution of international telex traffic (1961)

Table 2

Country	Rate (pulses per minute) at 2d. per pulse	Country Code
Austria ...	14	53
Belgium ...	8	4
Denmark ...	14	51
Finland ...	21	55
France... ...	8	22
Italy	24	23
Luxembourg ...	8	58
Netherlands ...	8	21
Norway ...	16	25
Sweden ...	18	24
Switzerland ...	10	52
West Germany	12	3

on effective calls. Similarly, on ineffective calls the reason for failing to complete the connection is indicated by a printed signal sequence. To avoid confusion, similar indications must be given on outgoing international calls and the outgoing trunk relay sets have therefore to convert the service signals received from the distant systems into a suitable form for presentation to the calling subscriber in this country. In addition, if the distant system does not provide for automatic return of the called subscriber's answer back, the outgoing trunk relay set calls for the answer back automatically as soon as connection of the called subscriber is signalled.

These conversion facilities are not required on calls to switchboards and some points in distant systems. It is convenient, therefore, to arrange that the discrimination used for service calls originating in this country, should also suppress the signal conversion facilities.

Transit Traffic

To facilitate barring of irregular transit traffic the CCITT has laid down that national telex systems shall be arranged so that transit routings can be determined by the initial digit transmitted by the calling country. To do this, level O of incoming international selectors is used to provide access to the outgoing side of the international exchange so that it caters for transit traffic. The international 1st selectors can bar transit access to any incoming circuit if required.

Level O of the incoming international selectors is connected by way of a group of through-tandem relay-sets, an important function of which is to ensure that uniform signalling conditions are

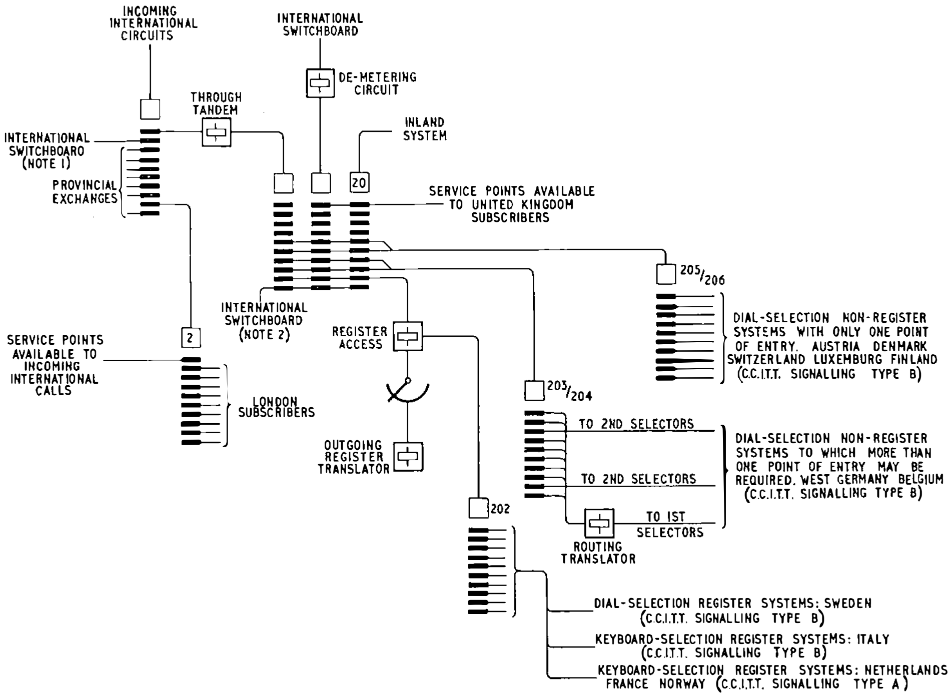


Fig. 3: Trunking principles of the International automatic telex exchange

Level 9 of the incoming international 1st selectors gives access to the international switchboard for calls via cable circuits. Level 201 gives access to the international switchboard for calls via radio circuits.

returned to each calling system, regardless of the type of signalling used in the destination system.

The Gentex Service

When designing the international automatic telex exchange, allowance was made for interconnection with the gentex system.

This service has been set up to deal with international telegrams and is based on an automatic switching network interconnecting the Post Offices in the principal European towns and cities. It has been built up over the past six years and is linked to the international telex network in a variety of ways in the participating countries.

Traffic from London to some countries uses a common trunk route both for telex and gentex and to others there are separate groups of circuits. Where a common group is used it is essential that the telex traffic meters on the trunk circuits should not operate on gentex calls. Provision for this is made either by using the discrimination provided for service traffic or by separate access to the trunk relay-sets. Incoming gentex trunk circuits terminate on 1st selectors in the same way as international telex trunk circuits.

The developments described here form a basis for mechanisation of the international telex service to countries both within and outside Europe for which metering is acceptable, provided the distant equipment conforms to CCITT recommendations. However, mechanisation of service over protected radio systems and to countries where metering on a proportionate time basis is not acceptable for administrative reasons, raises new problems which are now being examined.

The Post Office Role in the Glenn Flight

WHEN Colonel John Glenn, the American astronaut, orbited the earth three times on February 20, his astonishing achievement was due in no small measure to the vital communications network set up to control the flight and in which the Post Office played a notable role.

To control the flight a girdle of telecommunications was thrown around the earth and one of the sector controls, in a system linking 16 tracking stations throughout the world, was set up in the Post Office Cable and Wireless station at Electra House, London. Here, a room was made available to the National Aeronautical and Space Administration (NASA) and in it special switching, sequencing, monitorial and signal regenerating equipment, supplied by the Western Electric Corporation, was installed and operated and maintained by Post Office staff.

Through Electra House pass the circuits which link the Goddard Space Flight Centre in Greenbelt, Maryland, U.S.A. and the tracking stations in Kano, Nigeria, Las Palmas, in the Canary Islands, and Zanzibar. Messages to and from the American tracking ships off the West and East Coasts of Africa can also be routed through London by way of Las Palmas and Zanzibar if their main links fail.

During a flight like Colonel Glenn's, three telegraph circuits in the trans-Atlantic telephone cable (TAT 1) link Goddard with the London switching centre where they are extended, through the Post Office transmitting and receiving stations at Rugby and Bearley to two radiotelegraph circuits to both Kano and Las Palmas. This gives one direct bothway circuit between Goddard and Kano and another between Goddard and Las Palmas. There is also a shared circuit from Goddard to Kano and Las Palmas and in the other direction. Both stations have access through the sequencing equipment to the return channel to Goddard. The Zanzibar station is served from Kano and the facilities available to the latter are shared with Zanzibar.

The role of the London station during mission periods is limited to monitoring the circuits passing through the station and taking corrective action to restore service in the event of failure. A NASA representative supervises the room and during a flight he is in constant telephone communication with Goddard. Standby radio transmitters and receivers are kept on the air on alternative frequencies throughout the mission so that no time is lost from interference on the radio circuits. Standby power at all key points is kept switched on and special watch maintained in the Electra House Control room and radio stations.

Before Commander Carpenter tries in June to emulate Colonel Glenn's feat, the telegraph network may be supplemented by permanent telephone circuits, radio circuits to Kano and Las Palmas being linked in the London switching centre with a telephone circuit in the TAT 1 cable to Goddard. This time, perhaps, listeners to sound broadcasts covering the flight will be able to hear Carpenter's description as he crosses the African coast.

Outside mission periods the London switching centre plays a more active role in controlling the Mercury network. Frequent daily tests are made with all stations so that a high degree of efficiency is always maintained. The NASA room's activities are not confined to the Mercury project for it is one of the main communication hubs of the Space age.

Continued on page 95

Things are Looking up at Museum

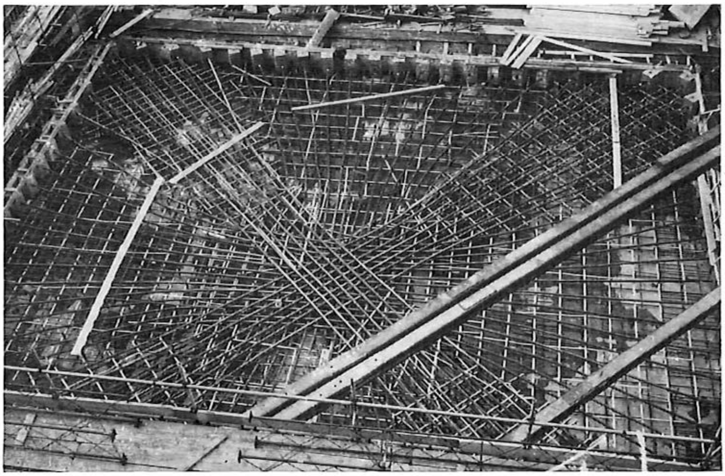


Fig. 1

The Winter 1961 issue of the *Journal* gave a general description of the Radio Tower and Exchange Building. The pictures on these pages show the progress which has been made since then.

One of the most important features to date is work done on the foundations for the Tower on one corner of the site.

Fig. 1 shows horizontal lattice steelwork bonded into the concrete piers seen on the edge of the square. The two large girders in the picture are there to withstand the thrust on the Icos retaining wall until the foundations of the tower enable them to be dispensed with.

Fig. 2 shows the lattice work now embedded in concrete and the next stage of building the buttresses. Shuttering is in position for constructing the circular form of the actual tower.

