

# The Growth and Development of the Irish Telephone System\*

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## INTRODUCTION

Although the Telephone service is now of considerable importance in the life of the nation little seems to be known about it. This is regrettable since there are not many enterprises in the state with a larger capital, or which employ more than the 4,000 people for whom it provides a livelihood. It is hoped that this paper will dispel some of the apparent lack of knowledge, and may even be of interest to those intimately connected with it.

The paper has been divided into three parts, firstly, a qualitative analysis tracing the development in narrative form. Secondly, there is a quantitative analysis of the service in which the more interesting statistics since the foundation of the state are reviewed. Thirdly, the service is examined from the outside, as it were, and is compared with that in some other countries.

## PART I—HISTORICAL REVIEW

### *Development in Britain*

Alexander Graham Bell whilst experimenting with a multi-frequency telegraph system more or less accidentally discovered that speech could be transmitted by his apparatus; and on the 7th March 1876 a United States patent was granted to him for his "Telephonic device".

In the following year, 1877, Bell came to England to exploit his invention and demonstrated it to the Post Office. The "Chief Electrician", Mr. Preece, whilst pointing out certain defects, urged his Department to secure the rights to manufacture and use the telephone with the intention of using it in the telegraph service. Accordingly in 1878 the Post Office proposed to the Treasury that they should be allowed to hire telephone sets from Bell and rent them at a profit to private wire users. Some six

\*All opinions and statements in this paper are those of the author and do not necessarily represent the views of the Department of Posts and Telegraphs.

months later the sanction was granted, but in the meantime The Telephone Company Ltd had been registered to acquire and work Bell's patent. In America the Western Union Telegraph Company, who had declined Bell's patent when it had been offered to them, began to feel competition from the telephone, so they asked Thomas Alva Edison to develop an instrument which would not infringe Bell's master patent. This he did, and in July 1877 obtained a patent for his instrument.

Edison's instrument was brought to England by a Mr Adams and was demonstrated in London by Professor Barrett of the College of Science in Dublin, and in 1879 the Edison Telephone Co of London was formed with a capital of £100,000. George Bernard Shaw, who worked for this company until it was amalgamated with the Bell Co. to form the United Telephone Co of London in 1880, has described this episode in his career as "my last attempt to earn an honest living". After the first telephone exchange in London had been opened by the Bell Co in 1879, the Post Office really woke up and saw that the telephone was going to be a serious competitor with the telegraph service. The latter had been made a government monopoly under the Telegraph Act of 1869, and the Post Master General now invoked this Act, claiming that a telephonic communication was legally a telegram. The government then offered to allow the companies to work under licence subject to the payment of royalty and restriction of the area of communication. The companies indignantly refused and the case came before the courts in November 1880 and a judgment was given to the effect that a telephone is a telegraph and a telephone conversation a telegram "within the meaning of the Act". The case turned on the definition given in the 1869 Act "the term telegraph shall mean and include any apparatus for transmitting messages or other communications by means of Electric Signals". Hence the Department of Posts and *Telegraphs*

In anticipation of a favourable judgment the Post Master General applied to the Treasury for authority to negotiate licences with the existing companies and also to establish Post Office telephone exchanges "in a wide and comprehensive manner throughout the country". The Treasury, fearing the large expenditure which might be incurred, authorised the Post Office to act only to such an extent as would enable the Post Master General to bargain with the companies in a satisfactory manner.

Negotiations were then opened with the United Telephone Company who agreed to forgo the right of appeal on being offered a licence to operate in London. The conditions were, however, severe. No wayleave rights were granted, and the right of the Post Office or other persons to operate telephones was maintained. The company was also prohibited from opening public call offices or constructing trunk lines. Furthermore, the company was to pay the Post Office a royalty of 10 per cent of its gross revenue.

Licences on similar terms were also issued to a number of more or less independent companies already operating throughout the

country, and at the same time the Post Office announced that it was prepared to supply the public with telephones and provide exchanges

In 1882 the Post Master General stated that as it was not in the public interest to create a monopoly in telephone communication he proposed to consider favourably granting a new licence to any responsible persons. The United Telephone Company, however, held the master patents, a trump card they did not fail to show, by threatening actions for infringement of patents.

