Post Office telecommunications journal

Summer 1971 Vol. 23 No. 2

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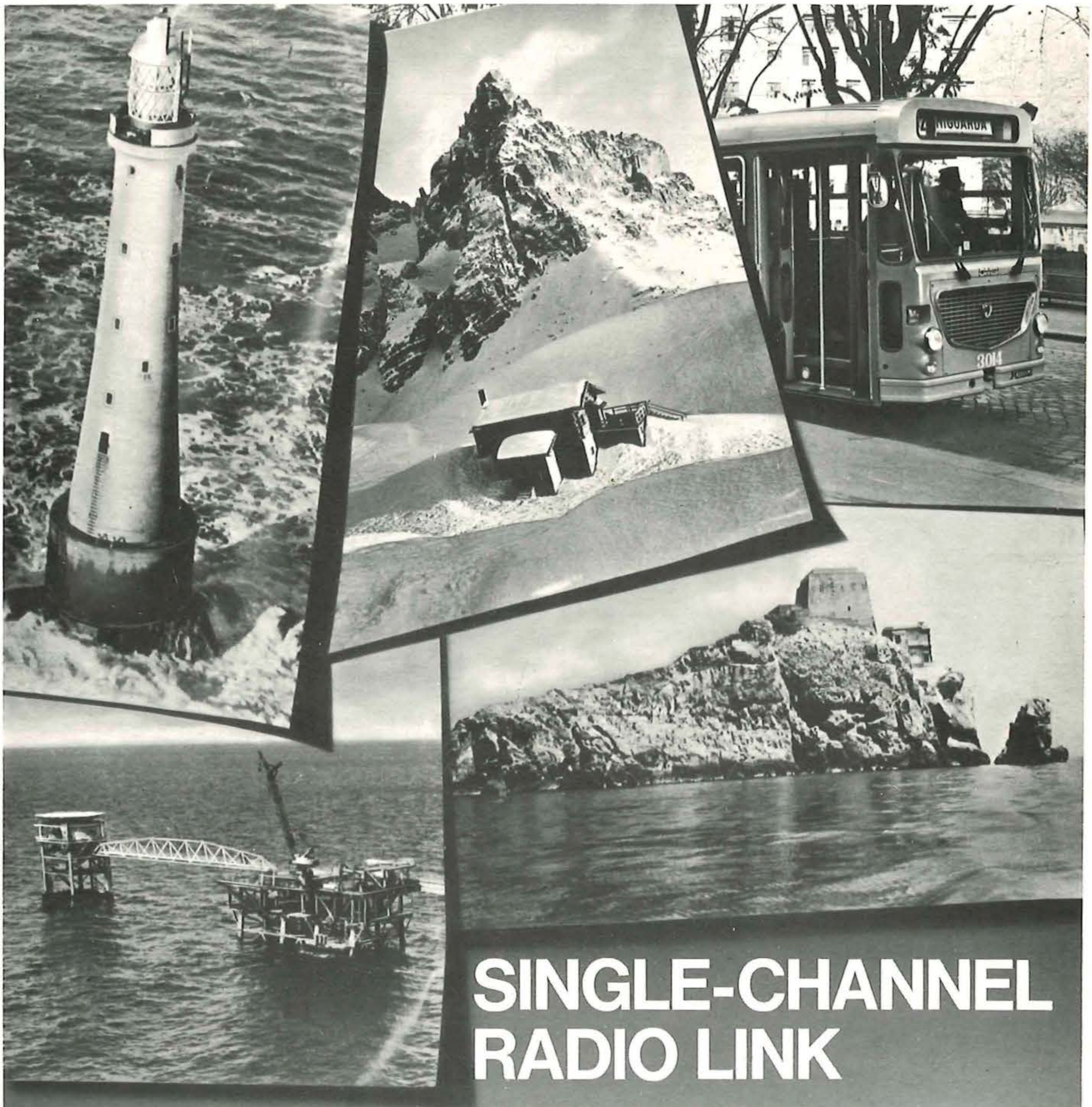

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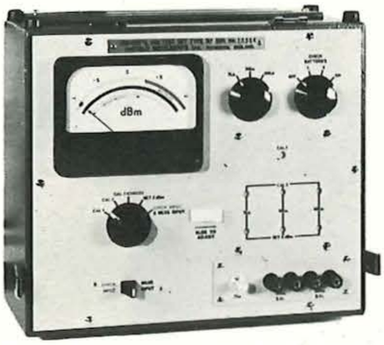

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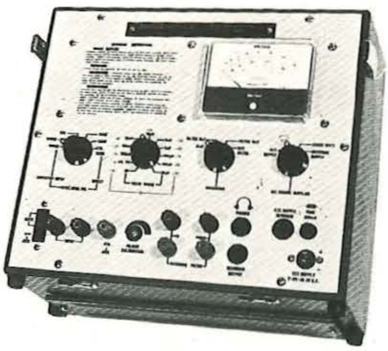

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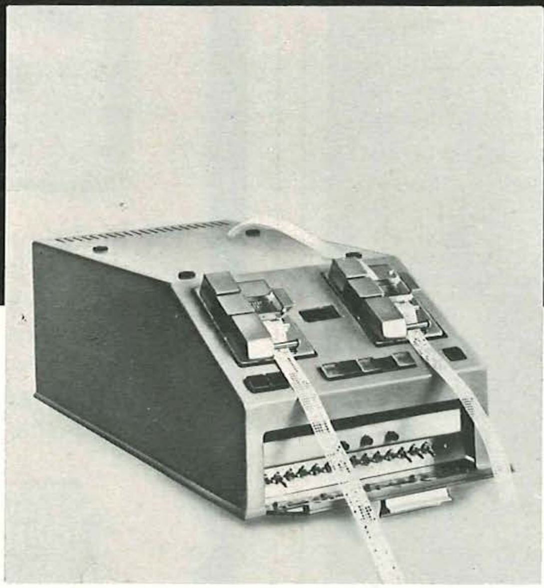

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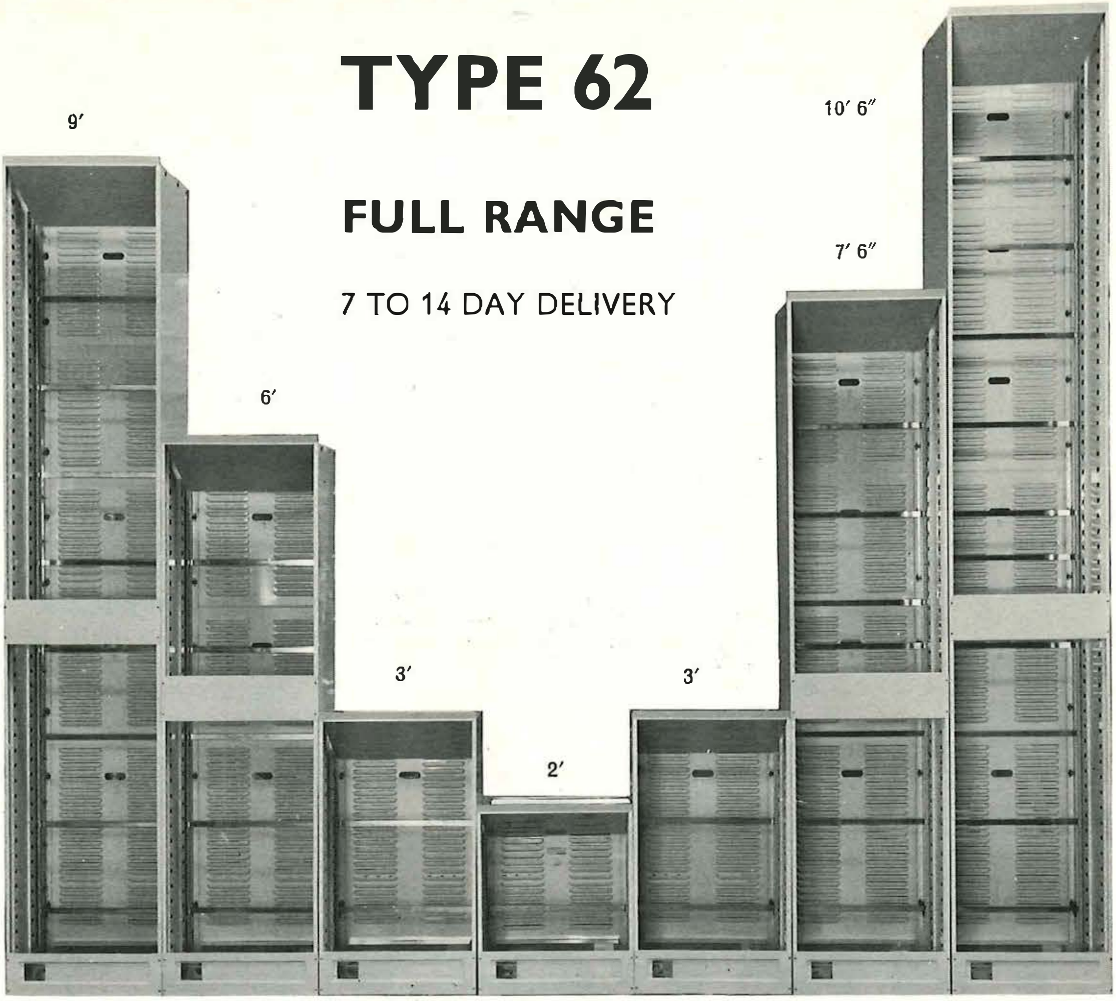

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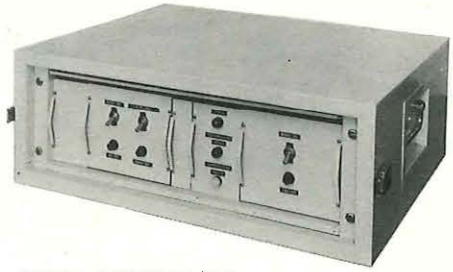

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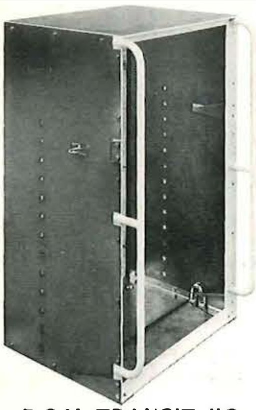

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Summer 1971 Vol. 23 No. 2

Post Office telecommunications journal

In this issue

COVER PICTURE: Helicopters are used for a number of telecommunications jobs, including the construction of aerial towers at Post Office radio stations. They are currently being used in tests to determine the way tall buildings affect microwave radio signals. See Hazard of the "skyscraper" age, page 17.

In Geneva this summer a major world conference has been discussing the rapid growth of space communications. Its decisions will set the pattern for further large-scale development of the use of satellites for telephone, television and other communications of all kinds. One possible development is a satellite communication system for the countries of Europe, and this is described in an article beginning on page 6. Continuing the space theme, we look at the "competition" between submarine cables and satellites (page 25) and there is a report on aerial developments (page 27). We begin on this page with details of a new Post Office service.

EXPERTISE ON OFFER

BRITISH Post Office expertise in satellite earth station communications is now available to administrations all over the world. It is being offered through a consultancy service known as Crown Communications which is operated jointly by the Post Office and the Crown Agents for Overseas Governments and Administrations. The consultancy service is a commercial venture for the two partners, with charges framed to cover costs plus a margin for profit.

The service covers the full range of activities involved in an earth station project. The Post Office provides the telecommunications expertise through a technical advisory group in the Earth Station Planning and Provision Branch; this is supplemented by the Crown Agents' experience in the fields of civil, mechanical and structural engineering and in the execution of major projects overseas. Crown Communications will carry out feasibility studies, site selection, specification writing, tender adjudication and will supervise the construction and testing of the installation. The degree of involvement depends on the requirements of the client administration which may wish to participate in parts of the programme.

The consultancy service has already carried out site interference measurements on behalf of the Telecommunications Department of the Government of Singapore and assisted the preparation of the specification and the evaluation of tenders. Crown Communications will also assist the final testing of the station.

The Post Office and the Crown Agents are currently engaged in their most comprehensive consultancy to date—the provision of a satellite communication earth station for the Government of the Republic of Zambia. Although the consultancy service was intended to cover satellite earth stations only, in this instance associated projects are involved—an international gateway telephone exchange, an international telex exchange and a public message automatic switching centre. The consultancy for these will be carried out by Cable & Wireless Ltd., though the overall responsibility for the project as a whole will remain in the hands of the British Post Office.

FROM EXCHANGE APPRENTICE TO CHAIRMAN

Mr. Ryland points out details of equipment at London's Post Office Tower during the visit to Britain of M. Mohamed Mili, Secretary-General of the International Telecommunications Union (right). With them is Mr. Edward Fennessy, Managing Director Telecommunications.

MR. William Ryland, who began his career as an apprentice at Cardiff exchange and rose to become Managing Director Telecommunications, was appointed Post Office Chairman in April. At the age of 57, Mr. Ryland brings to the job wide experience of both the postal and telecommunications businesses.

In a speech earlier this year, Mr. Ryland talked about the aims of the Post Office and gave this personal view:

"The Board is concerned with two groups of people—its customers and its staff. To them it assigns its best endeavours at all times. Their interests will be fairly served if the Post Office aims—

**To give a good service at a fair price which allows a reasonable profit*

**To act as a good and reasonable employer*

"This approach will give customer satisfaction and therefore produce the right environment in which the services can grow and develop. It will give the staff the satisfaction of doing a job of national importance while at the same time feeling sure of fair treatment.

"The approach will also produce profit, all of which will be ploughed back into the business for improvement and expansion. The profit motive will provide—in the Post Office as elsewhere—a much needed stimulus for efficiency.

"Here then we have, in my view at any rate, the three ingredients for any successful business. A good product which the customer gets where he wants it, when he wants it, and at such a price that he wants more of it. A good and justly treated staff who will provide the service the customer wants. And a fair profit without which expansion and progress cannot be financed."

The son of a former Telephone Manager at Newcastle, Mr. Ryland joined the Post Office as a youth-in-training in 1932. Later he transferred to postal work in North Wales, and during the war became a Colonel in the Army Postal Service (Royal Engineers) in the Mediterranean area.

He returned to postal work in the Midlands and moved to London in 1949 as a Principal in the Postal Services Department. Mr. Ryland's first directorship—of Establishments and Organisation—came in 1958 after spells as Deputy Public Relations Officer and Principal Private Secretary to two Postmasters General.

In 1961 he was appointed Director of Inland Telecommunications and later headed the study team to the Bell Telephone System of America. In 1965 he became Deputy Director General (Telecommunications) and in the same year received the CB.

After two years as Managing Director, Mr. Ryland was appointed Deputy Chairman and Chief Executive when the new Post Office Board was set up in 1969 in preparation for Corporation status. He was the first Post Office man to be appointed to the Board, and became Acting Chairman and Chief Executive following the departure of Lord Hall last November.

Co-operation in long-term studies

EUROPEAN co-operation in the field of long-term studies was the aim of a meeting of members of CEPT (European Conference of Posts and Telecommunications Administrations) held at Lutyens House in London in March. Representatives from ten PTT administrations met to decide how to set in motion a European programme of long-term studies in the timescale from 10 to 30 years ahead. A working group will look into the technological, social, economic and other factors likely to affect the nature and volume of telecommunications in this period.

The initiative came from within CEPT, following the increasing attention now given to long-term studies. In view of the work it has already done in this area, the United Kingdom Post Office was asked to provide the Chairman for the new group.

The task is being approached from two directions. The first, in response to a French initiative, is collecting from participating countries forecasts for public services for the year 1985. It would be possible to learn of new types of service under consideration with possible dates of their introduction, together with forecast rates of growth and similar details for existing services. Such information could be of considerable value to participating administrations in harmonising their plans. The real objective of this particular project, however, is to identify directions in which, from the point of view of long-term requirements, research efforts are particularly urgent and promising.

The second, and main, approach is concerned with the formulation of a European programme of studies of benefit to European PTTs which will look at long-term technological and socio-economic matters, taking into account existing work in these fields. In the words of one of the delegates, Dr. Kaiser (head of the West German PTT Engineering Department): "The future in the telecommunications field is characterised by an abundance of technological possibilities which face limited financial and other resources." It is therefore hoped to form, this year, an international team of about five people drawn from the fields of technology, sociology, economics, geography and telecommunications usage who will devise a suitable operating framework for their studies and follow this with a detailed programme. They will work as part of the Ecological and Economic Studies Branch of the Long Range Studies Division (LRS1).

No one can doubt the possible value of such work, any more than those with experience in the international field can doubt the problems which may be encountered in agreeing and funding the programme of work. However, if the co-operative atmosphere of the first meeting is any criterion, these problems will be overcome.

● *This report was contributed by L. L. Grey, head of LRS1, who was appointed chairman of the working group.*

Is the customer satisfied?

Market research has been an aid to management of the Post Office for a long time, possibly since before 1837 when Rowland Hill assessed the potential market for a prepaid penny postage stamp. Last year the Market Research Division conducted more than 20 surveys. These included the annual survey of customer opinion of the telephone service, subscriber reaction to official publications and their attitudes towards existing coinboxes. This article describes the need for market research in the telecommunications business. It is based on a lecture given by H. W. Jose to the Postal and Telecommunications Society.

IN AN expanding and sophisticated economy such as we have in Western Europe, and where customers have a choice of products and brands, customer satisfaction is essential to survival of a business.

Because the Post Office has a monopoly in certain areas of activity it is not always subject to the competitive conditions that in other markets enable customers to demonstrate their attitude to a company's products, prices, efficiency and friendliness by giving or withholding their business. The Post Office is therefore unable to measure the success of its operations by reference, for example, to its share of a total market.

Customer satisfaction is, and must continue to be, a specified aim of our business, and staff and management need to know to what extent that aim is being achieved. A corollary is that we must be able to identify matters that are or could lead to customer dissatisfaction, and experience shows that it is usually easier to find out what people dislike than it is to measure degrees of satisfaction.

Market Research must be related to business aims and should study consumers' needs, desires, attitudes and actions, so that reliable forecasts can be produced about the nature and degree of their reactions should they be faced with either a change in their resources or in the number of ways they can use them. For example, such resources can be affected by a Chancellor's Budget, by inflation, or a steady and general increase in real spending power. A change in the number of ways they can use their resources would be the introduction of a new commodity, such as cheap motor cars in the 1930s, television sets in the 50s or the Trimphone in the 60s.

We are therefore very concerned to forecast how people will be spending their resources in the future, and it is

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Press - TV
Friends
Business contacts
Parliamentary proceedings
Observation

Virtually every person in the country is exposed in one way or another to information about telephone services. A series of surveys is being held to find out how aware people are of the various services available and the charges for them.

important to recognise that customer resources do not always have to be described in pounds and pence. For example, an advertising agency would be concerned with the amount of time people spend watching television or reading, and with the number of choices (TV programmes and printed publications) available to viewers and readers. Market Research also embraces not only what is shown on the price-list, but the interface between customers and a company's operators, representatives and engineers, and with the effect on customers of a company's instructions, leaflets, printed letters, booklets, pamphlets, press and TV advertisements, as well as with customers' own evaluation of the quality of service received by them.

Market Research as presently exercised in the Telecommunications business could therefore be defined as an advisory service that reduces for management the number of "unknowns" in a business problem by systematically and quantitatively assessing existing and potential customers' reactions to present and proposed products, services, changes and procedures, and by foreseeing their future requirements.

How is Market Research done? The most important step is to identify the problem with which the manager is grappling and to agree with him what information he needs, when he needs it, how he intends to use it, and the financial and operational implications of his possible actions.

It is no use planning a sophisticated research that will take months to complete if the manager needs some information within weeks. On the other hand, it would be inadvisable to agree to a quickly conceived and low price survey when the results could influence a decision valued at millions of pounds.

The researcher will also have to do background and documentary research to bring his knowledge of the subject to a level suitable to enable him to understand fully his client's needs. He can then set about defining the population to be studied, drafting the questions to be answered, deciding how the results of field work are to be analysed and summarised, and consider the degrees of confidence that need to be built into different aspects of the survey. Only then is it sensible to work out how, when and where the population may be sampled to produce the required information at the right time, at a reasonable and acceptable cost, and with a degree of reliability that will enable the manager to use the information and any recommendations with reasonable confidence.

Each survey requires a separate and carefully thought out plan, the design of which rests on well established principles, particularly those related to the theory of probability. However, it should not be overlooked that for some problems a Critical Analyses of data and a few exploratory discussions can produce very meaningful information and serve the purpose as well as interviewing or studying fairly general statistically representative samples.

Another important aspect is that, having planned a survey, the execution of it must be tightly controlled and supervised. Invariably, the most expensive element is the field work—contacting the sample members and getting questionnaires completed. It would be a very false economy to select a cheap method if by doing so the questionnaires were not properly or truthfully completed.

Various methods are used to get information from people. Among these are the ballot booth; completion of questionnaires through the post or by telephone; by personal interview or by group discussion.

The Post Office has used the ballot booth method in special cases when we have asked questions of people visiting telephone sales bureaux. One of the weaknesses of this method is that there is usually a low response rate and the views of the silent majority are not recorded.

For relatively simple questions and answers postal methods are quite efficient and reasonably cheap, but do not permit the injection on-the-spot of supplementary questions aimed at probing the reasons why a particular answer is given.

Telephone interviews produce acceptable results but can also cause social disquiet because the authenticity of the person making the call cannot be easily verified. Old people living alone can become very frightened by telephone approaches, especially when they are asked questions about age, marital status, number of people in the household, etc. Telephone calls to business establishments can be quite effective, though the savings in travelling time are offset partially by call charges.

Personal interviewing is acceptable provided the person conducting the interview is able to satisfy the interviewee that he is trustworthy and that the market research is not a cover-up for a selling campaign. It is in the personal interview situation that one is able, if necessary, to probe very deeply into attitudes and opinions, but such probing in depth is expensive.

Group discussions are fairly expensive, but provided that the group leader is well trained and the environment is conducive to the airing of opinions and mental free-wheeling, they can produce by cross-fertilisation of ideas much more information than any of the other techniques.

Some of these techniques can be illustrated by Market Research exercises conducted by the Post Office in recent years: one is a series of awareness surveys, which attempt to discover how much people know about available services, and in another people were asked what telephone information services they would like.

In the first of the awareness surveys, in which 4,200 adults were questioned by personal or telephone interviews throughout 10 Post Office regions, five per cent or less knew the charges for telephone extensions and only 28 per cent were reasonably close. The availability of Plug-in Telephones (Plan 4) was known to 65 per cent. On Information Services, Recipes and Road Conditions were less well-known than Weather and Time. Many other responses about a wide range of facilities, services and charges were recorded. The identification of areas of consumer ignorance enables selling and advertising activities to be pointed in the most productive direction.

The survey about Information Services, in addition to finding out what services people would like, was aimed at assessing reaction to some possible ideas already listed by Service Department. From the Post Office point of view, any new services should not create embarrassing peaks of traffic and should have a time limit of three minutes for the recorded information. Would customers' needs and desires fit this bill?

This was a concept survey—that is assessing likely demand and reaction to an idea. We had nothing to demonstrate, no illustrations, no tape recordings, nor any equipment. The purpose was to point the way for further study by Service Department. What was wanted at this early stage of evolution was a rough measure of public interest and more pointed research on particular services would follow later if required.

A total of 1,200 questionnaires was completed—500 by interviewers in Telephone Managers' Sales Bureaux in each of 10 Regions, and 700 by Sales Representatives visiting customers.

Considering the number of people interviewed there were not many spontaneous suggestions. Three, however, met fairly well the criteria set by business requirements and were recommended for further detailed study.

Some suggestions, like Local Entertainment (Teletourist), Motoring and Weather were already operating in other parts of the country. Clearly, customers without these services locally wanted them as well and this reinforced plans to expand their scope.

