POST OFFICE

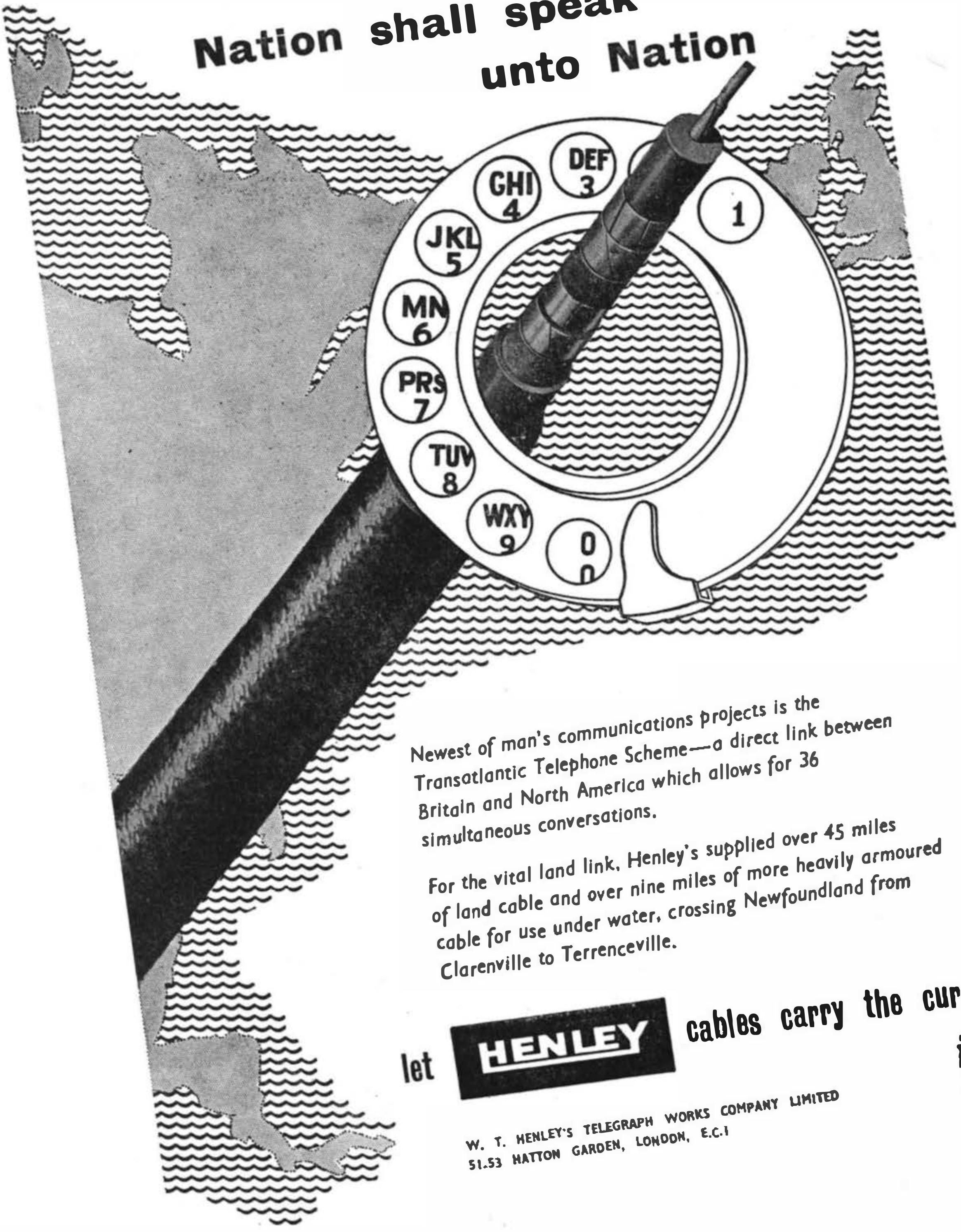
tele communications

JOURNAL

ONE SHILLING
AND
SIXPENCE

SPRING 1957

Nation shall speak unto Nation



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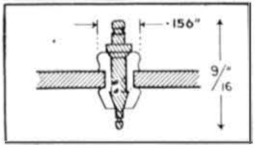

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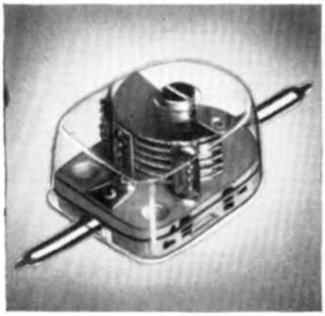

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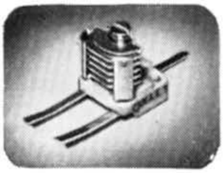

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Post Office Telecommunications Journal

Published by the Post Office of the United Kingdom
to promote and extend knowledge of the operation
and management of telecommunications

Contents

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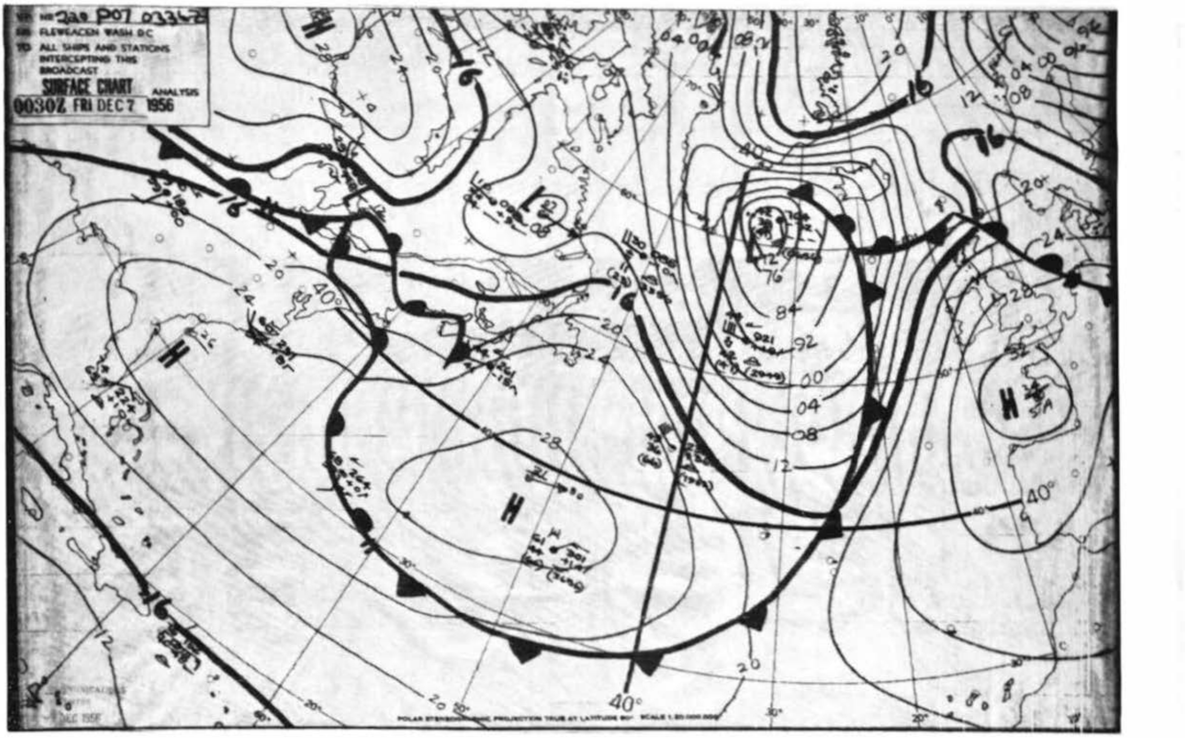
Vol. 9 *Spring, 1957* *No. 3*

Meteorological Messages

THE HOUSEWIFE RINGING WEA ON MONDAY morning—instead of looking at the sky and using her own judgment—to know whether she can safely hang out the washing may seem a very trivial use of meteorological science. But the complex organization which enables her to get the right answer also enables a pilot to plot his course with reasonable safety and to time his flight with reasonable accuracy over a route of several thousands of miles; helps ships in mid-ocean to avoid, or at least to prepare to meet, storm centres; gives farmers forecasts which help them in producing our food; and is a valuable aid to many other industries.

In this issue a meteorological expert and a Post Office engineer outline the work of Britain's "Met. Office" at Dunstable and show what a vital part Post Office and other telecommunication services play in helping us to know how and when a depression over the Atlantic or an anti-cyclone over the Pyrenees may affect the weather elsewhere.

Forecasting, though becoming more mathematical, is still empirical to a considerable degree, but it has advanced a long way since the days before the First World War. Telecommunications have played a large part in the advance, from the development of phototelegraphy to the invention of radio-sonde—that extraordinary device which, attached to a balloon and sent up to 60,000 feet or more, signals back the air pressure, the humidity and the temperature. The scientist and the mathematician play the greater part but ultimately they depend on the speed and reliability of the telecommunication services for exchanging their data and preparing a daily picture and forecast of the world's weather.



Weather chart

Britain's Weather Service

R. W. G. Carden • C. V. Ockenden

EVERYBODY IS AWARE OF THE EXISTENCE OF a weather forecasting service, if only because of the general weather forecasts broadcast by the B.B.C. and published in the daily press. Broadcasts have also made most people appreciate that weather forecasts are very important to farmers and shipping, but listeners do not always realize what a vital part forecasts play in the safe and efficient operation of civil and military aircraft. Even less do they appreciate the key position held by the Meteorological Office's Central Forecasting Station at Dunstable—the "nerve centre" of Britain's weather service—the vast quantity of data which has to be poured into Dunstable every hour, and the contribution made by the Post Office in transmitting these data and the subsequent forecasts prepared at Dunstable.

To compile a normal synoptic chart or "weather map" to meet the needs of the Central Forecasting Office, information is required on the instantaneous values of some 8,000 "elements" from a network of stations within an area from the Rockies to the Urals. A fresh chart is drawn every three hours, the fundamental hours being 00, 06, 12 and 18 G.M.T. At intermediate hours (03, 09, 15, 21), the area covered is rather less and fewer stations are plotted. Also, hourly charts are compiled for the British Isles and its immediate surroundings, and twice a day a chart is prepared for the whole of the northern hemisphere.

In addition to these charts which relate to conditions as observed from the earth's surface, upper air charts are prepared twice a day for several selected pressure surfaces in the atmosphere up to the height reached by radio-sonde* balloons, about 60,000-80,000 feet. The network of upper air stations is, of course, much less dense than that for surface observation stations, but the amount of information conveyed in an individual report is very much greater.

This vast amount of data has to be received at Dunstable and passed to plotters in the Forecast Division, and a large part has to be re-issued with a minimum of delay to operational stations, mostly civil and service airfields, from John O'Groats to Lands End. This is achieved very economically because a full surface "SYNOP" (synoptic) report consisting of only six or seven 5-figure groups conveys, in an internationally-agreed code, a complete "picture" of the weather experienced at a particular station, including observations of atmospheric pressure, temperature, visibility, types, heights and amounts of cloud, present and past weather, and so on. Looked at from another point of view it may appear extravagant because, first, not *all* the information can be said to be essential to *all* recipients *all* the time, and second, in stable weather conditions many of the figures appearing in the reports are unchanged from hour to hour; theoretically, the inclusion of the same figures or groups in consecutive transmissions is wasteful duplication, but there are several practical reasons why this must be done.

"Channel 1" Broadcasts

From a main switchboard at Dunstable teleprinter circuits radiate to about 12 meteorological "collecting centres" such as Uxbridge, Preston, and others, and each collecting centre has a switchboard with connexions to some 10 to 20 "satellite" stations, mostly on airfields. Between five minutes to and about three minutes past every hour a meteorological assistant at a satellite station reads his barometer and other instruments, makes "eye" observations, prepares his coded report for that hour, and stands by his teleprinter for a signal from his collecting centre to transmit the message. Having obtained each station's report an assistant at the collecting centre, after rapidly scrutinizing them for any obvious errors, omissions or garbling, transmits a collective bulletin simultaneously to all the stations on the teleprinter switchboard and to Dunstable, where it is received on a page-copy teleprinter and a reperforator; this is done by ten minutes past the hour.

Typical coded weather report

03772 62715 68808 05754 52602 48305 70459 85845

Explanation:—

03	Great Britain
772	London Airport
6	Total Cloud six-eighths
27	Wind Direction 270° (West)
15	Wind Speed 15 knots
68	Visibility 18 kilometres
80	Weather, slight showers
8	Past weather, showers
057	Barometer 1005.7 mb.
54	Temperature 54°F.
5	Five-eighths of low cloud
2	Form of cloud—large cumulus
6	Height of base of low cloud—3/5,000 ft.
0	No medium cloud
2	High cloud—dense cirrus
48	Dew-point 48°F.
3	Barometer rising
05	Barometer has risen 5/10 mb. in past 3 hours
7	Indicator figure
04	Rainfall 4 mm.
59	Maximum temperature 59°F.
8	Indicator figure
5	Five-eighths of cloud
8	Form of cloud—cumulus
45	Height of cloud—4,500 ft.

At Dunstable, operators tear off the page-copy material (3-ply paper is used) from the 15 or so teleprinters and put it on a conveyor belt which passes it to the editing and forecast rooms for plotting and processing. The corresponding "tapes" are marked and collected and taken to an operator at the switchboard for broadcast by automatic transmitter. At 10 minutes past the hour (H+10) precisely, the transmitter is connected to line and the tapes are fed through in sequence so that by 35 minutes past the hour (H+35) all stations connected to the network (approximately 150) have received all reports from the United Kingdom.

The plotting of local charts required at the outstations can start, of course, as soon as the first collective bulletin is received and goes on

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* *See leader, page 93.*

Preparing tape for wireless telegraphy broadcasts

as the broadcast proceeds. A good average rate of plotting is about three stations a minute, but the teleprinter broadcast provides the reports at the rate of about eight stations a minute.

By H+30 minutes, Dunstable has collected reports from the near Continent, Iceland, ships at sea, and so on. These are scrutinized and edited, and tapes are prepared for issue on the broadcast as soon as the United Kingdom station reports are cleared. In addition, "processed information" including coded surface and upper air analyses, forecast analyses, guidance forecasts and other messages prepared in the forecast room, is passed to the teleprinter room for "taping up" and inclusion in the broadcast according to a schedule which runs on until H+55, when broadcasting ceases and the lines are cleared for the collecting stations to take over the collection of the next hour's reports. This main "domestic" teleprinter broadcast has been functioning in one form or another since about 1938 with a varying number of recipients depending very largely on the number of airfields. In 1939 there were connexions to about 43 "tails", but during the war this increased to 552 by 1945 and the average since World War II has been about 150.

"Channel 2" Broadcasts

More foreign weather reports are received at Dunstable than can be accommodated in one broadcast and this, with the growth in the quantity of upper air data which became available during the last decade as a result of the development of the radio-sonde, makes it necessary to have a second broadcast to serve the collecting centres and important forecasting offices. This broadcast contains additional and more detailed information from a wider area and enables senior meteorological staff to give operational guidance to their stations as required for special operations. At present there are about 90 recipients of the "Channel 2" broadcast. The circuits are duplex so that centres can pass in to Dunstable reports from radio-sonde stations or from reconnaissance or transport aircraft, radar reports of cloud "echoes" and other special reports as soon as they become available.

"North Atlantic" Met. Broadcasts

Roughly speaking, the Channel 1 and Channel 2 teleprinter broadcasts contain data for the area of the east Atlantic, Iceland, western and central Europe and the Mediterranean, corresponding to the area for which data can be plotted on the chart normally used by outstations. However, about a dozen or so meteorological offices, including London Airport and Prestwick, require data for the western Atlantic and America. Dunstable supplies these data on a similar broadcast network, chiefly by "tape relay". The main collection is made by New York and about 120 bulletins, comprising some 30,000-40,000 five-figure groups a day, are transmitted to Santa Maria in the Azores on one leg of a radio teleprinter duplex-

Receiving a wireless telegraphy broadcast

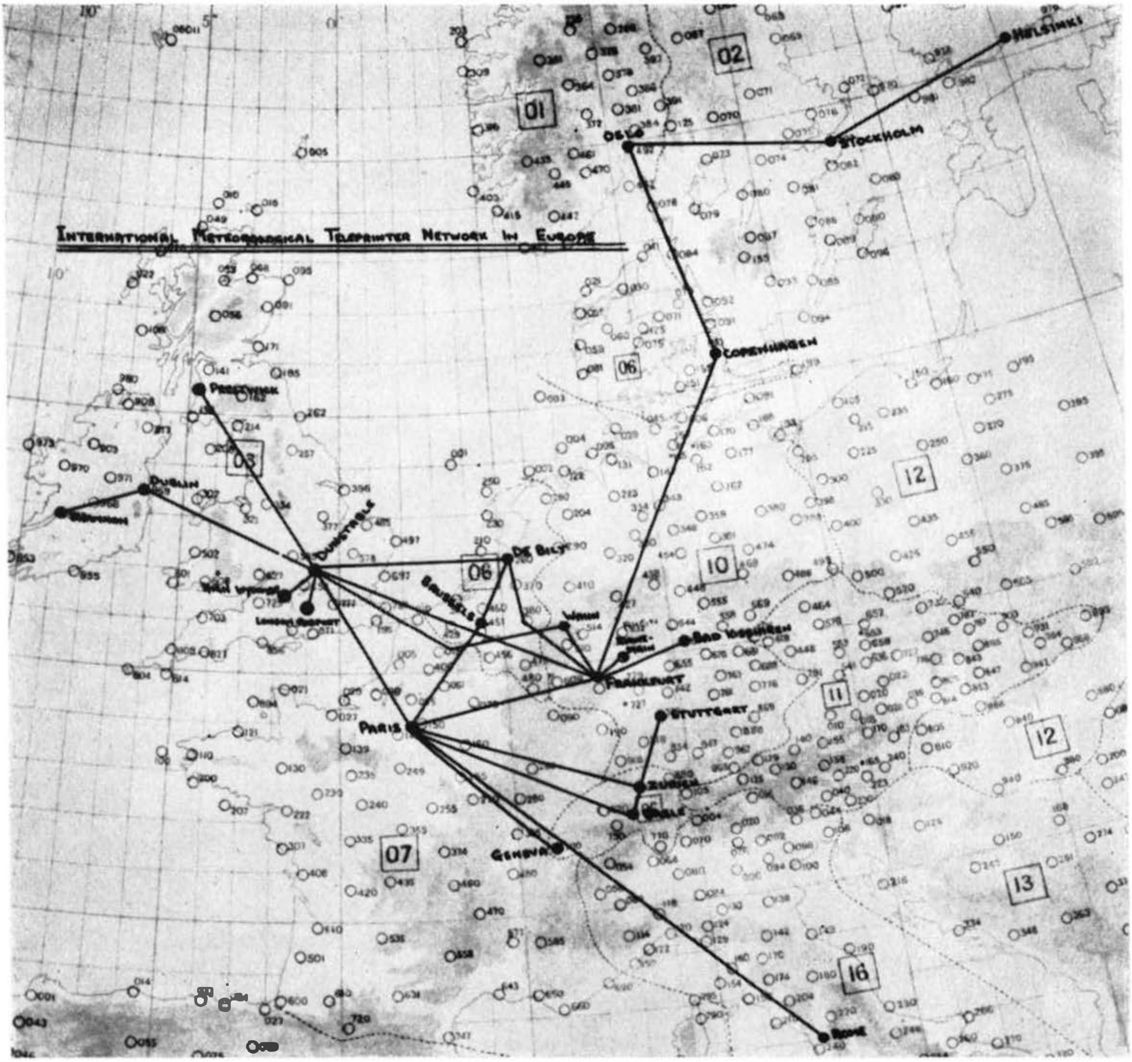
Teleprinter room [Courtesy of Muirhead & Co. Ltd.

diplex circuit. Santa Maria re-transmits by radio teleprinter to Paris, where the bulletins are distributed on land-line circuits to Dunstable as well as to Frankfurt-am-Main and Brussels, for further dissemination by these centres.

"Mediterranean" and "International" Met. Broadcasts

Many United Kingdom airfields require more frequent reports, with a considerable amount of coded "landing forecasts" from airfields in the Mediterranean area. Instead of each station employing man-power to intercept radio broadcasts from Cyprus, Rome, Malta, Gibraltar, and other places, interception is concentrated at Dunstable where the morse operator cuts a 5-unit tape at the same time as he prepares a page-copy for local use. These tapes are fed into another automatic transmitter and the data thus broadcast on a small network to the stations concerned.

Lastly, there is a special broadcast of data for a designated part of north-west Europe and the north-east Atlantic, responsibility for which has been undertaken on an international basis, and this broadcast is made on what is known as the International Meteorological Teleprinter Network for Europe (I.M.T.N.E.). This net comprises two duplex teleprinter circuits interconnecting Dunstable, Paris and Frankfurt with "feeder" circuits serving Dublin, Rome, Geneva, Copenhagen, Oslo, Stockholm and Helsinki, and there are



Western Europe International Meteorological Teleprinter Network

re-routing facilities through subsidiary centres at Utrecht and Brussels. Thanks to excellent servicing by the British Post Office and by Postal, Telegraph and Telephone administrations on the continent, breakdowns on the I.M.T.N.E. trunk circuits are extremely rare although traffic is passing continuously day and night according to rigid schedules framed to meet as fully as possible the varied requirements of the scores of meteorological forecasting centres scattered over western and central Europe. The schedules are published by the Secretariat of the World Meteorological Organization in Geneva and these schedules, with operating details, are kept under close examination by a Working Group of the European Regional Association of the Organization.