Fig. 3 shows the buttresses completed and

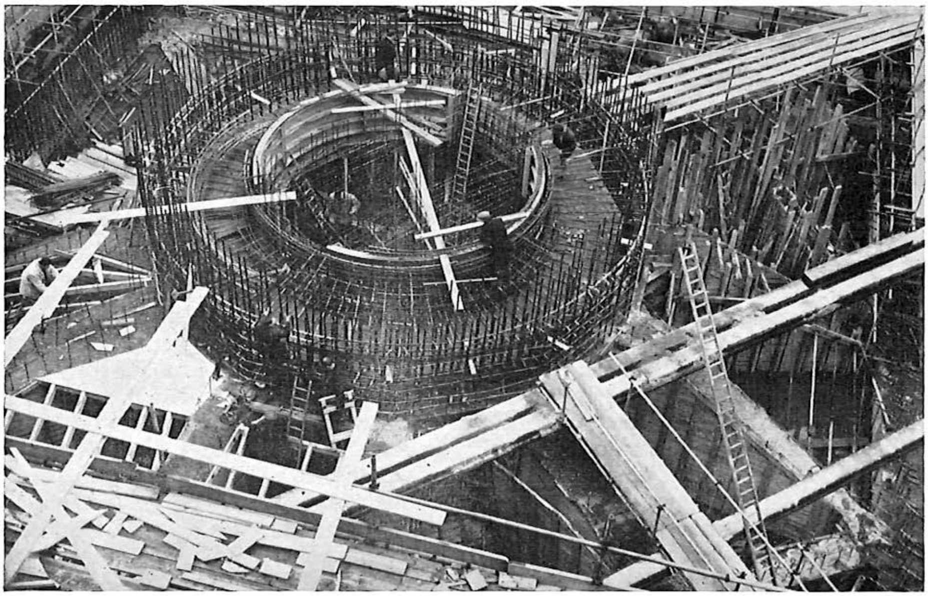


Fig. 2

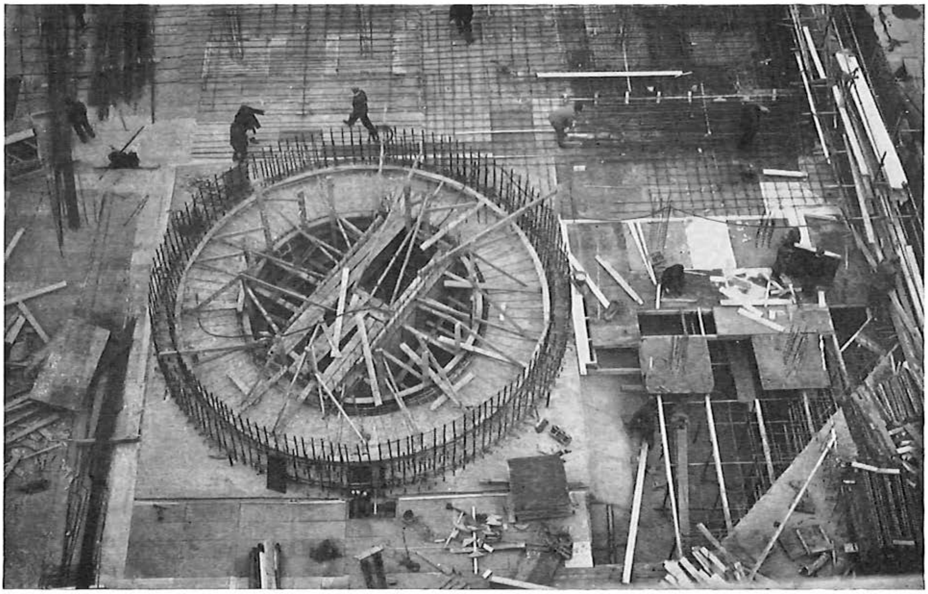


Fig. 3

roofed over. Construction of the ground floor is in progress with reinforcement laid over the shuttering. The triangular portion of the flooring seen in the right hand corner of the picture was constructed to enable the heavy girders (shown in Fig. 1) to be removed.

Though progress of the work was handicapped by the severe weather conditions during the winter, it is hoped that future progress will be fairly rapid.

Fig. 4 shows the progress of the work on the exchange building.

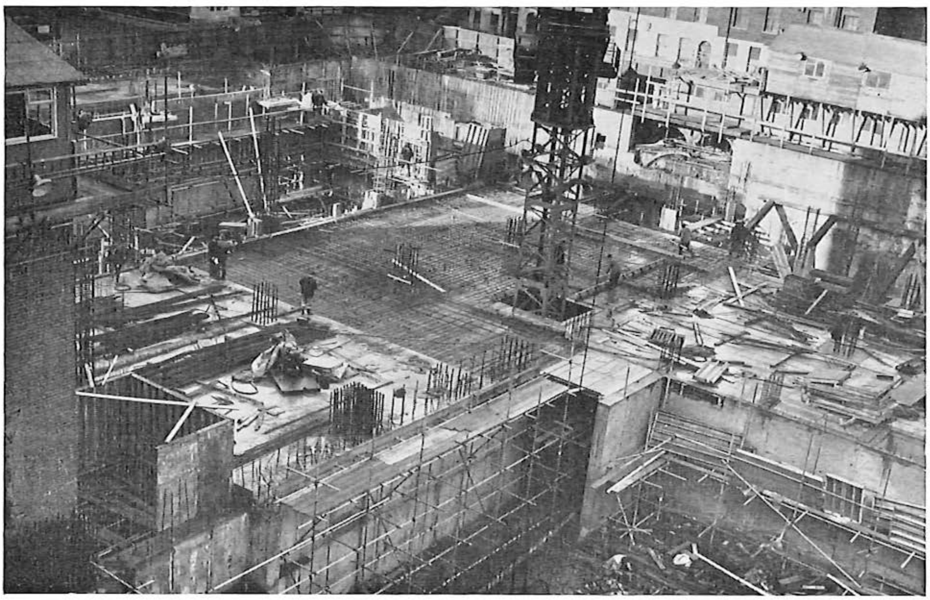


Fig. 4

The Nerve Centre on the Embankment

L. Veale, A.M.I.E.E. and **J. L. Crowther**

ELECTRA House on Victoria Embankment, in London, is one of the world's principal telegraph network centres. It is the terminal for all Britain's point-to-point public telegraph circuits and employs some 3,000 telegraphists. It also operates an overseas phototelegraph service which handles in a year over 15,000 pictures transmitted over both radio and cable. It maintains and operates the overseas public telegraph system, and is now playing an increasingly important role as the focal point for radio Telex circuits serving the international Telex exchange in Fleet Building, and for overseas circuits leased to private renters.

Engineering control and maintenance of these services is centred on the third floor at Electra House, where a 9,000 ft. square Control Room – see Fig. 1 – houses terminal equipment and testing and monitoring facilities. These are specialised since particular requirements have to be met to make maximum use of costly long-distance radio and submarine cable circuits. The high revenue attracted by these circuits means that out-of-service time has to be kept to a minimum.

Methods of operation

In the past, most overseas telegraph systems employed morse code in its basic form or in two variants of the cable code. These methods of operation are gradually being replaced by the five-unit code which may be transmitted overseas in its original form or converted before transmission to other codes, such as the seven-unit error-detecting code now being used extensively over high-frequency radio paths. This means that eight different codes are used on the 11 types of telegraph systems transmitting over cable and radio routes. The multiplicity of apparatus to deal with this in the Control Room provides a potted history of overseas telegraph communication.

The direct relationship between cost and bandwidth is more important on overseas circuits and, wherever possible, time and/or frequency-division multiplexing helps to make full use of circuit capacity.

Time-division multiplexing implies that a number of channels is combined on a strictly defined time-sharing basis over a single transmission path. All the time-division multiplex equipment, including the rapidly growing complement of automatic error-correction – ARQ – apparatus, is housed in the Control Room. Care has to be taken to ensure exact synchronisation between the London time-division multiplex terminals and those abroad. This is maintained by crystal oscillators and elaborate speed-correction devices incorporated in the multiplex installations.

A full speed teleprinter circuit normally transmits approximately 67 words a minute but some leased circuit renters have insufficient traffic to operate to full capacity and do not wish to pay the rental (which could be in the region of £40,000 a year for, say, a circuit to New York). These renters are offered circuits which operate at a fraction of the normal rate, with consequent reduction in rent. Up to four such "squeezer" circuits, as they are called in the United States, can share the transmission time allocated to a normal channel in a time-division multiplex (TDM) system. For leased

The Control Room in Electra House is the focal point for monitoring and processing signals on the overseas telegraph services between Britain and almost every country in the world. It is linked with six radio transmitting and three receiving stations, the Porthcurno submarine telegraph cable and the terminals in Britain of the VF systems carried over submarine telephone cables.

The overseas telegraph system comprises the public telegraph service, the Telex service and a rental service which commercial organisations, such as airlines, stockbrokers and the Press, use between their offices in Britain and those overseas.

The public service is operated from Electra House on the world-wide telegraph cable network. The radio services operate to and from most of the world's capitals and the submarine telephone cables carry telegraph services to and from Europe and North America. The introduction of other submarine telephone cable projects, such as the Commonwealth cable, will help reinforce the overseas telegraph system.

and public telegraph circuits the characters from the circuit user are called in by the TDM system before transmission overseas. As this cannot be done on radio Telex calls from the inland network to places abroad instruments in the Control Room store the Telex messages, either on paper tape or magnetic drum, before they are passed to the TDM system.

Frequency-division multiplexing, whereby a band of frequencies usually in the speech range is divided into transmission paths, each carrying a telegraph system, is often used on overseas radio routes. The high-frequency spectrum for long-distance radio communication is now very crowded and frequency-division multiplex helps to exploit the allocated bandwidths to the best advantage. Most of the frequency-division systems over radio are installed at the radio transmitting stations, the rest being in the Control Room.

In practice, a combination of time and frequency-division multiplexing is frequently used. For example, six two-channel ARQ time-division systems, with a transmission capability of some 820 words a minute, can be accommodated on a single frequency-division system. This can occupy one sideband, or speech circuit, in an independent sideband (ISB) radio transmission. Telegraph, telephone, and perhaps, phototelegraph services can be operated simultaneously on one ISB radio transmitter, which permits economies in radio equipment.

Voice frequency channels to pass signals over landlines between the Control Room and outlying radio stations in Britain differ from the normal inland variety, employing frequency modulation instead of the more usual amplitude (or on/off) modulation, and are capable of handling high telegraph speeds. This is necessary to cope with *Hellscreiber* transmissions and the aggregate signals produced by TDM systems when interleaving up to four full speed circuits. Fig. 2 illustrates how the various types of telegraph circuit and the FMVF channelling are associated in the Control Room.

Functioning of the Control Room

It is not easy to keep circuits operating smoothly with the complex equipment involved and the variable radio conditions encountered. Since the bulk of the traffic is inter-Continental the traffic flow is appreciable throughout the 24 hours. This results in little variation of the number of public circuits handled by the Control Room at any time.

To speed fault location the Control Room is organised into sections, each dealing with its own categories of circuit or modes of operation. These sections and the main equipment installations are shown on the layout plan, Fig. 3. Since many of the sections are interdependent close liaison between them is essential if minimum out-of-service conditions are to be achieved. Contact also has to be maintained with the British radio and cable stations, the users of the system, and with overseas telegraph terminals. Information to overseas terminals is usually passed by way of public message or Telex circuits, or on a direct overseas order-wire circuit if its provision is justified. The control lines of communication inside and outside the Control Room are shown in Fig. 4.