Having exhausted each respondent's own ideas we then started prompting from a Post Office list. This aroused much more interest and response and put Sports Results clearly at the top of the poll, followed by a Joke for the Day, Children's Bedtime Stories, Stock Market Prices and Shorthand Dictation practice.

These surveys and the many others that have been conducted have provided invaluable information for numerous Post Office departments.

Because it is involved in the testing of public opinion Market Research can never be an exact science, but the right balance of scientific method, common sense and intuition can produce extremely useful insights and comments.

With the huge growth in the Telecommunications business and with the introduction of new services and facilities, of which Viewphone is just one example, there is undoubtedly a continuing and perhaps greater role for Market Research in the Post Office. Up to the present time our activities in this field of business have been very largely centralised and concerned with national problems. A personal forecast is that Regions and Areas will recognise the value of Market Research in helping to solve local marketing problems and that with suitable guidance Market Research will, in due course, be as generally used as other specific aids to good management.

Recorded bedtime stories for children came near the top of the popularity poll in a survey in which people were asked which new information services they would welcome. The service has now been introduced in some areas.

Mr. H. W. Jose is a Principal Telecommunications Superintendent in the Marketing Department of Telecommunications Headquarters. Since 1956 he has been concerned with a number of different aspects of forecasting and marketing, and for the last three years has been responsible for market research and product management of certain new and modified services.

Mrs. Margaret Birch checks the arrival of postal questionnaires at Telecommunications Headquarters.

Satellite system for Europe?

A K Jefferis

COMMERCIAL satellite communications for long-distance international telephony and television have been with us now for over six years and are well established. In many parts of the world great interest is now being shown in national and regional communication satellites. For example, the USSR already has a national system, Canada will have one within less than two years and the USA is currently considering a number of proposals for a domestic system. In Europe studies of various practical applications for satellites are currently being made by the European Space Research Organisation (ESRO), and among them is a possible communication satellite to carry telephony and television in the period beyond 1980. The CEPT (European Conference of Post and Telecommunications Administrations) is collaborating in these studies at ESRO's request.

There is a lot of work still to be done before the administrations of Europe will be in a position to say whether a communication satellite system is the best way of meeting future needs, but it is perhaps worthwhile at this point in time to review the current state of the technical

studies and to give a picture of what a European satellite system might look like if a decision to proceed were taken.

The starting point in any study of this kind is the amount and type of traffic likely to be carried. Since the cost of a circuit carried by a satellite is independent of distance it is clearly preferable to use it mainly for the longer circuits and to continue with conventional means for the shorter circuits. Also, since alternative methods are available for practically all routes within Europe, it would be wise to split the traffic, even on the longer routes, between conventional and satellite means. Most administrations feel that no more than one third to one half of the traffic on any route should be routed through the satellite. The most recent traffic forecasts indicate that approximately 4,300 telephone circuits might be suitable for being carried by satellite in 1980, rising to about 14,000 in 1990.

In addition to providing for telephony, telegraphy and data, a European satellite would technically be well suited to television transmission. It has been estimated that two full-time television channels in the satellite, together with the associated sound and commentary channels, would meet the needs of the European network for the period in question.

The technical studies of a satellite system to carry this traffic have aimed at defining a system in which the overall cost is minimum and yet provides reliability, flexibility and scope for further expansion.

One of the technical factors which must be settled at the outset is the frequency band in which the system is to operate, since this affects almost every other aspect of the design. The current INTELSAT system shares frequency bands at four and six GHz with microwave radio-relay systems, and it is to avoid interference with the radio-relay network that earth stations like Goonhilly have to be located well away from the main traffic centres. It was realised at an early stage in the studies of a European system that the earth stations would need to be relatively close to the traffic centres since the length of some of the circuits to be carried was no greater than the distance from London to Goonhilly and back. So a decision was taken that any such system would use higher frequency bands not yet in widespread use for radio-relay. It is hoped that suitable frequency bands will be allocated for satellite use at an ITU conference this summer. These bands are likely to be in the region of 12 and 13 GHz, but bandwidths of probably no more than 500 MHz for the up-path and another 500 MHz for the down-path can be expected. One of the major drawbacks to using higher frequency bands is that the signals from the satellite are much more seriously attenuated by heavy rainfall so that extra transmitter power in the satellite is needed to overcome the effect.

The satellite itself would be in a geo-stationary orbit so that it remains in a fixed position above the equator, probably at 5° East! It would most likely be of the three-axis stabilized type in which the body of the spacecraft is maintained always with the same attitude relative to the earth and is stabilized by means of gyros or a flywheel. This is unlike the current INTELSAT IV, a spinning satellite, in which the platform carrying equipment and aerial is despun by means of a motor to keep the aerial directed towards the earth. Three-axis stabilization avoids the need for exposed mechanical bearings, the reliability of which is difficult to predict. It also allows the solar cells which provide the electrical power for the satellite, to be mounted on extending "paddles" rotating slowly and continuously facing the sun. This increases the efficiency of illumination by a factor of three compared with the body-mounted cells of a cylindrical spinning satellite.

The aerials of the satellite, which could be mounted directly on the stabilized body, would probably be arranged to focus on coverage areas something like those shown in the sketch (on the left). An elliptical continental coverage beam would include all the CEPT countries as well as the countries likely to require connexion to the Eurovision network. It may also be possible to extend service to some of the Atlantic islands. A circular spot beam would cover an area within which about 80 per cent of the telephony traffic falls. The narrower beamwidth of this aerial would result in higher gain and so save satellite power.

The communications repeaters in the satellite would need to radiate about 15 watts of power. Some would probably have a bandwidth of over 100 MHz and be connected to a spot beam aerial, while others would have a bandwidth around 36 MHz and be connected to the continental beam aerial. The total power needed by this satellite would approach one kilowatt and its mass would be about 1500 lb. It could be launched by either the American Atlas Centaur or by the proposed ELDO Europa III launcher. The satellite would probably be completely designed and assembled within Europe.

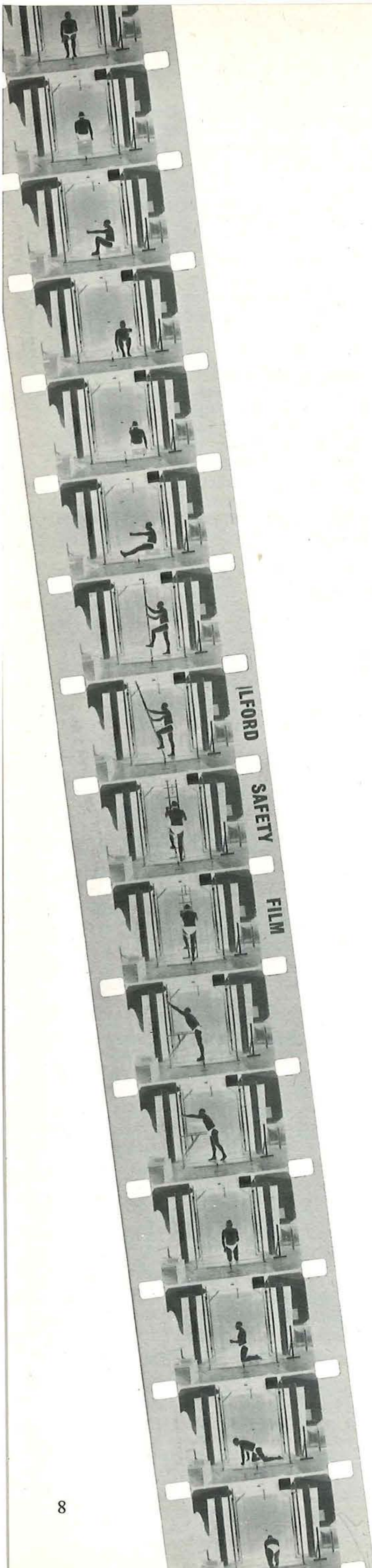
Some 31 possible earth-station locations are shown in the sketch. Of these about 20 would be equipped for telephony and television, two or three more for telephony only and the rest for television only. A typical earth station would have a steerable paraboloid aerial of about 45-feet diameter (compared with the 85 to 95 feet of the Goonhilly aerials) and the low-noise receiver would probably operate at room temperature, again unlike those at Goonhilly which are helium-cooled to approximately 20° absolute (—253°C).

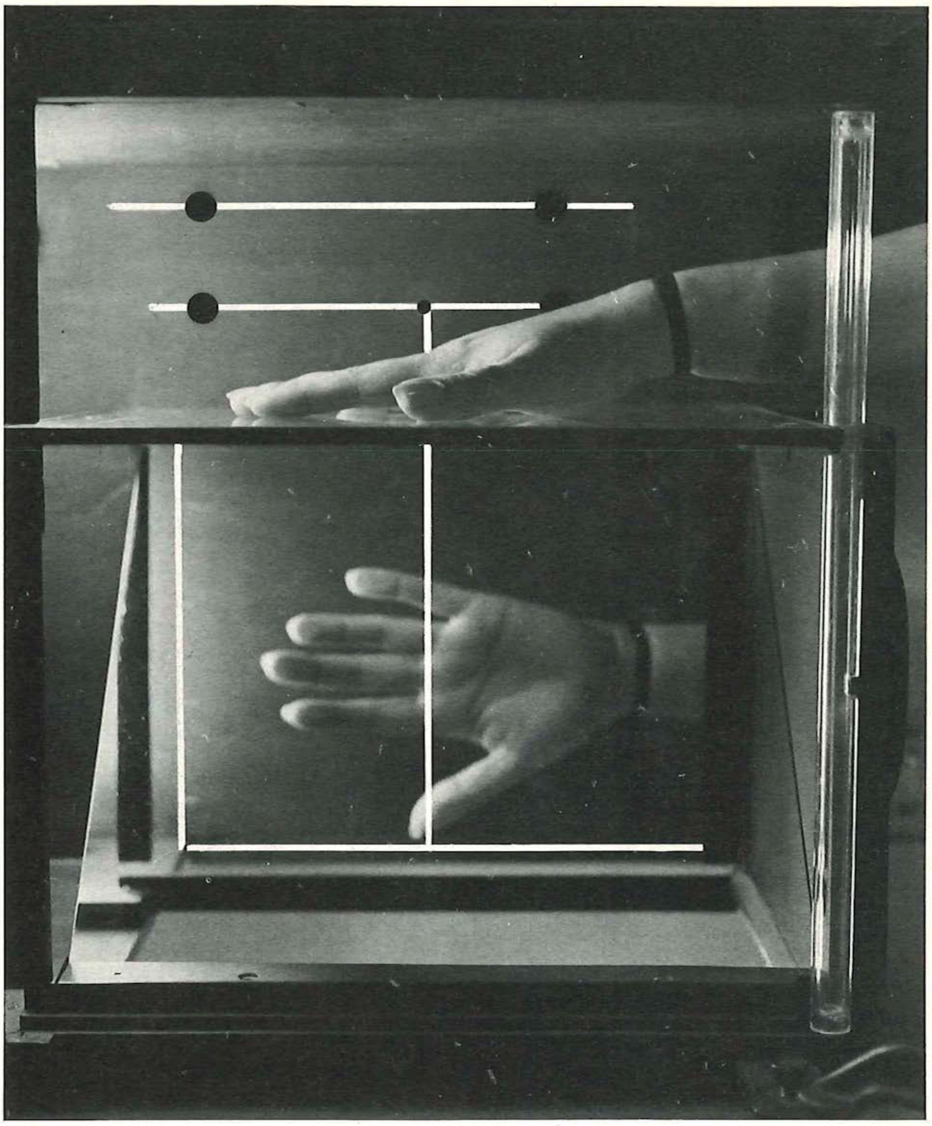
There are some other important ways in which the system would differ from present systems. For example, the method currently used to enable many stations to gain access to the same satellite repeater is for each to transmit on a different frequency—a technique known as frequency division multiple access. For the European system however it is likely that pulse code modulation (PCM) signals would be transmitted and that time division multiple access (TDMA) would be used. In TDMA each station transmits its signals in short repeated bursts, each burst lasting for less than a thousandth of a second, and synchronised in such a way that the bursts from different stations arrive at the satellite in sequence. Because this method is more efficient in the use of power and bandwidth than the present methods it is quite likely that it will also be adopted by INTELSAT in the future.

The satellite capacity likely to be achieved with PCM-TDMA would be of the order of 5,000 telephone circuits and two television channels. Various means for increasing this capacity are being investigated and the two most promising are frequency re-use and speech interpolation. In frequency re-use two signals can be transmitted on the same frequency but with different polarisations to avoid mutual interference. Speech interpolation is the principle already applied to submarine cables in the TASI (time assignment speech interpolation) system and increases circuit efficiency by taking advantage of the high proportion of time that each channel is idle in a normal telephone conversation. In an all-digital system speech interpolation is much easier to apply than in an analogue system. If both these techniques were successfully applied the capacity would be increased to about 18,000 circuits.

It is impossible in this small space to give full justice to all the work being done in these studies. However the picture presented gives some indication of what a European satellite system for the period from 1980 could be like. There are still studies to be completed—not the least of which are the economic ones—before decisions can be taken. In the meantime the Post Office plays a full part in the CEPT work by sending its experts to the appropriate working groups. In fact Mr. A. G. Reed of Telecommunications Development Department's Space Systems Division is a member of the CEPT "Permanent Nucleus" which has worked in Paris on these studies almost continuously since last September.

Mr. A. K. Jefferis is Assistant Staff Engineer in the Space Communications Systems Branch of Telecommunications Development Department. He is concerned with studies for the European project and the INTELSAT system.





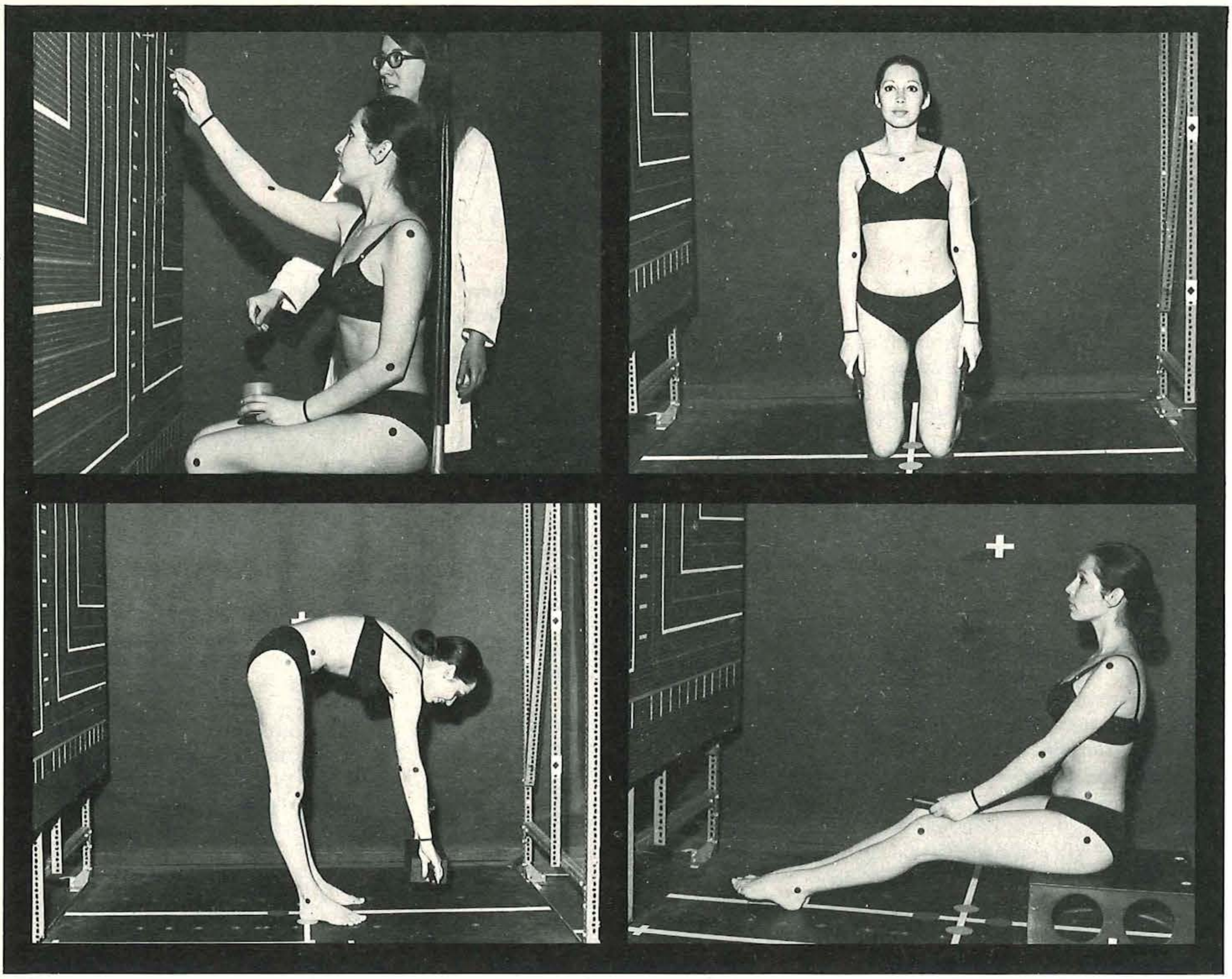
HUMAN ENGINEERING

HOW far is the hip bone from the knee bone, the knee bone from the ankle bone, the elbow from the shoulder, the shoulder from the fingertips? All very unfamiliar questions in the telecommunications business. But the answers to such questions will provide vital information for the designers of equipment and furniture.

The Medical Research Council is now carrying out a survey for the Post Office which will produce a range of body measurements for the average Miss and Mr Telephonist. The survey uses a new photogrammetric technique which enables measurements to be taken from photographs of volunteers. This information will be used in the future by designers of switchboards, telephonists' chairs and other equipment.

There has never been sufficient knowledge of the measurements of people who carry out a particular job and industrial designers have had no definite figures on which to base their equipment dimensions. The result has been the production of equipment which, although very comfortable for some people to work at, has been awkward for others. Data produced from the anthropometric (human measurement) survey of telephonists will enable switchroom equipment and furniture to be designed to give the maximum comfort to the maximum number of people.

A good example is a telephonist's chair. From the range of measurements of all parts of the body, figures can be produced which will enable a designer to produce a chair with ample width, seat depth and adjustment for leg comfort for the majority of telephonists. In the same way the



ABOVE: These pictures show some of the different postures in which volunteers are photographed. The black spots on the arms and legs indicate the joints, and they show up clearly in the photographic negatives from which the precise body measurements are taken. (Strips of negatives like those shown on these pages are used.) The circles and lines on the floor and the cross on the backcloth are used to position volunteers. All the photographs for this article were specially posed.

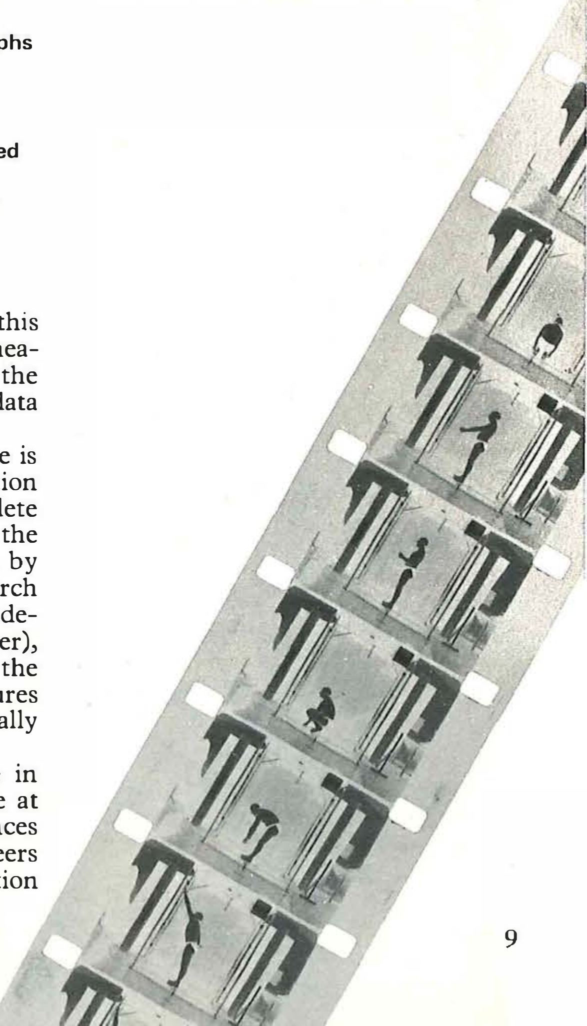
LEFT: Equipment with precisely angled mirrors is used to obtain exact measurements of the hand. The black spots and white lines are again an aid to measurement.

distance between the arm joints and the length of the arm determines how far a telephonist can stretch sideways or upwards, and will indicate to the designer the ideal height and width for a switchboard.

Measurements are taken of volunteer men and women telephonists. The photogrammetric technique has been developed by the Human Biomechanics Research Laboratory, part of the Medical Research Council, and was recently used successfully in a survey of power station workers employed by the Central Electricity Generating Board. For the volunteer the exercise is simple—it involves being photographed in a number of postures used in various types of work. Because a high standard of accuracy is required, special clothing similar to swimming costumes has to be worn. Since the photographs are produced only in negative form, this type of clothing allows precise measurements to be taken from the silhouettes of the volunteer. The data is then processed by computer.

Before tests are carried out there is full consultation with staff association representatives. There is complete privacy for each volunteer during the photographic sessions, conducted by two members of the Medical Research Council's staff (male or female depending on the sex of the volunteer), and only Council personnel see the photographic negatives. The pictures illustrating this article were specially posed.

Tests have already been made in London and others will take place at five or six centres in the provinces where there are sufficient volunteers and where suitable accommodation is available.



The Post Office is studying a wider use of digital transmission

THE HIGH-SPEED CODE

W G Simpson

For some time the Post Office has been using a method of digital telephone transmission, known as pulse code modulation (PCM), on local circuits between telephone exchanges no more than 25 miles apart. Digital transmission makes intensive use of existing channels, and the Post Office is now studying ways in which this and other advantages can be applied to the longer-distance trunk routes which link our major cities.
How does digital transmission differ from the analogue system which has been used for telephone signal transmission since the service began? In the analogue system an electrical "copy" of human speech is transmitted as a *continuous* electrical wave. With a digital system the signal is converted into a stream of *separate* electrical on-off pulses and speech is transmitted in the form of a digital "code" which can be sent at high speed.
The coding is done by very rapid and continuous sampling of the signal; each sample is assigned an appropriate code from a pre-determined group of 128 codes which cover the entire range of speech values. The code is then transmitted to line in the form of a binary number.
The sampling and encoding process is repeated 8,000 times every second (i.e. at intervals of 125 microseconds). However, only a little over 5 microseconds is needed to transmit each piece of coded information which represents 125 microseconds of speech.
For instance, the coded version of a telephone conversation lasting two minutes would occupy the line for only five seconds, leaving time for 23 further conversations to be inserted.
At the receiving end the stream of digital information is decoded and a very close facsimile of the original speech directed into the appropriate channel.
Other types of signal—vision for TV or Viewphone, data and telex—can all be handled in the same way—although much greater transmission speeds are required—and any mix of these signals can be transmitted at the same time.
The problems which arise through operating at much higher speeds; the need to accommodate a variety of different services; the methods which could be used to overcome these problems and the undoubted advantages which would result from the introduction of digital transmission on the country's major trunk routes are discussed by the author in the following article, the first of two.

THE success of 24-circuit PCM junction systems in the Post Office network and of similar systems in other countries has led engineers to consider how the advantages of PCM techniques could be exploited more widely in the telecommunications network.