Adjoining the main editing and teleprinter rooms at Dunstable are the radio intercept and transmission rooms. For climatological purposes and for research into forecasting for periods longer than 24 or 36 hours there is a requirement for charts covering practically the whole of the northern hemisphere, for both "surface" and "upper air" conditions. Sometimes, especially in winter months, a depression may travel some 1,000 to 1,500 miles in 24 hours and the success of a forecast depends partly on the accuracy with which the centre of the disturbance can be tracked from chart to chart. Listening watches are therefore maintained on many wireless telegraph meteorological broadcasts emanating from regions where data cannot be obtained by line or radio teleprinter.

Ocean Weather Watches

Watches also have to be kept on transmissions from the "ocean weather ships" in the Atlantic. Most important, of course, for forecasting in this country are the reports received from selected merchant vessels in the eastern Atlantic.

The number of ship reports received averages about 140 per day; they are received by the Post Office coast radio station at Portishead and dispatched immediately by direct teleprinter line to Dunstable. (Readers who would like to know more about this will find a brief account of the arrangements in force in an article by W. Swanson in the *Marine Observer* for October, 1956.) In reverse, so to speak, Dunstable originates the broadcasts made to shipping by wireless telegraphy and radiotelephony from various coastal stations, and originates gale warnings and any special forecasts which may be requested. This is additional to "basic data" information, which is broadcast according to schedule for the benefit of naval vessels and services overseas by two Air Ministry stations and the Post Office station Criggion, whose transmitters are keyed by land-line from Dunstable.

"Weatherfax" Service

To give guidance to forecasters and briefing officers at the scores of airfields in this country, charts known as "prebaratics" and "prontours"* are compiled by the forecaster at Dunstable at scheduled times throughout the 24 hours. The charts consist of families of curves giving the expected pressure distribution and the positions of "fronts" over a wide area 24 hours ahead of the time of the charts on which the forecasts are based. When the chart has been completed an assistant marks off "key points" on the lines, reads off the latitude and longitude of the points, prepares a bulletin of coded groups, which may be very lengthy in complex situations, for the wireless telegraph and teleprinter broadcasts.

All recipients of the bulletins have to decode the message, plot the points and draw the curves and fronts freehand. Not only is the whole process laborious, but the chart prepared by the recipient is liable to differ from the original to an extent that derived information—for example, upper wind speed and direction—may be in serious error. To overcome this, a system by which the original weather chart can be reproduced simultaneously at a number of receiving stations has been devised. It is known as "Weatherfax" and consists of British-made Mufax facsimile equipment which can reproduce full size a weather chart measuring 18 by 22 inches. Mufax transmitters are installed at Dunstable from which facsimile broadcasts are sent out by radio and land-line. The chart to be sent is clipped around the transmitter drum, which is 22 inches long and 6 in diameter. The drum may be driven at 60, 90 or 120 revolutions per minute and the chart is scanned at 96 lines per inch. At a speed of 90 r.p.m. the transmission of a chart takes about 24 minutes. The broadcasts are received at outstations on Mufax recorders which reproduce the chart on electrolytic paper. The latest type of

Facsimile Recorder. (*Courtesy of Muirhead & Co. Ltd.*)

"Prebaratics" : forecasts from ground level data.
"Prontours" : forecasts from upper air data.

recorder operates entirely automatically, starting, synchronizing and stopping being controlled from the transmitter.

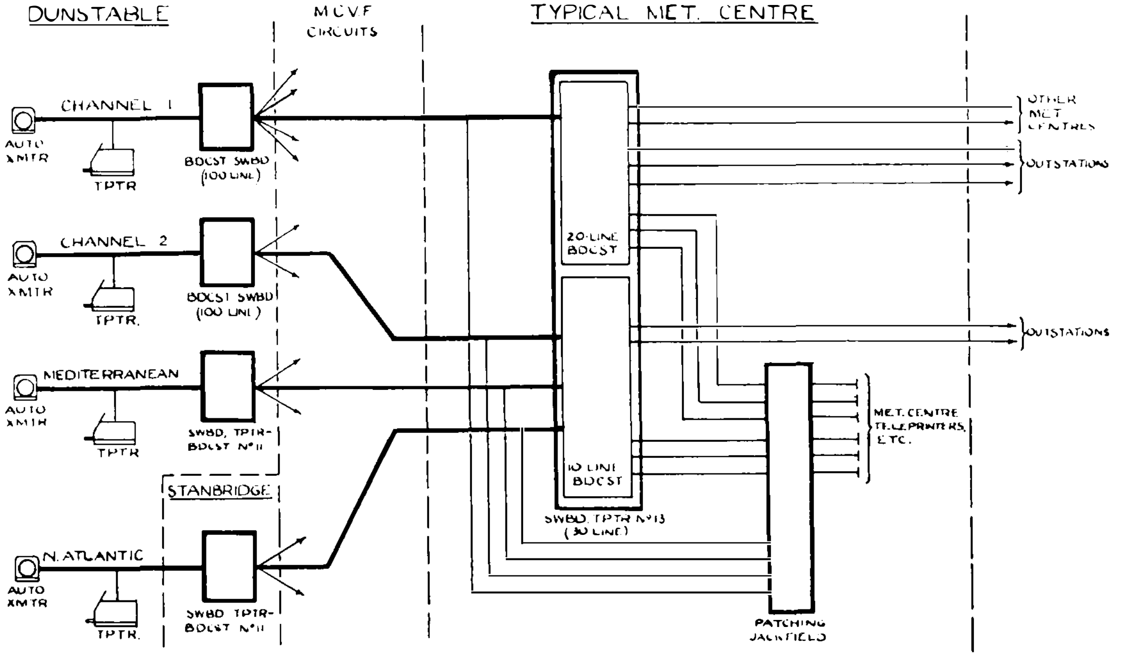
The land-line broadcasts are transmitted from Dunstable on a carrier frequency of 2,100 cycles per second over an omnibus telephone circuit to four main voice-frequency telegraph centres. At each main centre the signals are passed through a band-splitting filter to one or more multi-channel voice-frequency (M.C.V.F.) telegraph system lines for onward transmission to out-stations. As the facsimile signals occupy the band of frequencies lying between 1,600 cycles per second and the cut-off frequency of the circuit, only the band between 300 and 1,600 cycles per second is available for telegraphic use. The M.C.V.F. telegraph system is therefore restricted to a maximum of 10 channels.

Dunstable facsimile radio broadcast is made on a frequency of 4,780 kilocycles per second at present, while intercepts are made as circumstances require of foreign transmissions from New York, Montreal, Frankfurt, Oslo, Port Lyautey and Stockholm. San Francisco, Honolulu, Guam and Tokyo are also receivable under favourable propagation conditions. Facsimile is likely to be used to an increasing extent in the future for briefing aircrews on the latest weather map, transmitting pictorial route forecast charts, and exchanging weather-radar displays. It may perhaps be of interest to mention here that the Canadian meteorological service operates an extensive land-line "Weatherfax" system which uses Mufax equipment and connects forecasting stations from coast to coast.

The foregoing describes briefly the functions of the communications centre at Dunstable as carried out in the wireless telegraph reception and transmitting rooms, the teleprinter room, the facsimile transmission and intercept room and the editing room.

Post Office Circuits and Equipment

From this description it will be apparent that the Meteorological Service requires a large network of Post Office telegraph and telephone circuits and a considerable quantity of telegraph equipment, almost all of which is rented from the



Post Office. At present the telegraph machine installation at Dunstable consists of some 68 page-type teleprinters, 12 automatic transmitters, 42 reperforators and seven printing reperforators, while to equip the Auxiliary Met. Centres the Post Office has installed 21 30-line Teleprinter Switchboards, 13 10-line Broadcast Units and 19 8-line Conference Units.

The international met. teleprinter network in western Europe is shown on page 98. Action is in train to connect the international meteorological teleprinter network with a similar network in eastern Europe so that observations collected by Moscow, Prague and other main centres will be received in the United Kingdom without recourse to wireless telegraph intercepts. In fact, the use of morse wireless telegraph broadcasts for meteorological purposes is becoming out-dated. The internationally-agreed speed of 18 to 20 five-figure groups per minute is too slow to permit of enough information being received in time to be of adequate use in meeting demands imposed by aviation in these days of faster and higher-flying aircraft. Radio teleprinter broadcasts, planned for Dunstable, Paris and Rome, and already being made by Moscow, permit the exchange of nearly three times as much data in a given time.

Air Ministry Weather Actuals Network.

Although modern jet aircraft travel at speeds which only a few years ago would have seemed fantastic, they are prodigious users of fuel and the maximum flight duration of the smaller fighter and training planes is measured in minutes rather than hours. It is, therefore, a matter of some concern if there is a serious deterioration in the weather conditions at a base airfield between take-off and the time when the plane is due to return to base. In such circumstances the safety of the aircraft and its crew can depend on the ability of the base control to direct the aircraft to the nearest airfield at which landing conditions are suitable.

To meet this need the Post Office has provided for the Air Ministry a teleprinter conference network which is designed to give up-to-the-minute information on weather conditions at a number of widely-spaced airfields in the United Kingdom. This network, known as the "Weather Actuals Network", is shown schematically overleaf. It consists of three strategically placed 16-line conference unit installations which are fully interconnected by voice-frequency telegraph trunk circuits to form a conference network with a maximum capacity of 40 lines. Two subsidiary 8-line conference units (Units Tg. 3527) are being added to the network to expand its capacity.

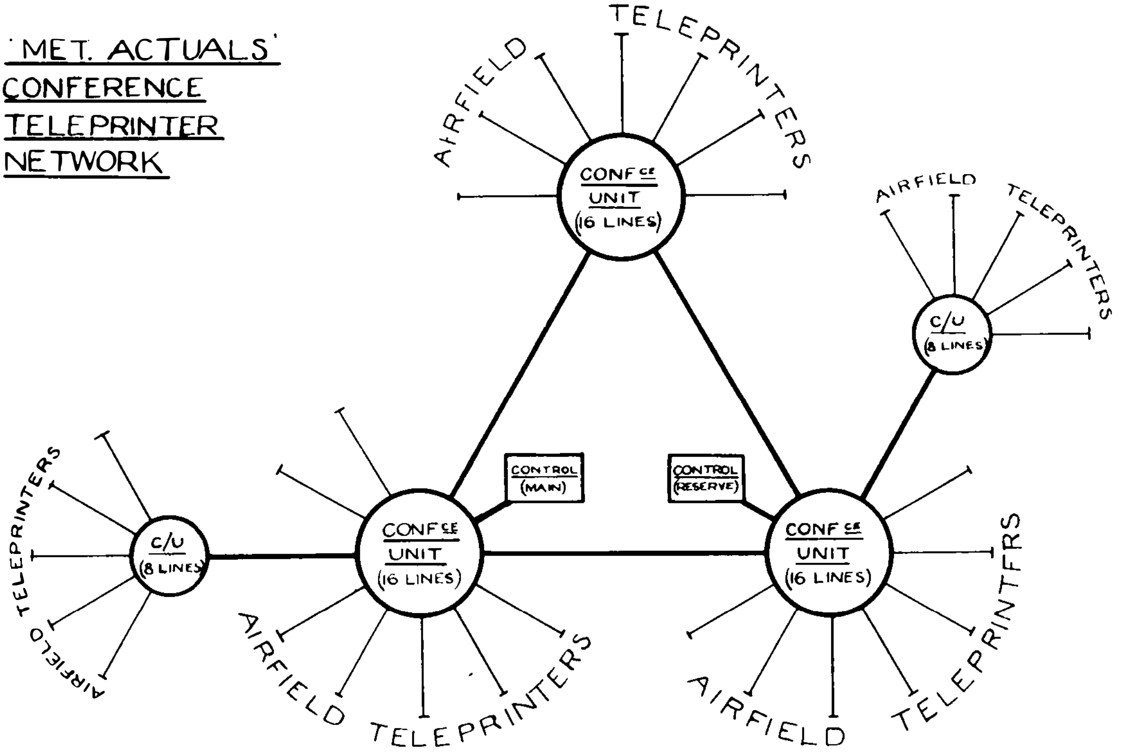
"Weather Actuals" broadcast report

		Cloud				
Airfield Code	*Landing State*	*Bottom Layer*	*Second Layer*	*Third Layer*	*Visibility*	*Weather*
Airfield A	Grn.	1 8 2,500	4 8 3,000	8 8 10,000	8 n.m.	Fine
Airfield B	Red	8 8 200			110 yds.	Fog
Airfield C	Yel.	1 8 4,000	3 8 10,000		3 n.m.	Fine
Airfield D	Grn.	1 8 2,000			13 n.m.	Fine
Airfield E	Red	7 8 2,500			1,900 yds.	Mist
Airfield F	Yel.	7 8 600			5 n.m.	Showers
Airfield G	Grn.	8 8 2,500			5 n.m.	Fine
Airfield H	Red	8 8 100			150 yds.	Fog
Airfield I	Grn.	7 8 2,500			6 n.m.	Fine
Airfield J	Yel.	1 8 1,500	5 8 2,300	8 8 8,000	3 n.m.	Showers
Airfield K	Yel.	3 8 2,500	8 8 3,000		2 n.m.	Fine
Airfield L	Grn.	5 8 2,500			16 n.m.	Fine
Airfield M	Yel.	8 8 2,000			1 n.m.	Haze
Airfield N	Grn.	1 8 2,500			4 n.m.	Fine
Airfield O	Yel.	8 8 400			2 n.m.	Rain
Airfield P	Grn.	0 8			14 n.m.	Fine
Airfield Q	Red	8 8 200			100 yds.	Fog
Airfield R	Grn.	1 8 3,000	3 8 4,000	6 8 8,000	10 n.m.	Fine
Airfield S	Yel.	1 8 1,000	8 8 3,000		2 n.m.	Showers
Airfield T	Yel.	6 8 2,500			600 yds.	Fog
Airfield U	Yel.	6 8 1,500			2 n.m.	Showers
Airfield V	Grn.	7 8 2,500			13 n.m.	Fine
Airfield W	Yel.	0 8			3,000 yds.	Haze

Each conference unit serves a number of airfields and the network is such that a message sent from any one airfield teleprinter is simultaneously received on the teleprinters at every other airfield connected to the network. Each airfield in turn is allotted 30 seconds in which to broadcast information on local conditions, and with the number of stations at present connected this allows a full statement of conditions at all reporting airfields to be disseminated every 15 minutes. All information is sent manually—no automatic transmitters are used for the transmission of messages—and the sequence in which the airfields transmit is controlled by an automatic transmitter at the control station which broadcasts the appropriate airfield code at the beginning of each 30 seconds period.

All stations connected to the network receive weather reports as they are broadcast, but not all stations are required to furnish reports. Some outstations therefore are equipped with "send and receive" teleprinters and the remainder have "receive only" instruments.

It is, of course, of great importance that the network should be as reliable as possible. To this



"Weather Actuals" network

end, conference units have been used which incorporate electronic broadcast units in the "send" side and an automatic cut-off facility which isolates faulty trunks or any group of eight lines which contains a faulty circuit. In addition a duplicate control installation has been provided which can be brought into service in the event of a breakdown of the normal control.

The Air Ministry has been very satisfied with the network which has achieved the object for which it was designed. The weather reports appear on the receiving teleprinters in compact page form and it is standard practice to transfer the "landing state" information to a wall map with the aid of coloured markers. In this way it is often possible to watch the progress of a weather "front" as it moves across the country.

One disadvantage of the system in its present form is the considerable force of skilled teleprinter operators required to maintain the service. This problem has been considered by the Post Office and the Air Ministry, and the Post Office has now designed a semi-automatic system which dispenses with teleprinter operators. In this system each sending outstation is provided with a set of multi-point rotary switches, the dials of which can be set to indicate the required information on local conditions. On receipt of a "start" signal from the control station, the local station equipment sends 5-unit teleprinter signals, which are generated electronically, and announces the sending station code followed by the information set up on the switches. This information is sent in under 15 seconds, enabling reports to be broadcast at twice the rate achieved by the manual system. Thus twice the number of reporting stations can be connected or, alternatively, reports can be received from each station twice as frequently. Plans to change over to this system are now going ahead.

What is Automation?

T. H. Flowers

“AUTOMATION” is one of the newest words to fire the public imagination and, like that other word, “atomics”, to cause it some anxiety. The anxiety is basically the same with both: the fear of the loss of livelihood, slowly, by creeping unemployment.

In a manner characteristic of the modern approach to new problems, much effort is being given to achieving a balanced view of the situation and to predicting in advance the effects of automation on our lives and society. The Department of Scientific and Industrial Research has taken a leading part in this direction and has published a booklet on the subject.* This article is intended to do much the same thing in much less detail.

In its simplest and widest sense, automation is the continuance of the movement which started some 200 years ago to augment and replace by machines the efforts of human beings. The steam engine and, later, other forms of prime mover, augmented and replaced human muscular force and movement. This started long enough ago for us to be able to see what effects it had on human society. The knowledge that some of the immediate effects were most unpleasant is one of the sources of apprehension about what this new development will do.

Muscles have to be controlled by a brain if the resulting force and movement are to produce useful results. The earliest use of steam was just to push on a piston and thus to move a load. A human brain guided a hand to operate the valves which controlled the movement of the piston. A boy saddled with the tedium of controlling the valves saw that the motion of the piston could be made to decide when to open and close them, and in that flash of understanding modern automatic machines were born.

Why then has the word automation only just recently been invented? And what is the difference between automation and the automatic machines we have known for so long?

No really satisfactory answer can be given to these questions but, before attempting to pursue them, let us see to its end the chain of thought which started with muscular force and movement but led to a brain to control the muscles. The brain has to have information to act on. It gets the information from the five senses of touch, smell, taste, sight and sound. However, the information is not by itself sufficient to decide the control which has to be exerted. It has to be interpreted into action. The interpretation may be fixed in advance: for example, “When you see the piston at the top of its stroke, open the inlet valve”. This action is that of obeying a memorized instruction, and it is not difficult to understand in man and machine.

Interpretation of a different kind is needed to decide what to do when confronted with a set of circumstances not recognized as having occurred before. This is creative thought and is not really understood in man, nor is it yet possible in a machine. Sometimes we believe we have had an original thought when in fact memory has recalled a similar situation in which we know what to do and from which the present action required is a simple deduction. Sometimes we keep on trying different actions until one gives us a satisfactory result. Some people believe that it may be possible to devise machines to “think” in these ways but, up to now, machines have only memories to obey instructions given to them in advance by a man. The machine with a brain, electronic or otherwise, is not yet a reality, either to work for man—or to overpower him as some people fear.

Machines masquerading as men fall short of men’s performance in many ways and excel them in others. The information which machines can gather from smell or taste is very little, if anything. Photo-cells enable machines to distinguish between light and dark, between large changes in colour, and small changes if they occur quickly enough, but on the whole sight is not very keen. Hearing by microphone is as good as, or even better than, human sound perception. Touch in a machine in

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* *Automation. A report on the technical trends and their impact on management and labour.* H.M.S.O., 1956.

the form of accurate movement or sensing of the position of something can be much better than in man. A machine can sense the proximity of a solid object without actually touching it. A machine can move and fix the position of something to closer than one-thousandth of an inch. A method recently developed at the National Physical Laboratory uses what are called gratings consisting of 5,000 lines to the inch ruled on plastic; the relative movement of two such gratings can be measured to the nearest 1/10,000th of an inch by using an optical system and photo-cells to count the lines as they pass one to another. Flying is an example of something a power machine can do but a man could never do unaided because his natural power-to-weight ratio is too low.

Where machine sensing is better than human, can it be used to control a machine to perform or make something beyond man's powers?

A machine tool directly controlled by a computer may possibly give an affirmative answer to this question. At present it seems that only the speed at which machines can work enables them to surpass the achievements of men, other than in producing things in greater numbers and more cheaply. There are, for example, accurate methods of calculating the stresses in complicated structures, like airplanes, which require so much computing as to be beyond the powers of humans, but not of electronic computers.

Application of Automation

At this point we might return to the question, what is automation and why has the word suddenly become popular?

Curiously enough, it is difficult to give positive answers to these questions. One manufacturers' association has defined automation as the technique of improving human productivity in industry. Certainly it is in industry and commerce that automation is being developed and used. This is perhaps hardly surprising. We would not expect our pleasures and relaxations to be substituted by machines but, nevertheless, it is reported that a machine for producing popular song tunes is in existence.

It seems that the modern interest in automation is due more to a better awareness of the possibilities of automatic devices by a greater number of people, than to anything fundamentally new in the subject by itself. Factors which have contributed to this include the evolution of a completely automatic factory. Recent advances in the machine handling of articles and particularly of automatically assembling complicated apparatus like radio sets have linked the previously known automatic machines to make the completely automatic factory possible.

Several other causes are also thought to be important. The electronic computer and kindred machinery are invading the territories of classes of workers previously immune from such competition, particularly the professions, such as accountancy; this is focusing attention on machinery. Doubtless also the rapid development of automatic control systems like robot airplane pilots has had an effect. Electronic devices have undoubtedly made a great contribution to automation by increasing the extent and accuracy of the controls which can be exerted and the speed and reliability with which they can act. It is very likely that a good deal of the public interest in automation arises out of the publicity given to electronics.