The Treasury, moreover, placed such stringent financial restrictions on the Post Office that it was prevented from extending the service nor was it even able to maintain its existing position. The Treasury minute in this connection is worth quoting. "The sound principle in the opinion of My Lords is that the State, as regards all functions which are not by their nature exclusively its own, would at most be ready to supplement, not endeavour to supersede, private enterprise, and that a rough, but not inaccurate, test of legitimacy of its procedure is not to act in anticipation of public demand."

In face of this the Post Master General withdrew many of the restrictions placed on companies in 1884 permitting them to extend anywhere in the United Kingdom and to interconnect exchanges by trunk wires

In spite of the heavy royalties and other restrictions the United Telephone Company did not do too badly, for although it made a profit of only £370 17s. 7d in 1881 it was able to pay dividends of no less than 13, 13, 15, and 17½ per cent in the years 1886 to 1889 respectively. This company had in 1884 offered to recoup the Post Office of the loss on the local telegraph traffic in order to maintain and strengthen its position, such action would at least indicate that the telephone business was profitable at the time.

In 1889, the three major licensees, the United, National and Lancashire and Cheshire Telephone Companies amalgamated under the title of the National Telephone Company. By its control of patents and by buying or forcing its rivals out of the field it got control in a few years of nearly all the telephone service in the country. In fact a virtual monopoly had been established.

### *Early development in Ireland*

The first telephone exchange in Ireland was opened in 1880 by the United Telephone Company on the top floor of Commercial Buildings in Dame Street with five subscribers. Initially a boy was employed to operate the switchboard, but finding time hanging on his hands, he adjourned to the court yard to play marbles, which led to his dismissal. A lady operator, Miss Agnes Duggan, was then employed, and in July 1881 the staff consisted of a manager, three clerks, the lady operator and a handyman who served as fitter, electrician and linesman, he had as helper a boy who carried all the tools in a straw basket on his back. The subscribers had grown to about 20 at this time, and as may be imagined, the switchboards were extremely primitive, subscribers were not

answered immediately when they called but had to wait patiently till the operator rang them back to ask their requirements. Continuous service was not thought of, the normal hours being from 9 a.m. to midnight.

In 1882 the Telephone Company of Ireland took over from the United Telephone Company from whom they obtained a licence to cover the various patents in use. The service continued to grow, but comparatively slowly, so that in 1888 there were only 500 lines and three sub-exchanges in the Dublin Area. Following the relaxation of Post Office restrictions in 1884 the company built a trunk route on the road from Dublin to Belfast.

In its turn the Telephone Company of Ireland gave way to the National Telephone Company in 1893, at which time the service was available only in Dublin, Belfast, Cork, Limerick, Dundalk, Drogheda and Derry. In the seven years that followed development was more or less rapid, and in 1900 there were 56 exchanges working in Ireland. In that year the Dublin exchange was transferred from Commercial Buildings to a new building in Crown Alley, where an exchange with capacity for 1,600 lines had been installed, this exchange was extended from time to time to meet growth and was not finally taken out of service until 1930 when conversion of the central Dublin area to automatic working was completed. The same building now houses an automatic exchange.

Up till 1893 the majority of the subscribers' lines had been single wire circuits carried on steel structures fixed to roofs, or on very tall poles, which sometimes reached 90 feet in height. With the growth of the system the overhearing between lines became quite intolerable. The first thing the National Telephone Co. did, therefore, on taking over was to make all circuits loop and, at the same time, lay an extensive underground cable network, the production of lead-covered paper insulated cables having become general in 1896. The largest size then available had 204 pairs of wires, the copper conductor weighing 20 lbs. per mile. As the number of lines increased these filled up and in the 'twenties these old cables were recovered and modern cables containing 1,000 pairs of wires or more, yet no larger in diameter, were drawn into the old ducts.

By now the telephone service had grown to such an extent that telegraph revenue was seriously depleted and the Post Office was becoming gravely concerned. So much so that the government reconsidered their former policy, the Post Master General announcing in March of 1892 that it was proposed to purchase the trunk lines from the National Telephone Company, whose work would henceforth be confined to local areas. It was also proposed to extend and develop the trunk system; to this end a Bill was introduced and became law in June 1892 authorising expenditure up to £1 m., of which £459,000 was to pay for the Company's trunk system. The Post Office hoped by these means to offset the loss on the telegraph service.