What reasons are there for using digital transmission systems in an all-purpose network? Flexibility is one attractive feature. The present analogue frequency division multiplex (fdm) multichannel systems are optimised for speech transmission and when signals such as data, facsimile, music programmes, television are also carried, these tend to interfere with each other. The time-sharing of the medium inherent in digital transmission avoids such mutual interference and makes it

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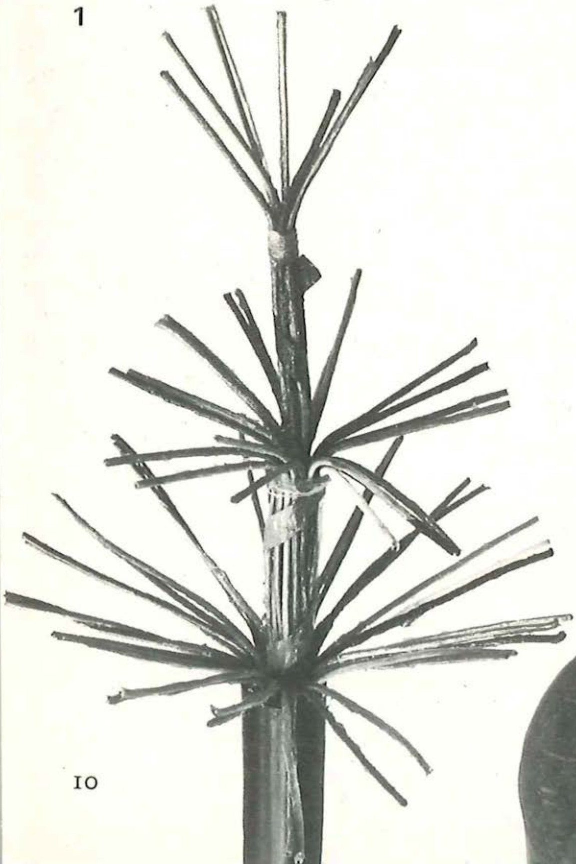

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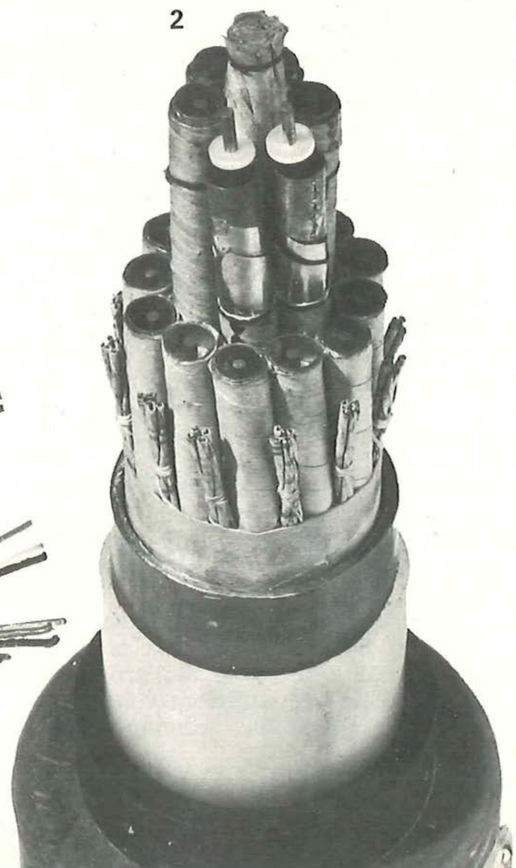

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What digital speeds are envisaged for different types of transmission media and what capacity could they provide? The speeds are given in Mbit/s—a million binary digits transmitted per second.
1 *Pair type cable*—Only modest transmission speeds of from 1.5 to 2.048 Mbit/s are possible and would allow from 24 to 30 telephone channels for every two pairs of wires.
2 *Coaxial cable*—The types of cable used for existing systems could be used for high-speed digital transmission—120 Mbit/s on the 0.174 inch tube cable (about 1,600 telephone circuits on each pair of tubes), and at least 500 Mbit/s on the large 0.375 inch tube (some 6,000 telephone circuits on each pair of tubes).
3 *Microwave*—A system is being developed to carry four 6.336 Mbit/s channels (90 circuits per channel). Speeds up to 120 Mbit/s and higher per channel are envisaged for the future.

possible to have complete freedom to use any mix of different types of signal on one transmission path.

Performance is largely independent of distance or the number of switching stages traversed and is mainly determined by the design of the encoding/decoding equipment. The greater economy of digital transmission, made possible by its more intensive use of existing channels, will become an increasingly attractive feature as the demands for data circuits increase in the future.

Perhaps the most far-reaching reason is that the use of such systems will prepare the way for future savings by switching signals in digital form.

What types of transmission media do we have to consider? Pair or quad type cable will only allow modest transmission speeds because of the limitations of the crosstalk performance of the cable and the impulsive noise induced from circuits in the same cable carrying other types of signal. Although special pair-type cables can operate at higher speeds than the normal junction cables used for the present 24-circuit system, the inherent limitations due to crosstalk make them unlikely to be laid, especially for high-capacity digital systems.

Coaxial cables, on the other hand, are not limited in speed of operation by crosstalk considerations, although there are other limitations arising from the quality of construction of the coaxial tube itself. Small variations in the dimension of the tube, particularly when repeated at regular intervals along its length, give rise to distortion of the digital signals which cannot be easily compensated for in the regenerators. A further factor is the inherent noise at the input to regenerators. In principle, this can be overcome by increasing the amplitude of the transmitted signal but this in turn is limited by the amount of power which can be made available to operate the intermediate regenerators. Present indications are that the cable types at present used for fdm systems could be used for high-speed systems—about 120 Mbit/s on the small 0.174 inch tube cable and at least 500 Mbit/s on the large 0.375 inch tubes.

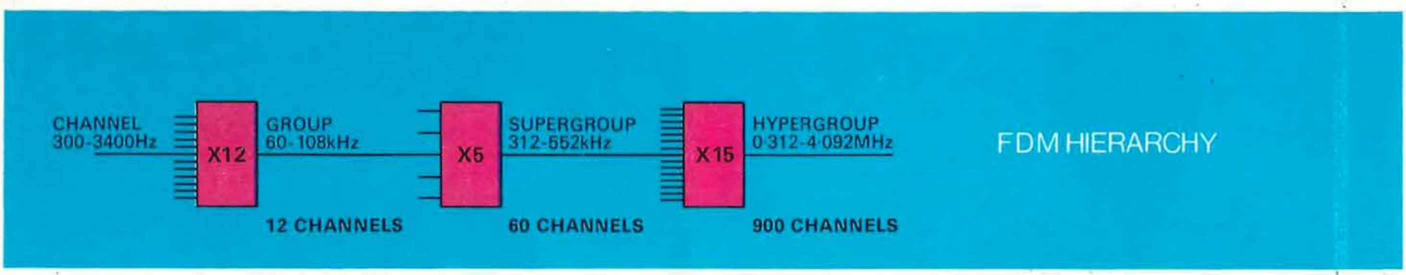
Terrestrial microwave radio relay systems may be used for digital transmission. A system is now being developed to carry a number of 6.336 Mbit/s channels (90 circuits per channel) in an, at present, unused portion of the lower-6GHz frequency allocation. This system is intended to be associated with existing analogue systems and to use existing aerials and feeders. Speeds up to about 120 Mbit/s on each carrier are envisaged for systems now being considered in higher-frequency radio bands which are not yet exploited; higher speeds are possible and may be used on systems for service. Limitations here are the radio frequency bandwidth available, the fading effects at the carrier frequencies used, and the interference from one system into another. The greater immunity of digital signals from interference could perhaps result in a more intensive use of the available spectrum by permitting smaller angles between the paths used at a relay station.

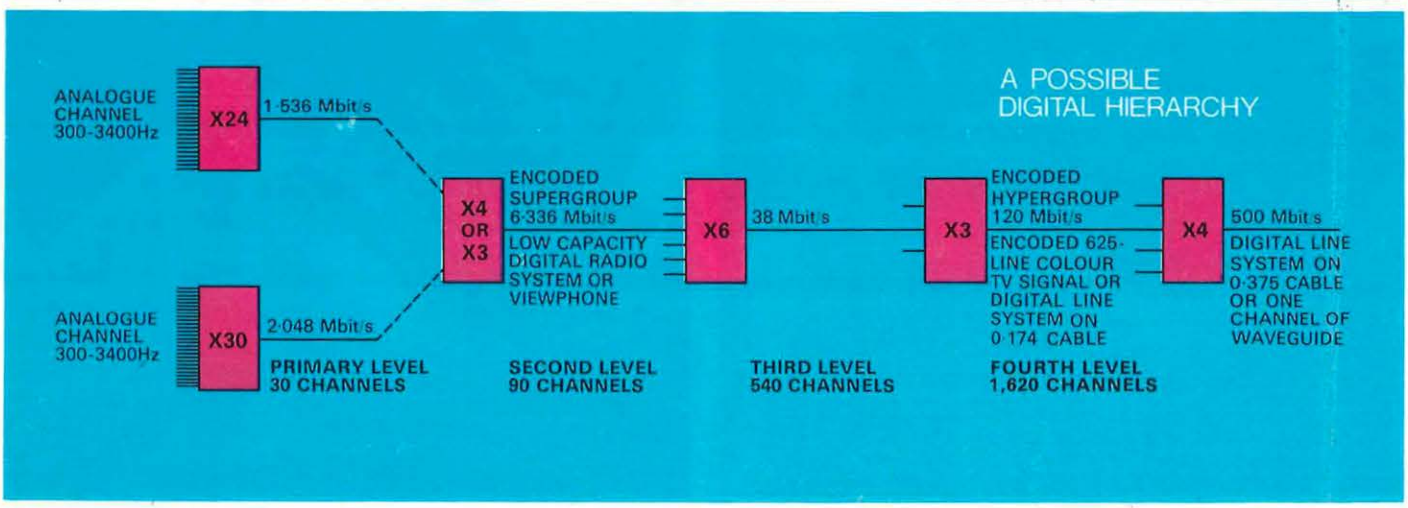
In the case of microwave radio transmission via satellites, digital operation gives about the same channel capacity as an analogue method but with the advantage that smaller angular displacements can be used to allow more satellites to be operated. Digital satellites are particularly suitable for efficient multiple-access systems where a number of earth stations can intercommunicate using a single satellite on a time-division basis. Transmission speeds of 50-100 Mbit/s are proposed.

In the future very large capacity systems may be provided by circular waveguides. A single guide would transmit many broadband channels operating at speeds of between 500 and 2,000 Mbit/s. Perhaps further in the future, systems using guided light waves in glass fibres may be used at speeds of 120 Mbit/s or higher on each fibre. Present experiments visualise 100 fibres, each just one-tenth of a millimetre in diameter, in one cable.

Before transmission over any of the different types of media available, however, it is essential that the assembly of the high-capacity digital signals is done in a way which will facilitate interconnexions between them. The arrangement used must also recognise the need to accommodate a variety of different services. This is achieved by multiplexing equipment which accepts input signals from different services and outputs them as one signal. The assembly principle is hierarchical; outputs at each multiplexing stage are at the same speed as the input of the next higher stage in the hierarchy. (See diagram.)

Occasionally a departure from this principle may be needed, for example to assemble signals for a transmission link not operating at a standardised speed in the hierarchy or to multiplex a service which cannot conveniently operate at a standardised speed. As a general rule





the hierarchical principle will be used as it affords much greater flexibility in the interconnexions between different transmission links. The principle, in fact, is analogous to the assembly via group, supergroup and hypergroup stages used in the present frequency division multiplex systems. As in the fdm network in which flexibility points are established at the group, supergroup and hypergroup levels and paths can be provided between these points to carry any signals which can be accommodated within the appropriate bandwidth; so in the digital network paths between flexibility points will be available for interconnecting signals at the various speeds in its digital hierarchy.

While methods are available to permit any digital signal to be accepted irrespective of its rate, provided it is below or equal to the standard speed, efficiency demands that the speeds most widely used should be used as levels in the hierarchy. The levels should therefore be chosen paying attention to the types of input signal and in particular to the speeds of those signals. The table shows possible speeds for various likely input signals. Data sources have not been included as most data terminals are likely to operate at speeds well below the first level of the hierarchy: it can be expected that higher speed data sources or multiplexed streams of lower speed data signals would naturally follow the speeds of an established hierarchy provided that no large ratios are used between successive levels.

The table (right) shows the digit rates which will result from encoding fdm groups into digital signals. These blocks will be important during the early stages of introducing high-capacity digital systems into the network as a means of interworking with the present fdm network and corresponding means of carrying high-speed digital signals over existing fdm analogue plant will also be needed. However, the hierarchy levels chosen now will become fixed parameters of the digital network and must be optimised for the future, whilst not ignoring the transitional problem of interworking with the fdm network.

The most significant speeds in the future Post Office digital network can be expected to be those of the primary multiplex, the lowest level of the hierarchy (this will include data sources multiplexed into the primary multipled rate), Viewphone and colour TV.

The international aspects must not be forgotten either when choosing the hierarchy levels. We can expect to have digital links by satellite to other countries and by microwave relay to Europe. As far as possible we should choose levels which will also appear in the digital hierarchy used in other countries so that digital paths could be established to and through their networks.

● *In a future issue of the Journal the author will discuss studies which are now taking place on the various aspects of the digital hierarchy and will look at the methods of multiplexing that could be used.*

Mr. W. G. Simpson has been involved for some time in the development of digital transmission systems. He was recently promoted to Staff Engineer and is now Head of the Line and Radio Systems Planning Branch of Network Planning Department.

DIGITAL RATES FOR VARIOUS SERVICES

Service	Digital Rate (Mbit/s)
Primary multiplex—P.O. 24 circuit	*1.536*
Primary multiplex—CEPT 30 circuit	*2.048*
Visual Telephone—USA Picturephone	*6.312*
525-line Colour TV —USA—NTSC	*92*
625-line Colour TV —UK and Europe—PAL	*119*
Encoded fdm blocks	
12 circuit group	*1.344*
60 circuit supergroup	*6.336*
300 circuit mastergroup	*30*
600 circuit USA mastergroup	*46*
900 circuit UK hypergroup	*80*
900 circuit supermastergroup	*80*

4 ***Waveguide*****—A 16-channel broadband system operating at 500 Mbit/s would provide a capacity of 100,000 telephone circuits.**

5 ***Guided light waves*****—A cable of 100 glass fibres, each fibre just one tenth of a millimetre in diameter, could give a capacity of 80,000 telephone circuits. Speeds of 120 Mbit/s or higher on each fibre would be possible.**

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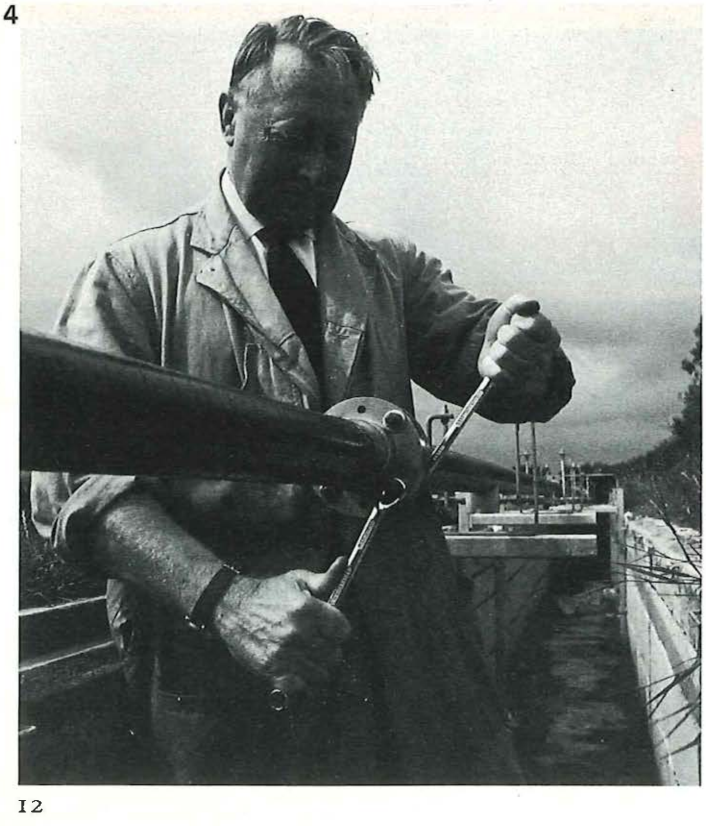

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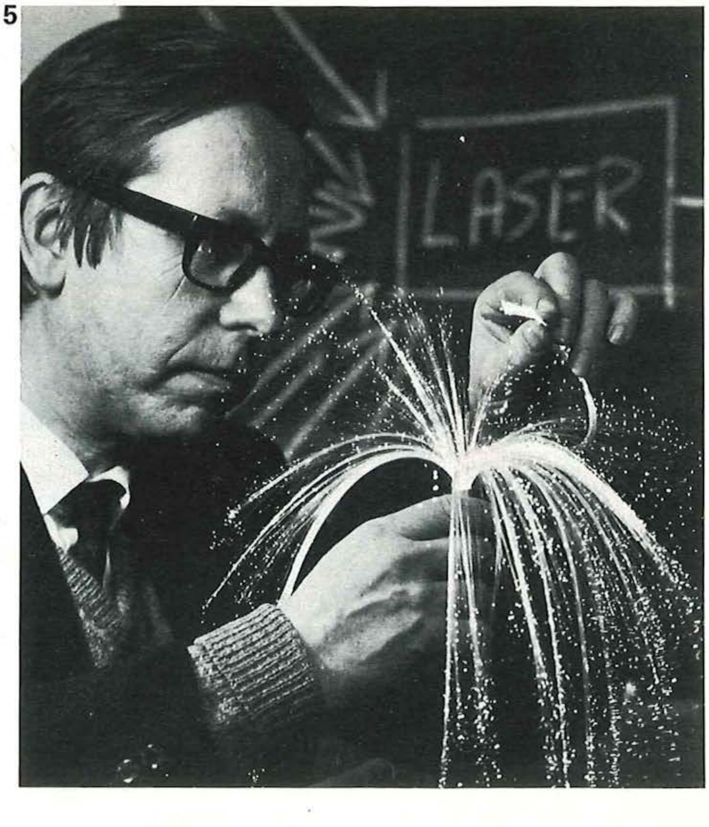


Left: Laying ducts in the 36 in-diameter pipe, made of thick concrete, which is thrust through the soil in sections.

Above: The completed ducts in the concrete pipe.

IT IS one of the ironies of planning economics in the telecommunications business that the best location for a relief exchange is usually near to the existing building which almost always is in a congested town centre. Under the busy pavements and highways is a maze of cables and pipes for the provision of other public services. For Post Office engineers the laying of underground duct in such circumstances can be fraught with problems. At Guildford in Surrey, however, some unusual answers were produced when a 54-way duct route was laid from a relief exchange in the town centre to an area west of the town.

Confronted with the usual town centre congestion and the need to take the duct route over one of two "bottleneck" bridges across the River Wey which bisects the town, a normal surface-ducting operation would have been extremely difficult. After a year of negotiations, involving no fewer than 10 different authorities and organisations, External Planning Division at Guildford TMO opted for the unconventional. They decided that the best way to overcome all the problems was to pass under them.

This has resulted in the creation of a duct route more than 400 yards long and up to 29 ft deep which passes under one of the busiest sections of the town centre, beneath the River Wey and through the deep piling for a new comprehensive development of shops and offices.

The methods adopted have ranged from practices first used centuries ago by the Egyptians, to the present-day technique of pipe-jacking which employs a hydraulic ram to thrust pipes through the earth.

The depth of the new route was determined by the depth of the Wey and the safe working distance under its bed. To pass 10 ft under the river bed necessitated a working depth of 24 ft. As it was not practicable to pass under the 30 ft-deep piles for the new development area near the river bank, the architect eventually agreed to re-design their layout to leave an avenue 10 ft. wide between which the ducts could pass. In return, the Post Office agreed that over this section the ducts would be laid in a 36-in internal diameter pipe installed by the pipe-jacking technique. This eliminates any chance of subsidence as only the soil cut as the pipe is thrust forward is removed.

The first section of the route extends from a manhole near the top of the town's busy North Street to a two-tier manhole 280 yards away. This section is laid in conventional timbered tunnelling 4 ft high by 3 ft wide, followed by the pipe-jack section under the comprehensive development and the river, then by another 52 yards of conventional tunnel on the west side of the Wey to the final manhole.

The manhole at the top of North Street was excavated to the required depth and used as the main shaft to drive the tunnel down the hill. Airshafts were sunk at approximately 50-yard intervals. The miners worked in pairs, one at the face and the other operating a "skip" to remove the soil.

Frequent checks were made on the line being taken by the tunnel using the ancient Egyptian technique of checking lines against a light source. Two plumblines were set up on the surface and placed one behind the other in the exact line of the tunnel. These were then extended down the shaft and a lamp aligned with them and hung from the tunnel roofing timbers. So long as the plumblines remain one behind the other and bisect the source of light, the position of the light relative to the walls will indicate the line of the tunnel.

While the conventional tunnelling work proceeded, the pipe-jacking was also started. A pit 22 ft by 12 ft and 29 ft deep was dug on a vacant site between the Wey and the re-development scheme and the hydraulic ram, capable of delivering a thrust of up to 200 tons, was set up. The pipes, made of reinforced concrete 5 in thick, are just over 8 ft long. They were thrust in 4 ft at a time and then the miners, again working in pairs, removed the soil before the next thrust. Although soil conditions limited the thrust to a length of 200 ft this was sufficient to get the pipes clear of the development area and the section was then completed by normal tunnelling. After this the thrust equipment was turned

WHF Rushton

TUNNELLING UNDER A TOWN CENTRE

round to face the river and the pipe-jacking continued under the bed.

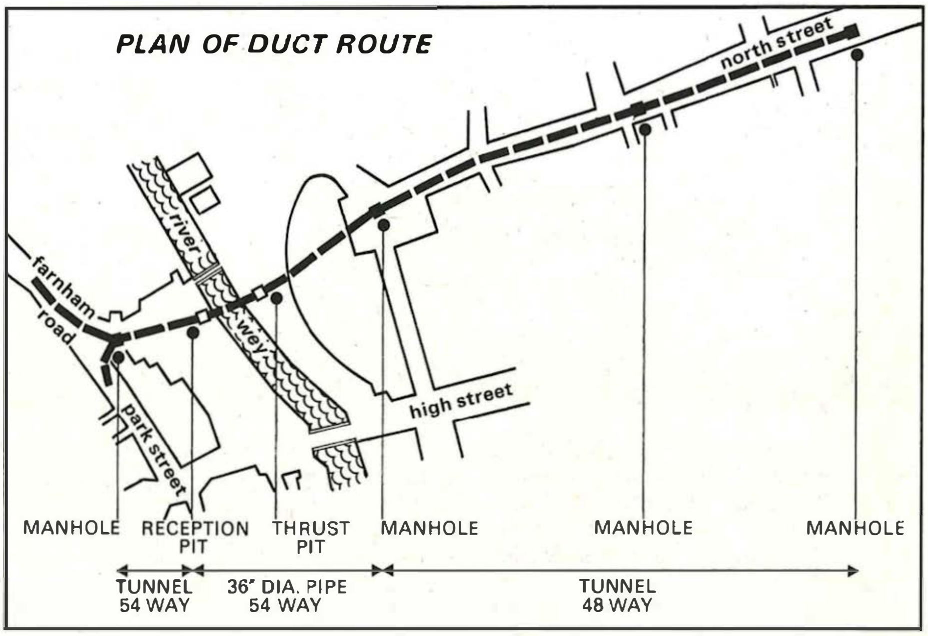
In the conventional tunnels, the ducts are laid in 5 ft lengths and are held in position by spacers. As each layer of ducts was laid all voids were filled with concrete. In the pipe-jacking section, as there was no possibility of subsidence, no spacers were used and no filling was placed between the ducts.

Almost half of the entire tunnelling operation was carried out in chalk which presented no problems, but for most of the way from the lower end of North Street the excavations were in dry running sand which posed the very special problem of how not to disturb the sand outside the excavation area. Again taking a lead from the ancient Egyptians, straw was packed tightly between any gaps in the timbers to prevent the sand from moving.