Some Examples

In making objects which require machining, a machine such as a lathe or milling machine is used. The rough part having been fixed in the machine, a man controls the cutting tool—in small-scale production—until the required size and shape has been produced. The automation method uses a punched tape like a teleprinter tape, or a magnetic tape, in which the required movements of the tool are recorded; this is fed into the machine and is used to produce the same effect as would the man. The tapes may be prepared by an automatic computer from the dimensions supplied from a drawing. In one particular type of machine an operator makes the first object by the usual manual control methods, all his actions being recorded on a tape which can then be used in the making—automatically—of any number of copies of the part. Such methods are more usually limited to short runs and may not greatly affect mass production.

A production process of interest to communications engineers is the printed circuit[†] which replaces the tedious hand process of forming, baring the ends and soldering a great many wires on to the tags of electronic components. In the new process the required wiring is printed as lines in waterproof ink on a thin metal sheet, usually copper foil, which has been strongly bonded to a sheet of insulating material. The layout of the components to be fixed to the wiring must be such that none

[†] *See "Printing Aids Electronics" in Autumn, 1956, Journal.*

of the printed lines cross one another. The combined sheets are immersed in acid which dissolves all the metal except that covered by the ink. What is left is a complete set of "wires" in their correct places. Holes are drilled through the board and wires at appropriate places, the wire ends of the components are pushed through the holes from the side opposite to the wiring, and a quick dip of the wire side into molten solder solders all the ends at one operation simultaneously. All these operations can be performed by a series of machines without human intervention.

The "process industries" offer great scope for automation and have been quick to adopt automatic methods. In an industrial process the chemical or physical state of the product, or its size or colour or some such property, is continuously observed and used to control the process. The previously discussed machine methods of "sensing" the required properties are the basis of this form of control by means of which vast plants, notably petroleum refineries, can work with very little human attention and yield products of great uniformity.

The newest field for automation is based on the use of electronic digital computers. The Post Office constructed a large machine of this kind some years ago for the Ministry of Supply. These machines operate with numbers to perform sorting, collating, mathematical and kindred operations at prodigious speed. Developed originally for scientific computation, they are now being applied to commercial office routines and professional work. The Post Office is contemplating a machine of this kind to do some of its pay-roll work; it regularly hires time on commercial machines for scientific computations.

These machines require punched cards, paper tape or some such means of feeding numbers in. Inside the machine there has to be a means of remembering numbers, and of reproducing them when required. The size of "memory" needed depends on the work being performed. Book-keeping for a business house dealing in many products and having many customers requires a very large memory, which may take the form of long reels of magnetic tape. The machine must also possess an arithmetic unit for performing the required mathematical operations, the results of which have to be put into the memory unit to be used again later in the same way as an arithmetical problem may need several lines of working before the final answer can be read out. Reading out from a computer is a question of printing or recording on a tape or card. The control of the task to be performed is specified by a set of instructions, called a programme, which is coded into numbers and fed into the machine together with the numbers required in the computing.

Electronic digital computers are expensive but they get through a vast amount of work in a very short time. In order to keep one busy it can be used to do work for a whole organization with a number of dispersed establishments, the information being fed to the computer by means of high-frequency telephone or low-frequency telegraph communications.

Automatic telephone exchanges go back a long time now in history, the first having been put into service long before 1900. All the major countries have reached or are nearing fully automatic working for their local calls and are extending automatic operation to all their national and ultimately their international calls. The system of subscriber trunk dialling which is to be introduced in this country will use many of the computer techniques just described. The routings and their rates will be stored in a memory unit. A built-in programme will cause the route and rate to be extracted from the memory when sufficient digits of a call have been dialled. The call will be set up and meter pulses generated as the call proceeds.

Another possible application would be to use a computer type memory to store the meter reading for each line and at the appropriate intervals to use automatic office machinery to read the meters and to make out the bills.

What of the Future?

The use of automatic computers in offices and industry is only just beginning. In the same way that the fully automatic factory is now possible, so fully automatic offices are in sight. In reaching this objective much work has to be done to analyse the present procedures and adapt them or devise new ones to fit the machine conditions. This will take time. It is thought that the rate of application of automation to industry and commerce will not be limited by the capital investment required, large as that will be. There may be some resistance from those whose traditional skills and managerial methods would be affected. The most decisive factor is likely to be the supply of trained managers, engineers and technicians.

Taking all factors into consideration, it is thought that the rate at which new machinery will be introduced will not be so great that the consequent re-adjustment and re-deployment of labour will cause serious hardship. Meanwhile working hours should be decreasing and many repetitive and boring tasks taken over by machines. Moreover, new fields will have opened up for manufacturing machines for automation with, of course, much scope for the new style technicians who will be required to maintain them.

Because the proportion of managerial, designing and technical posts naturally rises, the number of interesting and remunerative jobs will increase. Machine minding will also increase but an optimistic view of this can be taken that job satisfaction is likely to increase rather than decrease. This is because the machine minder will have a number of machines to supervise, giving him a wider view of the manufacturing processes involved and a greater sense of responsibility. Moreover, as his function will be supervision of machines instead of feeding them and taking away the finished product, the machine minder will not have the sense of being driven by the machines as he now so often has.

A high degree of automation is inevitable if this country is to maintain its competitive place in the world. Many of the consequences are attractive—greater leisure and more satisfaction from work. Given good will on all sides, there seems no reason why the necessary re-adjustments to society and industry should cause a great deal of stress and distress.

"Introducing Telex"

"*Who are those people?*"

"*I believe they're some film people—making a film about Telex.*"

"*Telex? What's Telex?*"

"*Dunno, but I think it's some new sort of toothbrush.*"

The title is that of a new film, which opens with the question—"What is Telex?", and then proceeds to answer it. The film is designed primarily to explain the service to prospective subscribers and business men generally, but is also to be used for information and training within the Post Office. The need for this is underlined by the above conversation overheard in an official canteen.

Creeds Limited (the teleprinter manufacturers) accepted a Post Office invitation to make a film and agreed to sponsor the production.

R.H.R. Productions, of Merton Park Studios, were asked to produce a script, which was written by Mr. R. F. Tambling, who later directed the film. The story tells of the mythical firm of Baskerville, Brown & Co. Ltd., of Norwich, how they decide to rent Telex and how they use it to improve their communications—and their business. We meet Harold Brown, the director, who welcomes the new service and whose foresight is justified; Mr. Dyard, his colleague, whose nature matches his name, but who is converted; and Miss Tapper, the typist-operator, who brightens the office, spreads an air of quiet efficiency and, occasionally, contributes to the commentary.

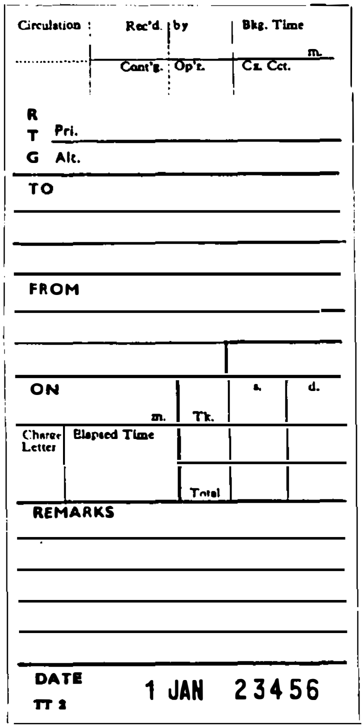
Brown is played by Martin Boddey and Dyard by Cameron Hall, but Miss Tapper—virtually the "leading lady"—is played by one of our own people, Mildred Morgan, a London telegraphist. Authentic touches are also lent by Rose Wederell, a London Telegraph Service Representative, who gives Miss Tapper her training, and by Ronald Gee, Technician Class I, from London South West Area, who, with his assistants, delivers and installs the new machine. Two other Post Office telegraphists, Margaret Vennell and Jean Wrighton, also appear in an early, explanatory, scene in which we are shown two teleprinters interworking.

On the "set" in Central Telegraph Office

Trial of a Ticket Date-Stamping and Numbering Machine

G. R. Sealey

The date-stamping and numbering machine described in this article is one of a number of developments at present under investigation to eliminate the manual counting of telephone tickets.


Circulation : Rec'd. by Bkg. Time m.
Cont'g. Op'r. Cz. Cct.
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Total
REMARKS
DATE
TT 2
1 JAN 23456

TT 2 type ticket

WE ARE ALL AWARE OF THE IMPORTANCE OF statistics to any large administration dealing with communications, not only for assessing current revenue and costs but also for the all important purpose of planning and fixing tariffs for the future. The main trunk traffic statistics required nationally are the totals of trunk calls handled during full rate and reduced rate periods, and a detailed analysis of every thousandth ticket.

At present only two methods are employed in exchanges for obtaining these statistics: manual counting and weighing. This may seem surprising in these days of advanced mechanization and it was not only with the idea of reducing tedious manual operations, but also of increasing efficiency and accuracy, that the Post Office approached a manufacturer of accounting machines to supply for trial a machine to date-stamp and number tickets consecutively.

The main difficulty in producing such a machine has, of course, been to design a suitable feeding mechanism, bearing in mind the flimsiness of the telephone ticket; indeed, it is understood that in the past this has made manufacturers reluctant to undertake a design. Powers Samas Accounting Machines have, however, overcome this difficulty successfully by employing a suction feed, and a prototype machine was delivered to Southampton Exchange in July, 1955, to undergo a field trial.

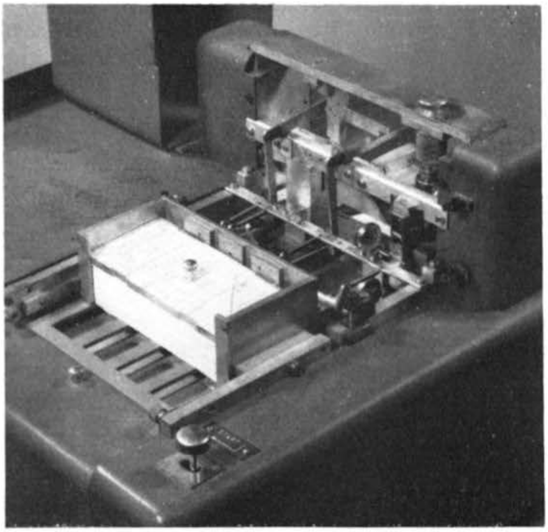
The machine was installed in an annexe adjoining the clerical and accounts room, allowing easy access by the operator carrying trays of tickets. This position was found to be desirable in view of the running noise which, while not great, would nevertheless distract other staff engaged on pricing duties. The noisiness of the prototype is not surprising, as it has no sound absorbing lining on the covers.

The machine is designed to feed and stamp tickets at the rate of 200 a minute. The date is set manually, but the tickets are consecutively numbered from 0 to 99999; that is, a straightforward count of 100,000 tickets is achieved before serial numbers are repeated. Tickets are fed from a magazine by air suction produced by an electrically-driven vacuum pump (decompressor). The suction is led to a carriage beneath the magazine where the lowest ticket is drawn and held against perforated suction pads, and is moved by the carriage into the feed rolls. A stop halts the ticket momentarily under the stamping mechanism before it is released into the discharge hopper.

The operation is simple and consists of switching on the electric motor, filling the magazine and pressing the starter button. Thereafter the discharge hopper must be emptied and the magazine replenished from time to time, the capacity of each component being about 600 tickets. A felt pad has to be re-inked after each run of 5,000 or so tickets.

Some re-organization of the exchange accounting work was carried out when machine dating and counting was introduced. Normally tickets are collected from the switchboard by runners at half-hourly intervals, chargeable timed calls being date-stamped by hand, and sorted into originating exchange order. Subsequently, the timed tickets are priced and counted in various categories for statistical returns (T6B), which are sent daily to the Telephone Manager's Office. At the same time each 1,000th ticket is selected for the trunk call analysis. The tickets are then bundled and despatched to the Telephone Manager's Office. The tickets may be priced and counted, particularly at times of pressure, several days in arrear.

To make the daily totals and sample tickets required for statistical experiments available as early as possible, it was decided to sort the tickets into originating exchange order and into the various T6B categories, and to machine them immediately. This procedure had the additional advantage that, by reducing the amount of handling, tickets were easier to stack in the magazine and were less likely to jam in the machine.

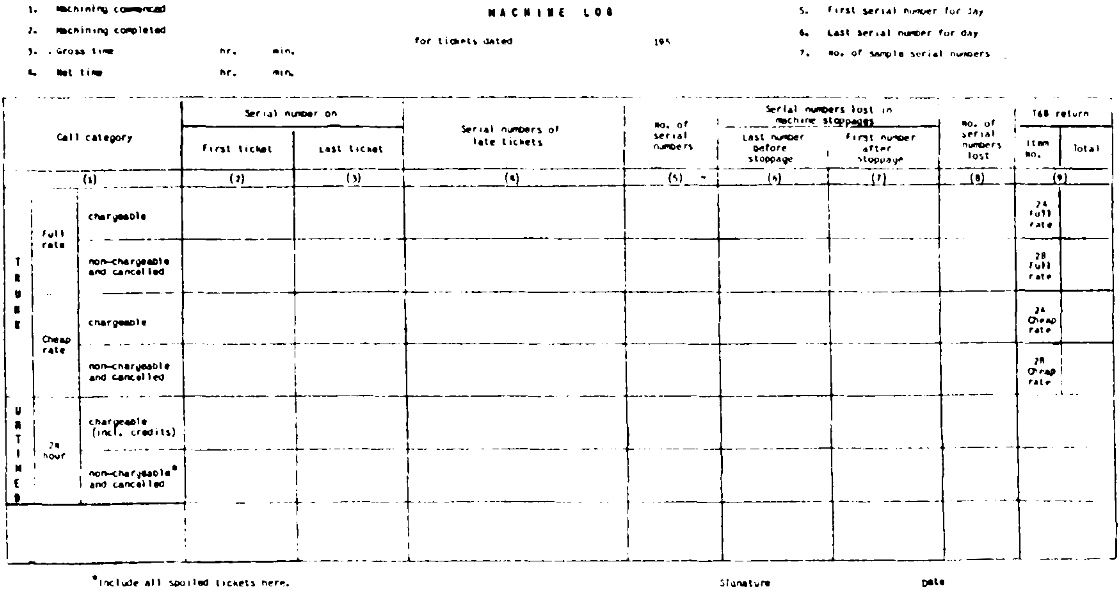

Detailed view of machine, with cover raised
(Courtesy of Powers Samas Ltd.)


General view of machine showing operator placing tickets in the magazine. *(Courtesy of Powers Samas Ltd.)*

Although untimed tickets are not normally counted in exchanges, they have been included in this experiment. The information is useful for exchange management purposes and the machine may provide a convenient method of obtaining it.

The diagram of the machine log form incorporates a "ready made" T6B return, which is completed daily. It is largely self-explanatory, the only reference to serial numbers being the five figure number printed on the right of the ticket. The trunk call analysis ticket is extracted by withdrawing every trunk ticket with a serial number ending in "000".

It will be seen that columns 6 and 7 cater for machine stoppages. At first, when teething



MACHINE LOG

1. Machining commenced
2. Machining completed
3. Gross time hr. min.
4. Net time hr. min.

for tickets dated 195

5. First serial number for day
6. Last serial number for day
7. No. of sample serial numbers

Call category			Serial number on		Serial numbers of late tickets	No. of serial numbers	Serial numbers lost in machine stoppages		No. of serial numbers lost	T68 return	
			First ticket	Last ticket			Last number before stoppage	First number after stoppage		Item No.	Total
(1)			(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	
TRUNK	Full rate	chargeable								2A Full rate	
		non-chargeable and cancelled								2B Full rate	
	Cheap rate	chargeable								2A Cheap rate	
		non-chargeable and cancelled								2B Cheap rate	
UNTIMED	24 hour	chargeable (incl. credits)									
		non-chargeable* and cancelled									

*Include all spoiled tickets here.

Signature Date

Machine log form

troubles were experienced and stoppages causing damage to tickets were frequent, allowance had to be made for the theoretical loss of serial numbers.

As can be imagined, the problem of tickets damaged or "wrecked" by machine stoppages gave rise to great concern, bearing in mind that, for the most part, the tickets passing through the machine were chargeable documents. Indeed, at the end of the machining process, an operator was often faced with the exasperating task of piecing together a mutilated ticket with Sellotape or attempting to decipher details of an original for copying.

It was not until January last year that it was felt that the machine would ever be a reliable proposition and would allow general usage by any staff. The improved performance and reliability were achieved only after the manufacturers had made determined efforts, and several re-designed and additional components had been incorporated.

Close watch is kept on accuracy and this is achieved by a daily test of 1,000 tickets, which are withdrawn for scrutiny. The results of these daily tests have shown that absolute accuracy is always obtained when the machine is correctly adjusted and clean, and an error nowadays of one unnumbered ticket in 500 is considered to warrant attention by the maintenance engineer. It is unusual to have to call for special attention if the machine receives regular maintenance at fortnightly intervals.

The main feature determining this frequency is that of paper dust—a problem, ever-present in paper feeding or punched card machines, to which British and American manufacturers are giving considerable thought. As will be appreciated, the amount of paper dust obstructing an air feed and clogging a mechanism depends, in turn, on the quality of the paper; hence, because of the texture of the paper used for telephone tickets (TT2) the machine must be cleaned regularly.

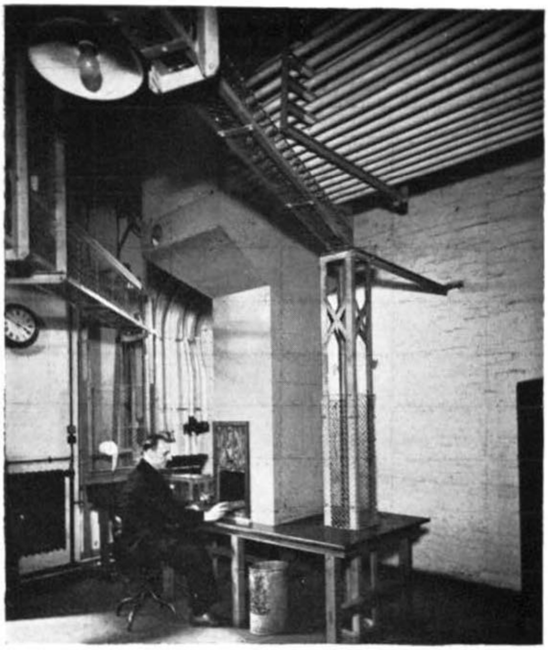
The question of advantage has to be considered in terms of increased efficiency in the day by day running of an exchange. Of great importance to management is the fact that a complete record is available on any day of the previous day's total traffic—information which is not usually obtainable until several days following.

Lastly, an unbiased sample of any size is readily available, by extracting tickets with serial numbers ending with pre-determined digits.

It would be rash to imagine that all exchanges, or even group centres, will be supplied with machines of this type in the future. However, it seems certain from the experience gained at Southampton Exchange that the Post Office would be justified in negotiating for the manufacture of additional machines, for use in the large exchanges.

The London Telegraph Street Tube System

J. Short



Incoming tube discharge chute

TODAY, WHEN A TELEGRAM IS HANDED IN AT the counter of a Post Office the first stage of its telegraph transmission is usually by teleprinter or telephone. In the reverse direction, too, a telegram arriving at a telegraph delivery office is generally received from the last transmitting office by one of these two media. There are, however, certain important exceptions where, for many years, another method of communication has been in operation at terminal offices.

A number of large towns have busy Branch Post Offices within a radius of, say, a mile or two from the Head Office. Large numbers of telegrams were accepted or delivered at these offices, at any rate in the past. In accordance with the principles of telegraph routing then in operation these telegrams had to be sent or received via the Head Office, usually an important zone or area centre on the telegraph network. The transmission of the telegrams by the methods then in general use—morse, in the main—was neither convenient nor economical. It was therefore necessary to find a cheap and rapid alternative method by which the telegrams could be exchanged between Branch and Head Offices.

The London Street Tube system was therefore developed for Central London, where there were many busy Branch offices. The area that it serves probably has a greater telegraph density—even today—than anywhere else in the world.

It is more than a hundred years since street tubes were first used for conveying telegrams. A tube between the Stock Exchange and the International Telegraph Company's telegraph centre was in use in 1853. The first Post Office street tubes from the Central Telegraph Office (C.T.O.) to Temple Bar and Charing Cross were completed in 1870. By 1875 the number had increased to 25, with a total length of some 18 miles. Today, street tubes radiating from the C.T.O. serve 40 London District and Branch offices, two postal sorting offices, two railway station offices, three service departments, and a branch of the Accountant General's Department. In addition three cable companies, three newspapers and one commercial bank privately rent tubes between their premises and the C.T.O. The lengths of the individual tubes vary from a few hundred yards to about three miles. The total mileage is about 75.

The tube system was severely damaged during the war. In December, 1940, when the C.T.O. was destroyed by fire, the air compressor plant and the automatic switching equipment in the basement were damaged beyond repair. Replacement of the plant and equipment was a formidable undertaking, but it was given a high priority after the war, and by the middle of 1946 the whole of the tube system had been restored to service. Many repairs had to be made to street tubes which had suffered damage from high explosive bombs, but some of the tubes laid under the City streets over 75 years ago are still in service today.