Fig. 1: The Control Room in Electra House

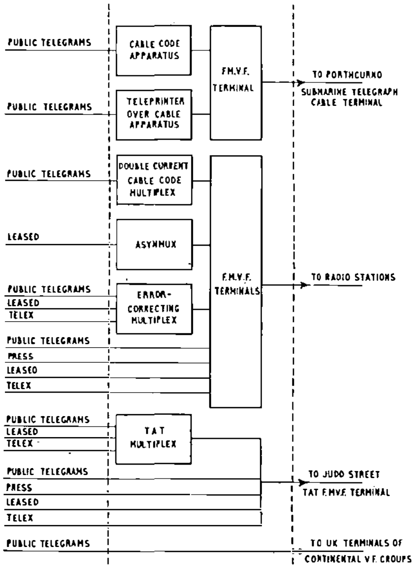


Fig. 2: Routing of circuits via the Control Room

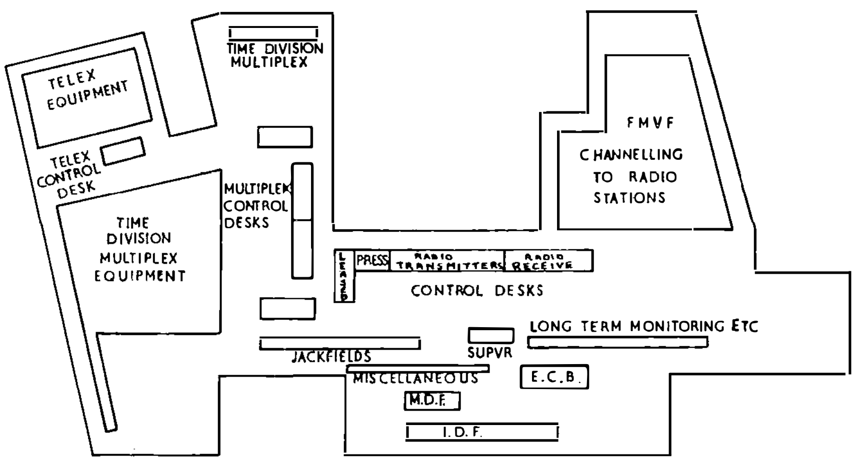
An example of the way in which a fault is handled by the Control Room is given in Fig. 5. This assumes that a fault has developed on a rented circuit using an ARQ multiplex system over a radio route. Depending upon the ARQ section's diagnosis of the probable sources of trouble, other sections may help to restore the circuit. For instance, in the example in Fig. 5, it may be necessary for the incoming radio signal to be retuned (this will involve co-operation of the Radio Receiving section) before a better assessment can be made by the ARQ Multiplex section of a fault, possibly on a multiplex transmission from overseas.

All radio telegraph circuits are monitored and controlled by the Radio Transmitter and Receive sections, except the outward Press broadcasts which are handled at a separate position. The Radio Transmitter section institutes transmission checks and, to ensure that radio transmitters are on the air to meet schedules, requests frequency changes and suggests alternative frequencies in case of radio disturbances or jamming. The section is assisted by prediction charts compiled from sunspot and other data which indicate the optimum radio frequencies to be used on each route at any time.

Although specified radio frequencies are allocated to many routes, the Transmitter section, with its overall picture of frequency availability at the six British transmitting stations, exploits frequencies to best advantage.

Besides taking action as detailed in Fig. 5, the Radio Receive section passes requests for frequency changes to overseas stations and advises the British receiving stations when frequencies are on the air. On long and difficult routes, for instance, Australia-Britain, a transmission may be simultaneously relayed through one or more points, such as Perth, Nairobi and Barbados, as well as beamed on the direct route. When this is done the Radio Receive section must constantly compare signals arriving by different routes and select the best for operational use.

Fig. 3: Control Room layout



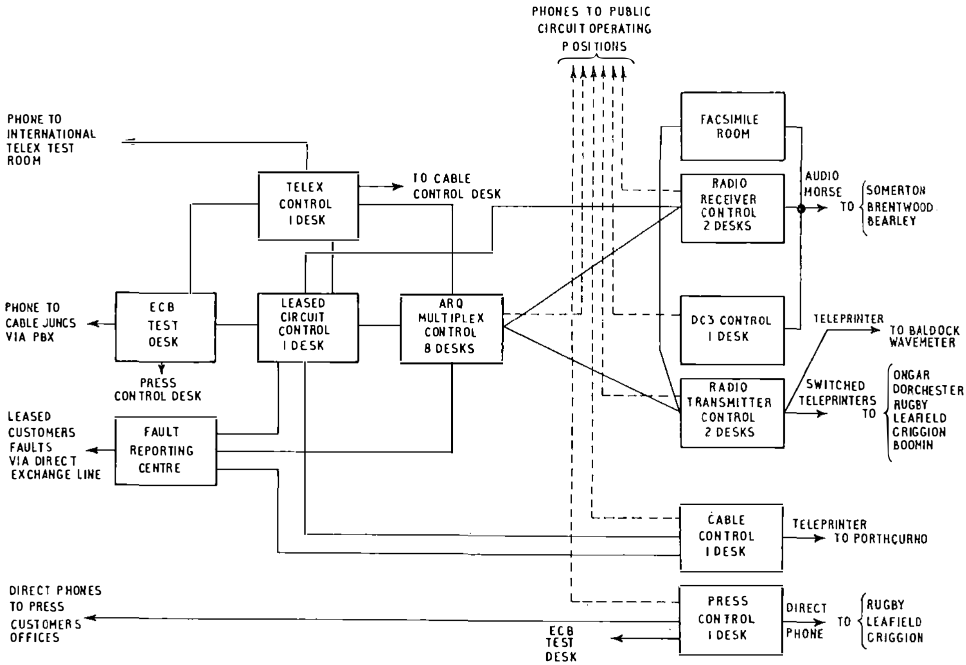


Fig. 4: The control lines of communication inside and outside the Control Room

There are three time-division multiplex sections in the Control Room – the ARQ and Double Current Cable Code (DCCC) sections, which deal with multiplex over radio, and the Cable Multiplex Section. The DCCC multiplex, using a two-condition version of the morse cable code, has given good service on public telegraphs, but is rapidly being supplanted by the ARQ multiplex which can be connected to inland five-unit circuits and, having automatic error-correction, provides a high grade service suitable for extension to leased customers and Telex networks.

The Cable Multiplex Section handles circuits which use the world-wide submarine telegraph cable network and has an expanding complement of multiplex equipment for use over the FMVF channels in submarine telephone cables. As none of the multiplex equipment is of a type used elsewhere in the Post Office, it requires special monitoring equipment to detect faulty functioning of the channel time sharing and code conversion processes carried out by the multiplex terminals.

The Control Room Telex and Leased Channel sections deal exclusively with Telex and rented circuits. They act as liaison points, on the one hand with the Multiplex and Radio sections, and on the other with the Fleet Telex test room and private renters. The Telex and Leased sections also diagnose faults and in line faults receive assistance from the Engineering Control Board which is responsible for maintaining all lines entering the Control Room.

Although the number of Telex and Leased circuits is increasing, the volume of overseas public telegraph traffic is still considerable – approximately 19.2 million telegrams a year (including transits). To handle this traffic it is necessary to operate over 85 public overseas telegraph circuits, using some 60 radio routes as well as the channels maintained in the overseas submarine telegraph and telephone cable networks. To achieve rapid fault reporting and clearance traffic operators manning radio circuits generally have direct telephone contact from each circuit

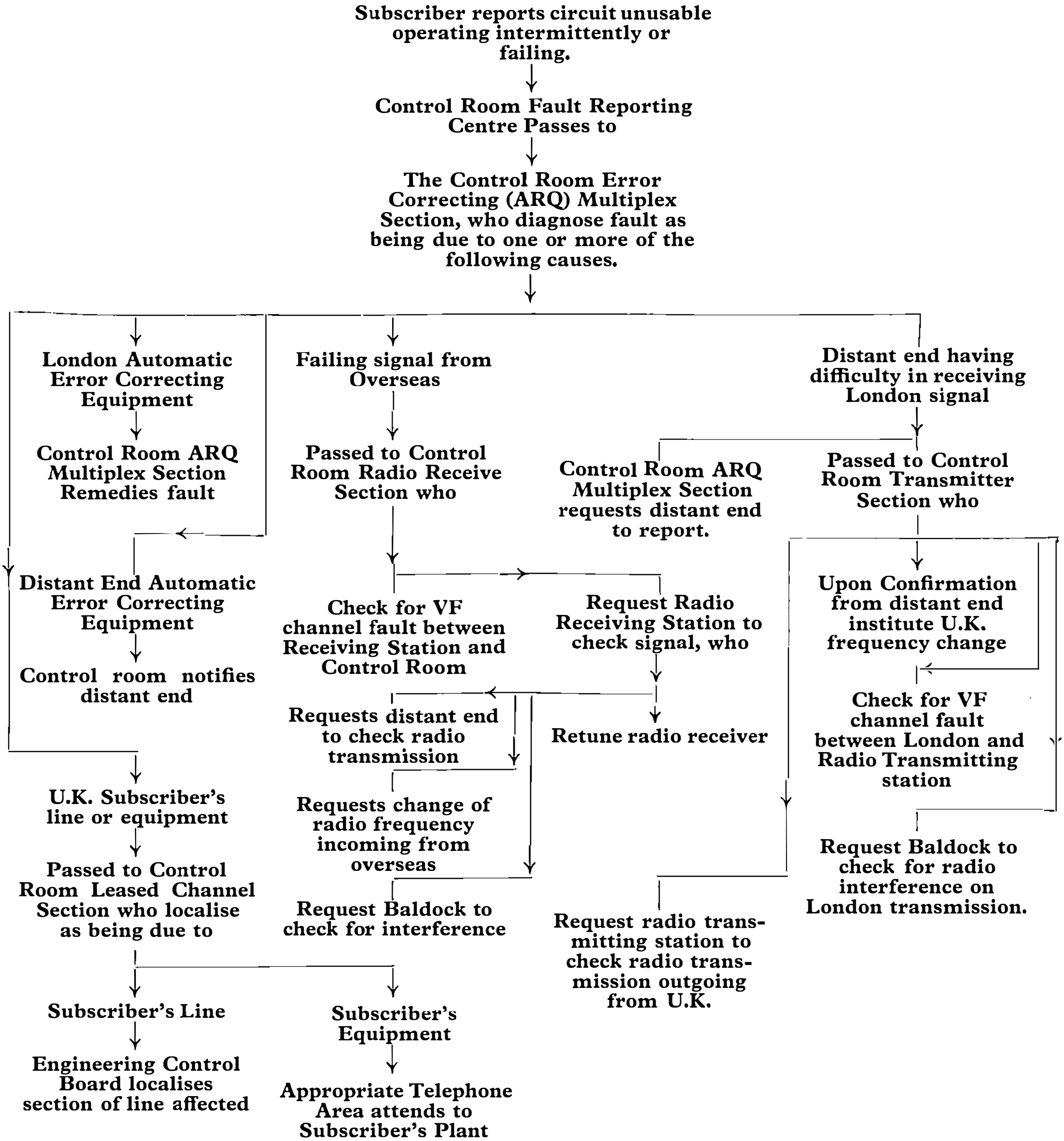


Fig. 4: Example of handling of faults on a leased radio circuit using an automatic error-correcting system

position to the Control Room section responsible for it.

A special Press position controls outgoing Press broadcast transmissions to overseas zones and ships. Accurate timing is essential, partly because different renters share the same radio transmitters. To meet this tight programming, self-contained order wire and landline connections are provided to ensure speedy working.

The wide range of telegraph techniques and the nature of the services require a technically skilful and resourceful Control Room staff.