Although the presence of water was expected to prove troublesome none was encountered, and even when the River Wey rose to an alarming level after the rains of early November last year nothing worse was suffered than a few anxious hours.

The work was completed within five months. During this time the public were kept well informed of what was happening through notices and the local press. The success of this public relations exercise was underlined by the absence of any adverse comments and the generous co-operation that was obtained from all members of the public.

Mr. W. H. F. Rushton has been a Planning and Works Executive Engineer in the Guildford Area since 1969, after more than 30 years in London.



Office lay-out for DQ

There is a new look in directory enquiry bureaux where the introduction of modern office furniture is replacing the conventional wooden "Southampton-type" cordless positions. In place of the more formal lines of positions, at which DQ operators sit facing directories, desks and separate bookracks can be arranged in a normal office-type layout.

Directories are stored in a double-sided bookrack on one side of the desks and in bookcases in the body of the unit. This layout provides increased storage space, eliminating the need for operators to share directories, and makes for easier handling of the books.

All the directories are at the right-hand side of the operator, leaving the desk clear for the local directory and behind this an answering unit housing the position controls. Where the local directory is particularly bulky, as in London, it may be necessary to raise the answering unit slightly.

The facilities provided are similar to those of the present Southampton-type call-queueing positions. The new positions will normally be provided in units of two, connected on opposite sides of a central spine which supports the bookrack. With the spines connected, suites of up to eight positions can be formed.

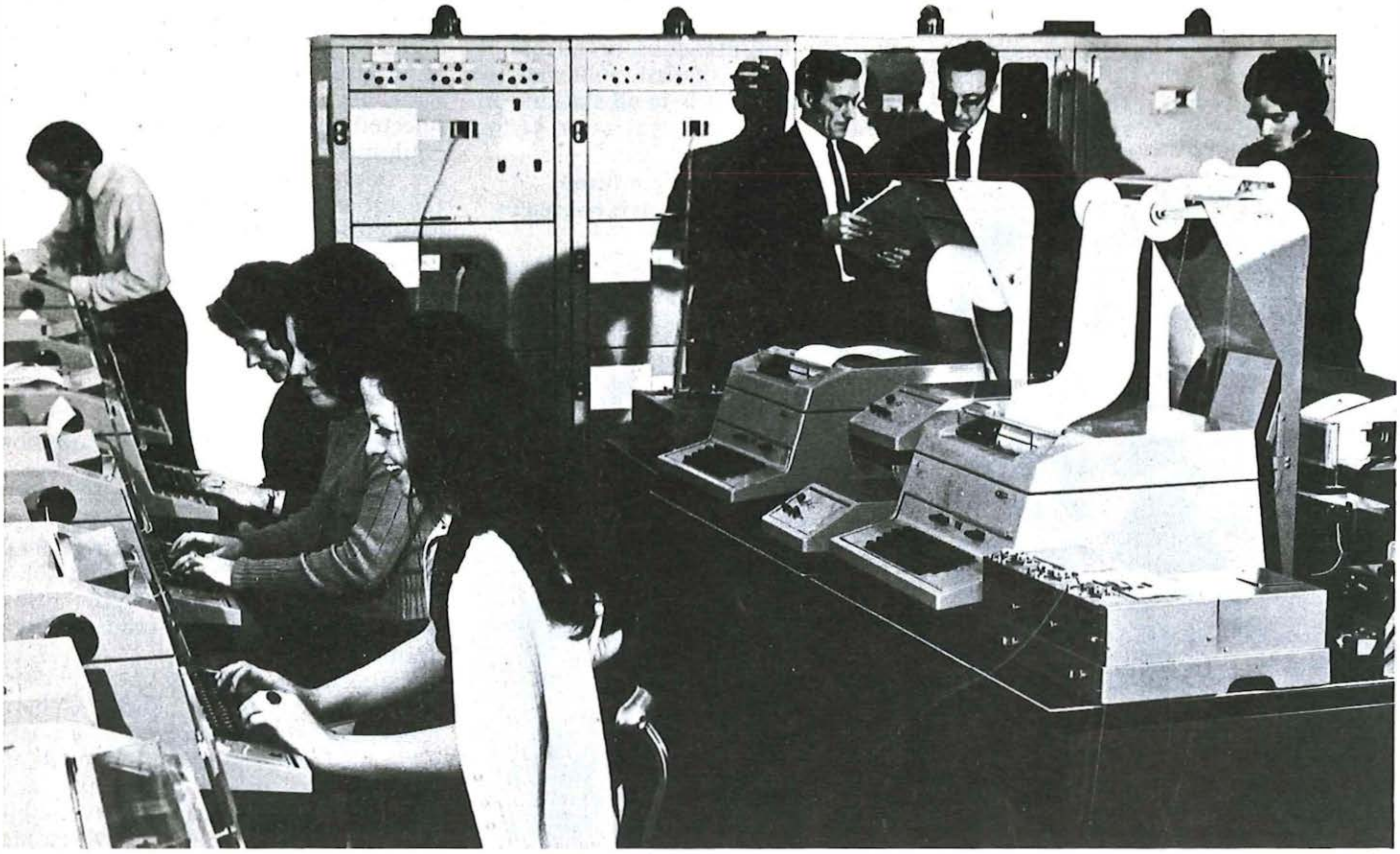
The desks and book units are of an attractive design, and are less costly than the wooden Southampton-type positions. The metalwork is finished in grey and the desk top is covered in blue PVC, edged with anodised aluminium. Assistant Supervisors will be seated at matching desks equipped with a telephone and key and lamp unit.

This equipment is being specified for all new contract orders and where possible will also be used for extensions to existing bureaux. The desk units have already been used for a number of locally designed expedient schemes which employ key and lamp units, connected directly to the "192" circuits, instead of the new answering unit.

The new office-style furniture at Heswall DQ Bureau in the Liverpool Telephone Area.

THE TELEPRINTER EXCHANGE

C Oakes and
C A R Turbin



The new telegraph exchange can provide a nationwide private network for a large firm. There would normally be a single local terminal, but auxiliary working allows up to five teleprinters at one office.

BUSINESS concerns make wide use of the telegraph and telex networks in this country. For some time now, however, there has been a need, certainly by the bigger users, for their own private telegraph networks which would link their teleprinter stations in offices, factories and warehouses anywhere in the country.

While private networks have been possible for some time, the equipment used, modified Equipment Telex No. 1, has limited both their size and performance. No more than 20 lines can be interconnected; operators often find themselves engaged on the time-consuming and tedious task of repeating a message which has to be transmitted to more than one station; and when it is not possible to establish a connexion the equipment can give no indication of the trouble.

These limitations have been overcome and additional facilities made available with the introduction of the Private Automatic Telegraph Exchange (PATX 1A). Designed specifically for 50-baud working, a PATX will serve up to 20 teleprinter stations and with each customer allowed a maximum of four it would be possible, by placing units strategically around the country, say in London, Birmingham, Manchester and Glasgow, for even the largest company to have its own nationwide private network. These networks and their teleprinter stations will operate to the same standards as the UK telex network and telex stations.

A major advantage of the new equipment will be the optional provision of a broadcast unit which will enable a teleprinter station to transmit simultaneously to up to 20 other stations—to all the stations on its own PATX, or to stations on another PATX within its own network which is fitted with a broadcast unit, or to any of up to four pre-arranged groups which can include any number of stations up to 20.

Station lines which have consecutive numbers can be combined into auxiliary groups in much the same way as telephone lines. When a number is dialled and is engaged the call is automatically offered to subsequent lines in the group. As

A typical PATX network. Connexions between stations on different PATXs are set up by prefixing the station code by the appropriate routing codes which are limited to the digits 2, 3 and 4 in the dialling range. For example from a station on A to one on C station A dials 4XX.

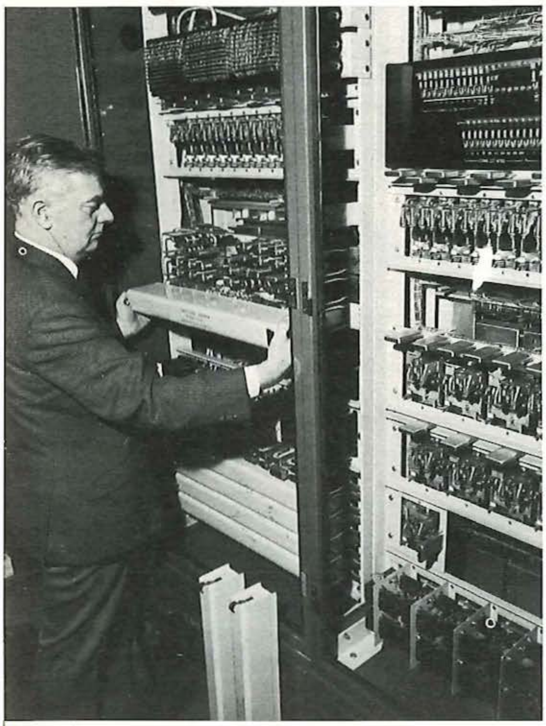
with Telex operation, each station will have its own Answer-Back code which should be automatically returned to a calling station within three seconds of a connexion being established. If this is not achieved an operator can use the "Who Are You?" key to obtain the distant station's Answer-Back.

Operators who cannot establish a connexion will not be left in ignorance as to the cause. Printed service signals will provide an indication of what is happening. The letters OCC (occupied) will be printed when stations, trunks or connecting circuits are busy; when wrong digits or codes are dialled or when a trunk circuit is faulty. When a spare station number or a station in the absent condition, for example where the power has been switched off, is dialled it is indicated by the letters ABS (absent). Whenever a printed service signal is returned the connexion is automatically released.

Operational methods are fairly simple. For calls to a station on the same PATX, only the two-digit number of the called station is dialled. For trunk calls, the station number is preceded by the digit or digits necessary to select the trunk route or routes.

For the simultaneous broadcast of a message 01 is dialled, followed by 55 if the broadcast is to all stations on the same PATX; 51, 52, 53 or 54 for pre-arranged groups; or just the codes of the individual stations required. The connexion is completed by dialling the digit 0. The "Who Are You?" signal is then transmitted and the selected stations which are not engaged return their Answer-Back codes in ascending numerical order. Stations engaged, faulty, in the absent condition or working in local, will be indicated by the receipt of the OCC signal and these stations will not receive the broadcast message.

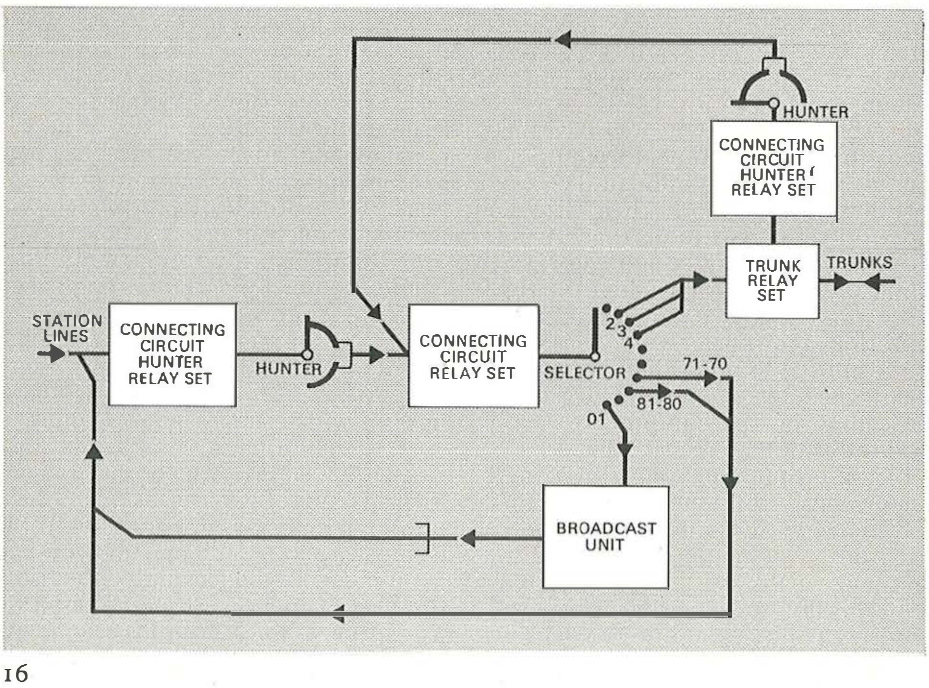
For broadcasts to stations on a distant PATX the trunk routing digits to it must be dialled before 01 otherwise dialling procedure is the same. At the end of a broadcast the selected stations and the broadcast equipment are restored to normal by the operation of a "clear" button at the initiating station only. On ordinary calls either station can clear down.



Left: Protective covers are fitted over the equipment which is housed in two cabinets.

Above: Testing the relays on one of the first PATXs off the production line at Standard Telephones & Cables factory at New Southgate.

Below: This shows the stages involved in setting up a call between stations on the same PATX, between stations on different PATXs, or a broadcast call.



The PATX equipment is enclosed in two lockable metal cabinets to ease transport and handling. When assembled, side by side, the cabinets are just under 7 ft high, 5 ft 8 in wide, 2 ft deep and weigh nearly 13 cwt when fully equipped. While a PATX can serve up to 20 teleprinter stations connected by physical or voice frequency links, it is installed with only as many circuits as are necessary to meet a customer's requirements. Each teleprinter station consists of a Teleprinter No. 15 and a Unit Telex No 6 or No. 10, all standard telex items.

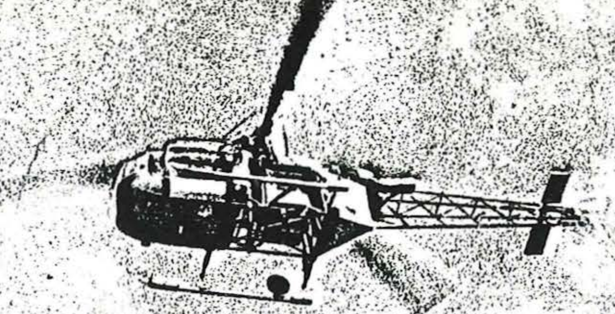
The circuit elements were chosen from those used on Telex where reliability had been proved in service. This has reduced the time spent on development and will eliminate any need for special training of maintenance staff. Uniselectors, which are simple to adjust, were chosen as the switching devices and the circuitry is arranged so that if any of the common equipment, other than the power packs, develops a fault the unit will continue to function with reduced facilities.

The PATX will fulfil a very real telegraph need. Certainly, there has been a great deal of customer interest which has not been deterred by equipment limitations resulting from a need to balance facilities and circuit simplification so as to reduce size and cost.

The first batch of PATXs from the manufacturers is now being delivered and to keep up with demand a further order is to be placed soon.

Miss C. Oakes is a Telecommunications Traffic Superintendent in the Datel, Telex and Telegraph Network Branch of Network Planning Department. Working in the Customer Apparatus Planning section she has been involved in co-ordinating the introduction of the PATX.

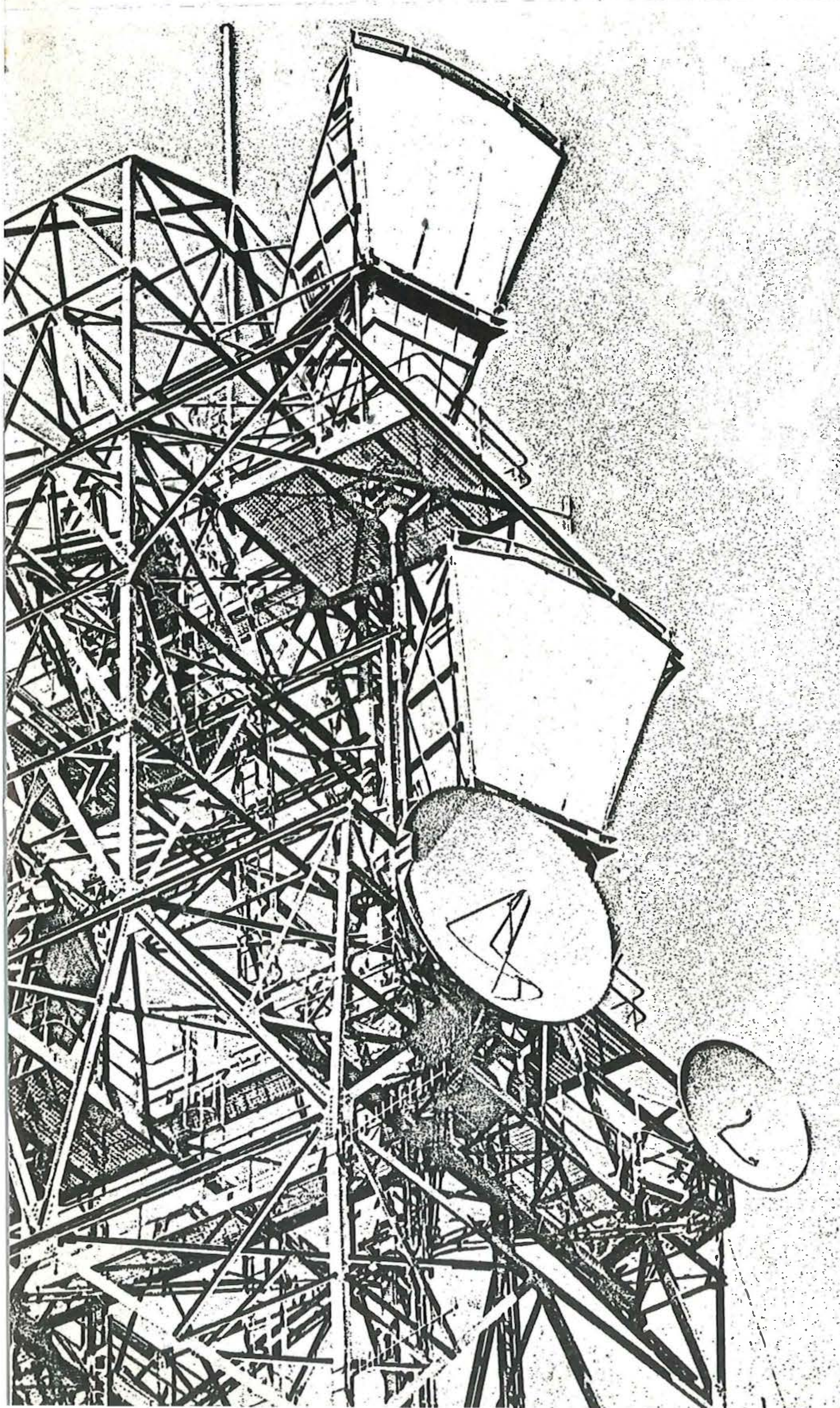
Mr. C. A. R. Turbin is an Assistant Executive Engineer in the Telegraphs and Data Switching Branch of Telecommunications Development Department and worked on the circuit development of the PATX.



A helicopter is being used by the Post Office as a transmitter station in the sky to find out how tall buildings affect microwave radio signals.

E S Doe and H S Buist

HAZARD OF THE 'SKYSCRAPER' AGE



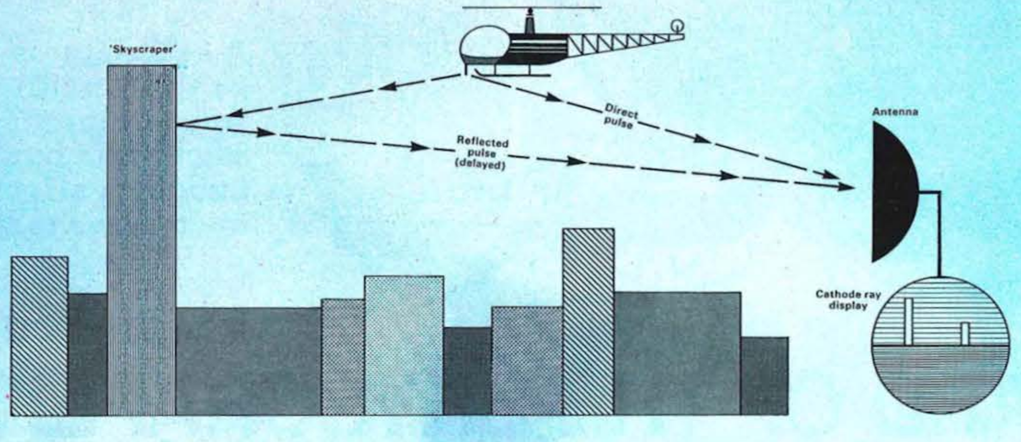
THE tall buildings which are being put up in this country in such increasing numbers and to ever-greater heights are a potential hazard to the satisfactory operation of the microwave radio-relay systems which form part of the Post Office trunk network. To determine how seriously reflections from tall buildings might degrade microwave radio signals a joint investigation is being carried out by the Post Office and the Radio and Space Research Station of the Science Research Council.

Radio stations are strategically sited on high ground and with aerials mounted on towers tall enough to give a direct, line-of-sight propagation path between stations. They are planned so that no obstacles intercept the path of the signals, or are within a certain distance of it.

Any tall building actually intercepting a radio path could cause serious degradation because it would partially block the signal; but the extent of this blocking can be calculated. A building near the path, by reflecting radio energy, could be just as serious a problem. In these circumstances, however, the effect cannot be calculated because little is known about the phenomenon of the reflection of radio frequency energy by buildings. The power level of the interference depends on many factors, including the size, shape, position and orientation of the building, its detailed structure, the materials from which it is made, and the frequency of the radio wave. All these factors will determine the re-radiation pattern of the building.

The principles involved in the behaviour of reflected radio energy are exactly the same as with the reflection of light from a mirror (specular reflection) or from a piece of matt white paper (diffuse reflection). For some types of building the reflected energy will be highly concentrated while for others the energy will be diffusely scattered. The power-level reflected in any particular direction will vary according to the angle which that direction makes with the reflecting surface. It also depends on the angle of arrival of the incident energy.

The investigations now being made



Two pulses are received from the helicopter – one direct from its transmitter and the other reflected from the building. The attenuation and delay are measured.

The helicopter takes off for the Romford tests after an equipment check.

are designed to determine the re-radiation pattern of different types of buildings and involve taking a series of measurements of reflections from buildings, using a pulse technique similar to that employed in radar. A transmitter, carried by a helicopter, transmits short pulses of radio energy which are received and measured at a receiving station a few kilometres away. Normally two pulses are received—one direct from the transmitter and the other delayed and attenuated, after reflection from the building. The relative intensities of the two pulses is a measure of the reflection loss of the building for the particular relative directions of the incident and reflected waves. The time delay between the two pulses is also measured to confirm that the reflected pulse has arrived via the building and not from some other reflecting surface.

The equipment being used is a proprietary 9.4 GHz radar set modified by the Radio and Space Research Station who also constructed two omnidirectional antennae for the transmitter. The receiving equipment consists of two 0.9 metre parabolic dish antennae connected by coaxial cable to the receiver. If it is not possible to use a Post Office site as the receiving station, the equipment is housed in a caravan trailer and the antennae mounted on its roof. There must be a clear line-of-sight path between the receiving station and the building which, because of trees and other local obstacles, makes a receiving site not always easy to find.

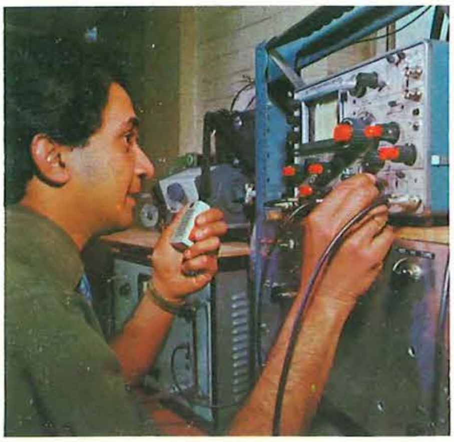
During the measurements the helicopter flies level with the top of the building and is required to hover for a few minutes in each of a number of selected positions along an arc centred on the building. Generally, a reading is taken every five degrees of arc, but if a particularly strong reflection is recorded this is investigated in more detail and readings are taken at shorter arc-intervals. Ideally, the helicopter would fly a full 360° round the building, but because of restrictions on their use in built-up areas, it is normally possible to fly only over a limited arc. The helicopter flies at various radii of between 300 metres and one kilometre centred on the building. In order to be able to plot the re-radiation pattern the precise position of the helicopter is determined by two engineers on the roof of the building using surveying equipment. They also co-ordinate and control the experiments, communicating with the helicopter and the receiving site by radio telephone.