Development of the trunk service was, however, very slow as Treasury policy laid down that demand could not be anticipated

but had to be assured before any extension to the network could be provided

As part of the general development under the Act a two circuit submarine telephone cable was laid between Port Patrick in Scotland and Donaghadee in Co. Down at a cost of £20,000. The circuits from Belfast to Glasgow and Carlisle were formally opened by Lord Kelvin on the 5th day of April 1893 giving Ireland its first external telephone connection. In 1898 a submarine cable of novel and unusual design was laid between Newcastle, Co Wicklow, and Nevin in North Wales, since the normal type could not be used because of the distance involved. The design of this cable was in advance of the manufacturing capabilities of the time and the circuits were found to be useless for telephony; the wires were used as telegraph circuits until the cable was abandoned in 1935

At the beginning of the century the inland trunk service was very tenuous. There was one circuit from Dublin to Wexford with an extension to Waterford. Cork and Limerick shared a circuit between them to Dublin, the latter being tied off at Limerick Junction. Today there are 108 circuits between Dublin and Cork and 78 between Dublin and Limerick.

By 1906 trunk routes had been extended from Belfast to Omagh and Derry and circuits provided from Dublin to Dundalk, Balbriggan and Mullingar via Clara. Many exchanges had no trunk service, for example, Galway, where an exchange had been opened in 1897, but was not connected with the trunk system till 1914.

All trunk routes were open wire aerial lines which were, with few exceptions, notably the Dublin-Belfast route, run alongside the railways since the Post Office had free wayleave rights under the various agreements with the Irish Railway Companies. In order to meet the transmission requirements heavy gauge copper wire had to be used for the longer circuits; wires weighing 300, 400 or 600 pounds per mile were not uncommon. A circuit was even erected between Dublin and Belfast using wire weighing 800 pounds per mile in order to give something like adequate transmission on cross-Channel calls, and using this circuit it was just possible to speak from Cork to London via Dublin, Belfast and Glasgow if all conditions were favourable.

The first telephone cable between the south of Ireland and Great Britain was laid in 1913 from the Martello tower in Howth to Nevin in North Wales, a distance of 63·4 nautical miles. This cable, one of the first of its type, was insulated with Balata and was "lump loaded". The cable gave Dublin one circuit to London and one to Liverpool, and was retained in service till 1938 when it was abandoned on the provision of new cables

Meanwhile the National Telephone Company had been living under a continual threat of being taken over by the Post Office, which threat became a reality in 1905. On the 2nd of February of that year, after prolonged negotiations and haggling, the Post Master General and the Company signed an agreement fixing the conditions under which the state was to take over the whole

of the Company's system when the licence expired at the end of 1911. In this agreement provision was made for an inventory of the Company's plant and for arbitration should there be disagreement as to the takeover price, no payment was to be made in respect of goodwill or profits. The Company claimed £20,924,700 for the undertaking and were actually paid £12,470,264 after arbitration. In 1909 the company showed their capital assets, including land and buildings, as almost £16 m. and the amount raised under stocks and shares as £11 5 m. The gross income for the year was £3 149 m., 10 per cent of which was paid in royalties. The amount of profits or dividend paid was not stated

Notwithstanding the contribution from royalties the Post Office Telephone service did not balance their accounts as indicated by revenue and expenditure figures for the financial year 1909-1910. Gross revenue amounted to £1,750,328, made up of £651,638 from the trunk service, £778,100 from the local service and £320,590 from National Telephone Co Royalties, on the other side expenditure was £1,789,924, leaving a deficit of £39,616

By the end of 1908 there were 118 exchanges in Ireland as a whole, 85 of which were owned by the National Telephone Co and 33 by the Post Office, in this year the company opened 18 and the Post Office 11 exchanges. During the years 1907 and '08 the National Telephone Co. had also laid some 20,000 yards of multi-way duct in Dublin, a very considerable work for those days. There were at that time about 4,000 lines working on the central Dublin Exchange at Crown Alley.