Increasing use of five-unit systems in error-corrected and other forms over radio and cable means that near compatibility in operating methods should eventually be reached between British overseas and inland telegraph networks. This, in turn, will pave the way to making London an overseas automatic or semi-automatic message-routing centre. International radio Telex services are expanding rapidly and some circuits are already being provided with automatic instead of manual switching. These schemes, and others such as satellite communication, will create further expansion and development of the Electra House Control Room as a nerve centre of the Post Office overseas telegraph communications system.

World Wide Satellites

ALTHOUGH a great deal of research and experiment has still to be done before a satisfactory commercial satellite communication system can be established, there is no doubt that satellites will play a big part in international communications of the future.

This is one of the findings of the Commonwealth Conference on Satellite Communications which, in a three-weeks meeting in London, discussed the technical, financial and organisational problems of satellite communication.

The Conference, which was attended by representatives from Britain and ten other Commonwealth countries, was opened by the Postmaster General, Mr. Reginald Bevins, M.P., who told the delegates that satellite communication "could lead to a tenfold increase in the capacity of international systems and enable television signals as well as telephone and telegraph messages, to be transmitted".

In its conclusions the Conference recognised that research and experiment should continue in Commonwealth countries and that early discussions should take place with the United States and European countries in the hope that they would lead to a pooling of effort in achieving the best possible world-wide system of satellite communications. Any commercial system should serve as many countries as possible and have maximum flexibility.

The Conference recognised the advantages of a satellite system based on stabilised active satellites in orbit round the equator at a height of from 5,000 to 10,000 nautical miles and felt that a global system could become financially profitable only a few years after it had been introduced. It also recognised that satellite communications and submarine telephone cable systems would be complementary and agreed that research and development in the submarine cable field should continue. The Conference report, which was agreed unanimously, is being submitted to the governments of the following Commonwealth countries represented at the meetings: Britain, Canada, Australia, New Zealand, India, Pakistan, Ceylon, Ghana, Nigeria, Sierra Leone and the Federation of Rhodesia and Nyasaland.

New Light on

Early Telephone Experiments

E. J. Lally

"*It will be interesting news to many to hear that the first telephone ever used in England came into operation at Saltburn. Mr. Francis Fox (now Sir Francis Fox) saw an account of the then new invention of the telephone in an American paper, and in conjunction with Judge Ayrton, then of Cliffden, reduced theory to practice on his own account. An instrument was made and the wire extended across the Valley Bridge. The experiment was completely successful and a conversation across the bridge, per telephone, ensued between the two gentlemen named.*"

So read a cutting from the *Saltburn Times* dated December 1, 1911 which came into the hands of Colonel J. R. Sutcliffe, Telephone Manager, Middlesbrough 47 years later.

At the time little notice was taken of this strange claim but when the Yorkshire town of Saltburn-by-the-Sea celebrated its centenary in 1961 interest was once more aroused in this extract from an obscure and long defunct newspaper. The chairman of the committee arranging a local centenary exhibition approached the Telephone Manager to ask whether the Post Office could supply any further information which would help substantiate the claim. Nothing was known locally, and neither the Post Office archivist nor the museum had knowledge of this early experiment. It seemed that any attempt to prove the truth of the claim was bound to fail. The newspaper cutting gave no date of the experiment and there was no other evidence on early telephone calls with which to compare the claim. All that was known were the names of two of the people who, it was said, had constructed the telephones, or taken part in the experiment—Mr. Francis Fox and Judge Ayrton.

There were many questions that needed answers. What was the earliest recorded date of a telephone communication? What, in fact, was the date of the Saltburn cxpcrimcnt? Why had it been made at Saltburn? What knowledge had the persons concerned of electrical matters? Were any witnesses still alive who had seen or taken part in the experiments? If not were there any eye-witness accounts? As the subject was of topical interest it was decided to enlist the aid of a local newspaper, and the *North Eastern Evening Gazette* gave the story wide publicity.

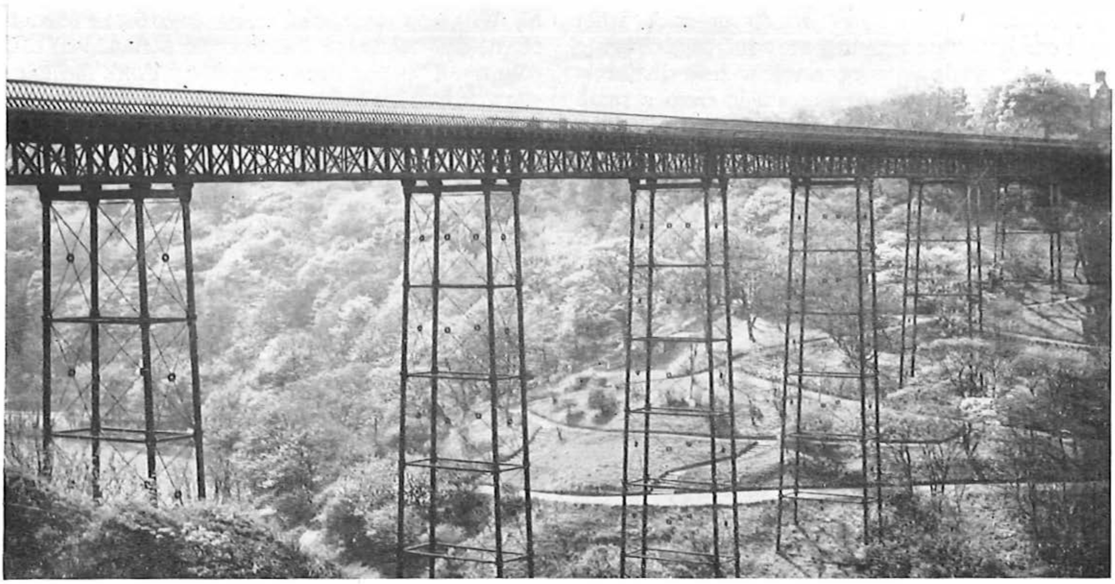
Next day three more press cuttings were made available, two from the *Saltburn Times* undated, and one from the *Middlesbrough Evening Gazette*. The cuttings from the *Saltburn Times* had obviously been inspired by the article previously quoted. Two were eye-witness accounts, the third a short statement that Sir Francis Fox, one of the authors of the experiment, had described it in his book, *Road, Rail and River*.

One eye-witness account stated: "It (the experiment) was conducted by Sir Francis Fox and Mr. Bell who afterwards became associated with Edison, the great American inventor, in the development of the phonograph. The wires were laid across the Valley Bridge".

The other eye-witness stated that "Mr. Irvine, a gentleman of considerable scientific ability, on reading the accounts of Professor Graham Bell's invention, set to work to build a similar instrument, and during a visit in August 1877 to Sir Francis Fox at Saltburn he made a number of experiments. One was made across the Valley Bridge".

This additional information supplied some answers to the questions, but in turn posed others. Did Professor Graham Bell take part in the experiments, for example? If not when had the first experiment taken place? Was the book still in print?

It was known that Mr. William H. Preece, then Electrician to the Post Office and later to become Sir William and Engineer-in-Chief, had brought two telephones from the United States in 1877 (*Journal*, February-April, 1953). Alexander Graham Bell followed in August of the same year and attended the British Association meeting at Plymouth. He had made some experiments in Glasgow, presumably on his way to Plymouth. Had he for some reason been at Saltburn en route to Plymouth? If so, the first experiments had not



Courtesy, Middlesbrough Evening Gazette.
Valley Bridge, Saltburn

been made there. It was thought that the book *Road, Rail and River* might supply some answers.

The book proved to be a mine of information, not only about these early telephone conversations, but also on the first telegraph cable laid in this country in 1837. Sir Francis Fox did not make the claim given in the original cutting. His words were: "My friend Archibald H. Irvine brought to my house in August, 1877, two of the first telephones ever used in England. He had made them from a description which had been cabled from America as soon as the invention was completed there".

Sir Francis does not describe the experiment related by the eye-witness which probably took place between his home at Rushpool Hall and Clifton, the home of Judge Ayrton, but he does quote a newspaper report from a Middlesbrough paper dated September 29, 1877. This mentions that an experiment was made between the two houses. It also contains a description of a further experiment. Wishing to try the equipment over a greater distance, Fox asked Bell Brothers Limited for the loan of some telegraph wires. This probably clears up the eye-witness reference to Graham Bell. The Bell family were great Ironmasters and worked ironstone mines in the area. With the help of the railways communication was established between Bell Brothers Middlesbrough office and the Huntcliff mines, a distance of some 17 miles.

These early experiments encountered some of the difficulties met today. In the words of the newspaper: "Unfortunately through the misapprehension of one of the clerks the circuit could not be completed on Tuesday but on Wednesday the experiment was repeated with satisfactory results".

While the experiment was in progress telegraphic interference was experienced from "the powerful currents employed in ordinary telegraphy. Usually these do not impede in any way telegraphic communication but with so delicate an instrument as the telephone they are a serious hindrance."

The article then describes the instrument. "The telephone, we may say, consists of a straight magnet something under five inches in length. In front of one of the poles is fixed a plate of iron about the thickness of a piece of note paper. Round the magnet is wound a fine copper wire closely wrapped with silk and to the ends of this wire is attached the wire of communication".

A very early Bell telephone in the possession of the Middlesbrough Area Engineer, Mr. F. W. Allan, conforms to the pattern and dimensions given by Fox.

The article then goes on to describe what happened. "Those who had the advantage of being present on Wednesday were able to hear distinctly the sound of voices and the music from a small child's musical instrument. It will be clear that until means are discovered for preventing the action of the induced currents from the neighbouring wires the telephone is not likely to pass into ordinary use. The ingenuity of telegraph engineers is so great that we venture to predict that they will either succeed in preventing this action or in strengthening the current produced by the telephone so as to overcome this difficulty."

It is not possible to decide whether or not the Saltburn experiments were really the first ones made in England. Fox is not particularly good on dates. It is known that neither he nor Irvine attended the British Association meeting at Plymouth in 1877. Fox makes the claim that the experiment over the telegraph wires was " the first application in England of the telephone to any long length of wire". Yet an editorial in the *Northern Echo* dated August 23, 1877 tells of tests made between Plymouth and Exeter during the British Association meeting. Fox's experiment is not mentioned. Fox was, however, an acquaintance of Sir William Preece, and Preece gave him a section of the first telegraph line ever constructed in this country. This had been ordered by Fox's father in 1837. It would not be unreasonable to suppose that Fox must have mentioned his own work on the "first telephone" and Preece would have been in a position to deny the claim. From his writing Fox appears as a man of great principle. In his preface to his book he says, "I have told a simple unvarnished story, every word of which is strictly true". If he had not thought his experiment was one of the first it would seem that he would have said so.