Tests have so far been completed on two buildings, one at Luton and the other at Romford. Although the results have yet to be analysed the general level of reflected signal was about 30 dB below the direct signal. At Romford a specular reflection was observed which was eight dB below the direct pulse. Reflections of this order could cause severe interference.

Once the effects on signals by different types of buildings can be calculated it will be possible for the Post Office engineers to take the necessary steps to minimise interference. New radio routes can of course be planned so as to avoid undesirable reflections, but where new buildings are put up near to existing routes it will be possible to approach architects with a request to alter the position of a building—a move of a few degrees may be all that is needed—or to change structural details such as surface materials. Alternatively, repositioning radio station antennae could be sufficient to reduce interference to an acceptable level.

Mr. E. S. Doe is a Senior Executive Engineer in the line and radio branch of Telecommunications Development Department responsible for fundamental studies on radio-relay links and for the development of digital radio-relay links.

Mr. H. S. Buist is an Executive Engineer in the same branch and is working on the experiments on microwave reflection.

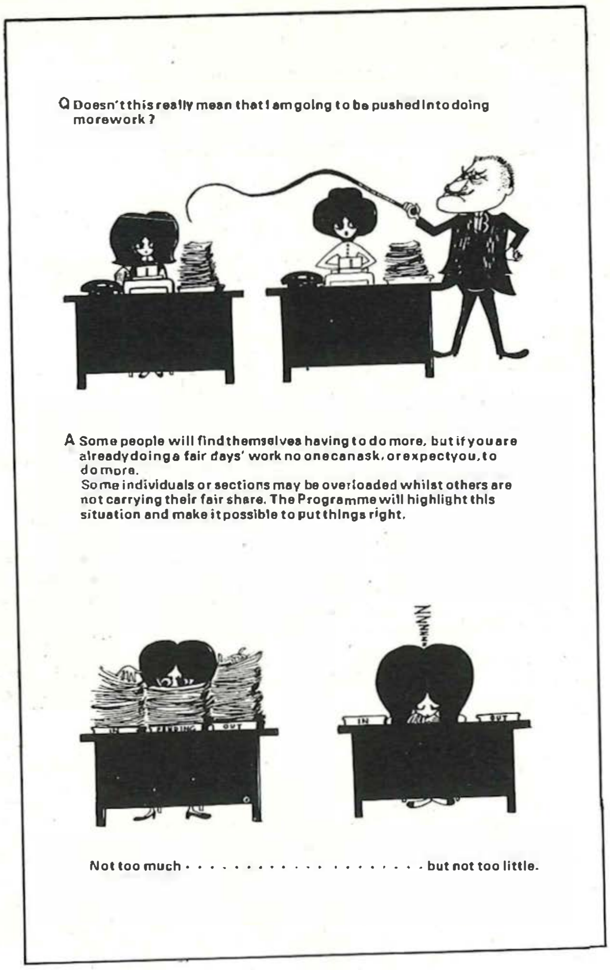


Top: The precise position of the helicopter is plotted with surveying equipment from the top of a block of flats at Romford.

Above: Executive Engineer Henry Buist (right) and Assistant Executive Engineer Mike Sheldon check the helicopter's transmitting equipment.

Right: Signals from the helicopter are measured on receiving equipment at Romford Telephone Exchange.

The first Post Office productivity agreements for office workers began operating in January. They cover clerical grades, executive officers and sales superintendents. Next year typing and secretarial grades will be included and possibly others. The Telecommunications Office Productivity Programme was one of the key schemes covered by the productivity agreements. In this article the author discusses the aims behind TOPP and how it works.



productivity in the office

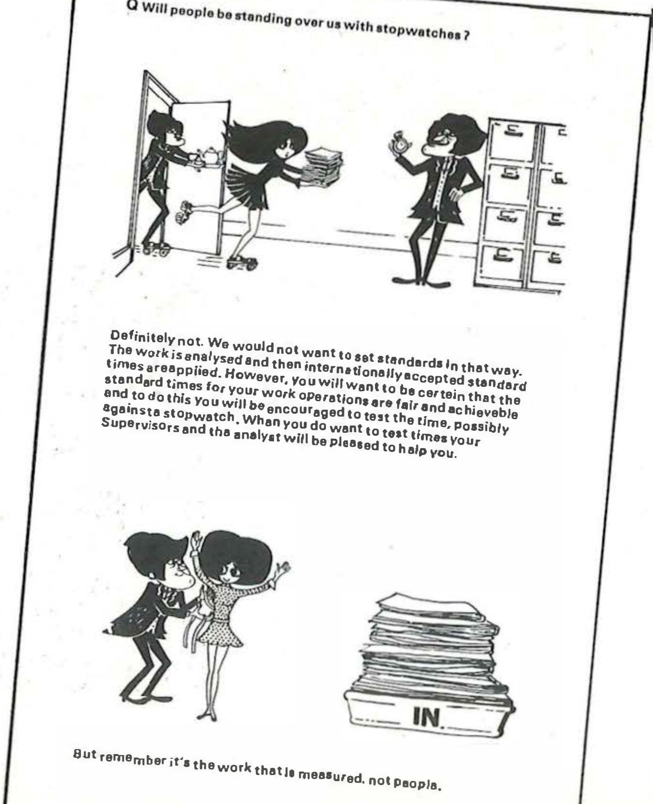
P Carpenter

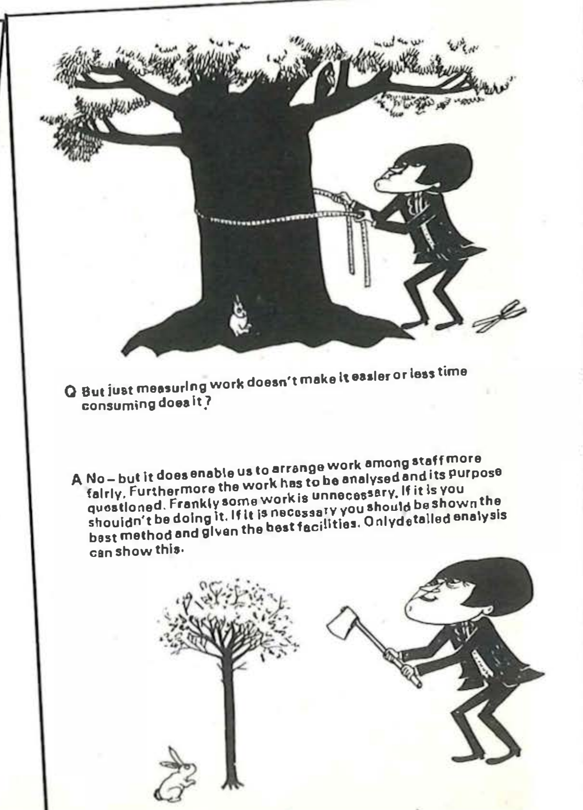
AN improvement in office productivity helps to combat rising administrative costs. At the same time it makes it possible for office staff to take part in productivity bargaining which until recently has largely been denied them. Both these aims will be achieved by the Telecommunications Office Productivity Programme (TOPP) which has been devised to suit the particular needs of the telecommunications business.

TOPP is built upon the assumption that improvements in office productivity can be achieved only by the direct involvement of staff and first-line managers in Telephone Managers' Offices and Regional and Telecommunications Headquarters. It puts particular emphasis on the role of the first-line managers, the section supervisors, who are in direct control of day-to-day allocation of work and are the people best able to set and achieve productivity targets.

The TOP Programme therefore goes direct to each individual section and requires the supervisor to undertake a survey, helped by his staff and a specially trained work analyst, to quantify the work of his section. Throughput is measured in terms of standard hours taken from the Mulligan Manual of standard-time data for the office which has been specially developed for office work over the past 30 years. The times are derived from films taken in typically organised office conditions and are the average of the times taken to perform a specific action by a large number of trained clerks.

The relationship between the number of standard hours for a job and the number of hours actually spent doing it produces a group-effectiveness figure which is a real, concrete, measure of productivity directly related to the work done, rather than a global measure imposed from "above"





which may not reflect the actual situation in individual sections.

On the basis of such figures and other facts produced from the local survey a plan for improving the productivity of a section is produced and a monthly reporting system set up to monitor the section's progress in achieving its targets.

To demonstrate the viability and acceptability of the Programme to both management and staff, Management Services Department introduced a pilot scheme in January 1970 in West Midland TMO, Manchester Central TMO and the Accounts Branch and Postal Stores Depot in Purchasing and Supplies Department.

The TOP Programme is now being run by Regional Management Services Sections. Each Region has appointed its own organiser to co-ordinate the project and is recruiting its own analyst teams, each consisting of a team leader, a Higher Executive Officer, and five Executive Officer analysts. Training by Management Services Department consists of an intensive three-week course followed by six months on-the-job training.

Initially some 160 analyst staff will be involved in the project, and it is planned to survey the work of some 30,000 clerical staff throughout the business within three years. Subsequently the number of staff employed will reduce to a small team in each Region. This approach has been adopted to enable potential savings to be realised as quickly as possible, and because the rate at which procedures change within the business is so great that a slower implementation of the programme would present serious practical problems.

Before a survey can begin a considerable amount of preparatory work has to be done. Senior and middle management are introduced to the Programme and select the sections to be surveyed. The section supervisors then attend a short, intensive course where the mechanics of the TOP Programme, and in particular the survey, are explained. All local union representatives whose members are involved are invited.

Section supervisors are given specific instructions on the collection of the information about their sections. Details of the Programme are contained in a supervisors' handbook which also gives an example of a survey report. Short appreciation sessions are then held with all staff involved at which the TOP Programme is broadly outlined and specific details given on the ways in which the staff can assist their supervisor in the recording of information. A staff guide, prepared jointly by the Post Office and the Unions, is also distributed and contains an outline of the Programme together with answers to some of the most frequently raised questions.

About a month later the analyst arrives and the survey begins. With the help of the detailed job knowledge of his staff, and the experience of the analyst, the supervisor establishes a detailed specification for every job his section does. The analyst then breaks the specification down into smaller elements and applies the predetermined standard-times from the Mulligan Manual to them. (Included in the standard-time is a one-sixth allowance added to the actual times to make provision for personal needs and relaxation.)

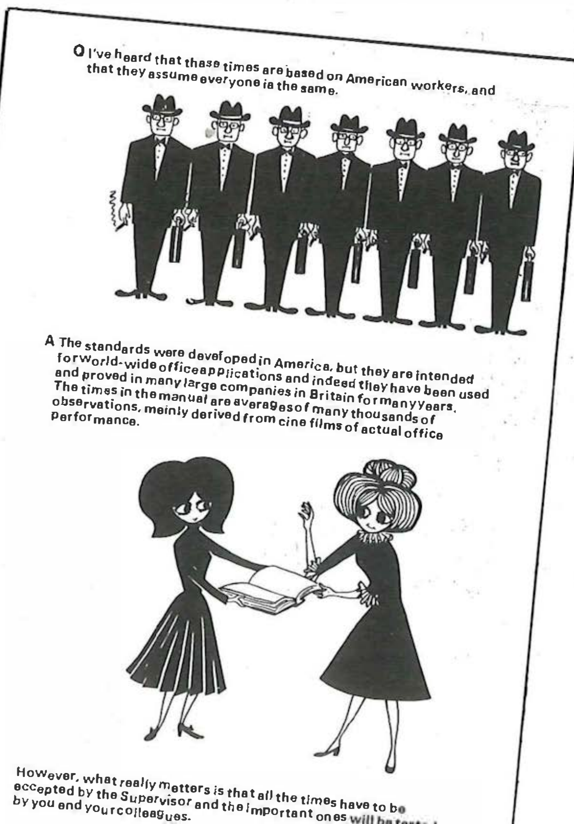
These times are tested under normal working conditions by the supervisor and his staff, to satisfy themselves that they are fair and reasonable. When the supervisor has accepted them they are multiplied by the actual monthly volumes of the various jobs, which are taken from the section records. This produces a measured monthly workload for the section, which is compared with the section's actual staffing, to arrive at its average effectiveness.

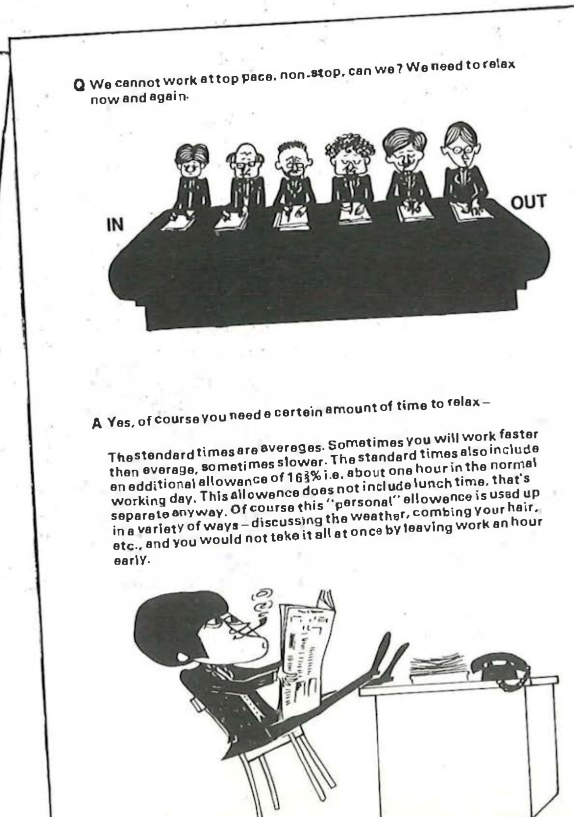
The supervisor uses these facts about his section workload and its distribution to prepare a plan for improving his section's effectiveness, and he submits this in a written survey report to his manager. Following acceptance by management and ratification by Staff Side the report is implemented. Every month from then on the supervisor prepares a report showing his progress in achieving his targets.

The benefits of the TOP Programme derive from the fact that it enables effective control to be maintained over individual work sections. Staff benefit through more equitable workloads, better and more detailed job specifications, and the prospect of higher pay through the productivity agreement. Supervisors gain a meaningful managerial role with the ability to plan the work of their section and the use of their staff. Management is given the basis for realistic manpower planning through the ability to quantify the effects of proposed changes in requirements.

The business is expected to save £30 million over a ten-year period and will have better standards of management; the unions are given a positive participative role and the opportunity to increase the prosperity of their members. At every stage there has been the fullest co-operation from the unions, particularly during the pilot scheme. This is specially appropriate since co-operation is the keynote of the TOP Programme.

Mr. P. Carpenter, a Higher Executive Officer in Management Services Department, has been involved in the TOP Programme since he joined the Post Office in 1969 as a Telecommunications Management Entrant.





These pages are taken from a booklet given to staff in an office where a survey is to be carried out.

POWER IN THE SEVENTIES

C R Nightingale and R Pine

This article describes a new universal power system for the future telecommunications network. It is modular in approach – it grows as the power demand grows. It is fully automatic – requires little maintenance. It is simple to plan and install – is less dependent on accurate long-term forecasts. It is highly reliable – and is cheaper.

Executive Engineer Steve Humphreys, who has been responsible for much of the design work on the dc power modules, measures voltages during performance tests on the new equipment at the Telecommunications Development Department's laboratory in North London.

OVER the years the power systems of the Post Office's telecommunications network have grown and evolved to keep pace with the ever-increasing demands put upon them. As new technologies have changed the basis of equipment design, so the number of supply voltages in use, and the differing types of plant needed to produce them, have grown to such an extent that there can now be as many as eight separate power supplies in a large communications centre.

The system has become complex and the maintenance costs and man-power requirements high. In addition, plant cannot be extended after installation and has to be large enough at the outset to cater for estimated loads up to 20 years ahead. Forecasting errors can result in either the over-provision of equipment, tying up capital which could be put to better use elsewhere, or in the premature replacement of plants.

If this tendency to proliferate were allowed to continue the costs of plant, accommodation and maintenance could only rise, the complexities would increase and overall reliability be reduced. Such a prospect, at a time when the explosive expansion of the network demands improved man-power productivity, greater system reliability and reduced costs, has led the Post Office to take a close look at the requirements of power systems that will be needed for the network over the next decade.

The result is the development of a radically new system, based on modern techniques, which will be capable of universal application. It will employ a modular approach in which the performance of the whole power system, from the public mains supply through to the –50v power connexions to the equipment racks, has been treated as a unified system. It will grow as the power demand grows, will therefore be less reliant on accurate long-term forecasts and will allow the deferment of capital investment until it is actually required. It will be fully automatic and highly reliable, will need minimal maintenance, will be simple to plan and install and will be cheaper.

The new system evolved from a study of future power requirements which concluded that there should ultimately be one dc supply at one voltage for all purposes and that, since the bulk of the power consumed in the network is at –50v, this should be the new standard for all types of communications equipment.

The next step was to look at the possible future use of existing –50v plants. Three are in use. For the smallest telephone exchanges, for example the UAXs, there is the small fully-automatic Power Plant No. 227 which is of modern design. Medium and large exchanges are supplied by Power Plants Nos. 210 and 225, the former for loads up to 800 amperes and the latter covering a range 1,000 to 20,000 amperes.

Their reliability, the amount of maintenance required, problems of forecasting and planning, and the overall costs were looked at and compared with the business objectives of the Post Office and new targets of reliability set by Service Department.

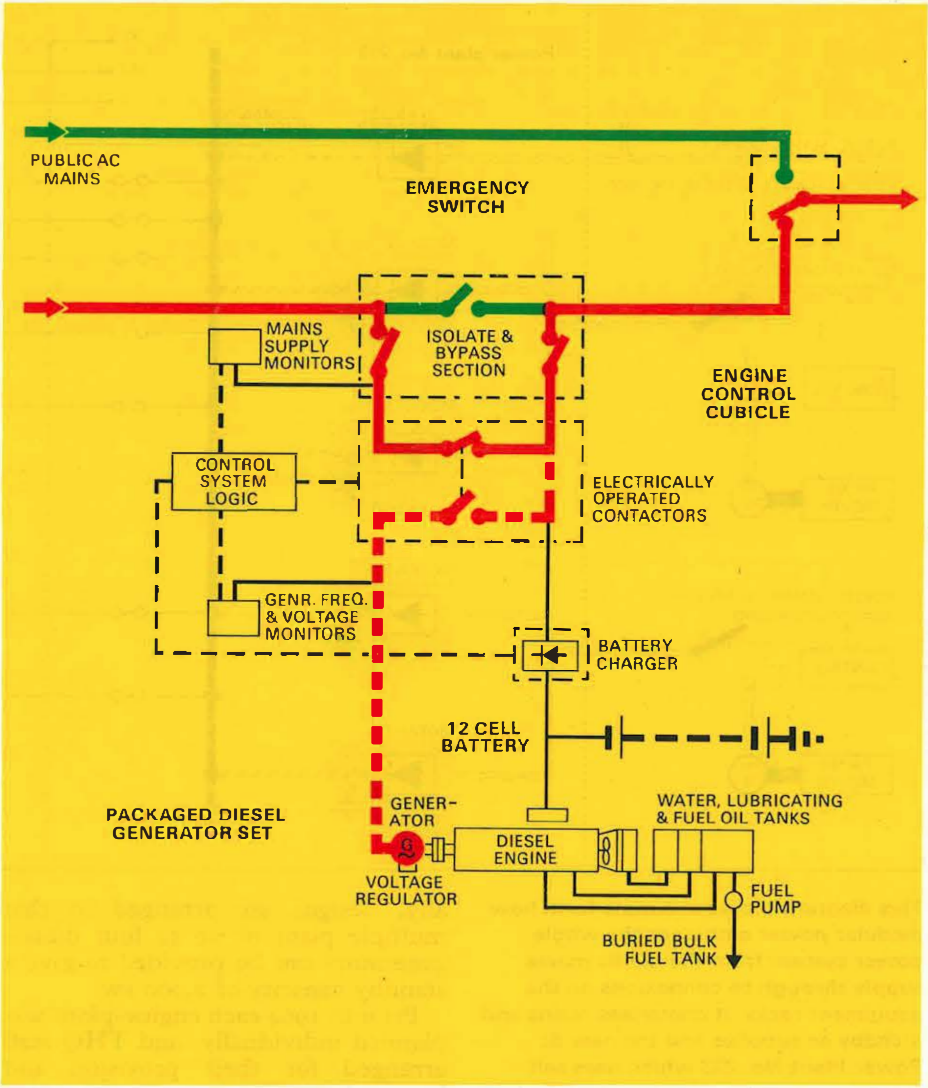
Except for some faults resulting from minor design defects, which can readily be corrected, Power Plant 227 has proved to be satisfactory and for the foreseeable future will be adequate as a source of UAX power.

The other two plants are inadequate. Designed with just sufficient rectifier capacity to meet the varying demands of electro-mechanical Strowger-type exchanges, neither will be able to cope with the more constant loads which will be imposed in the future by electronic equipment. For these, sufficient rectifier capacity will be essential to ensure that power supplies are secure even if one rectifier should fail. This lack of reserve rectifier capacity coupled with the use of electro-mechanical common control, parts of which are subject to a large number of faults, does not allow the plants to meet the new targets of reliability.

The heart of the modular system is a new dc plant, to be known as the Power Plant No. 233. It employs self-contained power modules, each a fully automatic unit comprising a rectifier and 25-cell battery. The output voltage is maintained within the limits 46 to 52 volts and batteries are kept fully charged without routine charging, which will reduce maintenance manpower needs. Should a module fail, a standby rectifier provides spare capacity and also allows batteries to be recharged while the modules continue to supply the load.

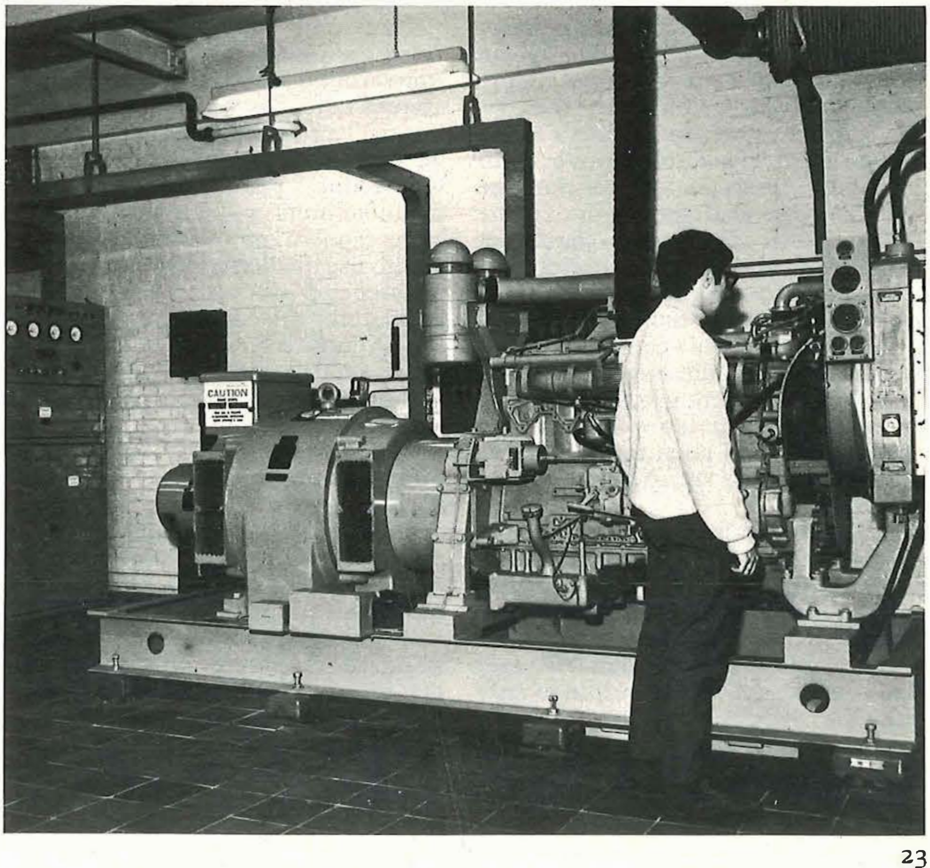
Initial installation will normally comprise a standby rectifier and one module, additional modules being added as required up to a normal maximum of four. Exceptionally, five or six could be used when the load grows above that expected for the installation. The plants will be produced in a range of sizes to supply loads in the range 50 to 8,000 amperes. Reliability will be achieved by simple design with minimal control, by spare rectifier capacity and by the use of solid-state circuitry.