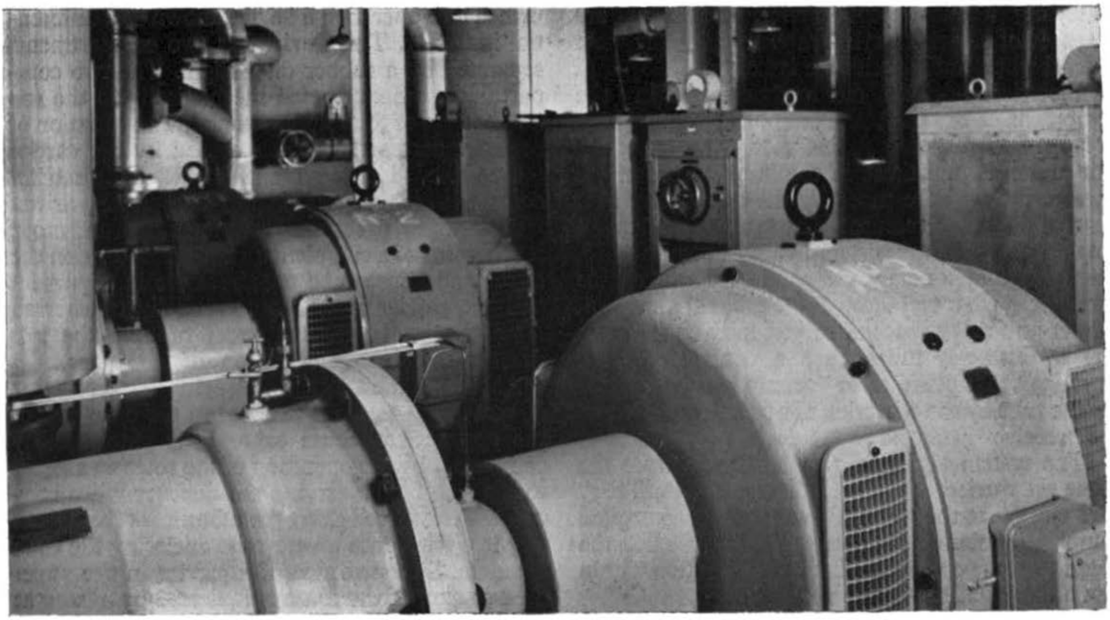
Some tubes are used for one-way traffic to the C.T.O. Others carry the traffic in either direction but where the traffic is very heavy, two tubes are provided to the same office, and the "up" and "down" traffic is conveyed by separate tubes. Most tubes are direct point-to-point connexions between the C.T.O. and the "out" offices. One or two offices are, however, intermediate on a through tube serving a more distant office. For instance, there is a terminal sub-centre on the tube system at the War Office. In addition to carrying War Office traffic, the "up" and "down" tubes carry the traffic for six other offices, mainly Branch post offices in the South West inner London Area. The tubes serving these six offices terminate at the War Office, and the traffic to and from the C.T.O. is intercepted and re-tubed at the sub-centre. Among the six offices is the House of Commons Branch office; when this is closed after normal hours the tube is extended to the Press Gallery in the House. At the War Office terminal, which also closes after normal hours, the tube is switched to connect with the C.T.O. Direct communication is thus made between the Press Gallery and the C.T.O. for sending Press messages arising from late and all-night sittings of the House.

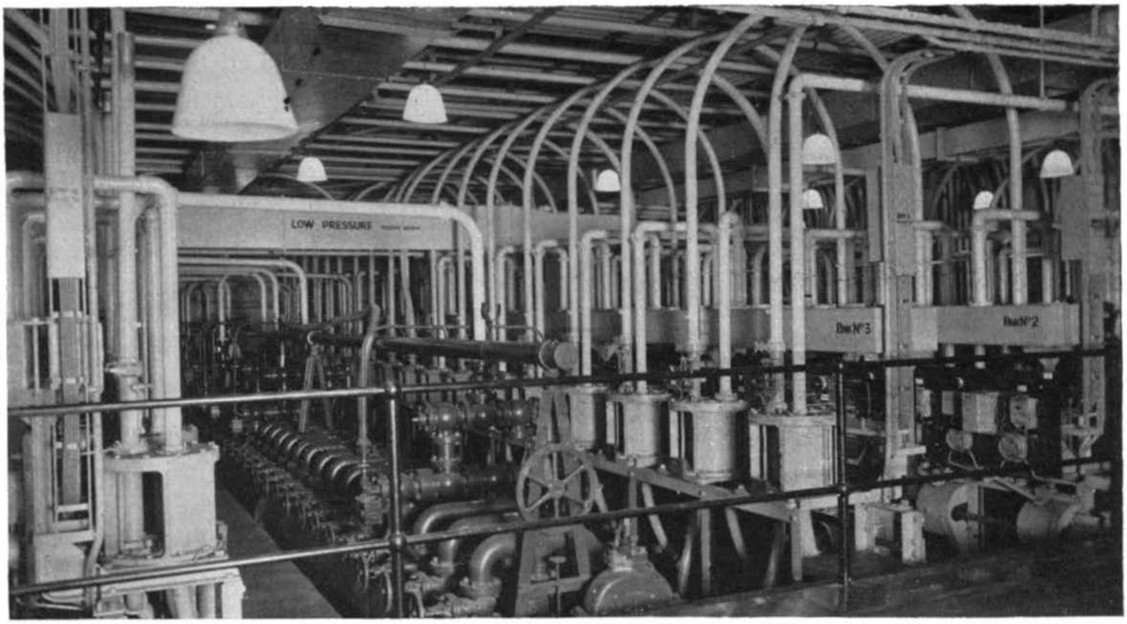
At present some 10,000 telegrams are conveyed by street tube each day to and from the C.T.O. The tube system must be maintained in a high state of efficiency if this considerable volume of traffic is to be accorded the rapid transit which its importance demands. The system is, in fact, remarkably free from major interruption arising from technical causes. Street repairs resulting in damage to the tubes are responsible for most of the minor interruptions.

The street tubes are made of lead and are laid in iron pipes at a shallow depth below street pavement level. The internal diameter of the standard tubes is 2¼ inches, but 3-inch diameter tubes are used on some of the longer and more heavily loaded routes.

The carriers in which the telegrams are conveyed are made of plastic material and are cylindrical. Those used for the 3-inch tubes are about eight inches long, and those for the standard tubes about five inches. At one end they have a laminated felt buffer of rather wider circumference than the body of the carrier; this serves to prevent leakage of air between the carrier and the tube when the carrier is in motion. An elastic band stretches lengthwise round the plastic body of the carrier and prevents the telegrams becoming dislodged from the open end during transit. A carrier for the standard tube is large enough to hold about 20 telegrams.

Electrically driven air compressors





Automatic switch room

In the longer and more heavily loaded tubes, carriers can be inserted at intervals controlled by a timing regulator. By thus avoiding the necessity of waiting until the tube is clear of traffic before inserting a subsequent carrier, the tubes are capable of a high carrying capacity which is most useful when traffic incidence is heavy.

Electrically-driven air compressors in the basement of the C.T.O. operate the system. The "down" carriers are forced along the tubes by air pressure, and those in the "up" direction are drawn through the tubes by the application of a partial vacuum. Pressures of up to 12 lb. per square inch above atmospheric, and vacua down to 6½ lb. per square inch below, are applied. These enable the carriers to travel through the tubes at a speed of about 30 feet per second or just over 20 miles an hour. Both-way tubes have a control valve so arranged that pressure or vacuum can be applied to the tube by the operation of a switch and "send" or "receive" arranged as required.

The system works fully automatically from the time the carriers are inserted at one end until they are ejected at the other. Pneumatically controlled automatic rotating switches at the C.T.O. link the high pressure or vacuum house tube system within the C.T.O. building, and vice versa.

On arrival at the rotating switch the carrier is stopped by a grid. The presence of the arrested carrier obstructs the flow of air and creates a difference in pressure across the switch, which brings into operation a device known as a differential indicator. This device has two compartments separated by a rubber diaphragm. The two compartments are connected mechanically to the top and bottom of the rotating switch. The variation of pressure across the switch caused by the carrier moves the diaphragm and makes an electrical contact which causes a magnetic clutch, driven from shafting, to seize the rotating switch and move it one-third of a complete turn. In this position the street and house tube terminals are in alignment and the carrier is thus automatically transferred from the high pressure street tube to the low pressure house tube extension, or vice versa.

At the C.T.O. a carrier conveying "down"—that is, outgoing—traffic is inserted in the open end of the appropriate house tube. It is automatically connected, by the operation of the rotating switch, to the street tube serving the delivery office concerned. It is forced along the tube and at the distant end is ejected into a wire cage enclosing the tube terminal. The presence of a carrier in the street tube section of the route is indicated by a lamp at the tube head. The light changes colour when the carrier reaches its destination or, with long tubes, as soon as a further carrier may be inserted.

A carrier conveying "up" traffic to the C.T.O. is placed in the tube at the distant office by lifting a small flap door which covers the aperture. It is drawn by vacuum through the street tube and is transferred again by operation of the automatic rotating switch to the appropriate C.T.O. house tube. All the house tubes to which incoming traffic is transferred at the C.T.O. converge and discharge into a single chute. By this arrangement two tube attendants can, at one point, conveniently extract the messages from the carriers ejected from all the tubes, and place them on a band conveyor which carries them to the circulation point in the instrument room.

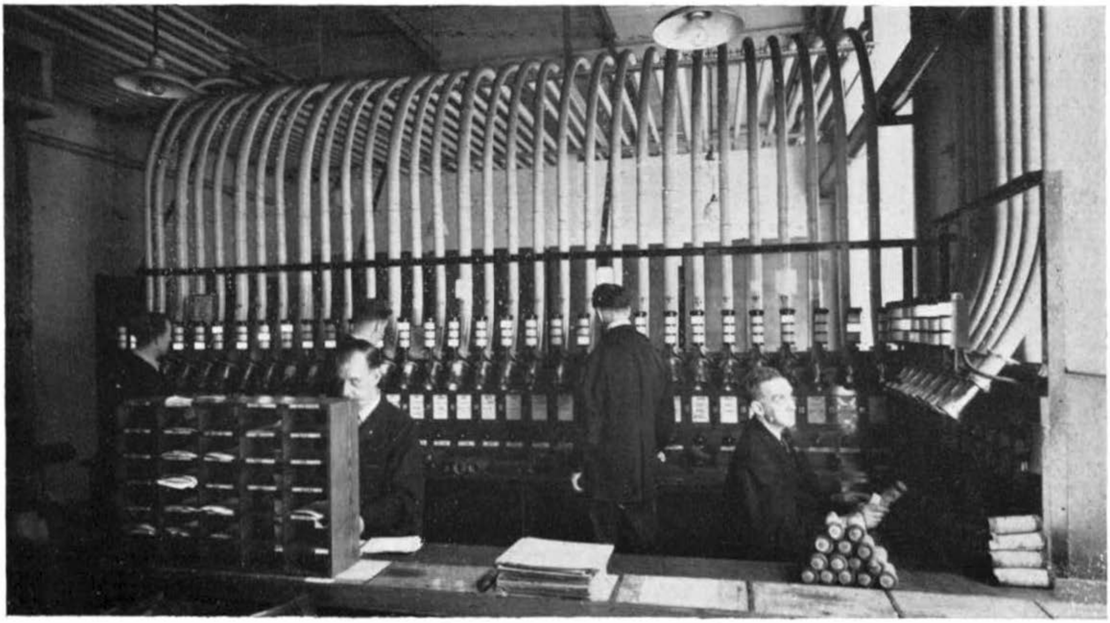
Once every hour a test carrier is exchanged between the C.T.O. and the terminal office on each route. This is to safeguard against possible delays caused by any obstruction that might not make itself manifest in normal course.

With the arrival of teleprinter automatic switching the pattern of the telegraph communications network today is very different from when street tubes were first introduced. At that time it was necessary, because of the limited extent of the telegraph trunk network, to concentrate traffic on large centres which were provided with outlets to other centres on the national network. By so doing, maximum use was made of the long and expensive physical circuits, but several re-transmissions were often necessary before a message reached its destination. The concentration on the C.T.O. of all the Central London tube office traffic was an illustration of the routing organization which then operated.

The development of voice frequency working by means of which telegraph channels are made available at a relatively low cost has in recent years made it possible to widen the access to the telegraph trunk network. Direct intercommunication by teleprinter over the national network is now provided at telegraph offices where the load is as low as 90 telegrams a day in both directions or 120 a day in the outgoing direction. Teleprinter working has already been introduced at nine of the busier London tube offices.

Tube working has therefore become obsolescent as a means of conveying telegrams from one delivery office to another. There still remains, however, the problem of the smaller offices which accept but do not deliver telegrams, and which already dispose

Outgoing tube terminals at Central Telegraph Office



of their traffic by tube. The recent fall in the amount of traffic handed in over the counters at these offices places many of them outside the range for economic inclusion in the teleprinter automatic switching network.

The normal alternative to tube conveyance for these offices would be disposal by telephone. This, however, often creates staffing, organization and accommodation problems at the busy and congested offices in central London. Hitherto, at these offices, telegrams have been despatched with speed and without inconvenience by inserting them into the tube concealed under the public counter from where they disappeared as if by magic.

At one stage facsimile seemed to offer the most promising alternative to tube working for these offices, but so far experiments in this field of communication have not been very successful.

Whatever alternative is ultimately decided on, whether it be teleprinter, telephone or facsimile, one thing is certain: the new method of working will not provide such long, economic and trouble-free service as has been given by the faithful street tube and it seems possible that street tube transmission in London will continue for some time.

Teleprinter Automatic Switching on a Private Network

M. G. Bell

ON JANUARY 17 THE POSTMASTER GENERAL opened the first privately rented network using Post Office teleprinter automatic switching (T.A.S.). Shell-Mex and B.P. Ltd., the renters, have used teleprinters since 1933 but, as the size and complexity of the network grew, operation on a manually switched basis became progressively more difficult. Expedients introduced from time to time to overcome or mitigate various troubles had inevitably complicated operating procedures. In 1954 the Company felt the time was opportune for a complete overhaul to increase efficiency and reduce staff costs.

The first step was to obtain detailed information on the network's traffic characteristics. Special traffic records were organized and on the data collected rough plans of suitable networks were produced. Two techniques were considered: tape relay and automatic switching. Although a number of refinements could be offered on the basic torn tape system, operators still had to be employed at the relay centres as well as at the outstations. On the other hand, T.A.S., while it needed operators only at the outstations, seemed likely to be more expensive in lines and equipment.

T.A.S., which was introduced on the public telegraph network in the period 1950 to 1954, provides for the direct transmission of messages from station to station via an automatic switching network. Fundamentally, the system is similar to an automatic telephone exchange network on which telephones are replaced by telegraph machines, and tone signals, such as engaged tone and number unobtainable tone, by automatically generated telegraph signals having recognized forms. Connexions may be set up from station to station within a few seconds, confirmation of each connexion being signalled automatically by receipt of the called station's code by the originator. Calls failing to mature because the wanted station is engaged may be automatically diverted to "overflow" telegraph apparatus associated with the wanted station's switching centre, the message being forwarded subsequently when the wanted station becomes available.

After careful study, assisted by demonstrations of the available systems, Shell-Mex finally decided that T.A.S. would be the most suitable if the Post Office could provide some terminal station facilities not available on the public network and reduce costs to a more acceptable level. Preliminary investigation showed that development of the extra facilities would not produce insurmountable difficulties, nor require an undue proportion of available development effort. The cost problem was more difficult.

Generally speaking a substantial portion of the cost of such a network arises from provision of the switching centres, and it was fortunate that considerable economy could be made by using

Shell-Mex House Teleprinter Room

switching centre equipment which had become idle at centres on the public network because traffic had fallen following the 1954 tariff increases. Although switching centre equipment such as power supplies and signal generators are shared, intercommunication is not possible between the public and Shell-Mex networks.

The expensive feature remaining was the cost of providing sufficient lines between the switching centres and the stations to be served. For successful operation of a switched network, the number of calls failing because lines are engaged must be kept low and this requires fairly light traffic loading of circuits. Even using four or five switching centres, however, the cost of many station line circuits could not be reduced below £200–£300 a year, and every expedient for reducing the number of station lines without risking objectionable overloading had to be examined.

The high proportion of rather complicated messages and order forms sent over the network had always led Shell-Mex to favour automatic transmitters rather than keyboard sending direct to line. This reduced line time per message and made practicable a more accurate assessment of the line time required at each station. Moreover, provision of automatic transmitters at stations serving as overflow centres made it worthwhile to accept overflowed traffic on reperforating machines instead of the teleprinters used on the public network. This meant that the operating work involved in handling an overflowed message was much reduced, and the objection to traffic being overflowed lessened. By accepting more overflow traffic in the peak hours station lines could be loaded to a greater extent than on the public network and, in fact, no standard grade of service, as used on the public network, was applied. Instead, Shell-Mex and the Post Office examined the traffic at each station and the number of circuits required was determined in the light of several factors which included the traffic to and from the station, the cost of a line to that particular station, and the importance of the station's traffic.

Eventually, a network based on four centres, London, Manchester, Glasgow and Bristol, was built up and, in April, 1955, the Post Office formally offered the network to the Company. The offer was accepted on condition that the work could be completed by the end of October, 1956, which left the Post Office 18 months to clarify details in the design, to obtain, install and test the new apparatus and to change over the network.

Although the planned system was basically the system used by the Post Office for public telegraph traffic, several new facilities had to be developed. The more important were:—

Teleprinters. Shell-Mex required page teleprinters and the standard page machine, teleprinter No. 7B, had to be modified to make it suitable for use on a T.A.S. network.

Printing reperforators. The standard machine was modified and a unit designed to separate consecutive messages automatically by an easily recognized series of letter shift characters punched into the paper tape.

Dialling units. The unit used on the public network was unsuitable. The modified unit provided an additional alarm operated on receipt of a figure shift-J signal used to indicate an urgent message, and key-controlled local record of signals sent from the station. The local record could be disconnected for duplex signalling but, generally, simple signalling with local record was to be used. A further development was the design of a dialling unit for use on station lines equipped with automatic transmitters. Having set up the desired connexion, the operator was able to load the automatic transmitter head with the message tape and then start the transmitter. The start key controlling the transmitter was given two positions, one for holding the connexion until the operator released it, the other for automatic release of the connexion when the tape had been fed through the head.

Precedence circuits. It was feared that the rather high circuit loadings being used might cause occasional difficulty in clearing traffic. Although delay could be tolerated on most messages, some had to be cleared very quickly. For these the Post Office developed a special selector which took preference over other calls which might be waiting for the required station. Access to the special selectors was restricted to the four overflow centres.

Terminal equipment in the 37 Shell-Mex offices concerned had, of course, to be installed without interrupting service on the manually switched network. The largest terminal installation is at Shell-Mex House, London, where 2,000–3,000 messages are handled daily. This office required special care in layout and furnishing to provide for an efficient flow of work and to reduce operating effort to a minimum.

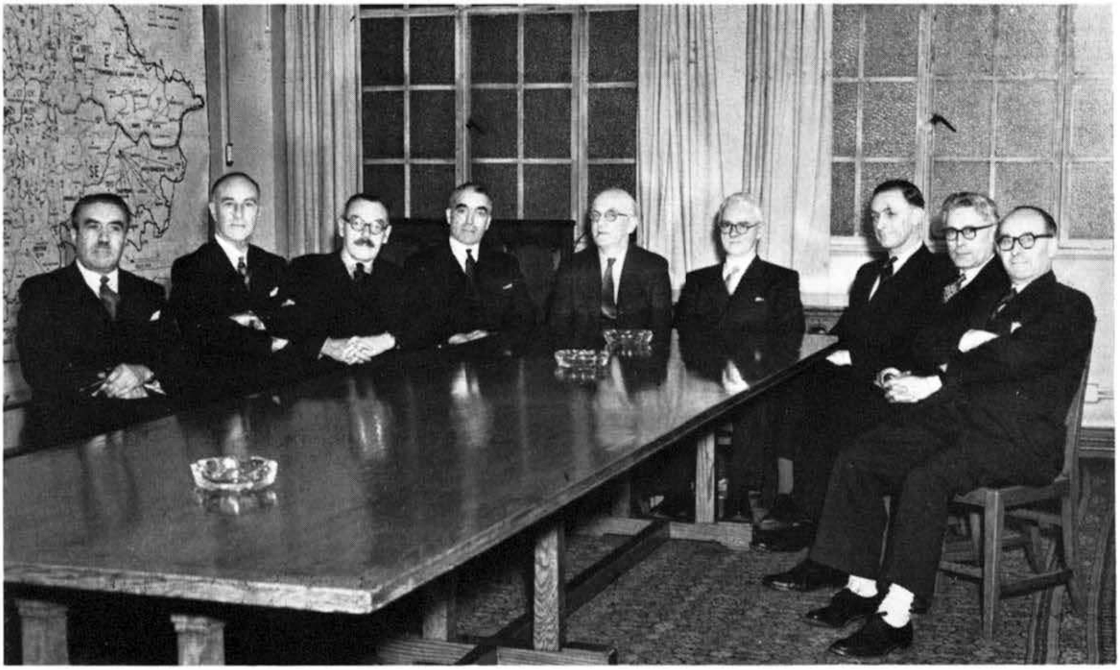
Messages for transmission are recorded on magnetic tape via the office internal telephone system or received in manuscript, are transferred to punched tape by operators at a suite of 10 perforating machines, and then fed by conveyor belt to a traffic controller. The controller allocates messages to the outgoing T.A.S. positions installed *en suite* with the receiving positions, local copies of sent and received messages being carried by a second conveyor band to a pneumatic tube station serving Shell-Mex House. The overflow reperforators are in specially designed three-tier cabinets at the back of the traffic controller, who thus has direct access to overflowed messages and is quickly warned of any traffic overload in the London area.