An interesting sidelight of this research is the vindication of Sir William Preece as a believer in the future of the telephone. The leading article in the *Northern Echo* mentioned earlier, contains these words: "Mr. Preece is so thoroughly satisfied as to the complete success of the telephone that he told working men of Exeter that he was prepared to hear at no distant date that conversations were being carried on across the Atlantic Ocean".

And then in prophetic note the article ends: "The telephone brings all the world within earshot. When will arise an inventor who will do the same for the eye?"

Cable Link to South-East Asia

THE telephone cable between Australia and South East Asia and Hong Kong – part of the round-the-world telephone cable link – will be completed by 1966, it was announced recently.

As this was being written HMTS *Monarch*, the world's biggest cable-laying ship, was on its way to lay the cable between Sydney and Auckland, in New Zealand. By July of this year the first part of the Commonwealth Pacific Cable (COMPAC), which is to link Canada, Australia and New Zealand, will have been completed. By the end of 1963, this cable will have been continued through Fiji and Hawaii, across the Pacific Ocean to Vancouver, to link up by microwave across Canada with the Commonwealth Trans-Atlantic Cable (CANTAT) which was opened last December.

Following agreement between representatives of Commonwealth countries meeting in Kuala Lumpur, Malaya, last year, the South-East Asia Commonwealth Cable (SEACOM) is to be laid from Australia, through New Guinea and North Borneo, to Singapore and a spur will be added between North Borneo and Hong Kong.

SEACOM will provide at least 80 telephone circuits and will employ British techniques similar to those used on CANTAT and COMPAC. It will cost about £22½ million, of which the British share will be borne by Cable and Wireless Limited. Detailed planning is due to begin this summer.

As well as improving regional communications, SEACOM will also provide greatly improved long-distance telephone and telex services between Australia, New Zealand, Canada, the United States, Britain and Europe.

Mr. D. A. Barron, CBE, MSc.

"Expanding Horizons in Communications"

J. A. Povey

A COMMERCIAL satellite communications system will be in operation within five to seven years.

This was one of the prophesies made by Mr. D. A. Barron during the 33rd Faraday Lecture when he surveyed the astonishing developments in telecommunications since a Post Office official last delivered the Lecture in 1938-39.

Taking as his title "Expanding Horizons in Communications", Mr. Barron first described how, in principle, a subscriber's number is selected in a manual telephone exchange by an operator and in an automatic exchange by a switch in response to off-on pulses produced by the dial. The audiences were clearly delighted by the eight feet tall working models of a dial and selector – probably the largest ever made.

The Faraday Lecture was initiated by the Institution of Electrical Engineers in 1924 as an annual tribute to Michael Faraday (1791-1867) for his pioneer work in electrical engineering. It is delivered in a dozen or so major cities in Britain and is intended not so much for specialists as for enlightening the public in developments in electrical engineering, especially those which closely affect the life of the community.

An eminent electrical engineer or scientist is invited to undertake this challenging task each year. For the 1961-62 Lecture—the 33rd in the Series—the honour was given to Mr. D. A. Barron, CBE, MSc, the Deputy Engineer-in-Chief of the Post Office.

Mr. Barron then showed how a simple numbering scheme could be extended by adding digits so that a subscriber could reach other towns and countries by dialling codes himself, and outlined the principle of a register-translator which converts a national number dialled into the routing instructions needed to complete the call. He also explained a new and faster method of sending the numbers 0 to 9 by using five musical tones arranged in pairs and demonstrated how much faster it was. This section of the lecture was based on a series of large illuminated panels which showed how calls were routed and so on. The panels were of great value in illustrating and clarifying technical points and the ingenious arrangements for them to be shown in quick succession, sometimes animated and always in split-second timing with Mr. Barron's remarks, delighted and intrigued his audiences.

Mr. Barron went on to explain telex-working – a telegraph system also using automatic switching – and included a demonstration, in which local teleprinter operators took part and messages between the two teleprinters were sent simultaneously with explanatory close-up film sequences.

The rest of the lecture described how information is sent from point to point. After outlining the development of local, trunk and submarine cables Mr. Barron described the techniques which have increased and fully exploited equipment capacity and enabled longer distances to be spanned. For example, in carrier working, many conversations, each with its own unique brand of frequencies, could be carried over one pair of wires. This technique, said Mr. Barron, offered tremendous scope for increasing the capacity of a telephone system because the number of telephone conversations handled depended on the bandwidth of the transmission medium. Thus, co-axial tubes could carry many more conversations than a conventional pair of wires. Microwave radio links, which had other advantages, too, could accommodate many thousands of telephone circuits, and waveguides, still under development, about a quarter of a million.

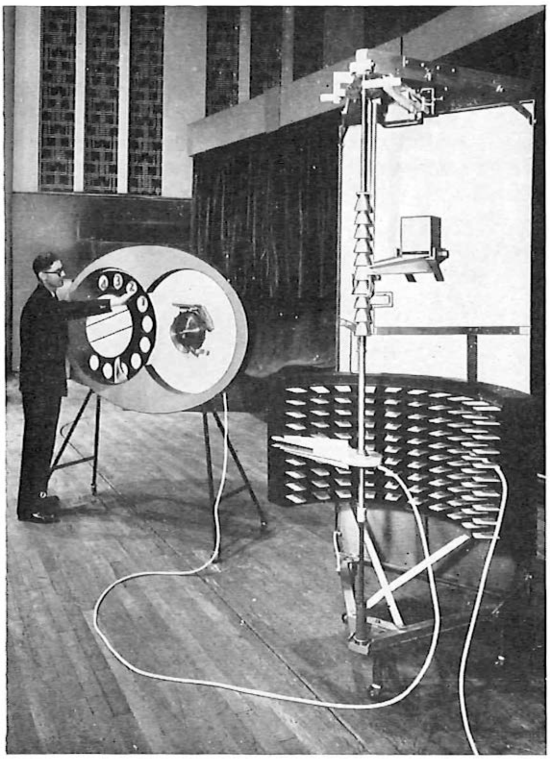
A description of a waveguide – basically radio waves guided by a copper tube – was accompanied by a demonstration in which music transmitted through a waveguide system was silenced when a section of tube was removed or a metal plate inserted across the tube to interrupt the radio wave.

After discussing submarine cables and repeaters and demonstrating with a film some of the activities of HMTS *Monarch*, the largest cable ship in the world, Mr. Barron spoke of "TASI" (Time Assignment Speech Interpolation), the high-speed electronic system which doubles the capacity of a trans-Atlantic cable. The normal arrangement with long-distance circuits was to provide separate channels for speech in each direction so that one channel was always idle. With a model and the aid of a tape recording, Mr. Barron explained how this was overcome by connecting a person to a channel only when he was speaking. Thus, one TASI

To help explain technical details to his non-technical audiences Mr. Barron made full use of demonstration equipment which included seven large models, eight animated panels mounted on a presentation unit, tape recordings, colour films and slides, two teleprinters staffed by operators from each city where the lecture was given, a modern undersea repeater, samples of trunk and submarine cables and a transistor oscillator powered by solar cells. This picture shows the complete stage layout at the Philharmonic Hall, Liverpool channel would contain snatches of many conversations.

Mr. Barron concluded by describing different types of satellites and saying how they could be employed in long-distance communication using micro-wave radio. Basically, there were two types: passive, which merely reflect radio signals, and active, which amplify signals before sending them back to earch.

Satellites, Mr. Barron said, may be in different orbits. For example, one in free orbit at 22,300 miles would appear to be stationary in the sky. But though this distance would enable fixed aerials to be used it would introduce a delay which could be disturbing to normal telephone conversation. Active satellites at lower orbits and tracked by steerable aerials were, therefore, the most likely to be used in telecommunications. Trials using American satellites were planned to begin this year and a steerable aerial, weighing 870 tons, was being constructed at Goonhilly Downs, in Cornwall. In his opinion, a satellite system would be in operation within seven years.



The eight-foot dial and selector

To demonstrate the difference between active and passive satellites, Mr. Barron presented on a blacked-out stage a dramatic model showing the rotating earth encircled by "stationary" and moving satellites, the latter tracked by a pair of steerable aerials. The model was also used for a practical demonstration in which music was stopped by interrupting a signal transmitted from one fixed aerial through the "stationary" satellite to another aerial.

Mr. Barron gave his Faraday Lecture to large audiences in London, Bristol, Cardiff, Birmingham, Hanley, Nottingham, Sheffield, Southampton, Newcastle, Liverpool, Belfast and Glasgow between November, 1961 and March, 1962. At seven of these places an additional students' lecture was arranged, sometimes in association with essay competitions. At the end of his tour, which was sponsored by the Institution of Electrical Engineers, Mr. Barron presented his lecture to Post Office staff in London.

The success of Mr. Barron's lecture was reflected in the enthusiastic reception it received all over the country and in its widespread coverage by press and television.

Closed-Circuit at Sea

As the *Journal* went to press the Royal Navy was preparing to berth its newest aircraft carrier, the 22,000-ton HMS *Hermes*, by closed-circuit television in foggy weather.

The device under trial is similar to that used in big United States carriers. Transmission "stations" are set up near the bow and stern and detailed pictures are flashed on a screen for use by the navigating officer. HMS *Hermes* was recently fitted with a closed-circuit television so that the Air Commander could follow from his control position all the movements of an aircraft from its approach to landing.

If the trial, which was to be carried out in the English Channel, is successful the system may be installed in all Britain's operational carriers.

Cable Laying—
By Parachute!

E. F. S. Clarke, B.Sc.(Eng.), A.M.I.E.E.
and
K. J. Chapman, B.Sc., A.M.I.E.E.

BEFORE the new lightweight, armourless cable could be used on CANTAT a great deal of development work was needed. One problem which had to be solved was related to the slow rate at which the cable sinks to the seabed.

The weight of lightweight cable in water is under one-third of that of conventional armoured cable of similar capacity, so that it sinks at a much slower rate. Laying trials showed that the cable takes several hours to sink to the seabed in deep water, and that at normal laying speeds it does not reach the bottom until the ship is from ten to twenty miles ahead.

A problem is created by the rate at which the rigid repeaters sink, which is much faster than that of the cable. When laying, this difference would result in a large loop of cable being formed and would cause too much slack near the repeater. To maintain the correct pattern of slack throughout the lay, it was essential to find some method of making the sinking rate of cable and repeater about the same.

It was considered that by using parachutes it should be possible to slow the rate at which the repeaters sink and at the same time reduce shock when they reached the seabed. In October, 1960 HMTS *Ariel* carried out trials with parachutes in Loch Fyne – water which has little tidal action. It was realised that under certain conditions severe tides and surface currents might drag the repeater off course, but no difficulties were expected on CANTAT. In the event, none was experienced.

A series of experiments was made at a depth of 90 fathoms, this being sufficient to ensure that the dummy repeater housing fell steadily through the water. Various types of parachute were tried and their rate of fall recorded. In a final experiment a repeater was dropped without a parachute and its rate of fall exceeded 8 knots. By using parachutes of the type employed in CANTAT this velocity has been reduced to three-quarters of a knot.