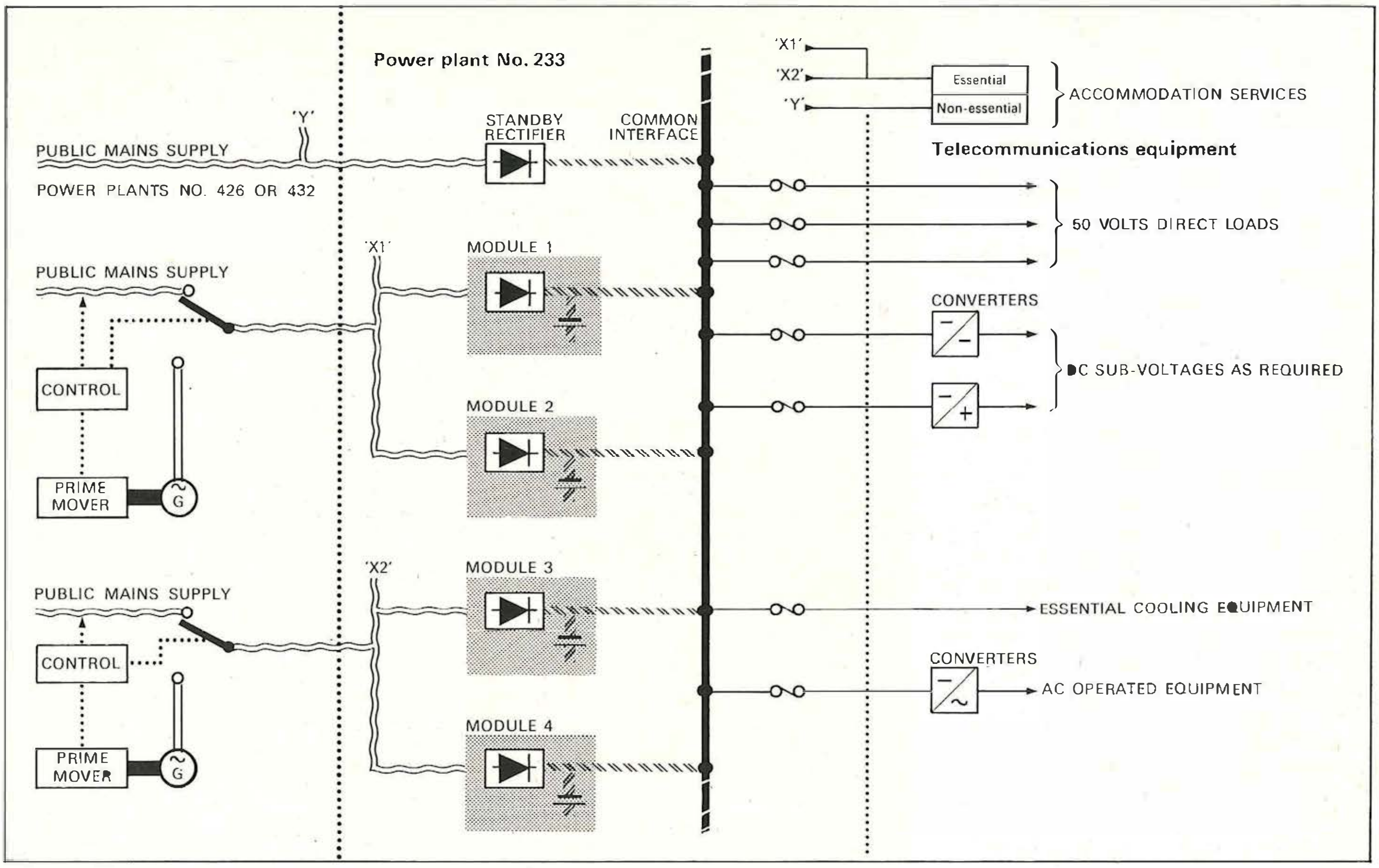
To ensure that standby ac supplies are available at all times, even when the public mains supply fails, automatically started diesel-generators are being provided in all but the smallest exchanges. The majority of centres will be equipped with one engine-set capable of supplying four dc modules. In larger centres costs will be reduced and higher overall reliability achieved by initially installing one engine-set capable of supplying two dc modules, a second similar set being installed when provision



The diagram shows the standardised units which will form standby Power Plant No. 426 – emergency switch, control cubicle, generator set and 12-cell battery.

Below: A standby diesel-generator set at Woking Telephone Exchange with a standardised control unit (left).





This diagram shows in simple form how modular power embraces the whole power system from the public mains supply through to connexions on the equipment racks. It comprises mains and standby ac supplies and the new dc Power Plant No. 233 which uses self-contained modules that can be added to as load demand grows. The converters are used to provide supplies at other than -50 volts.

of a third module becomes necessary. The batteries which form part of the dc modules will maintain the supply to the load during the time taken for the engine-sets to start. When a single engine is installed the batteries will provide a reserve of power for one hour at peak load should the engine fail to start. On a two-engine-set installation the same batteries will give a reserve of about five hours if one of the engines fail.

The number of communications buildings having diesel-generator sets installed has been growing rapidly. In 1966, less than 300 were available; by 1970 this had risen to about 1,200 and by 1973 over 2,000 plants will be in service.

The progressive development of standardised diesel-generator sets introduced in 1964 has resulted in a well-proven modern design giving a high degree of reliability.

The original Power Plant No. 426, had a maximum power-output of only 115 kw. Today, this plant has a maximum rating of 180 kw and a recently-developed larger version, the Power Plant No. 432, is now available with ratings up to 500 kw. Additionally, designs are arranged so that multiple plant of up to four diesel-generators can be provided to give a standby capacity of 2,000 kw.

Prior to 1964 each engine-plant was planned individually, and THQ staff arranged for their provision and installation. Today, except for very large and specialised plant, nearly all diesel-generators are arranged by Regions using standardised plant produced in rational ratings.

Plans now being implemented involve the central bulk-purchase of all standardised control and switching-system cubicles, which will allow all but the largest diesel-generator sets to be purchased as package units. This will reduce plant costs, and since manufacturers will be able to introduce modern production techniques and to use quality-control procedures, a better end-product will result. Some measure of the cost-reduction benefit can be judged by the fact that engine control and switching cubicles are now being bought for about half the price paid for individual units 10 years ago.

The most commonly used packaged units have been designed with standard interfaces so that a set may be simply replaced by one that is smaller or larger with complete safety of personnel and without affecting the security of supply. This facility, which will be most readily employed in standard buildings, will enable the planning flexibility of diesel-generator plant to match that of the new modular dc plant.

When this class of standby-plant is combined with the dc modules, the overall reliability targets for complete power systems should be easily attained, and probably exceeded.

Development work is also in progress to improve the distribution of dc power to the communications equipment. In most existing telephone exchanges groups of equipment racks are connected by group-fuses to a main distribution bus bar. A blown fuse can cause a major loss of service or even the complete isolation of an exchange. When it is necessary to extend the system, personnel sometimes have to work on live low voltage dc bus bars—a practice which results in mishaps which can cause interruptions in power supply.

Future distribution designs will aim at eliminating all need for staff to work on live conductors and make it impossible for a blown fuse to cause the isolation of a communications centre.

At present, the Post Office spends about £5 million each year on exchange power supplies. Under present conditions this would rise, at today's prices, to £8 million by 1980. The introduction of modular power into the network, with lower maintenance charges and maximum deferment of capital investment, is expected to reduce this expenditure by annually increasing amounts up to a maximum of 20 per cent by 1978.

Mr. C. R. Nightingale is a Senior Executive Engineer in Power and Ancillary Systems Branch, and heads a Group responsible for the design and development of standard ac power plant.

Mr. R. Pine, a Senior Executive Engineer in the same Branch, is Project Manager for the development of the modular dc power system.

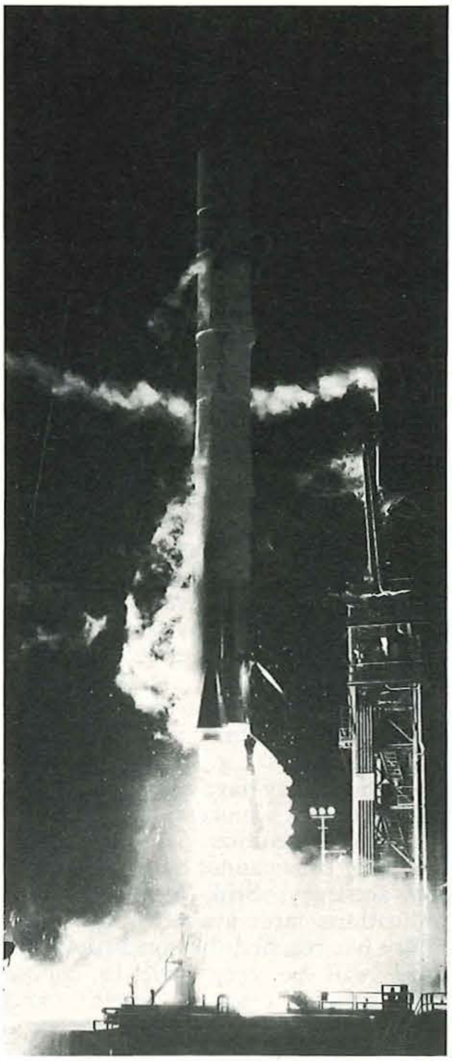
Intelsat IV—the latest and biggest in the series of communication satellites—was placed in orbit over the Atlantic earlier this year and is now in commercial service. Meanwhile plans have been agreed for a new submarine cable to be laid across the Atlantic to Canada with a capacity more than double that of existing cables. The relative advantages of these two methods of international communication are discussed by A. H. Mowatt, Head of Lines Division, External Telecommunications.

THE VALUE OF SATELLITES AND CABLES

INTER-CONTINENTAL telephone service depends heavily on microwave radio links relayed via communication satellites. They are now accepted as an important addition to submarine cables in providing inter-continental telephone communications along the major telephone highways. Speaking to North America one is just as likely to be speaking via a satellite as via a submarine cable. The quality of telephone speech is equally good by both media, although a satellite link is subject to slightly longer transmission time—less than half a second—which telephone callers may detect in the course of conversation but do not find a serious drawback.

Satellites also provide reliable communication between distant countries that could not today be linked economically in any other way. Cables are not economic in joining countries separated by wide stretches of ocean and not having a large volume of telephone business between them. There are, for instance, no submarine telephone cables across the South Atlantic or the Indian Ocean; although the cost of laying them might have been faced by now if satellites had not provided a cheaper alternative.

Terrestrial microwave radio systems or underground coaxial cables may be provided across a continent (at a rate per mile somewhat cheaper than submarine cables), but it still is not economic to provide these links across thousands of miles of mountains or desert where there is no local telephone development which would help to support a long-distance system. For this reason there still is no telephone connexion by land with India, or to the even more distant countries of the Far East.


Intelsat IV is launched from Cape Kennedy by an Atlas-Centaur rocket.

This is where communication satellites come into their own: each satellite provides a telephone relay station in the sky, interconnecting as many as 30 or 40 separate countries simultaneously. An earth station equipped to send and receive via an Atlantic satellite can, through it, make contact with any other earth station in the wide area of the earth from which the satellite can be seen. This area includes not only North and South America but also Africa and even Asia as far east as the oil fields of Iran. Similarly a satellite located above the Indian Ocean covers an area extending from Britain to Australia and Japan. There are now satellite services to Singapore, Hong Kong, Indonesia and Thailand and a new satellite service will be opened to India in the near future.

Another service "via satellite" which is now familiar to the public through the Olympic Games, Apollo and World Cup TV programmes is inter-continental television transmission. It would be extremely difficult, if not impossible, to provide this service by any other means. Even so the frequency band-width expressed in terms of the equivalent telephone lines, is very large even by satellite, so that the provision of even one television link through a satellite uses a significant proportion of its capacity. For example, a television service uses one of the 12 transponders available in the INTELSAT IV satellites, each of which can carry on average 300 circuits.

The global satellite system, which has been established for telephone, television and other kinds of telecommunication, is owned by the INTELSAT Consortium representing 76 different countries. The United States has provided about half the capital and most of the technology; the "manager" of the system, namely COMSAT, the Communications Satellite Corporation, is also a United States body. INTELSAT started with the Early Bird launch in April 1965, which had an expected operational life of 18 months but was only recently retired after more than five years of completely successful service. The second generation of satellites, INTELSAT II, began badly when the first satellite failed to be put in orbit and was lost, but the three other satellites of this kind performed satisfactorily although all had faults of varying importance. The first satellite in the third generation (INTELSAT III) also failed at launch. Out of a total of eight satellites launched in this series only five were put into a successful orbit and one of these had mechanical trouble which ultimately caused it to fail. The remaining four INTELSAT III satellites provide the present global satellite system, with two over the Atlantic Ocean and one over each of the Pacific and Indian Oceans.

A fourth generation of satellites has begun with the launch in January of the first INTELSAT IV satellite to serve the Atlantic region. This satellite and others to follow it are designed to have a capacity of more than 5,000 telephone lines plus one for colour television transmission. The average capacity will vary because the transmission of many small carriers from the earth stations will limit the satellite's efficiency as compared with the transmission of a few large carriers from a limited number of earth stations. A total of eight such satellites has been ordered: two for the Atlantic region, two for the Pacific and a fifth above the Indian Ocean. The remaining three are intended to be launched as spares in orbit, to take the place of any satellite that might not be put correctly in orbit or should later have trouble in operation. Each satellite is planned to give service for seven years, at the end of which a replacement is assumed to be necessary: this is longer than any satellite has worked so far.

A communication satellite system comprises not only the satellite but also the network of earth stations that work through it. The total cost of the system is not only that of launching the satellites to maintain a continuous service, but also the cost of providing and operating the earth stations which are owned separately by the countries in which they are located. The present INTELSAT system requires a large antenna, in the form of the familiar 85 to 97 foot dishes at Goonhilly Downs, together with a great deal of complex mechanical and electronic equipment. A simple earth station might cost as little as £1.5 million but a large earth station carrying a great many telephone circuits for simultaneous calls to about twenty other countries would cost from £2 million to £3 million in all. Goonhilly at present has two aerials one working with one of the Atlantic satellites and the other working with the Indian Ocean Satellite. A third aerial is being constructed and will be brought into operation next year for service with the new Intelsat IV satellite, in the Atlantic.

The cost of a satellite network cannot be directly compared to the cost of an equivalent network of submarine cables because it would be wholly uneconomic even to consider laying cables between some of the points joined together by satellite. Nevertheless some comparison is necessary in assessing the merits of laying new submarine cables in particular areas, e.g. across the Atlantic. A cable may have a life of 25 years, but the cost of a succession of satellites and earth stations over the same length of time cannot be forecast with any accuracy. Still, by using what indications are available the Post Office has reached the conclusion that there will be very little to choose between the costs of satellite and cable service in the North Atlantic over the next two decades. This conclusion may not however hold for longer, less well loaded, streams of telephone business such as the Pacific Ocean.

The kind of submarine cable which would be economically laid would have to be of much larger capacity than existing cables, the largest of which provides 800 lines. A British design is now available which has the capacity for over 1,800 lines, and both here and in America some preliminary work is being done on new designs which could nearly double this capacity. Seeing that costs of satellite and cable are not likely to be very different for North Atlantic service, the Post Office is in favour of laying new cables as well as expanding its use of satellites. By having different media of communication and different routes on the North Atlantic the service is protected against the effect of breakdown in any one system.

The same cannot be said of all areas of the world; the cost of a cable increases with the distance. This is not so for a satellite through which additional services within its capacity can be added at marginal cost; therefore it seems unlikely that submarine cable communication across the Indian Ocean will be economically competitive with satellite communication, but new cables might be laid in the South Atlantic and in the Pacific in the next decade.

The prospect for the future seems to be of relying more and more on communication satellites, although many more submarine cables are also likely to be laid as a complement to satellites in those areas of the world where cables will be economic. As telecommunications business grows there may well be a demand for cables in areas where at present there are none: but satellites are here to stay, and the two media are complementary, with satellites opening up communications with many countries which without them would have to go on relying on unstable high frequency radio services.

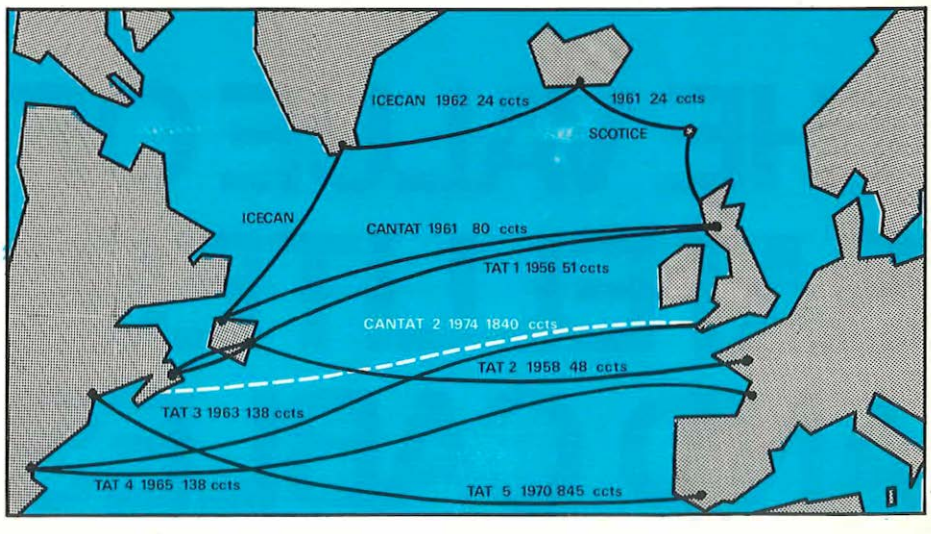
Dollis Hill design for Cantat 2

Cable links across the Atlantic will be more than doubled by the new large-capacity submarine cable to run between the United Kingdom and Canada. The British Post Office and the Canadian Overseas Telecommunications Corporation have signed an agreement for the coaxial cable to come into service in 1974. It will be known as CANTAT 2.

With a capacity of 1,840 circuits, the cable will have nearly 500 more circuits than the total of all existing transatlantic cables. It will be produced to an advanced design based on work at the Post Office Research Station at Dollis Hill.

CANTAT 2 will span 2,840 nautical miles between the British cable station in Widemouth Bay, Cornwall, and a new cable terminal to be built near Halifax, Nova Scotia. The earlier cable between UK and Canada, CANTAT 1, was laid between Oban, Scotland, and Hampden, Newfoundland, in 1961 with 80 circuits.

Below: The route and capacity of the new CANTAT 2 cable is compared with existing transatlantic cables.



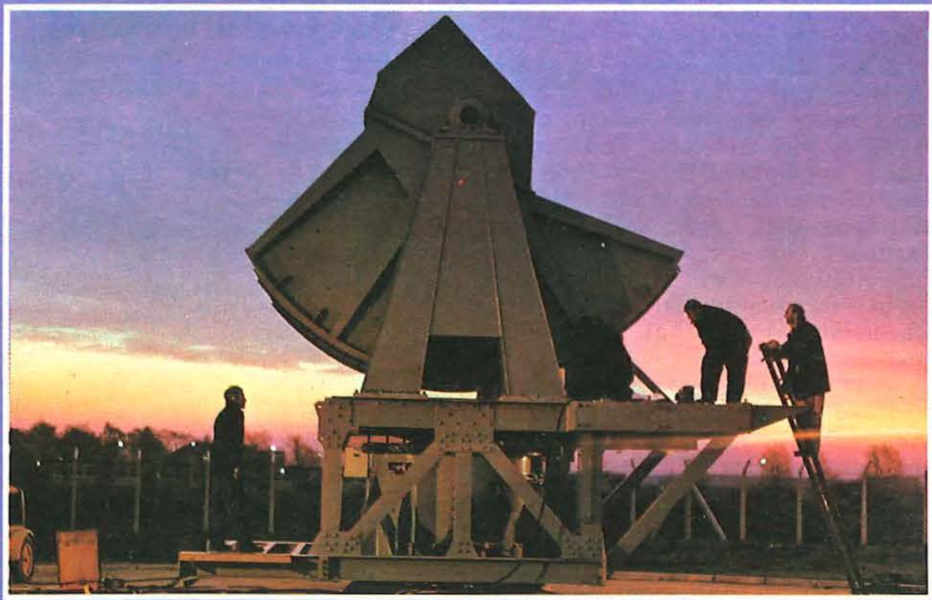
SPACE AERIAL FOR MARTLESHAM

A £75,000 "mini" satellite communications aerial has been erected at the Post Office Research Station, Martlesham Heath. It is to be used to study the effect the atmosphere, and particularly rainfall, has on radio transmissions to and from satellites at microwave frequencies higher than those currently used. Higher frequencies will be needed in the future as the volume of traffic carried by satellites continues to grow.

The new aerial is 20 ft. in diameter—about a fifth of the size of the aerials at Goonhilly. Its unusual design is expected to be less affected by extraneous noise than the more common symmetrical type, andeffi ciency will be improved because the beam from the main reflector is completely unobstructed. So that it will be capable of operating up to 40 GHz, the main reflector has a specified surface accuracy of 0.010 in. rms and the sub-reflector 0.005 in. rms.

To improve aerial efficiency the cooled, low-noise first stage of the receiver will be located in a special housing adjacent to the elevation axis, thus keeping the waveguide connexion to the feedhorn as short as possible. The main accommodation for transmitting and receiving equipment, however, is in a cabin which is part of the aerial structure. Movement of the aerial is controlled from a console in an adjacent laboratory building. Experiments are expected to begin when the Italian satellite, Sirio, is launched in July 1972.

● Other studies of the effect of weather on microwave radio systems were described in Telecommunications Journal, Winter 1970.



Work continued late into the evening during construction at Martlesham. The completed aerial is shown above.

No news is good news

A COMPUTER is now being used to monitor the performance of transmission and receiving systems at the Post Office's satellite earth station at Goonhilly Downs, Cornwall. Every radio channel bringing telephone calls by satellite into the United Kingdom is computer-checked fifty times a second. Almost as frequently the computer samples the outgoing radio beams carrying telephone calls—and television signals—through satellites to other parts of the world.

The computer operates "supervision by exception" techniques—no news is good news. So long as the monitored parameters remain within pre-set limits the computer keeps silent. But as soon as there are variations beyond the limits they are measured and recorded and the computer alerts engineers immediately.

The necessary adjustments are made and a report is teleprinted to COMSAT who operate the INTELSAT series of satellites on behalf of an international consortium including Britain.