The Post Office Telephone Directory for July 1907 listed 22 exchanges in Ireland of which 16 were in the Counties of Antrim, Armagh, Derry, Fermanagh, and Tyrone, the remaining six being Dublin with 10 subscribers, Cork which had 9 subscribers, Carlow, Tipperary, Mallow and Killarney, the biggest, with 23 connections. The only exchanges listed with night service were Dublin, Belfast and Cork. In Dublin and Cork there were of course also National Telephone exchanges, to which the vast majority of subscribers were connected.

Although not directly concerned with development of the telephone system an interesting interlude occurred in 1909 when the engineering work of the Post Office in the southern portion of the country, or more accurately in the provinces of Leinster, Munster and Connacht was taken over by the Signal Company of the Royal Engineers, under a Major Weber. Practically all the civilian engineers, supervisory staff and linesmen were transferred either to England or to the Belfast district and replaced by military personnel; only the construction gang staff and labourers remained untouched. On the outbreak of war in 1914 the military were withdrawn and the civilians returned

When the Post Office took over the National Telephone Co. telephone system on the 1st of January 1912 there was an acute shortage of exchange equipment and underground plant generally, and much of that which did exist was in a quite deplorable

condition, since the company was, understandably, not anxious to carry out renewals or improvements once it was clear that their days were numbered.

Many schemes were put in hands to relieve the situation but, perhaps naturally, Britain came first, and little if anything was done in Ireland before war was declared in August of 1914 when all work came practically to a standstill.

At the end of the war in 1918 there was a total of approximately 12,500 subscribers' lines in the 26 county area, of which 6,400, or slightly more than half, were in or around Dublin. Exchanges numbered 212, of these 25 were in the Dublin area. There were no exchanges in the Counties of Mayo, Leitrim or Roscommon, and only one in Longford. In contrast the southern and eastern parts of the country were fairly well developed; there were, for example, 36 exchanges in County Cork. Many of them were, however, very small; for instance, there was a total of but 41 lines working on the six exchanges in Co. Clare, and of these 27 were in Ennis.

#### *Development 1922-1945*

The next few years saw the Anglo-Irish and civil wars when little or no development work could be done, indeed the destruction of plant was considerable. From 1924 onwards a large programme of reconstruction was put in hands, many of the main routes were strengthened or rebuilt *in toto* and major underground cable schemes initiated in the larger cities. At the same time the system was extended throughout the country so that by the end of the decade the only considerable parts of the country without telephone service were the western parts of Mayo and Donegal.

Much of the switchboard equipment, particularly in the main centres, was very old and worn, and except for Ballsbridge in Dublin, where a modern exchange had been installed in 1921, dated from the early days of the National Telephone Company. Following an examination of the problem by a group of international experts, a plan was drawn up for an automatic exchange system for Dublin, using a uniform 5 digit numbering scheme. The first two exchanges under this scheme were opened in the latter half of 1927, and the subscribers in the city area were gradually transferred to them, so that in 1930 the manual switchboards in Crown Alley, which had been installed in 1900, could be withdrawn from service.

Due to economic conditions and the consequent financial stringency there was little development for the next few years. In 1937, Rathmines and Terenure exchanges were converted to automatic working, and in the following year a new main exchange was opened for service in the Crown Alley Building. The conversion of the Clontarf area was next undertaken, and this was followed by the installation of an automatic exchange in Dún Laoghaire to replace the manual exchanges in Dún Laoghaire itself, Blackrock, Dalkey and Foxrock. This exchange was opened just after the outbreak of World War II, when all hopes of further extending the automatic system came to an end for the time being.

Meanwhile, the trunk traffic, which had received a marked impetus following the rate reductions of 1936, continued to grow steadily. Even in the early 'thirties it became apparent that traffic needs could not be met for long by putting up more wires on the main pole routes, and as the distances were comparatively long the laying of cables to provide the number of circuits then required, or which could be envisaged during the next few years, was clearly uneconomic. Other countries, in particular the United States of America, had been faced with just such a problem, and to meet these needs the Bell Telephone Laboratories had developed a three channel carrier system to work on open wire lines. By this means the utilisation of open wire lines could be largely extended quickly and economically.