Parachutes are of conventional design with a 28 feet diameter canopy of rayon fabric, and have proved adequate for the stresses set up in passing through water. As it is desirable to disconnect the parachute on the seabed because drag would make recovery for repair of the cable more difficult, a hydrostatic type disconnect mechanism was

Repeater approaches stern sheave

Repeater leaves stern sheave and parachute bag falls clear

developed for use on CANTAT. This allows the parachute to be released only when the load is taken off and water pressure exceeds that at a depth of 250 feet. In this way the disconnect does not operate during the early stages of descent when the parachute is opening.

The parachute is attached to the repeater housing by a wire rope sling attached to two bands at each end, and is packed in a narrow sock about the length of the repeater. Before launching, the assembly is mounted on the repeater with a line attached so that the sock can be removed when required. All deep sea repeaters on CANTAT have been laid over the stern of HMTS *Monarch*, using the multiple V-sheave laying gear. As the last few turns of the preceding section of cable clear the cable tank the repeater starts its journey along the launching trough on the special trolley provided. It travels towards the after deck, bypasses the laying gear and travels up the ramp to the stern cable sheave. The parachute assembly is lightly taped to the repeater to retain it in position during this operation. As the repeater passes over the stern sheave the parachute operator (on the walkway beside it) takes control of the line. Its length is adjusted to ensure that the deployment sock is removed just as the repeater breaks the surface of the water. The red canopy of the parachute is usually just visible at this stage, partially concealed in the turbulence and foam of the wake of the ship.

The effectiveness of the parachute is clearly confirmed during a laying operation by observing the cable tension after launching each repeater. There is no increase in tension, as would be expected if the repeater were allowed to fall freely, for the weight of a repeater (half a ton) is significant in comparison with the laying tensions of lightweight cable. Approximately 60 repeaters and equalizers in the CANTAT system were equipped with parachutes and many more will be required for the deep sea section of the Commonwealth Pacific Cable project.

THE GLENN FLIGHT

(Continued from page 79)

From it there is a circuit to the *Minitrack* Station at Winkfield which, as this issue went to press, was preparing to become the scene of considerable activity on the launching of the first British satellite from Cape Canaveral (See page 63). Information about the launch was to be received over another circuit from Goddard to the London switching centre direct into the Winkfield station which itself was to track the *Ariel*. The United Kingdom Manager of the British satellite project, operating from the Physics Department of University College, London, and the Radio Research Station of the Department of Scientific and Industrial Research, which has been closely associated with several of the American satellite projects, also have access to the same trans-Atlantic link to Goddard.

Another network recently established through the room will carry the support communications for the communications satellites *Telstar* and *Relay* to be launched from Cape Canaveral later this year. This network will connect the Post Office Satellite radio station at Goonhilly and the Research Station, Dollis Hill, with the United States satellite radio and tracking stations and will, for example, carry the orbital information calculated by computer in Goddard which will be fed into the Goonhilly aerial control system. When the ground stations in France, Italy and Germany become operational later in the year and early in 1963, they too will be connected to the London switching centre by telegraph.

*A detailed article on the network of communications provided for Colonel Glenn's orbital flight appeared in the Winter, 1961 issue of the *Journal*.

Closed-Circuit Television at the Savings Bank

WHEN the Queen Mother visited the Savings Bank to inaugurate their centenary celebrations and unveil a plaque and memorial gates, closed-circuit television was installed for the day so that the maximum number of staff at both Blythe Road Headquarters and the outstations could take part. As most readers know, the Post Office provides television circuits for the Broadcasting authorities, but it is unusual for us to provide them for ourselves.

When the Queen Mother and the principal guests entered the building under an awning erected from the pavement to the main door, television cameras recorded her progress to the lift which took the party up to the canteen. This had been transformed for the occasion so that the speakers and unveiling ceremony could be heard and seen by a large number of staff seated in the hall. Television cameras again recorded the scene and other cameras followed the official party as it toured the building and finally arrived in the main entrance hall, where the Queen Mother signed the visitors' book.

In addition to facilities for the rest of the staff in other parts of the building at Blythe Road to see and hear the ceremony, lines were provided so that those at Charles House, Kensington, Bromyard Avenue, Acton, and the Records Office, Kew, could take part.

On the day of the ceremony leads from the various television cameras and microphones were connected to a control van of the programme contractors, Rank Precision Industries Ltd., parked in the Blythe Road yard. The picture and sound signals, as decided by the Producer, were then passed to a Post Office Outside Broadcast Van. Here they were received on distribution amplifiers, which give several outputs for one input and to which the outgoing lines to the distant offices were eventually connected.

Suitably equalised telephone type underground cable circuits were used to carry the sound signals to the distant points, which included Harrogate in Yorkshire. Unfortunately, no suitable line plant was available to carry the picture signals to Harrogate because of the very much higher frequencies required, especially as the 625 line system was being employed, and it was not economically possible to set up a vision circuit on this occasion. Arrangements were made to transmit the picture signals to Charles House over about half a mile of 2 pr/10 lb. polythene insulated cable run specially in existing ducts. Microwave radio links were used to Bromyard Avenue and Kew.

The London Telecommunications Region Outside Broadcast Group responsible for setting up the circuits have no portable microwave radio equipment available to them, so it had to be hired for the occasion.

Radio Link

The radio link from the roof of the Savings Bank at Blythe Road to the roof of the Bromyard Avenue building – a distance of some $1\frac{3}{4}$ miles – was satisfactorily set up in one line-of-sight hop, using EMI 7000 Mc/s equipment. The three-mile circuit to Kew proved more difficult because the building is bungalow-type and is screened by its surroundings. Several two-hop radio paths were investigated, using a suitable Post Office building roof as the intermediate relay point, but the problem was eventually solved by using a BBC mobile tower to carry the receiving aerial at Kew. This also enabled a technically better one-hop link to be established direct from Blythe Road, using 4000 Mc/s equipment.

From the Post Office receiving point at the outstations and at Blythe Road, vision signals were used to modulate a carrier frequency before being fed to the local distribution cables. This made it possible to use a normal broadcast type of television receiver suitable, of course, for 625 line signals. Fifty-nine receivers were installed in selected rooms throughout the building so that a potential audience of about 8,000 people could enjoy the proceedings – probably the largest closed-television circuit audience to date.

A member of the Blythe Road staff acted as commentator throughout the programme.

G. A. Thomas, LTR.

OUR CONTRIBUTORS

K. J. CHAPMAN (joint author, "Cable Laying – By Parachute!") is a Senior Executive Engineer in the Engineering Department Research Branch. His career in communication engineering began in 1941 with REME and Royal Signals. He was commissioned in 1944 and later seconded to the Indian Posts and Telegraphs Department in connection with their trunk development scheme. Subsequently he became an instructor in line communication at the School of Signals. On demobilisation he joined the Signals Research and Development Establishment, graduated in Physics in 1949 and transferred to the Post Office in 1950, since when he has been associated with submerged repeater system development.

E. F. S. CLARKE (joint author, "Cable Laying – By Parachute!") is an Assistant Staff Engineer in Research Branch. He left the Osram (GEC) Radio Valve Development Laboratory in 1931 to enter Radio Branch, Dollis Hill, as an Unestablished Skilled Workman, became a Probationary Assistant Engineer in 1936 and transferred to Lines Branch on promotion to Senior Executive Engineer in 1946. He returned to Dollis Hill, Research Branch, in 1952. Since 1954 he has been engaged on problems associated with submerged repeater schemes.

J. L. CROWTHER (joint author, "The Nerve Centre on the Embankment") joined Cable and Wireless Ltd. in 1948 as a Technical Assistant in Electra House. He was promoted to Assistant Engineer in 1952 and employed on operational engineering duties. In 1954 he moved to the Electra House Planning and Estimating group and has been responsible for much of the planning and development of the new Control Room and Facsimile Room.

E. E. DANIELS (joint author, "International Telex Subscriber Dialling") joined Manchester Telephone Area as a Youth-in-Training in 1941. He was transferred to the Engineering Department, Telegraph Branch as Assistant Engineer in 1949 and subsequently appointed Executive Engineer in that Branch.

A. E. T. FORSTER (joint author, "International Telex Subscriber Dialling") is a Senior Executive Engineer in the Engineering Department, Telegraph Branch. He has contributed articles twice before – "Automatic Dialling for Telex", Autumn 1956, and "The Twopenny Telex", Autumn 1959. His career is outlined in the Autumn, 1956 issue.

E. J. LALLY ("New Light on Early Telephone Experiments") is a Senior Telecommunications Superintendent in the Telephone Manager's Office, Traffic Division, Middlesbrough. He entered the Post Office as a Youth-in-Training in 1933, and apart from war-time service with the RAF, was employed on exchange construction and automatic exchange maintenance until 1949 in York Area. In that year he was promoted to Assistant Traffic Superintendent and transferred to Middlesbrough. He was promoted to his present rank in 1955.

C. F. MACHEN ("Telephone Exchange Relays") is a Senior Executive Engineer in Telephone Exchange Standards and Maintenance Branch. He joined the Engineering Department in 1939 and remained at Research Branch until 1948. Promoted to Executive Engineer in 1950, he transferred to Telephone Branch. He was promoted to his present rank in 1957 and is concerned with the development of electromechanical devices.

J. A. POVEY ("Expanding Horizons in Communications") is an Executive Engineer in the Exchange Equipment and Accommodation Branch of the Engineering Department and assisted Mr. Barron at his lectures.

E. C. H. SEAMAN ("Principles and Possibilities of Pulse Code Modulation") is an Assistant Staff Engineer in the Research Branch, Engineering Department.

G. A. Thomas ("Closed Circuit Television at the Savings Bank") is an Executive Engineer in the Engineering Branch at London Telecommunications Region HQ and is concerned with Outside Broadcasts, Television and Sound Programme Circuits.

L. VEALE (joint author, "The Nerve Centre on the Embankment") joined Cable and Wireless Ltd. in 1938. He was appointed Technical Assistant in 1943 and Assistant Engineer in 1949 and has been concerned mainly with the engineering aspects of maintaining overseas circuits, including supervision of the Radio Control, Phototelegraphy, and Error-correcting Multiplex sections at Electra House. In 1948 he was appointed duty Executive Engineer at Electra House and in 1961 transferred to the External Telecommunications Executive Headquarters planning section responsible for overseas telegraph mechanisation projects.

D. E. WATT-CARTER ("The End of an Era at Leafield") is an Assistant Staff Engineer in Radio Branch. He joined the Post Office as a Probationary Inspector (Old Style) in 1933 and after a few years in the Regions went to Radio Branch where he worked in the External Construction and Planning sections. He went to Dollis Hill and was concerned with the design of crystal filters and networks, and their microwave aspects of these. He now controls the Provision and Installation Section of Radio Branch and takes a study group of the CCIR (International Radio Consultative Committee).