During installation Shell-Mex, in consultation with the Post Office, drafted their operation procedures and trained staff.

It was arranged that the changeover to the new network (based on four switching centres and comprising 83 station lines, 12 overflow circuits and 27 inter-centre trunks) should be made on October 29, 1956. From the moment of its birth the new system operated smoothly, a tribute to the meticulous planning and training and to the work of the installation staff. In fact the Suez crisis subjected the network to an immediate and severe test, for the quantity and importance of traffic increased as measures were taken to maintain oil supplies.

When the Postmaster General formally opened the network Shell-Mex had had 10 weeks' experience and they were generous in their praise. The average message clearance time in peak periods had been reduced from 60–90 minutes on the old network to under 10 minutes, working conditions had improved and working hours decreased, and a net saving at the rate of about £15,000 a year had been achieved. The most tangible tribute is that Shell-Mex have already asked that additional stations be connected and are planning further extension of the network to provide even wider coverage.

London Telecommunications Region



The Directorate: left to right: Mr. R. H. McGann, Telecommunications Controller (Service); Mr. C. O. Horn, Deputy Regional Director (Planning); Colonel H. B. Somerville, Regional Director; Mr. H. T. W. Millar, Deputy Regional Director (Staff and Services); Mr. W. S. Procter, Chief Regional Engineer (Staff and Services); Mr. G. S. Berkeley, Chief Regional Engineer (Planning and Works); Mr. R. Martin, Staff Controller; Mr. H. M. Turner (Telecommunications Controller (Planning)); Mr. F. W. Fox, Finance Officer.

FOR MORE THAN A THOUSAND YEARS THE estuary of the River Thames has been the gateway into England. More than nine hundred years ago the Normans fortified it with the Tower of London, overlooking the Pool, at the highest navigable point for seagoing ships. Round this fort the City of London grew up through the Middle Ages within protective walls which reached in a semi-circle down to the north bank, where the first of many London bridges linked the Continent by way of the Dover Road with the Roman trunk roads to the north.

Increasing trade, needing more dock and warehouse space, made London spill over the encircling walls to the east; pressure of increasing population soon joined the City to villages westward—Westminster, Charing, and many others—and in time those north and south.

Today nearly one third of the total population of the United Kingdom lives and works in the 1,200 square miles of greater London, to which London Telecommunications Region roughly corresponds. It would be a 50-mile walk from Stanford-le-Hope in the east to the boundaries of Windsor Great Park on the western extremity, and a 45-mile walk from north to south. Within this area are concentrated the centres of Government, great shipping and trading concerns with world-wide agencies, and the large financial houses and central markets. Light industry has been attracted to its outskirts increasingly during the past 50 years.

Nearly one third of the United Kingdom's telephones are concentrated in the Region which is also a focal point for trunk and toll circuits, continental and international telegraphy and telephony, and the newer telex and television networks.

The heavy concentration of population in this relatively small area has determined the Region's composition and development. When the Post Office was regionalized about 20 years ago the postal and telecommunications sides, though operating over virtually the same geographical area, were each given separate directorates, and the Telecommunications administration at Regional Headquarters was divided under two broad headings, "Operations" and "Planning", each under a Deputy Regional Director.

The L.T.R. contains a comparatively small number of exchanges—only 283, 50 of which are manual. But some in the business centre of the Region may be as large as an exchange for a provincial town, while others on the fringes are semi-rural, with small manual switchboards. This diversity within a small geographical area, and the daily flow of population to and from the dormitory suburbs, introduces the acute service problem of differing peak traffic times.

Upwards of eight million wire-miles of telephone line run over and under Greater London's streets and the mileage is increasing year by year, as some 80,000 additional subscribers are given service.

It took 57 years, from 1879 to 1936, to create the first million stations on London's telephone service and 18 more years (including six years of war) to build the next million. More than a quarter of a million more stations have been installed since the two millionth was opened in September, 1954.

Today, London telephone service is handling about 35 million outgoing calls a week.

Future planning is particularly difficult, for the acquisition of sites for new telephone exchanges cannot be left until building is imminent. Sites have to be earmarked as long as 15 to 20 years in advance. The growth of, say, a factory estate in a dormitory area can swiftly change the character of the neighbourhood and so the potential demand for service. Constant re-planning is necessary to meet such changing circumstances.

The effect of a rising standard of living on the demand for telephone service creates a problem. Although the Region has doubled the number of its telephones since the war and has been installing new telephones at an increasing rate, the order list has only recently started to decline.

London's telephone service can never be static. With the coming of the Air Age, London's seaport to the east has been balanced by one of the world's largest airports near West Drayton, on its western fringes. The river docks and warehouses will continue to handle the bulk of heavy freight for some time, but will a time come when air-freight supersedes the slower cargo vessels and the focus of London shifts from London Bridge and Throgmorton Avenue—the financial centre—to West Drayton?

Inland Telecommunications Statistics

	Quarter ended 31st December, 1956	*Quarter ended 30th September, 1956*	*Quarter ended 31st December, 1955*
Telephone Service			
Gross demand	95,076	89,711	107,793
Connexions supplied	103,968	92,029	111,469
Outstanding applications	267,993	296,711	359,201
Total working connexions	4,412,303	4,357,610	4,208,232
Shared service connexions	1,160,441	1,135,390	1,053,014
Traffic			
Total inland trunk calls	79,946,000	82,733,000	81,800,000
Cheap Rate	18,163,000	21,460,000	20,511,000
Inland telegrams (excluding Press and Railway) ...	3,764,000	4,630,000	4,442,000
Greetings telegrams	781,000	1,011,000	939,000
Staff *			
Number of telephonists	47,216	48,523	48,824
Number of Telegraphists	6,178	6,363	6,965
Number of engineering workmen	64,295	63,779	61,671

* Staff figures relate to the 1st January and 1st October respectively

Tropospheric Forward-Scatter Radio-Relay Systems

W. J. Bray

DURING RECENT YEARS RADIO ENGINEERS concerned with point-to-point communication systems have shown great interest in a mode of radio wave propagation involving scattering in the troposphere, which is the lower region of the earth's atmosphere within about six miles of the earth's surface.

This mode of propagation has the outstanding property that it enables radio-relay links providing up to a hundred or so telephone channels to be established over distances of up to two or three hundred miles without intermediate repeater stations; even greater distances, perhaps up to six hundred miles, appear to be achievable if very high power transmitters and exceptionally large aerials are employed. There is also some prospect of the transmission of television signals over distances of up to about two hundred miles.

However, it must be stressed at the outset that this technique has certain limitations and is not a panacea for all the long-distance transmission problems of the telecommunications engineer.

If a beam of radio waves having a wavelength of less than about one metre starts off approximately parallel to the earth's surface, it is well established that the received signals become very weak in the region beyond the horizon, as seen under conditions of perfect visibility from the transmitting aerial. However, it is also known that some signals, although weak, can be received beyond the visible horizon under suitable conditions. Indeed Marconi, in 1932, carried out experiments which demonstrated that communication was possible over a distance of 168 miles using a frequency of 500 megacycles per second (Mc s) (0.6 metre wavelength), but communication was not reliable because of the limited transmitter power and the small aerials then available.

The development of high-power radar equipment and the trend to shorter wavelengths in World War II made possible more extensive observations of propagation beyond the horizon. These observations, however, were mainly of "anomalous" propagation occurring during exceptional meteorological conditions and it was not until 1950 that the pioneering work of the late Dr. E. C. S. Megaw of the Admiralty Signal and Radar Establishment demonstrated that persistent signals could be received on 3,000 Mc s (10 centimetres wavelength) well beyond the horizon of a long oversea path. Megaw advanced an explanation of these signals in terms of "scattering" in the troposphere. At about the same time H. G. Booker and W. E. Gordon in the United States also developed a theory of wave propagation by scattering which stimulated an immense volume of experimental and development work in that country.

It is to be noted that the tropospheric forward-scatter radio-relay systems which are the subject of this article differ markedly from ionospheric forward-scatter systems which involve scattering from layers of ionization at heights of some 50 miles above the earth's surface and provide ranges of up to some 1,400 miles but with a capacity limited to a few telegraphy channels, or one or two telephony channels.

Tropospheric Forward-Scatter Propagation

Scattering is the phenomenon by which a beam of light passing through a cloud of smoke or water droplets is made visible to an observer not in the beam itself. Light consists of electromagnetic radiation of extremely short wavelength and can be scattered to a certain extent by smoke or water particles whose dimensions are of roughly the same order as the wavelength of the light.

Similarly short radio waves passing through the lower regions of the earth's atmosphere, known as the troposphere, are scattered by irregularities in the distribution in space of the pressure, temperature and water vapour content of the atmosphere; these irregularities may take the form of turbulent eddies such as can be seen,

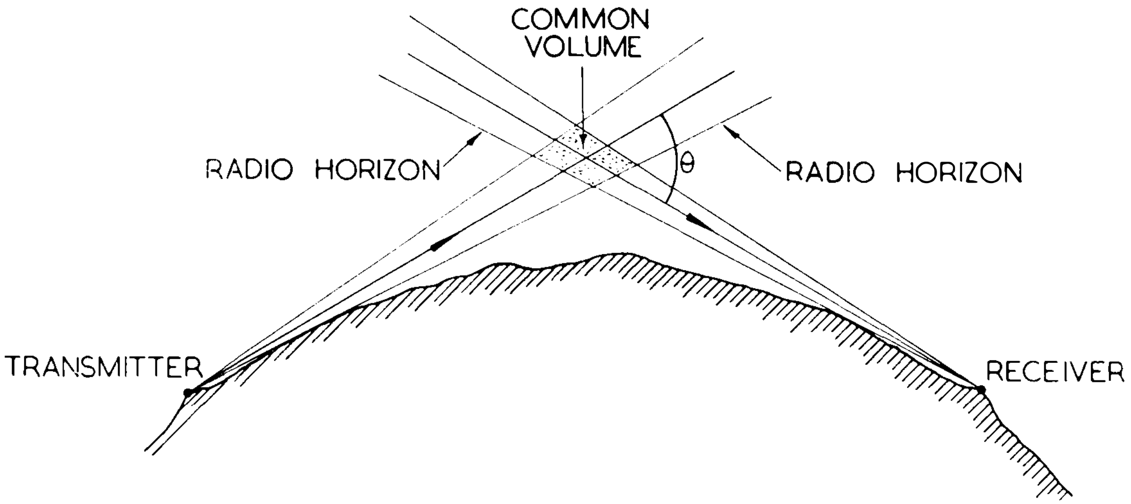


Fig. 1: Geometry of tropospheric forward-scatter radio link

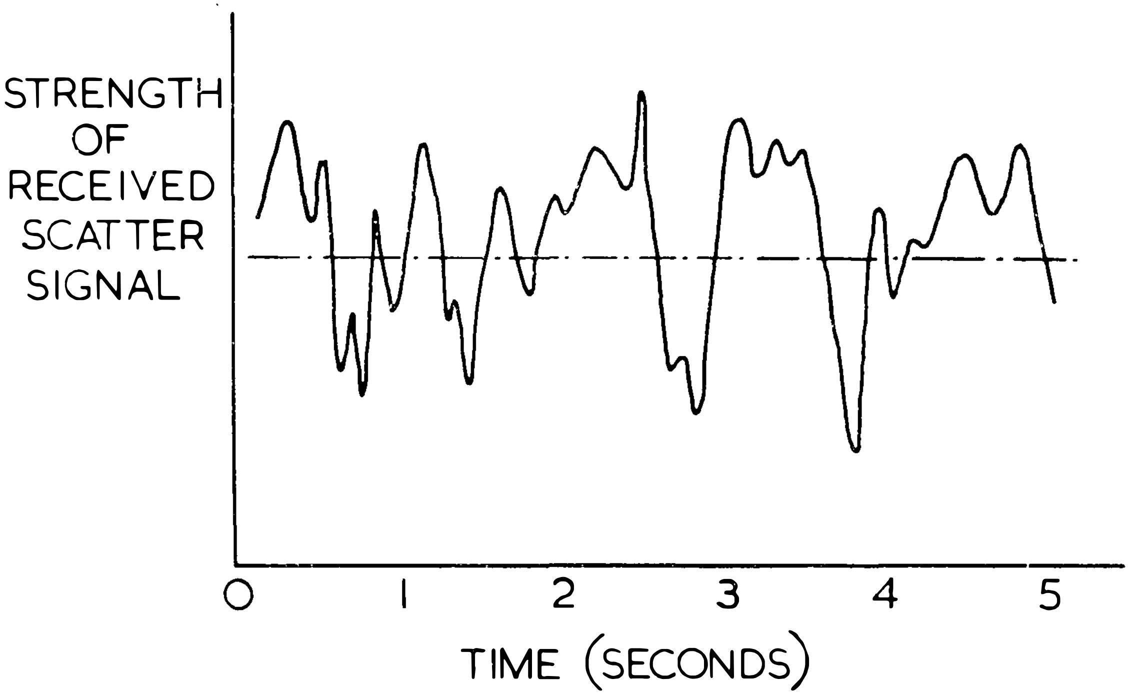


Fig. 2: Rapid variations of strength of received scatter signal

for example, in a column of smoke rising from a cigarette, or they may take the form of more or less horizontally stratified atmospheric layers known as "temperature inversions" in which the temperature rises instead of falling with increase in height.

It is important to note that the scattered energy is extremely weak; it may amount to less than one millionth part of the energy in the incident radio beam. It is only by using high-power transmitters, large aerials and sensitive receivers that the scatter signals can be detected; it is not surprising therefore that these signals have been largely ignored until recent years.

The scattered signals are best observed by using relatively short radio waves, with wavelengths of less than about 1 metre, corresponding to frequencies above about 300 Mc/s, and can be detected up to at least 10,000 Mc/s (3 cm wavelength). An advantage of the shorter wavelengths (the higher frequencies) is that they enable the transmitted radio wave energy to be concentrated into a narrow beam, thus illuminating the scattering region more intensely. To obtain the strongest received signal the beam direction of the receiving aerial must intersect that of the transmitting aerial and the angle θ between the beam directions must be as small as possible, see Fig. 1. The reason for this is that the scattered energy is strongest in the forward direction and decreases rapidly as the scattering angle increases. Tropospheric forward-scatter stations must therefore be sited so that they have a substantially unobstructed view from the aerials to the horizon in the directions of transmission and reception.

Perhaps the most striking characteristic of the scatter signals is that their strength varies continuously from second to second, as shown in Fig. 2. The strength varies because the received signal comprises a very large number of components, each of which corresponds to a separate scattering source or irregularity in the troposphere. Since these scattering sources are in a state of more or less continuous motion or turbulence, the resultant signal strength fluctuates over a wide range but the signal never disappears completely.

The mean strength of the scatter signal varies from hour to hour and there are also marked seasonal changes, the signal strength usually being greater in summer than in winter. A great deal of experimental work has been carried out, and more is in progress, to determine the dependence of these variations of signal strength on the frequency, path length and on other factors; the data already available are, nevertheless, sufficient to give an indication of the basis of design and the performance likely to be obtained in practice.

An important characteristic of all communication systems is the signal bandwidth that can be effectively transmitted; in tropospheric forward-scatter systems this is determined largely by the variation in time delay that occurs as a result of the different lengths of path that can exist between the transmitter and receiver (see Fig. 1). By using a narrow beam—obtained by large dish-shaped aerials operated at high radio frequencies—the path length differences can be reduced and the bandwidth that can be effectively transmitted is increased. If aerials of 30-foot diameter or more are used at frequencies above 500 Mc/s, bandwidths suitable for 100 or more telephony channels, or perhaps a television channel, may be achieved.

Equipment Techniques Employed

Because of the large and variable attenuation inherent in the scattering process, tropospheric forward-scatter radio-relay systems must use high-power transmitters and large aerials to achieve at all times an adequate signal-to-noise ratio at the receiver output. Furthermore, special techniques, which will be described later, must be used to compensate for the rapid variations of received signal strength.

The transmitter powers and aerial sizes currently employed range from 1 to 20 kilowatts (kW) and from 12 to 60-foot diameter respectively, for tropospheric forward-scatter systems providing from 6 to 150 telephone channels over paths from 100 to 250 miles long, compared with powers of up to a few watts and aerials up to 12-foot diameter used in conventional microwave radio-relay systems. Still larger aerials, up to 120-foot diameter, and powers up to 50 kW are under consideration for systems with 100 telephone channels spanning paths 400 miles or more long. The aerials are generally of the parabolic reflector type with a feed unit at the focus; one type of construction employed in an extensive network of tropospheric forward-scatter links in North America is shown in Fig. 3.

Because of the large size and high cost of the aerials it is usual to employ the same aerial for transmission and reception when "go" and "return" channels are required; a unit called

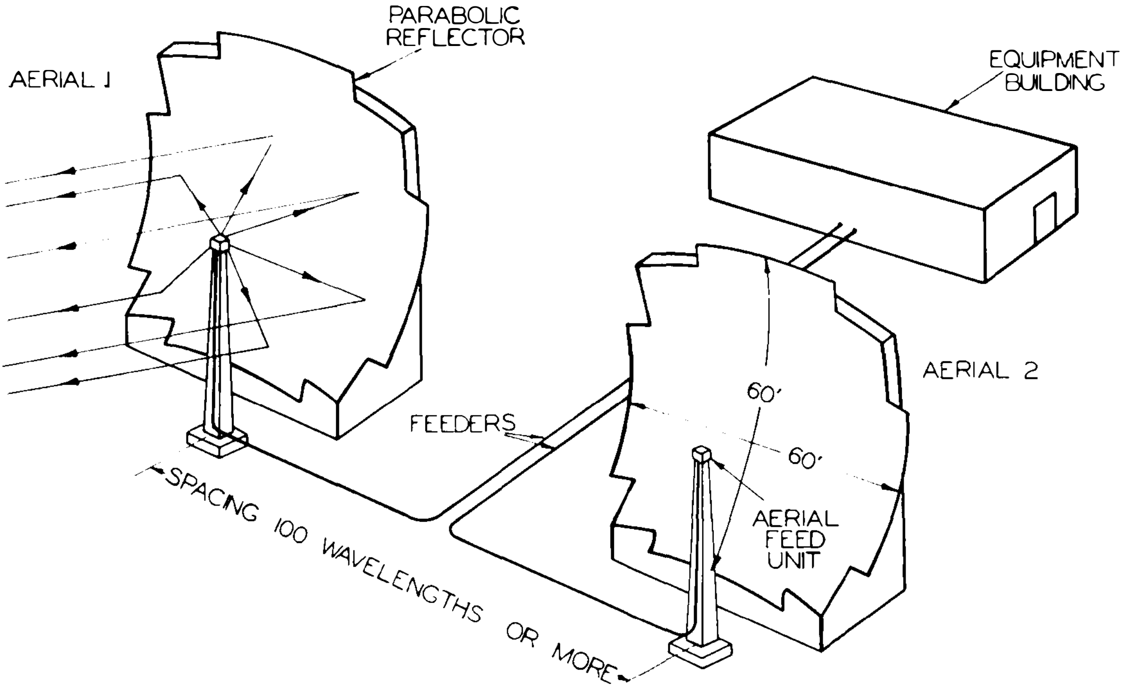


Fig. 3: Arrangement of aerials

a "diplexer" is used to combine the transmitter output and the local receiver input, as shown in Fig. 4. Radio frequency filters are provided at the transmitter output to reject transmitter noise in the local receiver pass-band, and at the receiver input to reject the high-level transmitted signal which would otherwise overload the receiver.

Klystron amplifiers are widely used in the high-power stages of transmitters because of the large power gains (1,000 times or more) and large power outputs (10 kW or more) available from a single valve. Klystron valves employ velocity modulation of the electron stream, as compared with intensity modulation in conventional valves, with the advantage of improved performance at the higher frequencies. Valves of this type were originally developed in the United States for television broadcasting in the ultra-high-frequency band (400-800 Mc s), but have since proved valuable for tropospheric forward-scatter links.

Most tropospheric forward-scatter systems at present in use employ frequency-modulation (FM) of the radio carrier wave. Furthermore, the transmitter power amplifiers are driven by a low-power FM exciter unit, which accepts a block of frequency-division multiplex telephony channels, say 12 channels in the baseband 12-60 kc s, and modulates the frequency of a low-power carrier by this baseband signal (see Fig. 4). However, it appears that single-sideband amplitude modulation may have certain advantages over frequency modulation for scatter links, notably as regards economy in the frequency space required, reduced high-tension power consumption and improved performance under the propagation conditions prevailing on tropospheric forward-scatter links.

The rapid variations of received signal strength shown in Fig. 2 can be appreciably reduced by spaced-aerial diversity reception. This technique relies on the fact that when signals are received on aerials spaced by a hundred wavelengths or more both signals rarely fade at the same time; thus, by selecting the strongest, or by combining the two signals, a useful improvement can be obtained. Fig. 3 shows a typical arrangement of spaced aerials employed in practice and Fig. 4 the schematic arrangement of the diversity receivers and the diversity combiner unit. In some systems frequency diversity is employed; this relies on the fact that signals on frequencies spaced by more than a few per cent. rarely fade together; however, this form of diversity is uneconomical in frequency space and its use is best confined to remote areas.

The residual variations of the received signal level are absorbed by automatic gain control or, in a frequency-modulation system, by limiting.