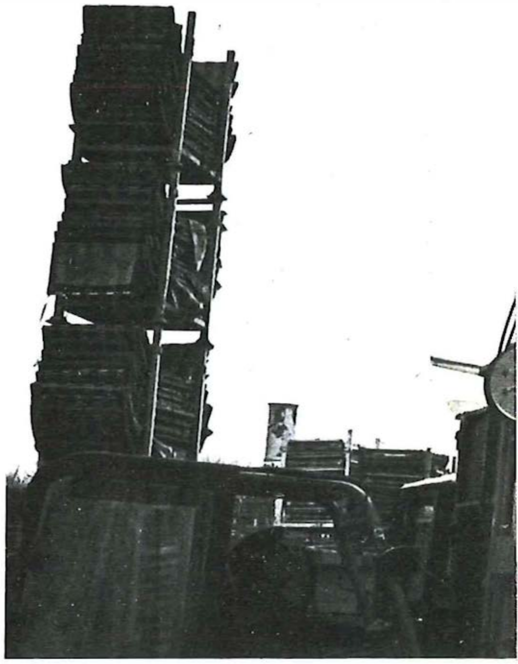
COMSAT want this important data from satellite earth stations throughout the world to assess the performance of satellite systems.

A Ferranti Argus 500 computer is being used. Post Office engineers wrote the main programs which enable the computer to monitor the two existing aerial systems, at present working to satellites over the Atlantic and Indian Oceans, and the third aerial system when it is brought into service in 1972.

The computer is able to sample the monitored parameters at the required rates including the measurement of radiated power at 160 millisecond intervals and a check of the noise level in receiving channels every 20 milliseconds. Mean values of the data collected are calculated at one minute intervals and can be displayed, printed on paper or held in the core stores of the computer until required.

Significant characteristics will be monitored for each of 15 transmitted carriers and 60 received carriers. The computer will also keep check on the availability of reserve common equipment indicating, for example, which of the high-power transmitters are carrying traffic and which are standing by.

Where there's muck there's money



Disposing of scrap metal is a big source of income for the Post Office. Large savings can also be made from the repair of old equipment recovered from Telephone Areas.

R E T Saunderson

EVERY working day lorries set out from each of the Supplies Division's engineering stores depots loaded with all the miscellany of items which Telephone Areas need to maintain and develop the telecommunications services. When they deliver these new supplies at Area stockpoints there are, almost invariably, considerable accumulations of old equipment waiting to be transported back to the Supplies Division depots.

This material which has been recovered from the network falls into two main categories—scrap metals such as wire and cable, and items of used apparatus. When Telephone Areas transfer scrap to Supplies Division they credit their accounts with its value at rates which approximate to what it will fetch when sold. When the material arrives in a depot it is sorted into sale lots which experience indicates will enable the best prices to be obtained from scrap metal merchants. For example, cables containing a high percentage of copper command higher prices than those in which the proportion of lead is greater, and the small cost of sorting the material is more than recouped by the better prices which are obtained.

The importance to the Post Office of Supplies Division's scrap metal disposal organisation is illustrated by the fact that during the year 1969/70 well over 30,000 tons were sold for nearly £8 million. Over 60 per cent of this, both in tonnage and value, was lead-covered cable.

Perhaps less spectacular, but occupying a very important place in the Post Office supply system, is the organisation which deals with items of recovered apparatus. Each year, at a cost of little over £4 million, Post Office factories repair second-hand engineering stores which would cost about £10 million if purchased new. Most of these stores, like the scrap metals, find their way as return

Pallets filled with recovered materials are piled roof-high in the Post Office Supplies Division depot at Crayford, Kent, before being sent to Post Office factories for repair.

vehicle loads from Telephone Areas to Supplies Division depots, where they are accumulated for despatch to the factories in batches as required. Clearly, the cost of this accumulation and storage must be added to the overall repair bill and any means of reducing this cost will enhance the overall profitability of the repair system.

To that end, a limited but radical change of procedure was introduced in March 1970. Prior to that date, Telephone Areas credited their accounts with the full, current value of the general run of old apparatus returned to the Supplies Division, no matter how long it might have been in service. On arrival in Supplies Division recovered stores depots the items were checked against the covering delivery note, upon which was recorded the amount of credit which had been claimed in the originating Area, and any discrepancies in quantity or description—and thus in value—were adjusted. The recovered items, packed in trays, pallets or other suitable containers, were then put away in stock in the depots.

When a batch was required to be sent to a Post Office factory for repair they were set out for examination ("grading") by teams of Factories Division personnel to determine whether they were, in fact, repairable. Those which were unsuitable for repair were scrapped and their value was written down in the Supplies Division books. In some cases the interval between arrival in a recovered stores depot and transfer to a factory for repair was quite short but, for various reasons, some languished in "old stock" for many years. Gradually, some of these slow movers became obsolete or, through other changed circumstances, were no longer likely to be repaired. When this became evident they were scrapped, but during the intervening years it had cost the Post Office a

great deal of money in manpower, storage space, pallets etc. to retain them in stock, and because they were on the books at full prices, they had artificially inflated the value of Supplies Division's inventory.

The underlying objective of the new procedure is to retain only those items which are likely to be repaired, and to eliminate all the rest from the system at as early a stage as possible. The foundation-stone is a document known as the "List of items recoverable for credit". It comprises—

- items which have been repaired at any time during the last 5 years.
- those (mainly obsolescent) items for which repair by a Post Office factory represents the sole source of supply.
- recently introduced items which have not yet been recovered in sufficient volume to make up viable repair quantities, but which are considered likely to be capable of being repaired economically.
- certain expensive items which, although not repairable, are likely to have a high sale value.
- certain items which contain components required by Factories Division.

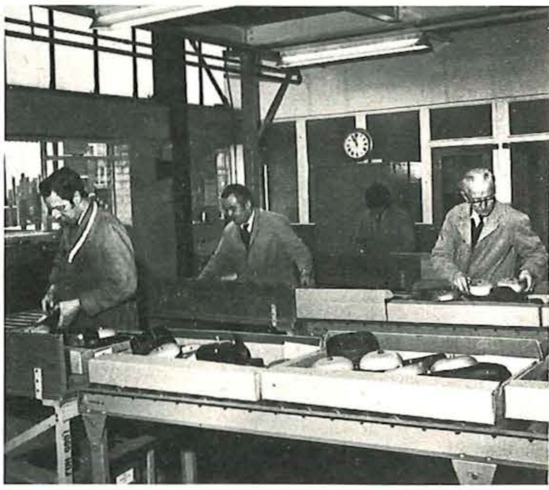
Recoveries of all items which appear in the list attract full credit and are dealt with in exactly the same manner as formerly. Everything else is scrapped, written down to nil value in Area offices immediately on recovery and placed unsorted into pallets for return as miscellaneous scrap to the territorial supply depot, where it is put up for sale in convenient quantities.

Having acknowledged that the material is scrap and that the Post Office has no further use for it, there need no longer be any inhibitions about dealing with it as such. In practical terms this means that a number of causes of nugatory expense which were inherent in the earlier procedure have been eliminated. For example, items no longer have to keep their separate identities when they are recovered from the system; Area offices no longer have to complete documents in order to claim credit for them; they no longer have to be packed to protect them against damage in transit; they do not have to be transported beyond territorial supply depots in Supplies Division; they do not have to be unpacked, identified, checked and taken into repairable stock in recovered stores depots; they do not occupy pallets and warehouse space in Supplies Division before eventually being scrapped.

The long-established axiom in warehousing that every time stores are handled something is added to their cost but nothing to their value has been amply demonstrated by this modest procedural change, for it has produced operating savings in the Supplies Division alone of over £50,000 per annum, much of which accrues from the fact that scrap material now passes through fewer hands than formerly.

Are the disposal arrangements capable of any further streamlining and simplification? Would it be possible, for example, for scrap apparatus to be sold under Regional contracts from one or two collection points in each Telephone Area? To facilitate this could Areas accumulate the material in big enough lots so as not to depress the price which it fetches? These are some of the questions which remain to be explored before one can be certain that the telecommunications business is now disposing of its scrap apparatus in the most advantageous manner.

Mr. R. E. T. Saunderson is an Assistant Controller (Senior Chief Executive Officer) in Supplies Division and is responsible for the efficient and economic operation of all the Division's engineering stores depots and transport fleets. He is a Fellow of the Institute of Materials Handling.



Above: Factories staff examine recovered items to determine whether they are suitable for repair.

Below: Jointers' tents, stacked in the yards at the Crayford depot, await dispatch to the factory for repair.

The International Computers Group, ICL House, London, S W 15.
Post Office Sales Area: Computer House, Euston Centre, London, NW1.

miscellany

Post Office at Datafair '71

THE WIDE range of services provided for the computer user was highlighted by the Post Office during Datafair '71, held at Nottingham University. Presentations covered line and radio transmission of computer data, Datapost and the National Data Processing Service.

A series of lectures was presented by Telecommunications Headquarters covering: data transmission users' needs and the effects on communication systems of future data processing developments; possible features of a new data transmission service, current study proposals and technical objectives for a national communications service; data transmission facilities available now and planned for the near future; maintenance work for Datel services on public and private networks and facilities offered to customers by the Datel Advisory Service.

The lectures and presentation by NDPS illustrated the great scope of the skills, resources and planning essential for developing and operating its bureau services on a national scale.

Coping with the demand from Datafair exhibitors for equipment and communications links involved Nottingham Telephone Area staff in 12 months of planning and installation work. Local cable distribution throughout the extensive Nottingham University campus was augmented and new cable pairs made available back to the Nottingham exchange.

With no computer centres in the area and a large number of long-holding trunk calls for data transmission likely, any threat of congestion was avoided by augmenting exchange equipment and trunk circuits from Nottingham to several major cities.

The installation period was limited to seven days, and although some stands and displays were not complete 48 hours before opening, Nottingham staff still managed to install 112 exchange lines, 74 data transmission circuits of various kinds and three Telex machines.

TRUNK CALL FOR JOHNNY

A BEDTIME story by telephone is now a regular treat for thousands of youngsters. Every evening they can dial Johnny Morris, the BBC Television Zoo Man, who tells a story from a collection of 50 based on his TV series Animal Magic. He is pictured here getting a trunk call from one of his "fans".

The Post Office launched the bedtime story service in April on a six-month trial in London and Birmingham, later extended to Cardiff.

A gardening information service by telephone was also launched in April. Talks by expert Eric Hobbis of BBC Radio are changed each Monday morning.

Dial-a-computer

THE POST OFFICE is co-operating again this year in the "Dial-a-Computer" competition sponsored by New Scientist magazine and Honeywell, the computer manufacturers, to find imaginative ideas for computer time-sharing. There are six prizes each of £1,000.

The Post Office is providing each winner with communications equipment, a telephone line and up to £300-worth of telephone calls free of charge. These facilities will enable the winners' typewriter terminals to be linked direct to a "Dial-a-Computer" time-sharing centre, and allow them to dial the computer whenever they need to "converse" with it.

Ministry post

MR. C. W. SOWTON is to succeed Mr. H. Stanesby, Director of Technology at the Ministry of Posts and Telecommunications, who retires on 2 August. Mr. Sowton has also been appointed chairman of the Technical Sub-Committee of the Television Advisory Committee which advises the Minister of Posts and Telecommunications on the technical development of television and sound broadcasting. Post Office representatives on the Sub-Committee are Mr. J. K. S. Jowett, Head of the Space Systems Division of Telecommunications Development Department, and Mr. D. Wray, Head of Line Radio, Datel and Submarine Division of Network Planning Department.

Dithering

AT THE annual Physics Exhibition in London in April the Post Office demonstrated the use of "dithering" in a 6 Mbit/s pcm television system. Dithering, produced with a pseudorandom signal, enables a television monitor to display a wider range of brightness levels. The system may find application in video telephones. Research Department also featured its work on high-reliability silicon transistors for use in microwave and high-bit-rate pcm systems.

These transistor devices are at present prepared using variations of conventional diffusion techniques, but the Post Office is studying ion implantation as a possible means of preparing them.

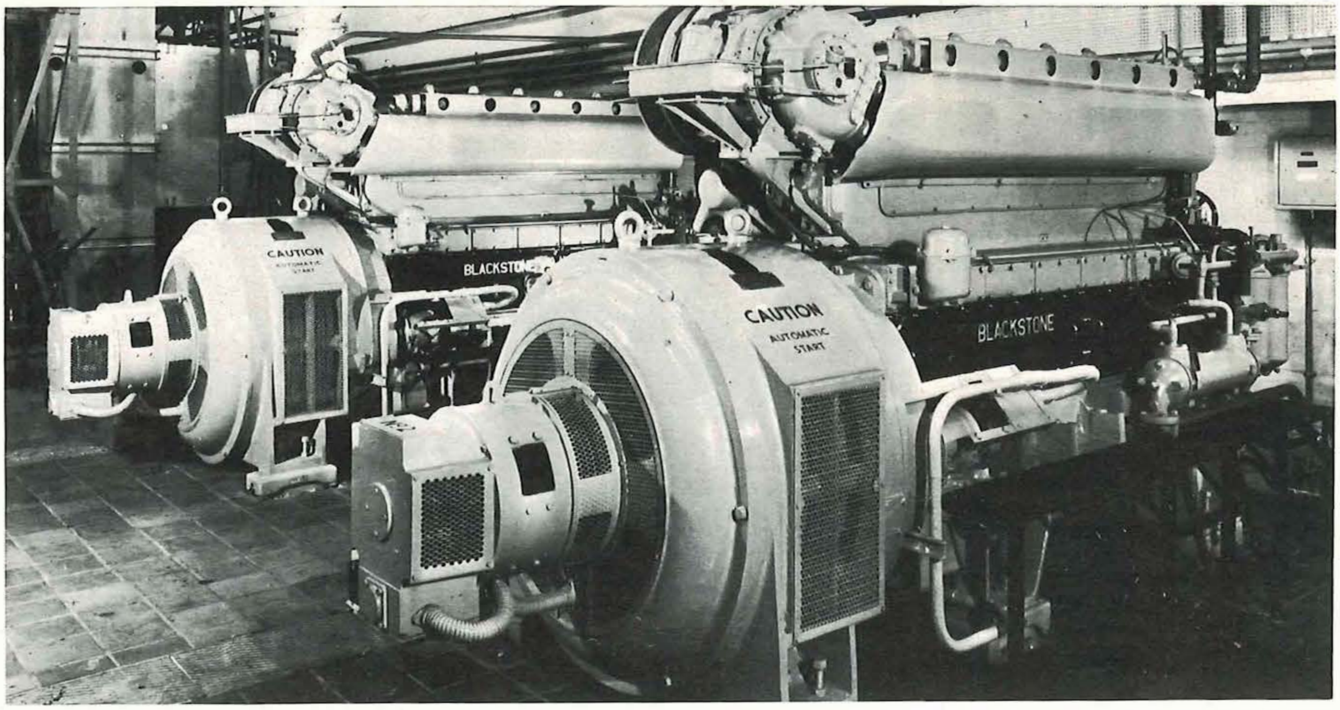
Essay results

RESULTS OF The Institution of Post Office Electrical Engineers Essay Competition for 1970-71 are:—

A prize of £6.30 and Institution Certificate, P. W. Barber, Mechanic A (Dagenham); £3.15 each and Institution Certificates, Technical Officers J. Maxwell (Glasgow), D. E. G. Coles (Birmingham), F. Eastham (Blackburn), D. Ellingham (Leeds). Institution Certificates of Merit, Technical Officers D. J. Griffin (Glasgow), J. S. H. Emm (Edinburgh), J. Morrison (Dundee), Technical Officer-in-training G. E. Coucher (Mount Pleasant), Trainee Technician R. P. Mowle (THQ/Circuit Laboratory).

New governor

PROFESSOR J. H. H. MERRIMAN, Senior Director Development and Board Member for Technology, has been appointed to the Governing Body of the Imperial College of Science and Technology.


CAUTION
AUTOMATIC START
BLACKSTONE

miscellany

Calls begin on UK-Spain cable

THE NEW submarine cable between the United Kingdom and Spain was inaugurated at a ceremony in London in April. Mr. Edward Fennessy, Managing Director Telecommunications, took the first call over the cable from Senor Barrera de Irimo, President of the Spanish National Telephone Company.

The cable runs from Kennack Sands in Cornwall to Bilbao on the north coast of Spain and has a capacity of 640 simultaneous conversations. Until its completion calls between the two countries went either by submarine cable to Portugal or through France.

The UK-Spain link will also connect with the transatlantic TAT 5 cable between Spain and the USA (brought into service in April last year) and give this country more telephone links with North America.

At Kennack Sands the cable connects with an underground cable running to Goonhilly Downs, four miles away, and from there calls are routed to and from London over the microwave-radio and underground-cable links which also handle calls from the Atlantic and Indian Ocean satellites received at Goonhilly.

The cable was manufactured by Standard Telephones and Cables Ltd. and laid by Post Office cable ships Alert and Ariel. It is polythene insulated over its entire length. For more than 200 miles—in the shallow waters of the Continental Shelf—it has the protection of an armoured sheath. For a few miles at each shore end it has two layers of armour for extra protection against damage from sea movements on the seabed and from fishing vessels at work.

Nursery popular

THE FIRST Post Office Day Nursery, opened at Reading Trunk Exchange last summer to boost recruitment of telephonists with young children, is flourishing. Nineteen telephonists now take their children to work compared with six when the scheme was launched. At the nursery, a large house adjacent to the Exchange which has been modernised and adapted to children's needs, the youngsters can play, eat and rest under the supervision of fully trained nursery staff.

VIPs meet

THE SECRETARY-GENERAL of the International Telecommunications Union (ITU), M. Mohamed Mili, met senior officials of the Post Office and made fact-finding trips to Scotland and the Research Station at Dollis Hill, London, during March. (See picture page 2.)

His visit, at the invitation of Mr. Christopher Chataway, Minister of Posts and Telecommunications, included talks with Mr. A. W. C. Ryland, Chairman of the Post Office, Mr. E. Fennessy, Managing Director Telecommunications, Professor J. H. H. Merriman, Board Member for Technology, Mr. J. Hodgson, Director External Telecommunications and Mr. W. J. Bray, Director of Research.

In Scotland, M. Mili saw advanced telephone exchange switching equipment and visited the South Queensferry Computer Centre. At Dollis Hill he saw experimental work involving far-reaching areas of telecommunications technology.

M. Mili, former Director-General of Telecommunications, Tunisia, was elected Deputy Secretary-General of the ITU in 1965 and Secretary-General two years later.

SIX CITIES DIAL AMERICA

FIVE-AND-A-HALF MILLION telephone customers in Britain can now dial their own calls direct to the whole of the American mainland.

Extensions to the International Subscriber Dialling (ISD) service have made the "all-America" service possible, and for the first time transatlantic dialling is possible from Liverpool, Birmingham, Manchester, Glasgow and Edinburgh.

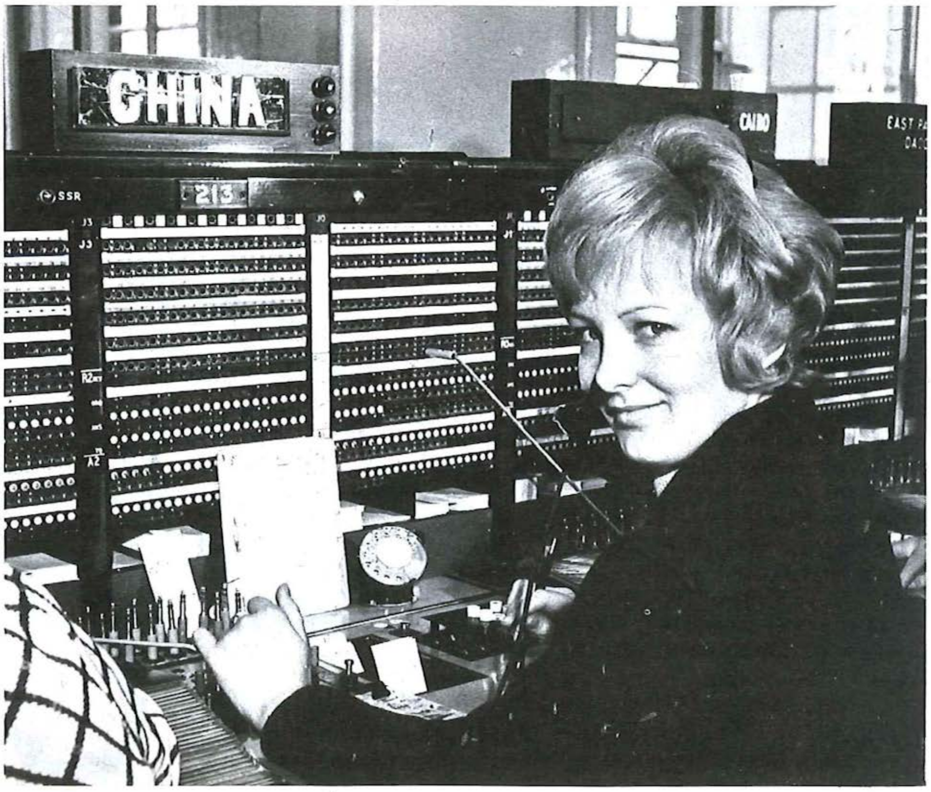
The extensions mark a significant step forward in the ISD services between Britain and the USA. The world's first major dialled telephone service across the Atlantic Ocean was opened between London and New York City in March, 1970 and this service was extended in February this year to more than 30 American cities.

Now customers in the six British cities with all-figure numbers have direct-dialling access to all automatic exchanges in the US (except Alaska and Hawaii)—about 99.9 per cent of the country's 115 million telephones.

The new ISD service started on 3 May in Birmingham (021), Liverpool (051), Manchester (061) and London (01) and in Edinburgh (on most numbers starting 031) and Glasgow (041) on 10 May. These cities already have ISD service to eight European countries.

Telephone operators at London's international telephone exchanges created a record in March when they handled a million calls in a month from customers in Britain to places abroad. The total was 30 per cent higher than the 760,000 calls made in March last year. Dialled international calls from the UK already number more than one million a month and the overall volume is expected to grow by about 20 per cent over the next four years.

A direct telephone service between Britain and China was re-established in April after a lapse of 22 years when a high-frequency radio link with Shanghai came into operation. The link, which was set up in March 1948, was closed-down by the Chinese telephone administration after only 14 months in service.



An international operator awaits a call from China.