Computers of the Future

"ELECTRONIC evolution is going forward at a hectic pace and the end is not nearly in sight", says John Davy, the Science Correspondent of the *Observer*.

In an article headed "Hard Life in the Electronic Jungle", Mr. Davy goes on to suggest that in a few years today's computers will look like "those lumbering reptiles that became extinct in the Jurassic swamps". One almost extinct species was the kind that used radio valves instead of transistors.

Mr. Davy prophesies that in a few years the parts of computers where calculating is done will be small boxes containing thousands of micro-miniaturised computing elements, linked, perhaps, to a central "boss-box" directing operations. These boxes would be surrounded by man-sized equipment needed for feeding facts and figures into the computer and extracting the results – automatic printing machines, typewriters, punched card apparatus, paper tapes and so on.

Notes and News

The *Journal* welcomes its new editor, Mr. John Grove, who took up his duties as this issue was going to press.

Mr. Grove began his journalistic career in 1932 as a reporter with the *Middlesex Chronicle* at Staines and from 1936-40 was a sub-editor on the staff of *Exchange Telegraph* in London. During World War Two he served with the Middlesex Regiment.

One of the founder members of *Soldier*, the British Army's monthly magazine which was formed in 1945, Mr. Grove served on its staff for 17 years – first as a feature writer, than as local editor in Hamburg and, from 1957 until his appointment to the Post Office, as editor in London.

* * *

With grateful thanks for his services the *Journal* says farewell to Mr. Bernard Hogben, of the Public Relations Department, who acted as editor after the retirement last September of Mr. John L. Young.

* * *

Comment in Comfort.—The seven BBC commentators who gave eye-witness accounts of the Boat Race to Europe this year did not have to suffer the discomfort of following the crews in a launch. Instead, they sat in comfort in the BBCs Television Centre and, each equipped with his own microphone, monitor screen and Eurovision telephone box, gave accounts to the eleven countries taking the telecast. It was the new International Commentary Area's first assignment.

From the United States comes news of a miniature television set which weighs only eight ounces, is strapped to the head and projects a picture on to a plastic monocle one-and-a-half inches in front of one eye.

The makers claim that the device enables its wearer to see in two directions at the same time. A pilot, for instance, could fly his aircraft and simultaneously receive televised information from a ground control tower on his viewing monocle. The cathode ray tube is only seven inches long and one-inch in diameter.

* * *

Noblesse Oblige.—If a British wife living in Paris feels lonely all she has to do is ring a "Dial a Chat" telephone number to be put in touch with other British wives in the city. The scheme has been introduced by the French Post Office to help homesick wives trying to get used to life in the French capital!

* * *

New Regional Representatives.—Mr. R. V. Dodson, Home Counties Region, has retired and is succeeded by Mr. V. F. B. Medland. Mr. T. E. Harries, Northern Ireland, has transferred to London and is succeeded by Mr. D. Davies. We thank Mr. Dodson and Mr. Harries for their work on behalf of the *Journal* and welcome Mr. Medland and Mr. Davies as Representatives.

New Kiosk on Trial in London

In the Spring, 1959 issue the *Journal* gave details of the new telephone kiosk designed by Mr. Neville Conder, F.R.I.B.A., A.A.DIP.(HONS.), M.S.I.A. Prototypes of the kiosk have now been put on trial in London—three at Grosvenor Gardens, Westminster, and one behind the Royal Exchange in the City—to seek public opinion on the suitability of the design before a decision is made whether to go ahead with full scale production.

A notice in each of the kiosks invites users to send their comments to the Postmaster General. If it is adopted the new kiosk will be used primarily for new call boxes. There is no intention of replacing the 67,000 existing kiosks by the new design as this would be too costly.

* * *

What do you think of the new telephone kiosks? Here are the three prototypes now on trial in Grosvenor Gardens.

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

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

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

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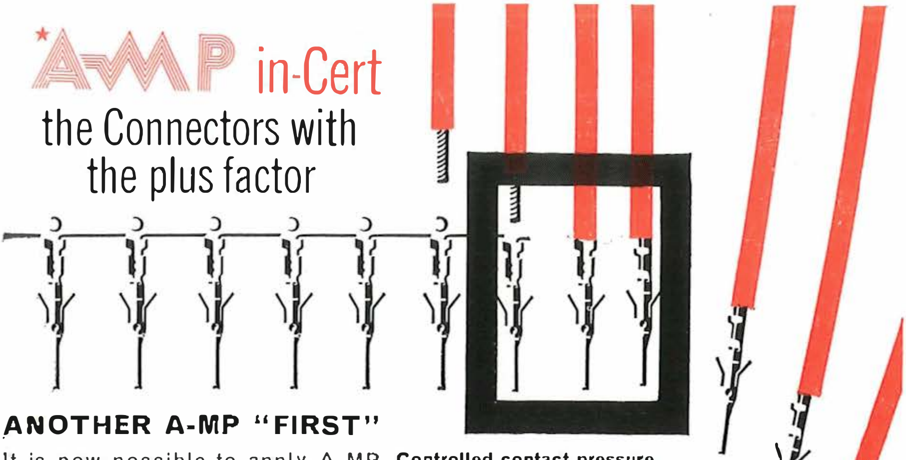

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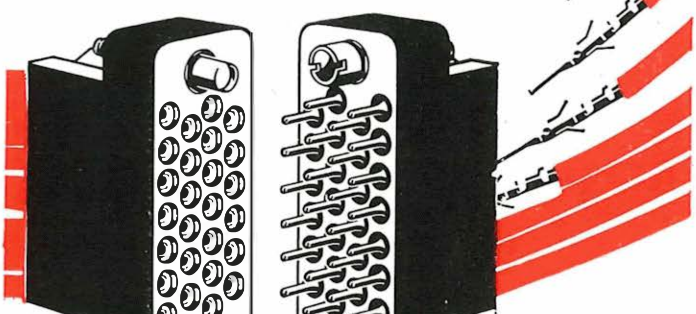

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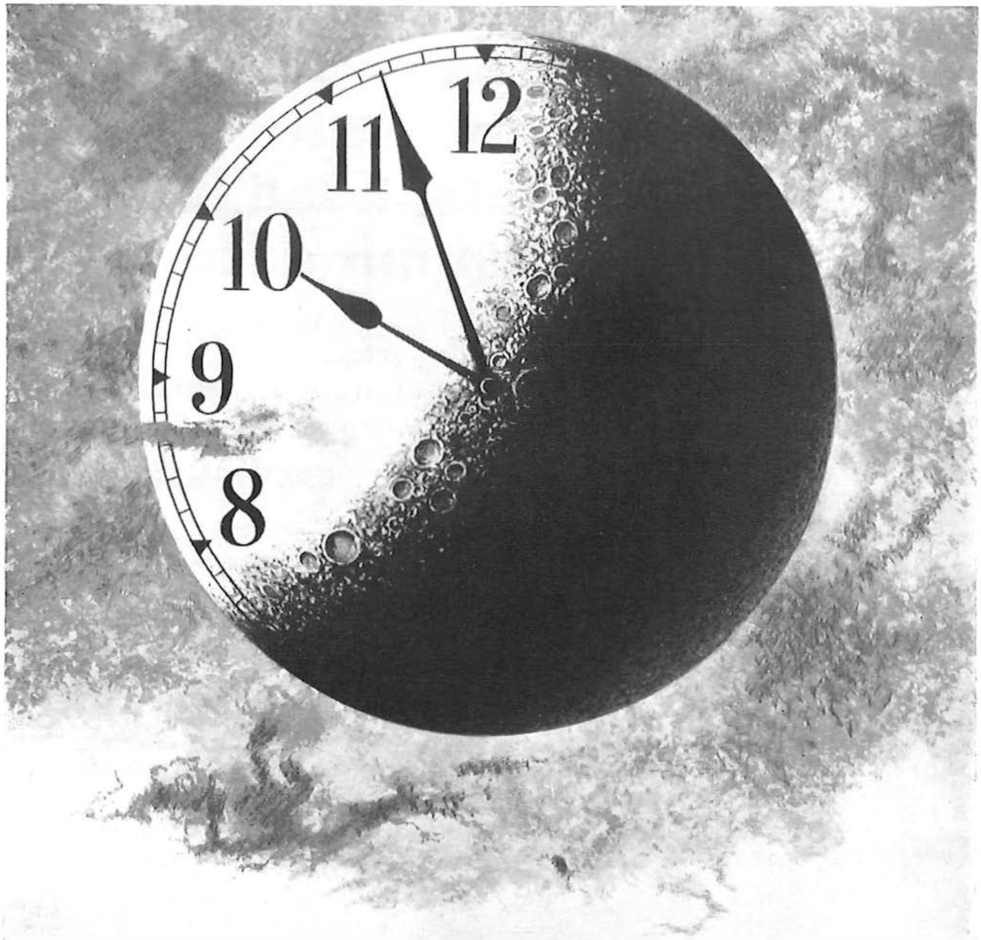
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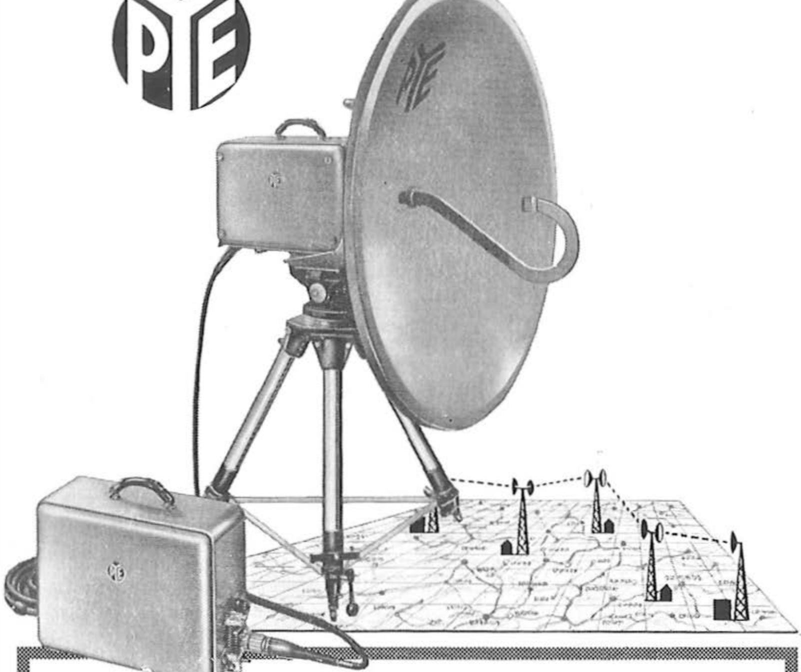
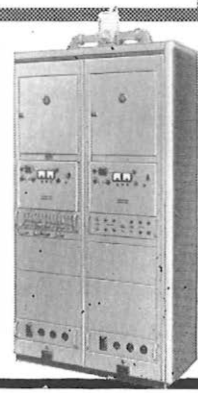
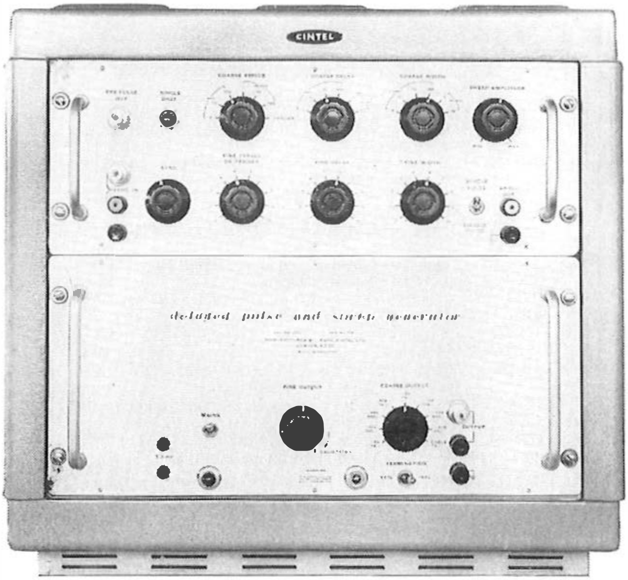




DELAYED PULSE

AND

SWEEP GENERATOR



A versatile pulse generator designed to meet the need for a comprehensive instrument covering a wide range of pulse work. Four main facilities are provided: a pre-pulse, a main pulse delayed on the pre-pulse, a negative going sawtooth and a fast rising pulse formed from a pure line.