Advantages and Disadvantages

The prime advantage of tropospheric forward-scatter radio-relay systems, compared with conventional microwave radio-relay systems or wire-carrier or coaxial-cable systems, is that they can provide direct reliable communication over distances of up to 200 miles or more without intermediate repeater stations or interconnecting wire lines or cables. This feature is of considerable importance when the intervening terrain is difficult of access—for example, because of mountains, forests, deserts, expanses of snow, water or sea, or even when the region is sparsely populated. It may also be important for military or defence security reasons, since such a system is less vulnerable to enemy attack or sabotage than systems with many intermediate repeater stations or wire or cable connexions.

On the other hand tropospheric forward-scatter radio-relay systems require high-power transmitters and large aerials which are expensive not only in direct capital costs, but also in operation and maintenance, particularly of the transmitters. It is by no means obvious that a tropospheric forward-scatter system is cheaper, either in capital cost or annual charges, than conventional microwave radio-relay or cable systems of similar capacity; each must be considered on its merit in relation to the particular job to be done. Furthermore, conventional radio-relay and cable systems can readily provide for dropping or inserting blocks of channels as required at the intermediate stations; this is of considerable value and is often required in a complex inland network. By its nature such a facility is not available in a tropospheric forward-scatter system.

Tropospheric forward-scatter systems are subject to certain technical limitations. For example, it would appear that frequencies used cannot readily be shared in the same geographical area with conventional low-power radio-relay or

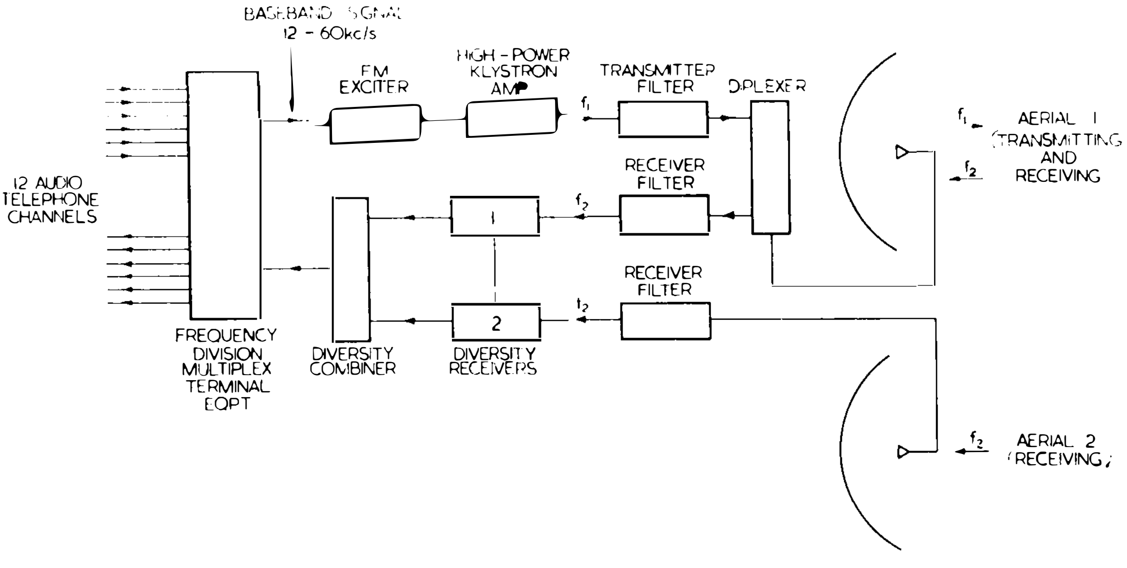


Fig. 4: Arrangement of equipment

other systems since the high powers used by the scatter systems, and the facility with which scatter signals are propagated over distances of hundreds of miles, introduce a considerable risk of interference.

At their present stage of development tropospheric forward-scatter systems require much more frequency-space than conventional radio-relay systems of comparable capacity; this limitation arises from the long distances over which scatter signals are propagated, a factor which may make it necessary to use different frequencies for the various sections of a multi-section link in order to avoid mutual interference between the sections.

Finally it is not practicable at the present time to engineer the longer tropospheric forward-scatter radio-relay links fully to meet the high standards recommended by the International Consultative Committee for Telecommunications for the noise levels allowable on "international" circuits. For a small fraction of the total time, generally much less than 1 per cent., the noise level on a long tropospheric forward-scatter link may be higher than is allowable on international circuits; nevertheless the performance may be entirely acceptable for many other purposes.

Applications

Extensive tropospheric forward-scatter radio-relay links are already in use in Canada and Alaska to provide communications between the radar stations forming part of the defence system of the North American continent, and for certain civil communications. These links provide for 36, or in some instances as many as 150, telephone circuits over distances of 1,000 miles or more in hops of 100 to 200 miles. Tropospheric forward-scatter radio-relay links are particularly valuable for this application because the intervening terrain is difficult of access and sparsely populated. In such circumstances conventional microwave links with repeater stations 30 miles or so apart would be not only more costly but very difficult to maintain.

Tropospheric forward-scatter radio-relay links are also finding application to long oversea paths, such as the 184-mile link between Florida and Cuba now under construction jointly by the American Telephone and Telegraph and the International Telephone and Telegraph Companies; this link is for some 200 telephone circuits and a television channel.

It has recently been announced in the Press that N.A.T.O. European Command (S.H.A.P.E.) plans to set up an extensive tropospheric forward-scatter network for military communications in Europe, which would be less vulnerable to interruption by enemy attack or sabotage than conventional microwave or cable systems.

Tropospheric forward-scatter systems are likely to find uses for civil communications in countries where the terrain is difficult or sparsely populated and the existing communication systems are not highly developed—as described, for example, in the article on "Libya's Telecommunications Plans" on page 125. In countries such as Great Britain with extensive line, cable or conventional microwave systems it would seem that extensive applications of tropospheric forward-scatter systems to the inland civil communications network are unlikely; nevertheless, tropospheric forward-scatter systems may well find important applications to links between Great Britain and the neighbouring countries.

U.S. Buys old P.O. Poles

After standing for 64 years beside a country lane near Dorchester, three telegraph poles have been bought by an American company whose products include creosote and pressure-creosoted poles, and have been shipped to the firm's research laboratory in Verona, Pennsylvania.

The Post Office has used pressure-creosoting for poles since 1870, but America did not adopt it widely until after 1900. The Dorchester poles, of Scots Pine, were carrying local lines up to the time of their removal and, apart from numerous pit marks made by decades of linemen's boots, showed no signs of wear or damage.

The new owners will examine the poles to determine how much creosote still remains in the cellular structure after their long exposure to the ravages of time, the elements, and other enemies of wood. Later, they will be used in a permanent exhibit.

Sir Gordon Radley, Director General of the Post Office, has been elected an honorary member of the Belgian Society of Electrical Engineers.

Libya's Telecommunications Plans

R. J. G. Blackett

Fig. 1: P. & T. circuits, 1956

On December 24, 1951, the United Kingdom of Libya became an independent state, a federation of three provinces, Cyrenaica, Tripolitania and the Fezzan. The country thus formed includes a large portion of the Sahara and is not well endowed with natural resources. Five-sixths of the area is desert, the coastal fringe only being relatively fertile. Libya's greatest assets are the determination of its people and the goodwill of other countries, who, through the medium of the United Nations or by direct aid, are assisting her in challenging the formidable obstacles that nature has bequeathed her. The Sahara does not remain dormant. It is constantly on the attack. At the moment it is being held in check, but if Libya is to prosper it must be made to retreat.

Libya was once a very productive country, as the remains of the great Roman cities of Sabratha and Leptis Magna and of the Greek cities of Cyrene and Apollonia bear witness. There are other ruins of much more recent origin with which those who served with the desert forces during the war will be familiar.

One of the victims of the war was Libya's telecommunications system. What remained after the various armies had trampled over it were pieces of the original system installed by the Italians, plus the various temporary military installations. The Italian system had suffered severely owing to lack of adequate maintenance and because modifications had been made to meet military needs between 1939 and 1951. Because of the country's meagre resources it was difficult to allot large sums of money to telecommunications so that until recently plans made to improve and expand the system were necessarily modest. However, now, through aid funds made available by the United States, it has become possible to tackle the problem on a major scale.

Libya therefore has the unique opportunity of installing a completely modern telecommunications system suited to the needs of its people and capable of being maintained by them within a relatively short period of years. I mention this because, like many other countries in a similar position, Libya lacks a sufficient number of trained technicians and for the moment has to rely largely on imported staff.

It was realized from the outset that a master plan covering a 20-year period was required and a leading firm of American consultants was engaged to provide the plan.

In the space of six months the firm had prepared a master plan, which has been accepted in principle by the Libyan government. It contains some interesting features, including the use on a large scale of trans-horizon links employing tropospheric scatter techniques. These are multi-channel ultra-high-frequency radio links based on the principle of scattering of a directional radio beam by turbulent eddies in that part of the atmosphere within a few miles of the earth's surface. Although the scattered radiation is very weak it can be picked up by sensitive receivers provided large aerials and high-power transmitters are employed. By this means ultra-high-frequency radio communications can be established beyond the line-of-sight up to distances of 150 miles or more. The principal features of the report are as follows:—

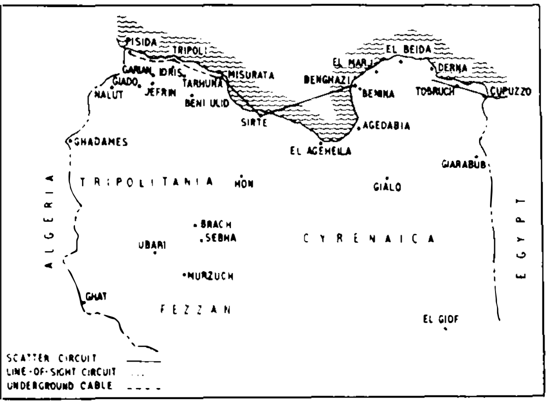


Fig. 2: Proposed Primary Toll network

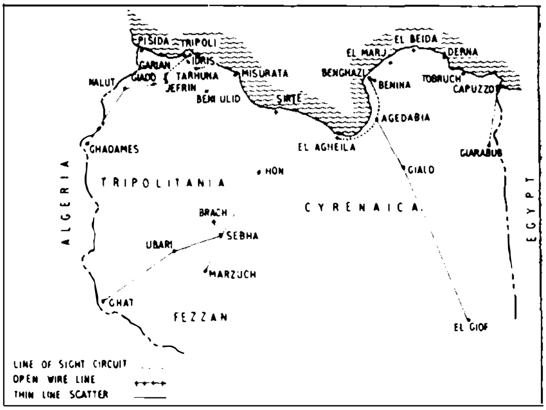


Fig. 3: Proposed Secondary Toll network

Main Trunk Network

The main trunk network runs from the Tunisian frontier at Pisida in the west to the Egyptian frontier at Capuzzo in the east, a route distance of 1,150 miles. This main route must serve Libya's internal requirements and form the main artery of a projected international route along the southern shore of the Mediterranean. It was calculated that, initially, 12 international speech circuits were required from frontier to frontier, but also that the whole system should be capable of rapid expansion to 48 through circuits. Various means of providing the main artery were studied but it was finally decided that no one method would meet requirements for the whole of its length and a combination of the various transmission media was recommended. Three methods will be employed as follows:—

Land Line or Cable, using open wire carrier, suspended cable or buried cable. This is most suitable for serving the more populous areas where towns lie close together. Cable, where justified by cost and expected growth, is preferable to overhead line as it is more secure and easier and cheaper to maintain.

Line-of-Sight Links, employing V.H.F. and U.H.F. systems. These are useful where the main population centres are spaced at say 20 to 40 mile intervals.

Trans-horizon Links, using tropospheric scatter. These will provide high grade, highly reliable communications where large areas of sparse population are to be crossed and hops of 150 miles or more can be made. (The technique is also useful for providing long distance "express" communications where intermediate points can be by-passed.)

All the conditions listed are present between Pisida and Capuzzo. High-frequency radio was considered for bridging the desert areas, but was ruled out on reliability and cost grounds.

Libya has a population of a little over 1,000,000. Of these, 700,000 live in the coastal belt of Tripolitania between Pisida and Misurata. A further 200,000 live in the area of Cyrenaica, between Benghazi and Derna. In the rest of the country there are only about 75,000 people.

In the coastal belt of Tripolitania the towns are relatively closely spaced. Therefore, a cable using polyethylene insulated conductor is planned to run between Pisida and Misurata.

Between Misurata and Benghazi there is desert containing only one important community, Sirte; therefore, tropospheric scatter systems between Misurata and Sirte, and Sirte and Benghazi, are recommended.

In north central Cyrenaica conditions are suitable for the use of line-of-sight radio links, which are therefore recommended to cover the distance from Benghazi to Derna with intermediate relay and drop off points at El Marj and El Beida.

Between Derna and the Egyptian frontier desert conditions are again encountered, so tropospheric scatter is recommended between Derna and Tobruk, and Tobruk and Capuzzo.

The Secondary Trunk Network

In areas of relatively high population density existing land lines will be retained and renovated. Several new line-of-sight radio links will be added. However, the major part of the secondary network will be provided by tropospheric scatter links running inland from the main artery towards the southern borders of the country. In planning, the possibility of "scatter" techniques providing a main international artery southwards towards central and south Africa is envisaged.

All exchanges will be re-equipped with up-to-date automatic equipment. These exchanges will be linked by a subscriber-to-subscriber trunk dialling scheme on a time zone metering basis. Teleprinters are recommended for telegraphs on international and main internal routes. The possible use of facsimile methods on minor routes is to be explored. With a view to simplifying maintenance, the supply of spare parts, and so on, the tropospheric scatter equipment will use standardized 1 kilowatt transmitters throughout.

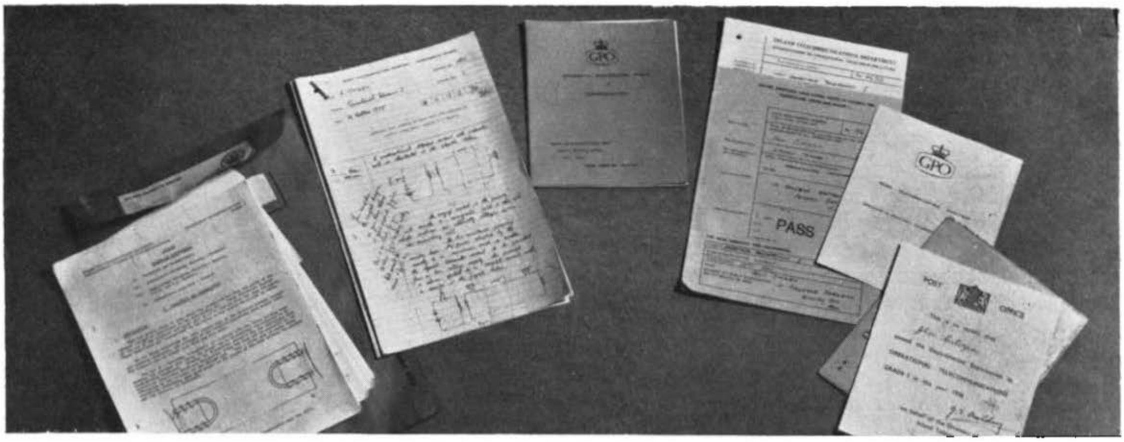
The cost of the scheme is estimated at £L.3,500,000. (The Libyan pound has the same value as the pound sterling.) It can be accomplished in two-and-a-half years.

When the plan is completed Libya will possess a model telecommunications system and may set the pattern for other countries which although large territorially have a small population.

In these days of popular air travel Libya is comparatively near to the United Kingdom. Tripoli is only six hours flying time from London airport and is the first stop on the air route from Britain to Nigeria. Thus, in terms of time, Tripoli can be reached by air in about the same time as it takes to travel by train from London to Edinburgh or even less. Increasing numbers of tourists are taking advantage of Libya's wonderful climate and beautiful and unusual scenery. There is no doubt that improved communications will prove an aid to stimulating her economic development, including tourism, which could be a valuable source of income.

Post Office Helps Colombo.—A team of four Post Office people (two Traffic and two Engineering) has gone to Ceylon to give technical assistance (under the Colombo Plan) in planning a new telephone exchange, of some 30,000 lines, to serve Colombo, together with a trunk cable which will link Colombo with Galle 70 miles to the south. A fifth member, from the Engineer-in-Chief's Office, will join the team for a short period.

The team comprises Messrs. S. W. Dabbs and J. F. Goodger of Headquarters (Inland Telecommunications Department); Mr. D. Holmes of Newcastle Telephone Manager's Office; Mr. R. H. Norman of Southend Telephone Manager's Office and Mr. T. J. Morgan of the Engineering Department (Equipment Branch).



Vocational Study by Correspondence Course

A New Venture in Traffic Training

C. R. Dancey

POST OFFICE HEADQUARTERS HAS FOR A long time recognized the need for the comprehensive training of staff on traffic work. Since 1946, a Traffic Training School in London has been responsible for training all new entrants to the basic traffic grades and for organizing " refresher " courses for the staff employed on specialist functional divisions of the work—for example, Lines and Equipment. A recent innovation has been a Service and Staff management course, designed on the lines of the courses at the Post Office Management Training Centre, to help the staff on territorial duties who are responsible for the efficient and economical operation of manual and automanual exchanges.

With the growth of the system and the progressive mechanization programme, there is a constant need for technique and aptitudes to keep pace with the changing pattern of operations. There are few, if any, text books and no organized courses of private study specifically on telecommunications traffic work, although a great deal has been achieved through the forum of recognized publications and through lectures and meetings. Studies in management, public administration and statistics can be helpful but clearly there is a gap between such academic studies and instruction specially designed with the changing operational problems of running a telecommunications service in mind.

It was with the aim of starting to bridge this gap that the idea of a course in what has come to be termed " operational telecommunications", to distinguish it from telecommunications engineering, was conceived. Its purpose was to provide the opportunity for students to undertake vocational study in their own time, and so foster further research and thought into traffic methods and techniques.

The field to be covered is a wide one; moreover, much of the statistics and mathematics behind the study of traffic theory is complex, and outside the scope of courses currently available. There was clearly a need, therefore, to plan the course on the concept of a number of grades of study starting from basic principles, building up to the more complex operational questions and coming finally to mathematical and statistical theory in its application to traffic work.

Although the scheme was first mooted in 1952, it was not until late 1954 that, with the co-operation of the Staff Associations concerned, the first course was planned primarily to provide a general background for subsequent studies. The syllabus of the Operational Telecommunications Grade I course (reproduced at the end of this article) covers the subjects in the City and Guilds Institute Examinations in the lower grades of telecommunications principles, as well as exchange systems and telegraphy, but the treatment is fundamentally different. For example, the principle of each system and important piece of apparatus is presented briefly, using simplified circuit elements only, but the emphasis is on operational needs and economic considerations rather than on technical aspects.

Telecommunications Traffic Officers, promoted to Traffic Superintendents, have to provide evidence of their technical suitability for the appointment before their promotion is confirmed. Hitherto the only suitable qualifications, which could be obtained after following a readily available course of study, were the City and Guilds Institute Certificates in telecommunications engineering subjects, and this has long been regarded as very much a makeshift arrangement. It was, therefore, natural to associate a departmental examination with the new Grade I course and to recognize a pass in this as a qualification for promotion.

Because traffic staff are widely scattered, and the subject needs specialized treatment, tuition could most conveniently be given by correspondence. Although this type of course has long been a feature of the engineering staffs vocational studies it was new on the traffic side. The Traffic Training School was asked to prepare the course, and a number of suitably qualified field officers, from among the many who volunteered, were selected as tutors. Drafting an entirely new correspondence course, including the preparation of nearly 300 illustrations and diagrams, was no mean task but with sterling co-operation from the Engineering Department's Editorial Branch the Grade I course was completed and 450 students were enrolled by September, 1955.

The interest aroused was evident from the fact that many of the students did not need the certificate as a qualification; some 370 completed the course itself and 310 sat the examination. Although the first course was regarded in certain respects as a pilot run there were, in fact, relatively few teething troubles, and only minor modifications to the subject material and the tutorial arrangements have been necessary for the current course. The tutors have been at pains to emphasize the need, in answering questions, for logical presentation and development of the subject. It is hoped that their advice, and the practice gained in this very important technique will be of particular value to recruits in what they often find to be a quite difficult part of their new job. Traffic staff enrolments for the course this year number well over 200, but there is also evidence of a considerable demand from other Post Offices grades. The question of making the course available on a wider basis is being considered.

A more advanced course, Operational Telecommunications II, is now being prepared, and this should be available as from September, 1957. It will be basically different from the Grade I or preliminary course in that it will be concerned almost entirely with " traffic " considerations and will, in effect, provide the foundation on which the more advanced studies of the traffic function can be built. The aim will be to develop in broad terms the principles underlying day-to-day operational practice with a view to stimulating further thought and research. The course will not provide specialist training in particular phases of traffic work; this can be far better tackled by means of special " tailor-made " official courses at the Traffic Training School.

Operational Telecommunications II is likely to be a two-year course of study. The correspondence course lessons will probably be issued monthly, in contrast to Grade I, for which they were issued fortnightly, and students will be required to tackle a general question paper after each three

Miss K. Beal, of the School Staff, assembles lesson material for dispatch

lessons. These question papers will be designed not only to test the student's understanding of the subject matter of the lessons, but will also call for a certain amount of local research and practical application.

The arrangement of the syllabus is not finally settled although broadly the aim will be to cover traffic flow and records, circuit provision and route efficiency in the first year, and operating procedure, call valuation, forecasting and planning technique and telegraphs in the second. The opportunity will be taken to include an elementary appreciation of statistics and the latest developments in trunk mechanization and subscriber trunk dialling.