The first carrier system in Ireland was opened between Dublin and Belfast in May, 1932, to be followed in the next few years by the installation of similar systems between Dublin and all the main centres. These early systems occupied considerable floor space and were relatively costly, being economic for distances over about 60 miles only; technical progress has since then been such that today a three channel system is economic for distances as short as fifteen miles. On the outbreak of war in 1939 some 20 such systems were in use.

As the trunk system grew, calls were being made over greater distances, the problem of maintaining better transmission became urgent and, to meet it, better types of telephones were installed in the more remote areas

Another advance, perhaps trivial at the time, but the forerunner of an important development, was an arrangement whereby an operator at a distant exchange, for example, Sligo or Waterford, could dial a number directly into the Dublin automatic network, without the intervention of the Dublin operator, thus laying the foundations of trunk automatisation and leading eventually to Subscriber Trunk dialling. The original circuit used direct currents for signalling and could not, therefore, be used on carrier circuits. To overcome the difficulty a system was designed which used two frequencies in the speech band to achieve the same end.

At the outbreak of war on the 1st of September 1939 all work of extension and development had perforce to be abandoned, although a reasonable stock of materials had been laid in, which enabled the more pressing needs to be met during the period when nothing whatever could be obtained from abroad. Following the fall of France the Department was called upon to provide, at short notice and as a matter of extreme urgency, lines to 84 lookout posts on headlands round the coast. The work was one of some magnitude and difficulty as well over 100 miles of new pole route had to be erected to such out of the way places as Achill Head, Slieve League and Brandon Head. These circuits, together with some hundreds of miles of urgently required trunk lines, were all completed within the months of June and July of 1940. Among these latter was a trunk line from Ballina to Belmullet, which had hitherto been without telephone service. In previous years this project had been mooted on many occasions but had



always been turned down because the demand could not be assured and, therefore, the scheme might not be remunerative. However, since the first circuit was provided, traffic in the area built up rapidly and there are now three circuits from Belmullet to Ballina, which will be increased to 12 in the near future.

On account of the great transport difficulties in, or sometimes lack of transport, during these years the telephone service came into its own and much greater use was made of it, more especially in the rural areas. Many came to rely on it, and the making of trunk calls became a commonplace amongst people who in the past had never dreamt of using a telephone.

Since nothing very material could be done at the time to meet the rising demand, delays on trunk calls rose inordinately, and in nearly all exchanges there was serious traffic congestion. Even when peace came to Europe there was little prospect of obtaining stores and equipment for quite some time, but the Department was fortunately able to buy about 60 three-channel carrier systems, a few switchboards and other war surplus stores which to some extent saved the day until major extensions could again be undertaken.

Just after the war the last trams in Dublin were taken off the streets and, in what was perhaps a unique transaction, the Post Office bought the whole underground duct network, totalling approximately 40 miles, which had been used for tramway feeder cables. These ducts proved invaluable to the Post Office when the work of augmenting and extending the city underground cables came to be put in hands

### *Development since 1945*

In 1945 the Government approved a plan which had as its main objectives (a) provision of sufficient circuits to give a no-delay trunk service; (b) increasing the number of subscribers' installations from 31,000 to 100,000 and increasing telephone stations to 150,000 within fifteen years and (c) the provision of a 24-hour service for practically all subscribers. This programme was estimated at the time to cost £10 million.

In putting the plan forward it was stressed that considerable sales effort would probably be required to increase the number of installations at the rate envisaged and, as regards the provision of continuous service, it was pointed out that it could not be given economically unless all but the very smallest exchanges were made automatic; there were at the time only 107 exchanges serving 27,300 subscribers with continuous service. The remaining 732 exchanges to which 5,900 lines were connected had restricted hours of service.

As events turned out this programme was, with the exception of the provision of continuous service, achieved within the 15-year period, notwithstanding unavoidable increases in charges, nor was any sales effort required. Indeed the waiting list of applicants for service has at no time been cleared entirely.

As part of the general plan call offices were installed in almost 1,000 sub-post offices hitherto without telephones, thus bringing the service into the most remote parts of the country. Although the capital cost was substantial they have proved a real asset to the rural community and are being more and more used as time goes on, they have also been an incentive to people in the vicinity to get lines of their own, so that many of them have now become small exchanges.