BRIEF SPECIFICATION

Period

Continuously variable from 0·9μsec to 1·05sec i.e. 0·95c/s to 1·1Mc/s. Accuracy ±5%.

Pre-pulse

40mμsec. 8V peak in 75Ω, positive going.

Main pulse

Width:	Variable from 0·09μsec to 105msec ±5%.			
Amplitude:	Control gives 4:1 attenuation of each of four maximum outputs as follows:			
	5V max in	75Ω	rise time	10mμsec
	10V max in	150Ω	rise time	<20mμsec
	25V max in	600Ω	rise time	<40mμsec
	50V max in	1000Ω	rise time	50mμsec
Polarity:	Positive or negative going.			
Accuracy:	±2%.			

Delay

Conclusion of pre-pulse to advent of main pulse, delay variable from 0·09μsec to 105msec. Accuracy ±5%.

Sweep

D.C. coupled negative going sawtooth same width and delay as main pulse.
15V peak max.

Cable pulse

Obtained from short circuited pure line.
One positive and one negative going pulse coincident with main pulse.
25mμsec wide 3V max in 75Ω, rise time <8mμsec.

Sync, trigger or single shot facilities provided.
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VR/64	Ribbon Velocity. Pencil Microphone. Low-Line or High Impedance.
LFV59	Full Vision Microphone—Low-Line or High Impedance.
C/48	High Fidelity Dynamic Stand Model. Low Impedance.
C51	General Purpose Dynamic Stand Model. Low-Line or High Impedance.
CH51	High Fidelity Handheld Dynamic, Diecast Case Low-Line or High Impedance.
H51/SB	Single Button Carbon, Handheld, Diecast case.
H51/DB	Double Button Carbon, Handheld, Diecast case.
HD/54	High Fidelity Dynamic, Handheld, Lightweight Moulded Case. Low Impedance.
HC/54	Single Button Carbon, Handheld, Lightweight Moulded Case.
HC2/54	Double Button Carbon, Handheld, Moulded Case.
CI.51/HMT	Dynamic Hand Microtelephone. Low Impedance.

Model	
VC52/H	Low Impedance Noise Cancelling Dynamic, fitted to Holding Handle.
VC52/B	Low Impedance Noise Cancelling Dynamic, fitted to Swivel Boom.
LD.61/Z	Dynamic, for tape recording. Low-Line or High Impedance. Moulded Housing, with 9 ft. Cable.
Type	
CI/48	High Fidelity Dynamic Insert for Intercommunication Equipment.
CI/51	High Fidelity Dynamic Insert for Intercommunication Equipment.
DI56	High Fidelity Dynamic Insert for Intercommunication Equipment.
VC52	Dynamic Noise Cancelling Insert for Telecommunication Equipment.

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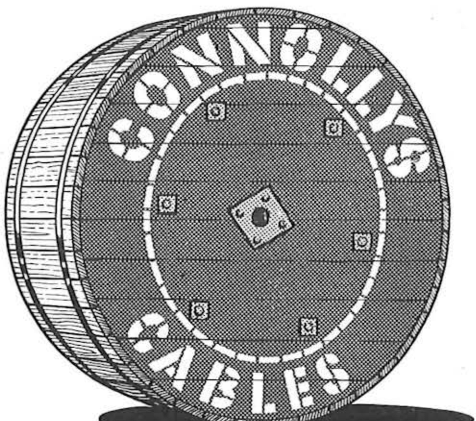

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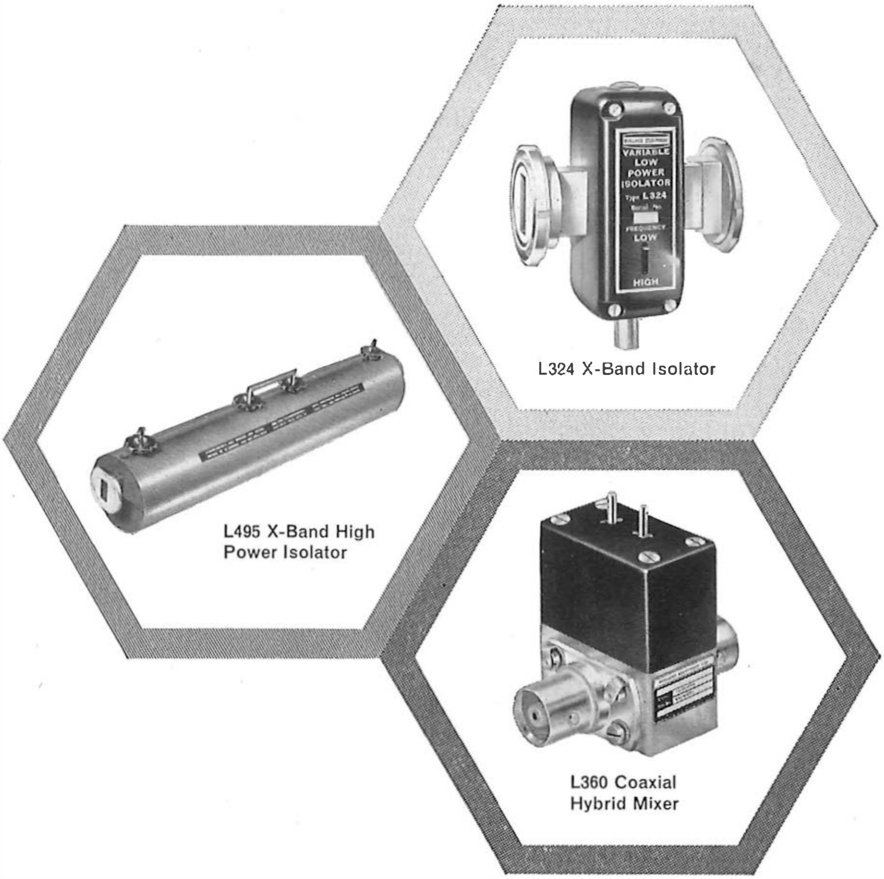

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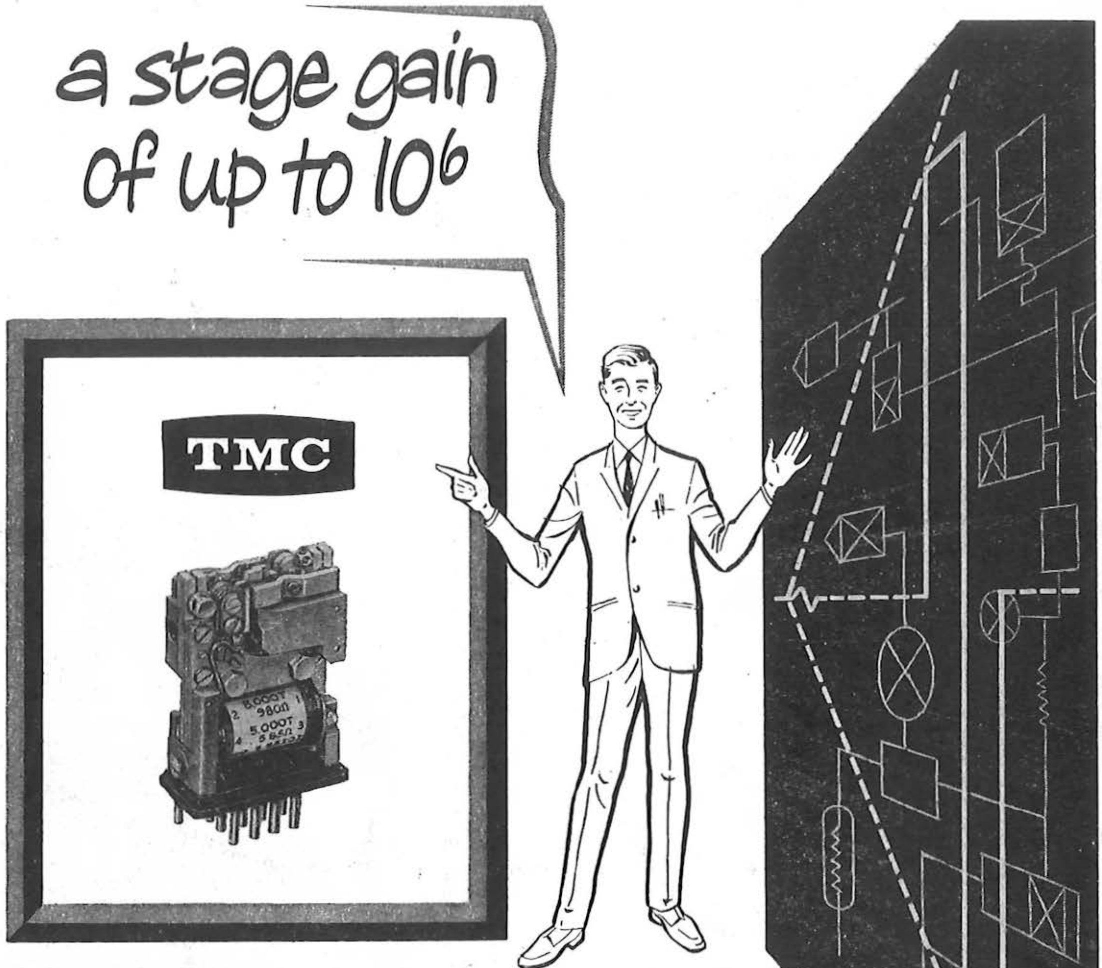

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