The project has an appeal outside the immediate departmental field, and many enquiries have been received from colonial administrations who feel the need for similar courses and have asked permission for their staff to participate.

Syllabus: Operational Course I

Subscribers' apparatus. Receivers and transmitters; subscribers' telephone circuits, magneto, C.B.S. and C.B. systems; protective devices; common extension Plan No. arrangements; shared service service; the house exchange system; coin boxes. Common types of P.M.B.X. and P.A.B.X. and the principal facilities they provide.

Exchange areas; overhead and underground distribution; basic electrical characteristics of lines. Arrangements for flexibility; auxiliary joints; cabinet and pillar schemes. Main and intermediate distribution frames. Interconnexion of exchanges; local and trunk networks. Group and Zone Centres.

Local line signalling; relays; calling supervisory signals; the need for transmission bridges. Manual exchange equipment; the magneto, C.B.S. and C.B. systems, main facilities and switchboard capacities; timing devices. Multiple and partial multiple switchboards; flexibility.

Automatic exchange principles (Strowger system). The dial; pulsing; two motion selectors; switching stages; hunting and testing. Circuit elements of, and facilities given by: uniselectors; linefinders; group and final selectors. Holding, speaking and guarding conditions. Automatic tones.

Automatic exchange practice. Elementary conception of traffic flow. Trunking diagrams. Non-director schemes; multi-office areas; satellite working (all types). The director system. Standard U.A.Xs. Multimetering in all types of exchanges. Signalling and dialling between exchanges; system in use and supervisory conditions encountered. Generator and D.C. signalling. Order wire and straightforward junction working; differential signalling. Auto to manual working; guarded metering. Loop and battery dialling; the distortion of pulses; Single Commutation Direct Current and Voice Frequency dialling; keysending. The mechanical pulse regenerator and its use in junction networks.

Automanual exchanges; requirements and facilities provided; switchboard equipment and layout of multiples. The bridge and sleeve control systems; cord circuit and connecting circuit elements. The cordless switchboard.

The telegraph service; general requirements. Signalling principles; Morse and Murray codes; methods of working; the teleprinter. Operating considerations—acceptance and delivery offices; appointed offices; phonograms and telephone telegrams. The teleprinter automatic switching (TAS) network.

Note.—Candidates for the examination will be expected to have acquired a general knowledge of the principles of operation of the systems detailed in the syllabus, and the particular conditions for which each system is suitable.

They should be able to illustrate basic principles with simple diagrams showing circuit elements, but will not be expected to reproduce complete circuits or to describe the mechanical operation of automatic apparatus. In their own interests, however, they are advised to inspect items of apparatus with which they are not familiar.

Automatic Telex by 1960

The Post Office Telex system will probably enable subscribers to obtain their calls direct, instead of through operators at the Telex exchanges, by 1960.

A pilot automatic exchange in London, is planned to be ready by September, 1958, and another will be opened in Leeds, which will serve Bradford, Lincoln, Middlesbrough and York Telex subscribers. Automatic intercommunication will be limited to the London and Leeds groups but subscribers on these exchanges will be given dialling codes to obtain access to all manual exchanges throughout the country.

This scheme involves the change of calling numbers to conform to a national pattern. Subscribers in the 8000–8799 number range will be changed to 22100–22899 by the 1st April next, and those in the 2000–2799 and 3000–3799 number range to 22100–22899 and 231000–23899 respectively by 1st October next.

In the two years ended December, 1956, the number of subscribers doubled and during 1956 nearly 5,000,000 calls were recorded.

Linen in Exchanges.—"Tons of waxed thread are supplied to the British Post Office for tying the insulated cables running behind each panel of the switchboards of some 6,000 public telephone exchanges", says *The Faithful Fibre*, a booklet, issued by the Linen Thread Co., Ltd., which tells the story of linen, its manufacture and uses, especially since 1750 when the founder of the oldest business in the group started bleaching in the stream which flowed beside his Scottish farm.

Decibel Notation in Telephone Transmission

H. R. Jones

"*WELL-INTENTIONED attempts have been made by teachers, engineers and others to produce for the special use of a certain type of student an explanation of the decibel technique of power transmission in which all reference to logarithms is expressly excluded. In the opinion of the author the inculcation of accurate ideas on the subject by such means is unlikely*".

So runs part of the preface to a book on the decibel notation by a former Superintending Engineer of the Post Office. I am sure strictly he is right. At the same time some idea of what this decibel business is all about can, I think, be conveyed to non-mathematical readers; also, knowing that the subject is of considerable general interest and that another former Superintending Engineer made the attempt to produce a "child's guide", I think a similar attempt might at least be tried in a *Journal* which numbers among its readers many to whom the mathematics of the decibel notation would be, to say the least, a bit difficult.

First, the term "decibel"—commonly reduced to "db"—is generally used only in connexion with the transmission of electric power in small quantities; the transmission of "high power" electricity supply raises entirely different problems.

Secondly, it might be as well to say what the decibel is not.

While for practical day-to-day purposes the decibel is sometimes loosely regarded as a unit of loss or gain during telephone transmission (expressions such as "3 db. loss" are used) it is not a tangible unit of "something" in the sense that a pound or a yard is. For example, the effect of cutting a yard length off a piece of rope is the same whatever the original length of the rope; that is, the length is always reduced by exactly one yard. And if, say, three yards are cut off, the length is reduced by exactly three times as much as when one yard is cut off.

But, if the amount of electric power transmitted over a circuit is cut down by one decibel, the amount of power lost depends on what the original level of that power was. For example, if originally, say, 100 microwatts were transmitted, the loss would be approximately 20 microwatts; if 10 microwatts, the loss would be approximately two. From this example it will be seen that although the effect of one decibel loss is different, *the power has been reduced in the same proportion*, that is, by about one-fifth, or 20 per cent. in both transmissions. If a further loss of 1 db. occurs, obviously the effect would be to reduce what remains after the first loss by the same proportionate reduction as before—by about another one-fifth or 20 per cent.

From an electric power aspect, therefore, the decibel notation can be regarded as a means of showing percentage reductions (or gains) in simple numerical steps:—1 step down (1 db. loss) is equivalent to a 20 per cent. reduction, 2 steps down (2 db. loss) to a 20 per cent. reduction occurring twice, and 3 steps down (3 db. loss) to a 20 per cent. reduction occurring 3 times and so on. (Similarly, it can be shown that 1 step up is equivalent to a 26 per cent. increase, 2 steps up to a 26 per cent. increase occurring twice, and so on.)

A table can thus be produced to show various percentage losses expressed in the decibel notation as follows:—

Expressed in percentages of power loss	*Expressed in the db notation*
20% loss (i.e., 20% loss occurring once) ...	1 db
36% ,, (i.e., 20% ,, ,, twice) ...	2 db
50% ,, (i.e., 20% ,, ,, three times)	3 db
75% ,, (i.e., 20% ,, ,, six times) ...	6 db
90% ,, (i.e., 20% ,, ,, 10 times) ...	10 db
99% ,, (i.e., 20% ,, ,, 20 times) ...	20 db
99.9% ,, (i.e., 20% ,, ,, 30 times) ...	30 db

(A similar table can be produced to show gains, but in the interest of clarity of explanation this is omitted.)

Why is this unusual unit—the decibel—used in telecommunications? As most readers will know, the sound waves created when one speaks into a mouthpiece are converted into electrical power which is transmitted over the lines and through the apparatus which form the telephone transmission system. On arriving at the distant end, this power is re-converted by means of the receiver earpiece into sound waves similar to the original ones. But the power received may be only a very small fraction of the power sent, because of the attenuation, or thinning down, caused by the electrical characteristics of the lines and apparatus through which it is transmitted.

Thus telephony is basically a form of power transmission, although the power used in telephony is infinitely smaller than that used in "heavy" power transmission.

Power engineers, transmitting power for industrial and domestic purposes, do not use the decibel. They are primarily concerned with supplying electric power as such and not in its subjective effects. For example, 1,000 watts consumed or lost is the same to the power engineer whether related to a basic consumption of 1,000 or of 100,000 watts and whatever it is used for; and from a power supply aspect 2,000 watts lost is exactly twice the value of 1,000 watts lost.

The telecommunications engineer is, however, very much concerned with the subjective impression created by the electric power. His job is to ensure that despite the losses which occur *en route*, the received speech is both loud enough and clear enough to be intelligible.

But reduction in loudness is not directly proportional to the reduction in power; that is, the loss of a specific amount of power does not necessarily result in the loss of a specific amount of loudness; it all depends on what level of power there was to start with.

For example, the loss of, say, 20 microwatts would have very different effects on the level of sound produced by, say, 40, 80 or 100 microwatts.

The telecommunications engineer is thus, unlike the power engineer, not really interested in the straightforward addition or subtraction of power.

What all this really boils down to is that equal steps down in the scale of loudness are not produced by equal reductions in power, but by equal *percentage* reductions in power.

Now a discussion on the assessment and measurement of changes in the level of loudness would no doubt be interesting, but it is outside the scope and intention of this article. It must suffice to say that the minimum change in loudness detectable by a well-trained ear is that produced by a 20 per cent. change in power—that is, 1 db. in the decibel notation. It should also be apparent, in the light of what has been said so far, that in determining what steps down in the scale of loudness are permissible so that the received speech will be of sufficient strength, the telecommunications engineer must know what percentage reductions in power are caused by the lines, apparatus, and so on, which form the transmission system. And this is where the decibel notation comes in.

It will be obvious of course that the losses (or gains) over a transmission system can be worked out without using the decibel notation. If, for example, power losses caused by individual lengths of line were expressed as a percentage of the total power entering each length (a percentage "loss factor" could be used for each length) the total overall loss in the system could be obtained by the rather laborious method shown below. (The longer the circuit and the greater the number of sections, the more laborious would the calculations be.)

Assume, for example, that there are three sections of a transmission line, the first causing a loss of 20 per cent. of the power entering it, the second 50 per cent. and the third 75 per cent. Let the original power level entering the first section be 100 microwatts. Then, after the first stage, the power will be reduced to 80 microwatts (100 less 20 per cent.) after the second to 40 (80 less 50 per cent.) and after the third to 10 microwatts (40 less 75 per cent.).

But the decibel system does away with the complicated "compound interest" calculations necessary to find the result of a percentage reduction (or gain) occurring several times. By applying the decibel notation shown in the Table to this example, the first section loss would be shown as 1 db., the second as 3 db., and the third as 6 db., and all we have to do is to *add* up these losses to find the total loss of 10 db. (The Table will tell us, if we want to know, the proportion of the power lost; in this instance it is 90 per cent., leaving 10 microwatts.) It is true, of course, that in the first place the percentages have to be translated into the db. notation, but this is a once-for-all operation so far as the practical day-to-day application is concerned.

An over-simplified definition of the decibel notation as applied to telephone transmission is that it is a system which enables us to express power losses (or gains) in the various parts of a transmission system on a numerical scale and to find out the overall loss or gain of the system by adding up the numbers thus obtained. There is thus really no such thing as "a" decibel, and when we speak of 2 db. or 3 db. we are referring to points in a notation scale and not to a number of "things".

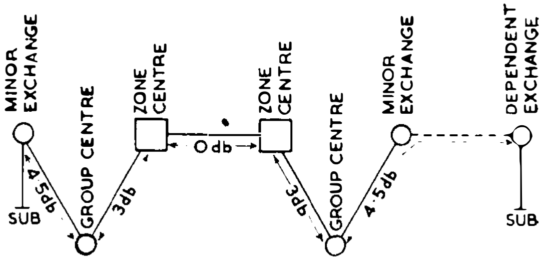
Let us now consider a practical application of the decibel notation. A certain minimum of loudness of speech must reach the ear of the listener to be intelligible. If the telephone receiver is efficient, it must be operated by at least the amount of power required to produce minimum loudness. This minimum amount of power is 0.05 microwatt (one twenty-millionth of a watt—which, incidentally, illustrates the fantastically small power required to operate a telephone receiver). In the British Post Office a higher standard is aimed at, and speech is considered to be satisfactory if the power reaching the receiver is not less than about 0.2 microwatt. (In this very outline explanation the question of the clarity of the speech received as distinct from the loudness has been ignored.)

If then we arrange matters so that, despite the losses that occur *en route*, a minimum of 0.2 microwatt of power reaches the distant receiver the loudness of speech will be satisfactory.

Let us next consider what power we start off with at the sending end. The telephone transmitter, by deriving power from the exchange (or local) battery, actually amplifies the speech power, and if the transmitter is of standard efficiency and part of an ordinary telephone set, working through the appropriate standard line to the local telephone exchange, the average voice will cause speech currents of a power level of about 200 microwatts (excluding the direct current) to emerge from the telephone instrument terminals. Now we know that a loss of 1 db. is equivalent approximately to a loss of 20 per cent. in power level. If we take the trouble to work out the number of times 200 microwatts must be reduced by approximately 20 per cent. to obtain the 0.2 microwatt necessary to operate the distant telephone receiver, we shall obtain the maximum overall allowable loss in the decibel notation. If we do this sum we shall find that the answer is 30 times.

This means that a total loss of up to 30 db. may be caused by the lines and apparatus which make up the various transmission paths between two subscribers before the sound received becomes too faint.

The Post Office ensures that transmission will be satisfactory by limiting the permissible line losses between any two exchanges. These losses are shown in the decibel notation in the diagram which also shows the maximum routing over which a call can circulate if the maximum allowable transmission loss caused by lines and apparatus is not to be exceeded.



TOTAL LINE LOSS BETWEEN EXCHANGES – 15db

Two points are worthy of special mention here. First, it will be observed that no line loss at all is allowed between the zone centres, despite the fact that some attenuation of the power must occur in normal circumstances. This is explained by the fact that the amplifiers used to "boost" the level of speech between exchanges are, for zone to zone circuits, so arranged as to overcome all the losses incurred.

In point of fact it is possible to arrange for an actual gain in power between two points by the use of suitable amplifiers and this gain can also be expressed in the decibel notation.

The second point is that in rural areas some exchanges do not justify direct connexion to their group centres. These exchanges are known as dependent exchanges, and it is arranged that the total loss between a dependent and its group centre does not exceed 4.5 db.

Standards of transmission are also laid down for routings, other than those shown in the diagram; for example, additional losses can obviously be tolerated on a group-group trunk circuit when the traffic over the circuit is confined to that between exchanges in the groups. Transmission standards for international calls is another aspect, which is outside the scope of this article.

No one realizes more fully than the author that in endeavouring to give a simple non-mathematical explanation of a subject which seems to cause a good deal of bother to many readers, he has made some very bold assertions and dodged some awkward fences. In fact there is no use denying the implication of the quotation at the head of this article—that without the use of logarithms it is impossible fully to explain the decibel notation. Let it be repeated, however, that my sole purpose is to convey to non-mathematical readers some idea of what it is all about. If what has been written has at least whetted the appetite of some readers to seek more information, and has shown that the decibel is not a simple unit in the sense of a measurable "thing" that some people appear to think it is (I have frequently seen "the" decibel described as the unit of sound), the effort will not have been made in vain. On the other hand I can only hope that what I have said has not added confusion to confusion in the minds of some readers!

Finally, having repeatedly throughout this article stressed that the decibel is not a unit in the normally accepted sense, it might, perhaps, be appropriate to finish by giving it a more positive definition. It is, then, a measurement of power transmission named after Graham Bell. It is one-tenth of a bel which is defined as the common logarithm of the ratio of the powers at two different points in a transmission network. The power loss or gain between these two points can therefore be expressed as $\log_{10} \frac{Ps}{Pr}$ bels or $10 \log_{10} \frac{Ps}{Pr}$ decibels where Ps represents the power sent from one point and Pr the power received at the other.

Our Contributors

M. G. BELL ("Teleprinter Automatic Switching on a Private Network") entered the Post Office as a Youth-in-Training at Portsmouth in 1936. He was appointed Assistant Traffic Superintendent in 1939 and, after serving for six years in the Royal Corps of Signals, was employed in the Birmingham and Canterbury Areas. Since promotion in 1953 to Senior Telecommunications Superintendent in the Inland Telecommunications Department, he has been engaged in the development of new systems for private teleprinter networks.

R. J. G. BLACKETT ("Libya's Telecommunications Plans") is Director-General of Posts & Telecommunications of the United Kingdom of Libya. He was previously Controller of Telephone Services, Sudan. He joined the Post Office Engineering Department in 1933 and before serving abroad he was an Assistant Telecommunications Controller Class I in the North Eastern Region. He has served in various parts of the United Kingdom, including several years at Headquarters in the Inland and Overseas Telecommunications Departments.

W. J. BRAY ("Tropospheric Forward-Scatter Radio-Relay Systems") is an Assistant Staff Engineer in the Radio Planning and Provision Branch of the Engineering Department and is responsible for the planning and provision of point-to-point radio-relay systems operating at frequencies above 30 megacycles. He entered the Engineering Department by Open Competition as an Assistant Engineer in 1934 and has spent most of his official career in the Radio Experimental and Development Branch at Dollis Hill, working on short-wave receiving systems and microwave radio-relay systems; his transfer to the Radio Planning Branch took place in 1954. In 1955 he was awarded a Commonwealth Fund Fellowship for advanced studies in the United States of America, where he spent some nine months studying research, development and operational aspects of point-to-point radio-relay and mobile radio communication systems, including the tropospheric forward-scatter radio-relay systems. He is M Sc.(Eng.), M.I.E.E.

R. W. G. CARDEN (joint author, "Britain's Weather Service") is a Senior Executive Engineer in the Engineering Department Telegraph Branch, working on subscribers' telegraph installations. He entered the Post Office in 1936 as a labourer in Canterbury Telephone Area and worked mainly on automatic telephone maintenance. Joining the Engineering Department in 1938, he went into the Telephone Branch and Circuit Laboratory. In 1941 he was promoted Inspector of Telephone Repeater Installations. After the war, in 1945, he spent eight months in France, Belgium and Holland re-establishing communications—mainly reconditioning the Calais–Paris carrier cable. He has been in the Telegraph Branch for four years.

C. R. DANCEY ("Vocational Study by Correspondence Course") entered the Post Office Engineering Department at Exeter in 1930. He became an Assistant Traffic Superintendent at Gloucester in 1935 and, following war-time service as an R.A.F. Signals Officer, was promoted Traffic Superintendent Class II, Glasgow. Transferring to Headquarters in 1948, he spent several years specializing on telephone exchange training and staffing problems. After a short spell in the Home Office as Senior Communications Officer, he returned to the Post Office in 1954 to take up his present position as Chief Telecommunications Superintendent at the Headquarters Traffic Training School.

T. H. FLOWERS ("What is Automation"?) is a Staff Engineer in the Research Branch at Dollis Hill. He learnt automatic telephony as an old style Inspector in the Circuit Laboratory and Telephone Development and Maintenance Branch between 1926 and 1930. After a period of training in the old South Eastern and London Engineering Districts, he entered the Research Branch in the Telephone Switching and Signalling Division of which he is now in charge. There he has witnessed electronics progress in switching from valves in long distance voice-frequency signalling systems, through computers to the present problems of fully electronic exchanges.

H. R. JONES ("Decibel Notation in Telephone Transmission") is Telecommunications Controller of the Wales and Border Counties Directorate. Coming from a Post Office family, he entered the service as a Telegraph Learner in 1917, and was appointed S.C. and

(*Continued on page 138*)

Notes and News

Royal Visit to "Monarch". While on a cable factory tour at Erith recently H.R.H. The Duke of Edinburgh took the opportunity to visit H.M.T.S. *Monarch* where he was received by the Postmaster General, Mr. Ernest Marples; the Director General, Sir Gordon Radley; and Captain J. P. F. Betson.

* * *

Books of Remembrance.—The Queen Mother unveiled and the Bishop of Guildford dedicated, at Busbridge Hall on April 2, the two Books of Remembrance, produced for the Post Office Fellowship of Remembrance, in which are inscribed the names of 12,830 Post Office staff of all ranks and grades who fell in the First and Second world wars. About 80 relations of the fallen, from the 10 directorates and regions, were present, with the Postmaster General, the Director General and others. Mr. S. D. Sargent, Deputy Director General and Chairman of the Fellowship, presided.

Her Majesty signed one of the plaques which are to be sent to all directorates and regions to commemorate the event.

* * *

Second T.A.T. by 1961.—A second transatlantic cable may be completed by 1961 as a joint undertaking by Cable & Wireless, Ltd., and the Canadian Overseas Telecommunication Corporation. The cable is to be made in Britain, with 50–100 British repeaters, to provide 60 2-way channels over one cable. H.M.T.S. *Monarch* will lay it between Scotland and Newfoundland. The cost will be about £8,000,000.

"Clearly", commented *The Times*, "it is to be exclusively a Commonwealth enterprise, since the United States are not associated with it, as with the first cable".

Register-Translators.—Two types of register-translator equipment, designed by the Post Office Engineering Department and the telephone equipment manufacturers for use in subscriber trunk dialling, are to be put on field trial in preparation for the first installation for public use at Bristol in 1959.

Each type performs the same functions, receives dialled information, stores it, translates into the form necessary to set up a route to the called exchange and subscriber, determines the charge step for the call and operates equipment to set up the appropriate charging conditions.

One of the two types incorporates the latest developments in electro-mechanical switching; the other uses electronic techniques which have proved satisfactory in other devices.

* * *

V.H.F. for Clyde Ships.—The Postmaster General, speaking from London with the Director of the Post Office in Scotland, opened on May 6, a new Very High Frequency Frequency Modulation radiotelephone service for ship-shore service over short distances.