In order to meet the ever-rising demand and as part of the general plan orders were placed for extensions to existing exchanges and for new exchanges in Dublin amounting to 20,000 lines. Three of these were satellite exchanges at Whitehall, Ballsbridge and Clondalkin, which were not in the original plan for Dublin, as it was then cheaper to cable the subscribers into a central exchange, but as metal prices had increased enormously since the war it became more economic to open exchanges in outlying areas. It also became evident that the five figure numbering plan which had a theoretical capacity for about 70,000 lines would soon be exhausted and, accordingly, a mixed five and six digit numbering scheme was evolved, the six digit numbers being allotted to residential areas where traffic is light, in the first instance; as the system grows all numbers in the Dublin area will have six digits. The provision of automatic exchanges with manual trunk switchboards in the provinces was also undertaken of which Cork was the first to be opened in November 1949. Today thirteen of the larger centres have been converted to automatic working and a number of unit automatic exchanges installed in the smaller towns.

When the extension of the trunk system came to be examined it was abundantly clear that the pole routes could never be extended to meet the then existing needs, let alone provide sufficient circuits to give a no-delay service or provide for the future. The laying of underground trunk cables on a large scale was obviously essential. To this end a scheme was prepared for co-axial carrier cables from Dublin to Cork via Limerick with a branch from Portlaoise to Waterford, and from Dublin via Drogheda and Dundalk to the Border where it met a cable from Belfast laid by the British Administration. In addition to the co-axial tubes the cables contained paper insulated loaded pairs of wires to serve intermediate places on the route. Yet another co-axial cable was later laid from Dublin to Mullingar, branching to Sligo and Athlone, from where a multi-pair cable had been laid to Portlaoise.

The design of the co-axial cable equipment is such that on the Southern and Northern cables an ultimate of 600 circuits can be provided. The Western cable is of later design and provides for 960 circuits.

The remainder of the country was until recently served either by 12 or 3 channel carrier systems working on open wire routes, by open wire lines, or in some instances, by audio frequency loaded cables radiating from the main cable terminals. As the circuit capacity of these pole routes was rapidly becoming exhausted other means had to be found to meet the ever-increasing needs.

Since the cost of cable, and particularly trenching, had risen sharply the possibility of using micro-wave or very high frequency radio systems was investigated and proved to be economically attractive in certain instances. In April 1961 the first micro-wave link was opened between Athlone and Galway with capacity for 240 circuits, and somewhat similar links will be provided between Dublin; Wicklow, and Waterford to Wexford and Enniscorthy in the near future. Several other links are in the course of planning.

On very many of the shorter routes serving comparatively small towns circuit needs were also urgent and, as underground cables would in these cases be clearly uneconomic, polythene insulated aerial cables are being erected on existing or new pole routes.

In order to meet the demand for more circuits to Great Britain two additional submarine cables were laid between Dollymount and Holyhead in 1946 and '47 which provided for 24 circuits. As traffic increased more circuits were necessary, and to meet this need two submarine amplifiers were inserted in each cable in 1953, thus increasing the combined circuit capacity to 120, so that with the 24 circuits working on the older Howth cables a total of 144 circuits became available on cross-Channel routes. As this number is now insufficient additional circuits have been obtained through Belfast as a more or less temporary measure until an additional route, either micro-wave radio or cable, is installed.

The provision of an efficient and at the same time economic service in rural areas has always, and everywhere, been a difficult problem, especially in Ireland, where the countryside is sparsely populated. About 30 per cent of all exchanges have less than 7 working lines and another 30 per cent have between 7 and 20 lines leaving only 40 per cent. with more than 20 subscribers.

To give continuous service to the large number of very small exchanges on a manual operating basis is manifestly uneconomic. On the other hand, the cost per line of automatization is comparatively large and would not be warranted unless growth could thereby be stimulated, and/or consequential economies achieved in the network as a whole.

The use made of the telephone by the rural subscriber has, in the past, been small, due in large measure to the few numbers which could be reached for the local call fee, the majority of calls involving a trunk charge. A vicious circle was thus created—few people wished to become subscribers because of the small number of existing subscribers.