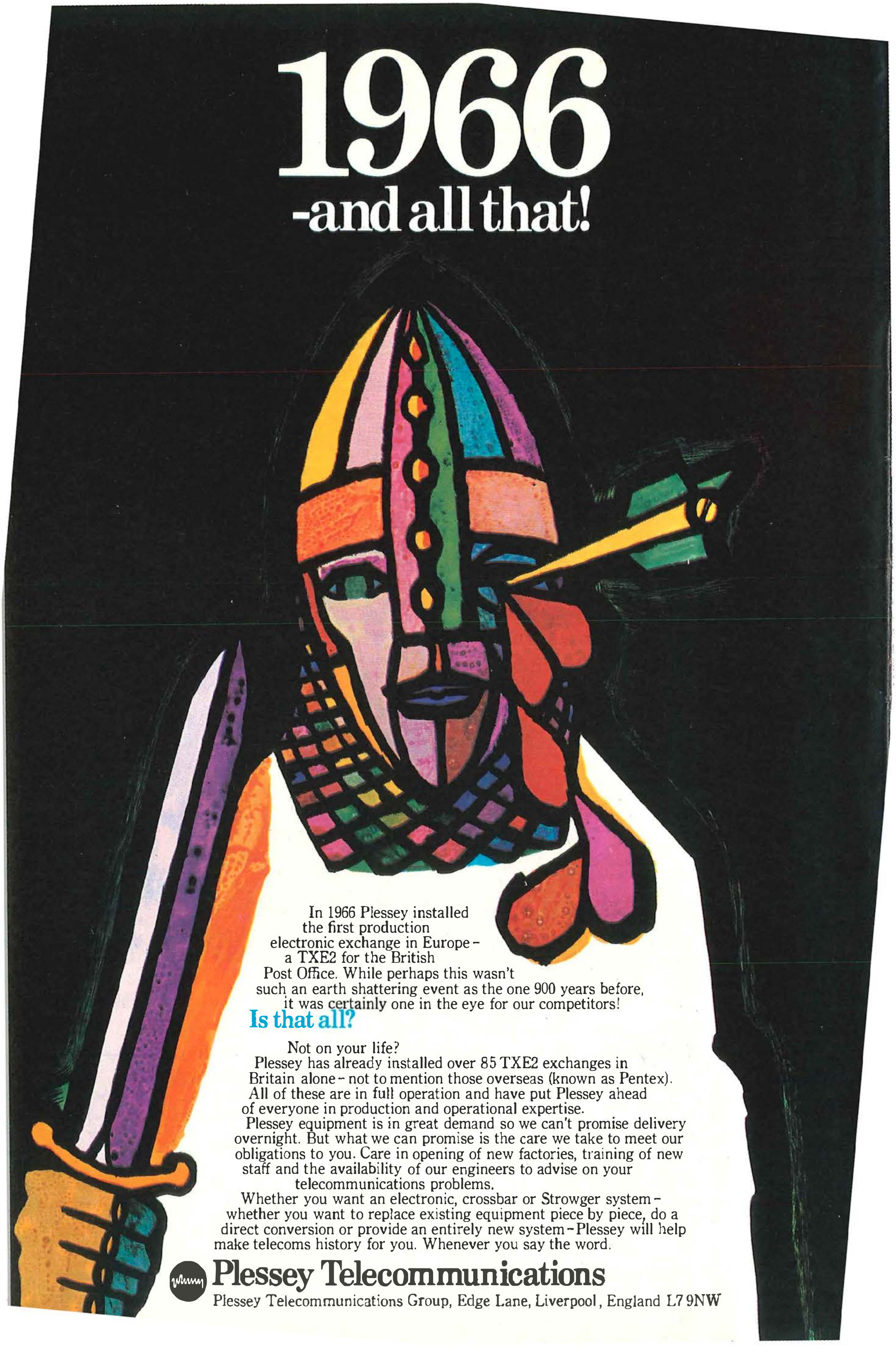
On-the-ball

THE POST OFFICE'S Test Match Information Service has been extended to Colchester, Ipswich, Grimsby and Reading for the England test series against Pakistan and India this summer. Enthusiasts in 68 towns can get up-to-the-minute scores between 8 am and 7 pm each day during Test Matches. Dial-a-Disc was introduced to Colchester, Ipswich and Grimsby during May.

With thanks

The Editorial Board would like to record its appreciation of the service given to the Journal by Mr. H. A. Longley who retired in May after 47 years in the Post Office.

Mr. Longley had been a member of the Editorial Board since 1962 and its Chairman since 1968. Before joining the Board, he contributed several articles to the Journal which ranged over his long interest in telephone traffic theory and service policies.



1966
-and all that!
In 1966 Plessey installed the first production electronic exchange in Europe – a TXE2 for the British Post Office. While perhaps this wasn't such an earth shattering event as the one 900 years before, it was certainly one in the eye for our competitors!
Is that all?
Not on your life?
Plessey has already installed over 85 TXE2 exchanges in Britain alone – not to mention those overseas (known as Pentex). All of these are in full operation and have put Plessey ahead of everyone in production and operational expertise.
Plessey equipment is in great demand so we can't promise delivery overnight. But what we can promise is the care we take to meet our obligations to you. Care in opening of new factories, training of new staff and the availability of our engineers to advise on your telecommunications problems.
Whether you want an electronic, crossbar or Strowger system – whether you want to replace existing equipment piece by piece, do a direct conversion or provide an entirely new system – Plessey will help make telecoms history for you. Whenever you say the word.
Plessey Telecommunications
Plessey Telecommunications Group, Edge Lane, Liverpool, England L7 9NW

book reviews

Colour Television Servicing by Gordon J. King (Butterworth) 316 pages plus index, £4.40

The author states in the preface to this book that, among other things, his aim was to write a comprehensive book about colour television and the servicing of PAL colour receivers in the most down-to-earth manner possible and with the least amount of mathematics. One will seldom come across a book which fulfils the aims of the author as well as this one does.

The basis of the complex subject of colour television is covered in the first five chapters in a clear and readable fashion. Five descriptive chapters follow in which the circuits in a receiver are examined; the relationships of each to the other and to the system are given with details of circuit operation, adjustments and commonly found facilities. The final six chapters deal with diagnostic testing and servicing of PAL receivers, including servicing in the field. Comprehension is greatly aided by the liberal use of diagrams, figures and photographs, which are well placed relative to the textual matter in most cases. A useful subject-index covering about 350 subjects is contained at the end of the book.

An overall impression of the book is that it is a well presented, well written book, covering the subject of colour television in a manner which would be comprehensible to the young engineer or technician of little experience, but at the same time not over-simplifying the subject to the point of offending the informed. The coverage given to the colour television receivers, adjustments and circuitry, skilfully guides the reader through the difficult area between working theory and detailed circuits, making detours into some of the circuit solutions adopted by different manufacturers and including examples of valve, transistor and hybrid circuits.

The servicing section presents a good deal of distilled know-how which could be of direct practical use. In addition, the examples on diagnosis should encourage the right sort of thought processes for successful servicing. The book can be highly recommended to those interested in the field of colour television, including serious students and enthusiastic amateurs as well as those primarily concerned with servicing.

GC

Electroacoustics: Microphones, Earphones and Loudspeakers by M. L. Gayford (Butterworth) 289 pages including appendices and index, £4.50

This book is one of a series of monographs which is being produced in collaboration with Standard Telephones and Cables Limited, with whom the author has been professionally associated for many years. It therefore carries authority appropriate to its subject and to the specialist reader to whom it is mainly directed.

The main object of the book is to give a broad treatment of electro-acoustic transducers for audio frequency operation, to outline the theory of their operation and to present contemporary practices in design and application. The first part of the book deals with the principles and design of transducers, both electro-magnetic and piezo-electric, followed by a section on the technology of microphones and earphones for general communications use; this deals particularly thoroughly with telephone receivers. Parts 3 and 4 give a general treatment of high-quality microphones and loudspeakers, particularly in respect of requirements and properties for use in broadcasting, sound recording and "high-fidelity" sound reproduction. Part 5 of the book, acoustic measurements, reviews subjective and objective tests including consideration of artificial mouths and ears. Finally, a series of short appendices summarises recent developments and gives useful tables.

Each section of the book concludes with an extensive list of references, from a wide range of sources and dated up to 1970. The book is comprehensive and well-supported with figures, tables and graphs. It can be thoroughly recommended as an educational text for students on degree and Higher National courses in telecommunications etc. as well as an informative reference book for engineers and others engaged in telecommunications and sound reproduction. The material on telephone instrument technology will have particular interest for readers of this Journal.

MBW

Telecommunications statistics

(Figures rounded to nearest thousand)

	Quarter ended Dec., 1970	Quarter ended Sept., 1970	Quarter ended Dec., 1969
TELEPHONE SERVICE			
Inland			
Net demand	279,000	256,000	284,000
Connexions supplied	272,000	257,000	278,000
Outstanding applications	284,000	277,000	248,000
Total working stations	14,712,000	14,448,000	13,641,000
Total working connexions...	9,057,000	8,881,000	8,342,000
Shared service connexions (Bus. and Res.)	1,686,000	1,646,000	1,517,000
Total effective inland trunk calls...	370,086,000	364,577,000	336,952,000
Effective cheap rate trunk calls	99,581,000	103,341,000	80,784,000
External			
Continental: Outward	4,160,000	4,183,000	3,635,000*
Inter-continental: Outward	545,000	534,000*	409,000
TELEX SERVICE			
Inland			
Total working lines	31,000	31,000	28,000
Metered units (incl. Service)	65,507,000	60,759,000	52,473,000
Manual calls from automatic exchanges (incl. Service and Irish Republic)	59,000	50,000	40,000
External			
Originating (U.K. and Irish Republic)	6,095,000	5,856,000*	5,183,000
TELEGRAPH SERVICE			
Inland telegrams (incl. Press, Service and Irish Republic)	1,923,000	2,291,000	2,059,000
Greetings telegrams	525,000	667,000	534,000
External telegrams:			
Originating U.K. messages	1,826,000	1,999,000	1,863,000
Terminating U.K. messages	1,779,000	1,871,000	1,764,000
Transit messages	1,621,000	1,639,000	1,605,000

**Amended figures.*

Publication and Price. The *Journal* is published in January, April, July and October, price 9p per issue. The annual postal subscription is 50p—reduced to 36p for former Post Office staff.

Advertisements. Communications, advertisement copy, etc., should be addressed to Sawell & Sons Ltd., 4 Ludgate Circus, LONDON, EC4M 7LE. (Telephone: 01–353 4353). No official responsibility is accepted for any of the private or trade advertisements included in this publication.

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 by 750, 1,500 or 2,000 words. The views of contributors are not necessarily those of the Board or of the Post Office.

Correspondence. Communications should be addressed to the Editor, Post Office Telecommunications Journal, Public Relations Department, Post Office Central Headquarters, 23 Howland St., LONDON, W1P 6HQ. Telephone: 01–631 2191 (editorial), 2193 (sales). Remittances should be made payable to "The Post Office" and should be crossed "& Co.". The Giro account number is 535–1006.

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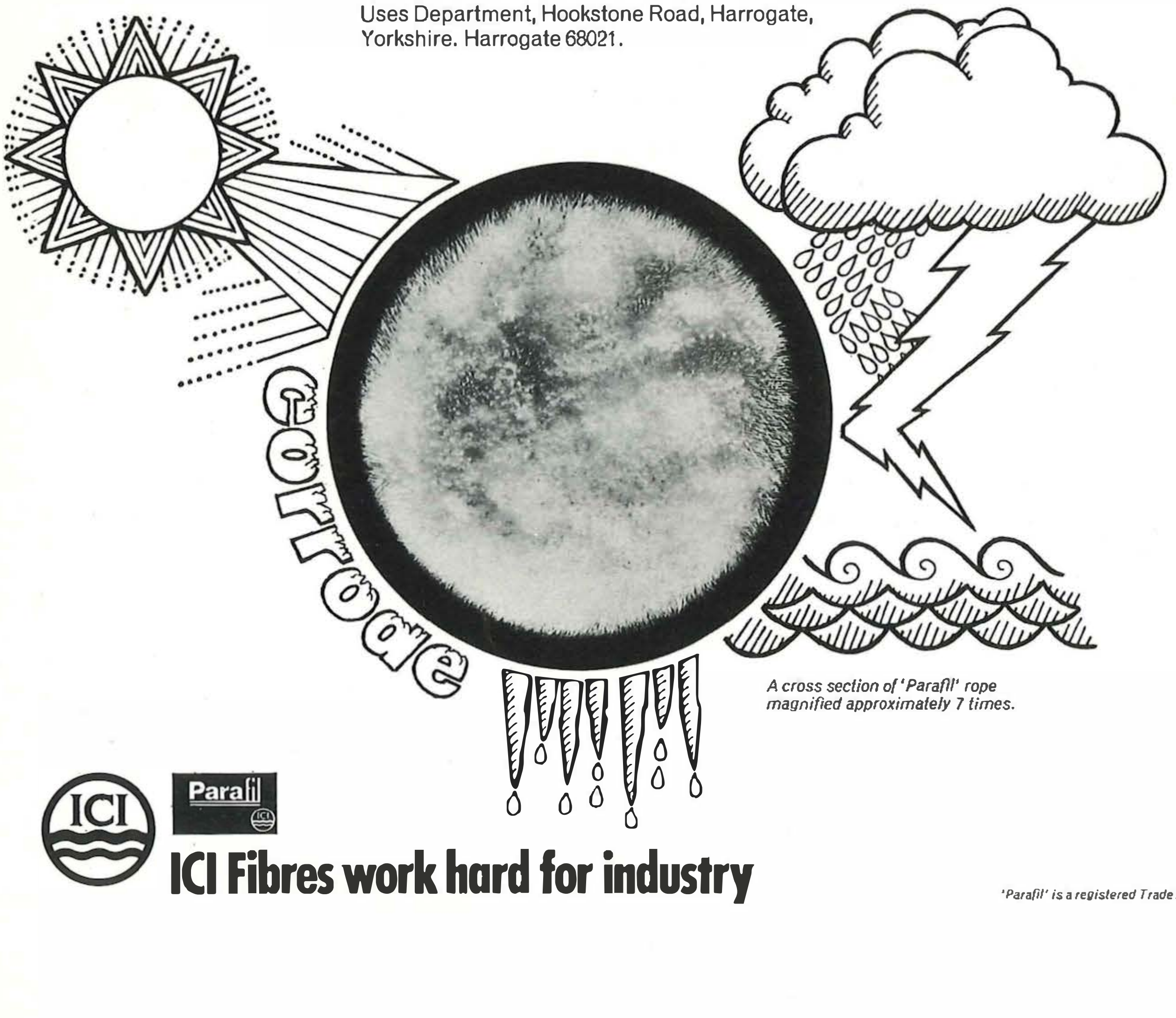
It's marketed in the U.K. by British Ropes Limited, Anchor and Hope Lane, Charlton, London, S.E.7. and by Marlow Ropes Limited, Lloyds Avenue, London, E.C.3.

To find out more, contact these firms direct.

Or contact ICI Fibres Limited, Industrial Uses Department, Hookstone Road, Harrogate, Yorkshire. Harrogate 68021.



A cross section of 'Parafil' rope magnified approximately 7 times.

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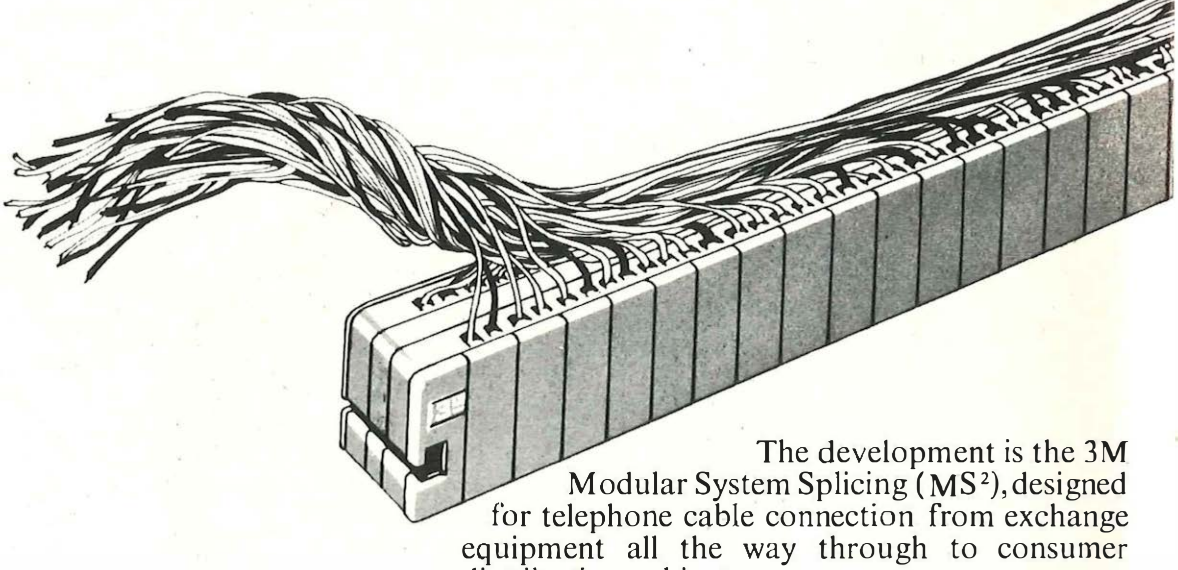
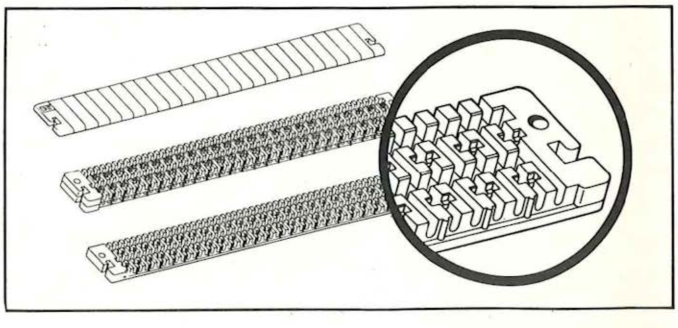


The development is the 3M Modular System Splicing (MS²), designed for telephone cable connection from exchange equipment all the way through to consumer distribution cabinet.

The heart of MS² is a three part module which connects 25 pairs of paper, pulp or plastic insulated conductors at a time using a simple



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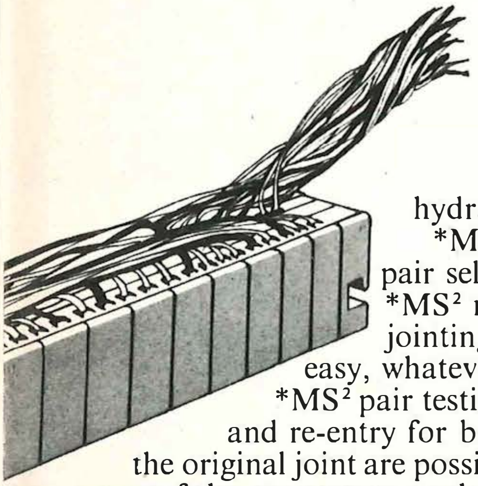
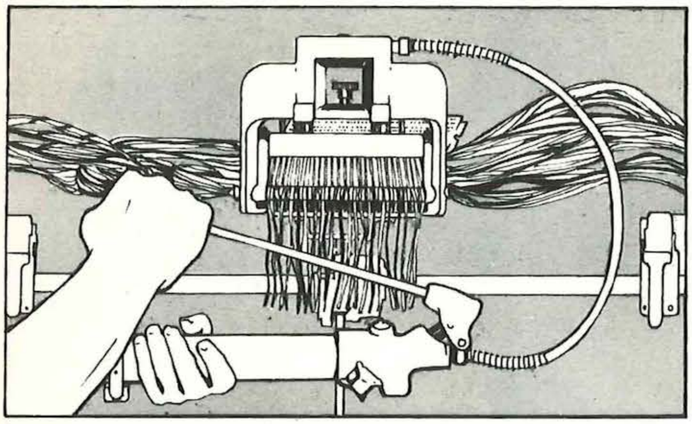
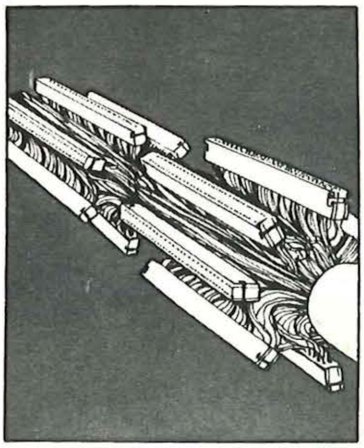


hydraulic crimping unit.
*MS² is fast – in correct pair selection and jointing.
*MS² makes colour coded jointing and pair checking easy, whatever sequence is used.
*MS² pair testing after connection, and re-entry for branch jointing from the original joint are possible without disturbance of the connectors or their integrity.



*MS² jointing rig is adjustable to suit individual jointer's needs.
*MS² modules can be identified simply by writing pair and group numbers in specially marked sections.
*MS² ageing tests on $6\frac{1}{2}$ lb. cable showed a typical resistance of less than 1 milliohm and only an average 3% change after test.
*MS² information available on successful Physical and electrical tests.
*MS² successfully accommodate $2\frac{1}{2}$, 4, $6\frac{1}{2}$ and 10 lb. conductors.



*MS² offers connecting, jointing, terminating, maintenance and installation capability.
*MS² meets these needs from exchange to cabinet.

This 3M development has been proved in the field and in the laboratory to be one of the most functionally reliable systems ever devised.

Under all known environmental conditions, the MS² 'U' element contact has shown an extremely low ohmic resistance change. In some cases, there was even an improvement of contact with time.

Of course, some people will prefer old-fashioned, tried and trusted methods. For that matter, there's no law against riding a horse.

3M Company Ltd., 3M House,
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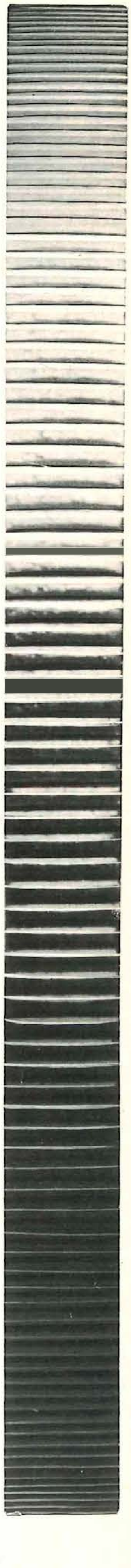

Ferranti all solid-state 300 channel long-haul communication system

Ferranti Type 14000/300 is a 100% solid-state, 300-channel long-haul Microwave Link. The system is engineered to exacting standards to operate reliably over long periods in the most adverse conditions at unattended stations, without maintenance. Type 14000/300 equipment is being supplied to the British Post Office.

A typical 7′6″ rackside in P.O. Type 62 practice. This is a 2-way, 1+1, space—and frequency-diversity terminal, containing four receivers, two transmitters and four power units, complete with modems, automatic switching and supervisory, test panel etc., all in modular form.

Panel space used by this equipment is a compact 4 ft. and all waveguide channelling is contained in that space.

Ferranti Ltd.,
Communication & Control Group,
Silverknowes, Edinburgh EH4 4AD,
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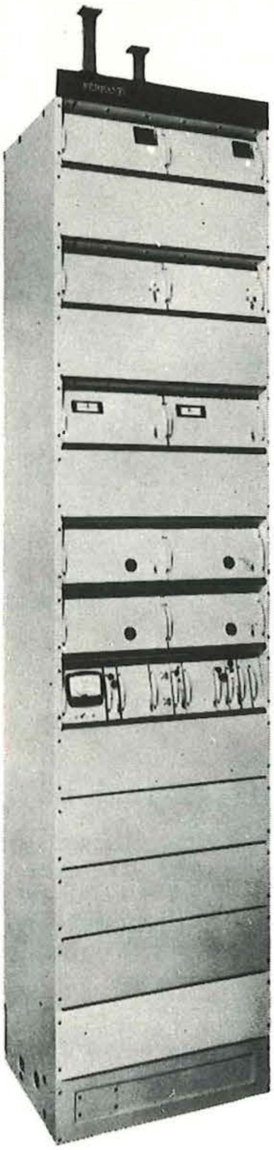

Brief Specification

Frequency Range
Variants available over band 5920 MHz-8200 MHz

Channel Capacity
300 Telephone channels for speech/data

Specifications
Meets or exceeds all C.C.I.R. recommendations and relevant P.T.T. specifications

Power Supplies
Mains or Battery operated

Construction Options
British Post Office Type 62 practice. Conventional 19″ rack mounting. Hermetically sealed units

Environmental Capability
Temperature Range—any 50° in the range -20°C to +50°C Relative humidity—95%

Systems Options

Hot Standby
Single or dual frequency with solid-state automatic changeover at radio frequency, intermediate frequency or baseband as required

Diversity
Frequency and/or space diversity

Repeater Types
Fully demodulating, or non-demodulating, with optional drop/inset facilities

Supervisory
Full remote indication/control facilities

CCD15a rb

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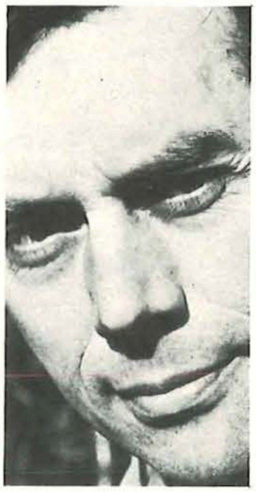
Signalling
Telegraph and Data
Equipment

Public Exchanges
Trunk Switching
RAX-UAX
Mobile Exchanges

PABX-PAX
Private Telephone
Systems



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