"Clyde Radio" station is unattended and is controlled from Greenock Telephone Exchange. Pye Marine made and installed the station equipment.

Similar stations are planned for Land's End, the Isle of Wight, North Foreland and Humber (Lincolnshire).

* * *

Rain or Fine?—In its first 12 months, from March 5, 1956, London's WEAther service recorded nearly 4,000,000 calls. The service was extended to Birmingham, Liverpool and Manchester in February, to Glasgow, Belfast and Cardiff in March, and to Edinburgh on April 1 The Postmaster General extended London's service to coastal areas in Essex, Kent and Sussex on April 11.

Telegrams from Ghana.—Over half a million words of Press traffic and 97 radio pictures were received in London by Post Office Cable & Wireless from Accra in eight days in connexion with the granting of independence to Ghana.

★ ★ ★

P.O. Telephone and Telegraph Society.—The second half of the Society's 1956-57 session travelled over a wide range of topics. Miss H. M. Trenerry, Long Distance Area, in a talk on "A Supervisor's Log Book" gave an accurate description of the daily life of a Chief Supervisor in a large telephone exchange, based on her experience while in charge of a London Trunk Control Centre; she ranged from the handling of traffic to the cleaning of exchanges.

Col. F. A. Hough, now Chief Regional Engineer, London Postal Region, gave a comprehensive talk on laying the transatlantic telephone cable across Newfoundland, on which he worked while in the Engineering Department; he illustrated it with the official American colour film, and a colour film made by Mr. H. E. Robinson, part author of the article on "Laying the Cable across Newfoundland" in the *Journal's* T.A.T. Supplement last Autumn.

Captain C. F. Booth, Assistant Engineer-in-Chief closed the session with a talk on "Colour Television", with a demonstration of reception on a couple of commercial screens, arranged with the co-operation of the B.B.C.

★ ★ ★

"New Look" Telephone.—Ericssons of Stockholm have developed the "Ericofon" telephone set, the main principle of which is that all parts handled by the subscriber are combined in one piece. It is, in effect, a standing microtelephone, horn-shaped, upright with a slight forward tilt, the dial and switch being in the substantial base. The dial is recessed under the base; the caller speaks with the side of the base; and the ear-piece—the opening of the horn—is shell-shaped to fit the auricle of the ear, the sound holes being immediately opposite the auditory duct. The set is attached by cord to a wall terminal box.

The Ericofon is made in pastel shades, of plastic, a copolymer of styrene and acrylonitrile, which is impact—and scratch—resistant and is not affected by hand-sweat, skin creams, lipstick, detergents or other chemical agents. The push-button stand switch projects from the finger-wheel and is pressed upwards by weight when the set stands on the table, switching the instrument from speaking to signalling condition.

The set occupies about a third as much space as an ordinary desk set, and weighs about 14 oz.

ATLANTIC TELEPHONE CALLS DOUBLED

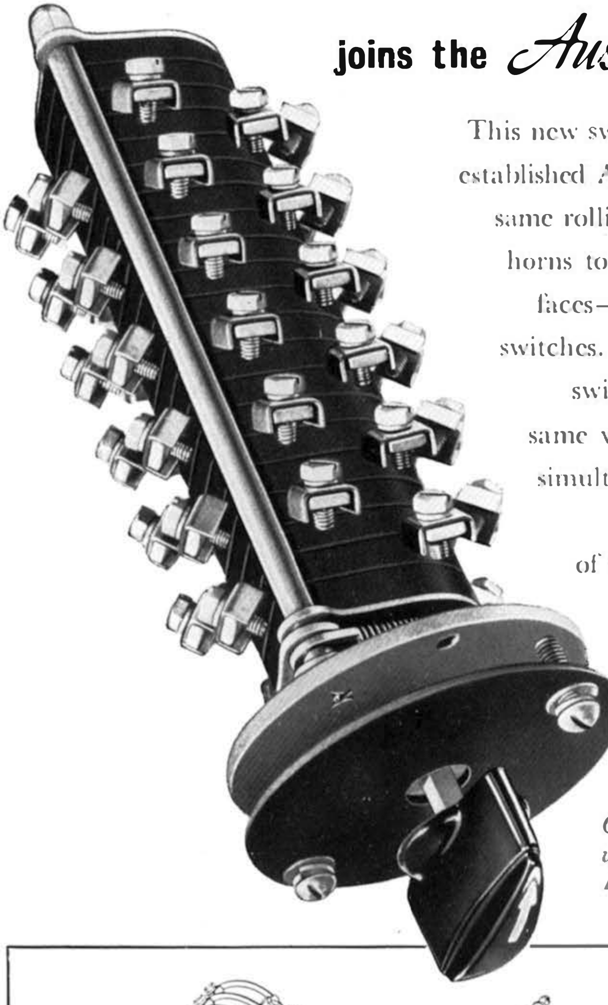
UNITED STATES

	Outgoing		*Incoming*		*Total*	
	1957	1956	1957	1956	1957	1956
January	9,500	4,583	8,175	4,181	17,675	8,764
	1956	1955	1956	1955	1956	1955
December	10,272	4,920	9,795	4,619	20,067	9,539
November	9,112	4,299	7,415	3,678	16,527	7,977
October	8,431	4,740	7,456	3,974	15,887	8,714

CANADA

	Outgoing		*Incoming*		*Total*	
	1957	1956	1957	1956	1957	1956
January	1,889	851	4,711	1,167	6,600	2,018
	1956	1955	1956	1955	1956	1955
December	2,389	1,084	5,554	1,433	7,943	2,517
November	1,790	768	3,819	998	5,609	1,766
October	1,719	813	3,413	1,214	5,132	2,027

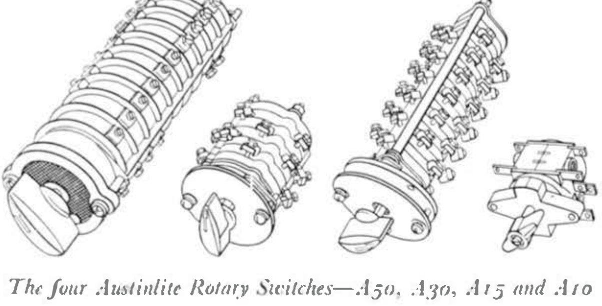
Now the A15—



joins the *Austinlite* rotary switches

This new switch is identical in principle to the well established A50 and A30 rotary switches. It has the same rolling, self-cleaning contacts with extended horns to keep any arcing away from the contact faces—a feature exclusive to Austinlite rotary switches. It has a similarly powerful and positive switch mechanism, and can be built in the same variety of forms to switch in sequence or simultaneously very large numbers of circuits. It is extremely compact, the smallest of the Austinlite multi-cell rotary switches. It bridges the gap between the A30 and the little single-cell 10-amp switch. Delivery, on standard applications, can now be made in four weeks.

Our brochure "SIMPLIFIED SWITCHING" will tell you more about the advantages of Austinlite Rotary Switches. May we send you a copy?



The four Austinlite Rotary Switches—A50, A30, A15 and A10

Austinlite

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OUR CONTRIBUTORS (*continued from page* 134)

T. in 1920. Two years later he was successful in the first examination held for Assistant Traffic Superintendents and was appointed to St. Albans. In 1925 he was promoted to Assistant Inspector, Class II, in the old Traffic Section at Headquarters, and he returned to the provinces in 1930. Promotion through the Traffic Superintendent and the Traffic and Sales Superintendent grades led to his appointment as Telephone Manager, Cambridge, in 1941, and Telecommunications Controller, Northern Ireland, in 1946. Mr. Jones has been on the Editorial Board of the *Post Office Telecommunications Journal* for the past two years and was previously a member of the Telecommunications Panel of the Joint Production Committee for several years.

C. V. OCKENDEN, O.B.E., B.Sc., F.R.Met.Soc. (joint author, "Britain's Weather Service"), is Assistant Director (Observations and Communications) in the Meteorological Office. Between the wars he was mostly connected with weather forecasting for the R.A.F. and served at several stations in Britain with tours of duty in Egypt and Iraq. During the last war he was at the Prestwick terminal of the Atlantic air routes and since 1946 has been responsible for the meteorological surface and upper air observational networks and the national and international exchange of information at the Central Forecasting Office at Dunstable. He is the present Chairman of the World Meteorological Organization (W.M.O.) European Working Group on Meteorological Transmissions.

G. R. SEALEY ("Trial of a Ticket Date-Stamping and Numbering Machine") is a Telecommunications Traffic Officer in the Telephone Manager's Office, Southampton. He was educated at Peter Symonds' School at Winchester and entered the Post Office as a Youth-in-Training in 1943. He transferred to the traffic side in his present rank in 1951. His military service was with H.Q., B.A.O.R. Signal Regt., when for some 18 months he was in charge of an operational Wireless-Carrier detachment.

J. SHORT ("The London Telegraph Street Tube System") is a Temporary Controller, Telegraphs, in the London Telecommunications Region. He entered the Post Office at Carlisle in 1914, and transferred to the Telegraph and Telephone Traffic Section, Secretary's Office, in 1930. Until 1945 he was engaged at first on work connected with the recommendations of the American Commission, and later with the introduction and development of teleprinter manual and teleprinter automatic switching. He was then transferred to the London Telecommunications Region as Assistant Controller, Telegraphs, where his duties lately have been largely concerned with the new telex system.

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

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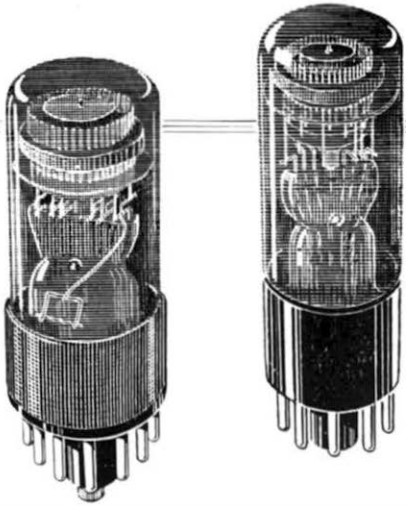

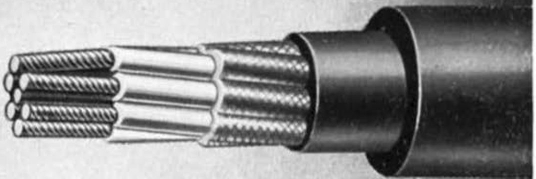

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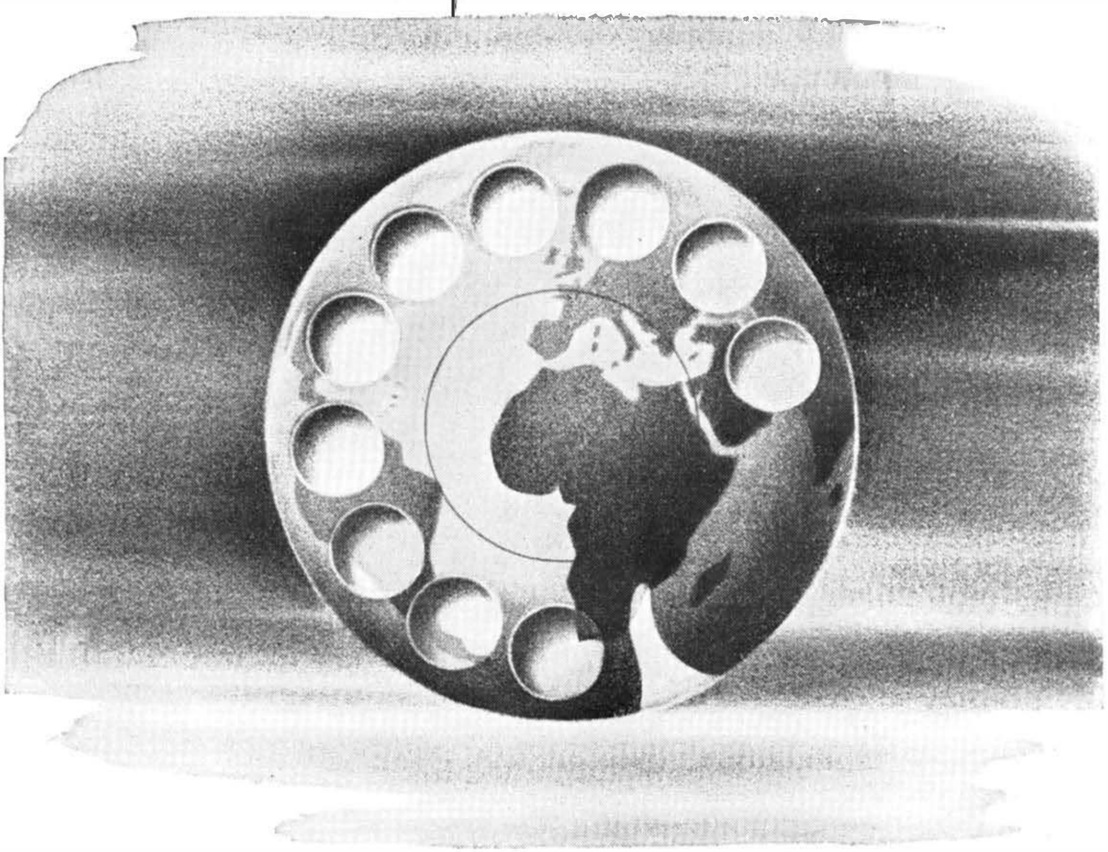

Photograph of the earth from 100 mile altitude — Courtesy U. S. Air Force

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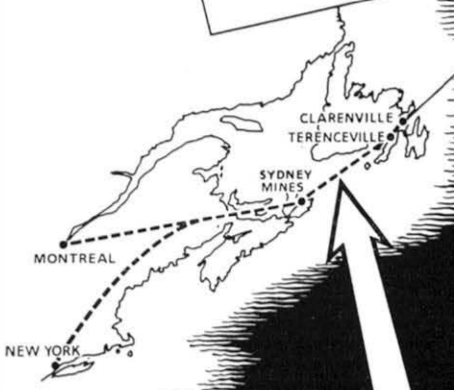
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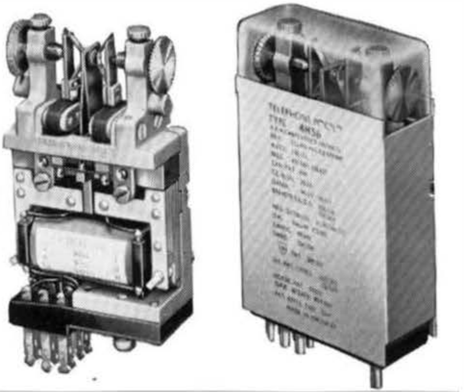

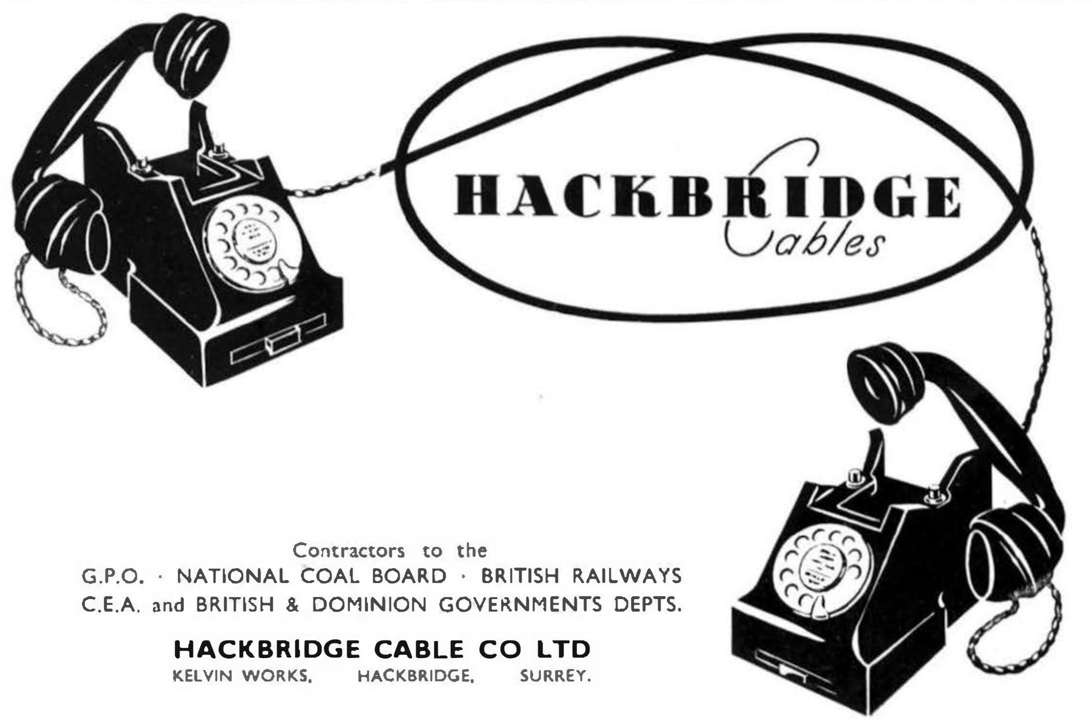
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CH51	High Fidelity Handheld Dynamic, Diecast Case. Low Impedance.
CH51/Z	High Fidelity Handheld Dynamic, Diecast Case. High Impedance.
H51/SB	Single Button Carbon, Handheld, Diecast Case.
H51/DB	Double Button Carbon, Handheld, Diecast Case.
HD/54	High Fidelity Dynamic, Handheld, Lightweight Moulded Case. Low Impedance.
HC/54	Single Button Carbon, Handheld, Lightweight Moulded Case.
HC2/54	Double Button Carbon, Handheld, Diecast Case.

Model	
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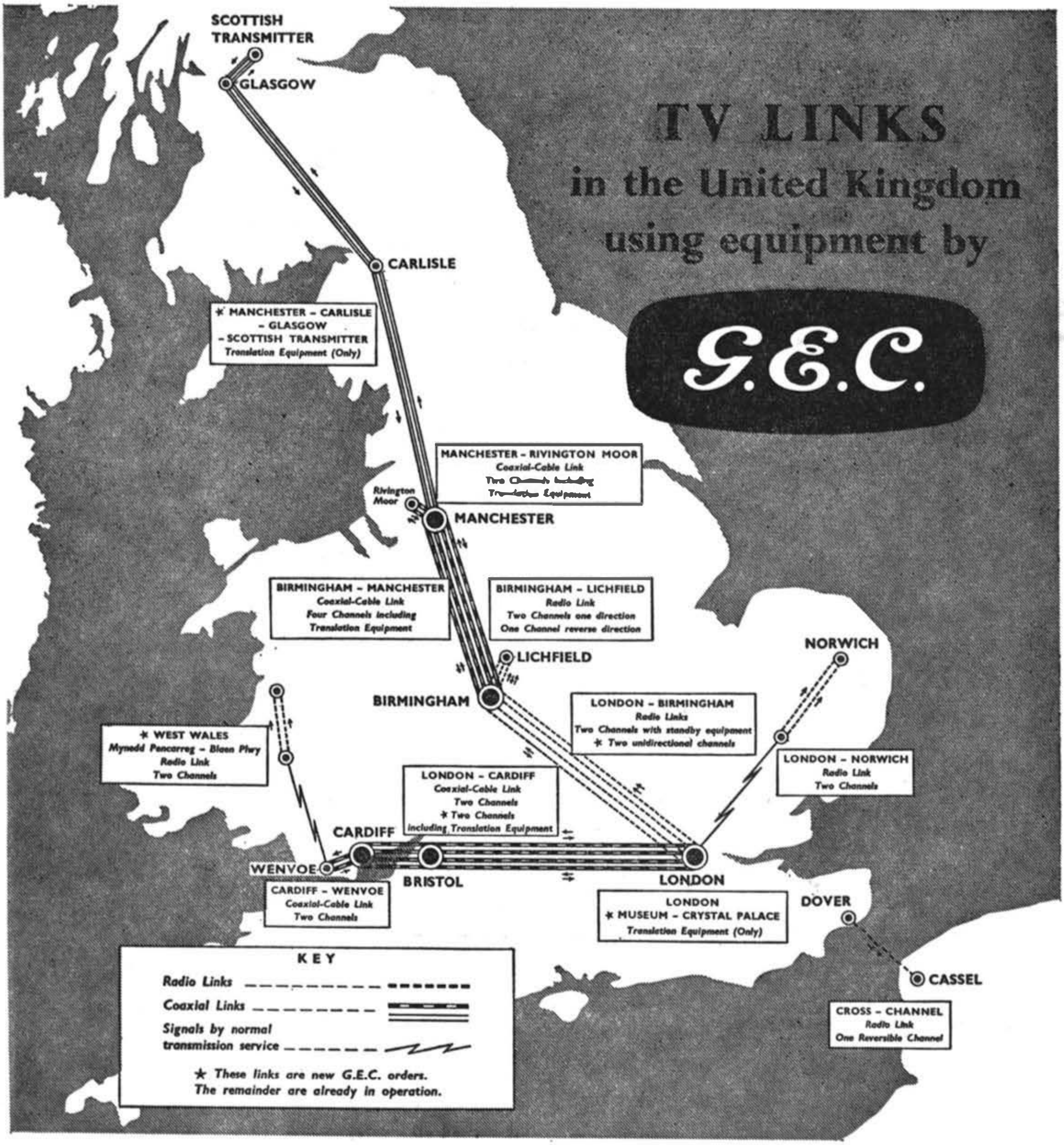

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