It is of course true that there had over the years been a certain development in rural areas, but for many reasons there had been little real progress in dealing with the problem.

It was realised at an early stage that a real advance could be made only by a complete automatization of the network coupled with a system whereby subscribers could dial any other subscriber's line in the country, and eventually outside it, by themselves, without the intervention of an operator—such schemes were a reality in many European countries, notably Switzerland, the Netherlands and Western Germany, and at the time (1957) were being planned actively in Britain.

In formulating a complete and overall plan for this work the help of an engineer of the Netherlands Post Office, Mr G J Kamerbeek, was obtained by arrangement with the United Nations Technical Assistance Administration. He arrived in this country in January, 1958 and presented his report in June of that year. This report was most valuable to the Department and has, with some modifications, been accepted as the basis for future planning.

Before this plan for subscriber trunk dialling had evolved a certain degree of automatization of the trunk system had already been reached. Operators at the principal exchanges could obtain by dialling directly the wanted subscriber's number if it were connected to almost any of the automatic exchanges in the country, or obtain the operator at a distant manual exchange if it had direct circuits to a main centre which was automatic. For example, a Dundalk operator could obtain a number in Cork by dialling through Dublin into the Cork automatic exchange, or reach the Ennis operator by dialling through Dublin and Limerick.

In addition some 55 small unit or rural automatic exchanges had been installed in rural or fringe areas round main centres and subscribers connected to these could dial calls to other automatic exchanges within 20 miles radial distance, the appropriate charge being recorded by operating the message register once, 3 or 5 times.

A small scale experiment had also been made with subscriber trunk dialling in the Athlone area in 1957 which was eminently successful. A somewhat similar scheme, but on a larger scale, which was introduced in Cork in December, 1958 was also completely successful in that 95 per cent of all the calls which could be so obtained were dialled by the subscribers themselves.

In order to formulate the plan for complete automatization of the network and subscriber trunk dialling decisions had to be taken on three fundamental and closely inter-related points, as follows: (1) The local subscribers' numbering scheme. (2) The trunk switching and numbering plan and (3) the charging plan. As a preliminary to the implementation of the scheme the country was divided into 127 primary areas of varying extent within which all calls would be charged at unit or local fee; in addition, calls could be made, in the majority of cases, for a local fee, to subscribers in adjoining areas. For example, a call from Ennis to any other exchange in Clare, from Keel to Castlebar or from Bray to Balbriggan would cost twopence.

The charging scheme for trunk calls would be drastically altered and the number of charging zones reduced from seven to three. When and as subscriber trunk dialling was introduced the three-minute charge would no longer apply but the subscriber's message register would be operated during the call at varying time intervals depending on distance between the charging points concerned. For instance, the message register will be operated once every 30 seconds for a call up to 35 miles, once every 15 seconds for a call up to 50 miles and once every 10 seconds for a call over 50 miles. Longer intervals would be given between 6 p.m. and 8 a.m. Calls made through an operator have of necessity to be charged for

a minimum period of three minutes but under the new system a short call is charged accordingly. For example, a 30 second call from Sligo to Cork costs 6d as compared with 3/- if the call were connected by an operator.

In 1959 the progress on telephone development was reviewed and the Government approved proposals for the adoption of Group charging and certain other minor modifications in rates affecting in particular the rural subscriber. The new arrangements were introduced in August of that year. They have definitely achieved their object of stimulating development, and the resources of the Engineering Branch of the Department have been taxed to keep pace with the rising demand for both trunk circuits and subscribers' lines. Subscriber Trunk Dialling facilities have now been provided in all the main automatic exchanges using the national numbering plan, but much remains to be done to provide an automatic service throughout the country as a whole.

It would perhaps be rash to prophesy too far into the future but one thing seems assured, namely, the service will continue to grow and develop for many years to come. Technical advances making the service both better and cheaper, will certainly never cease and many devices and techniques now undreamt of will become commonplace in time.

## PART II—STATISTICAL SURVEY

### *Subscribers' development*

As the telephone service exists for, and depends on the subscribers it would seem appropriate to begin the statistical review by considering their growth and distribution. Before, however, looking at the actual statistics some general remarks on their growth might be pertinent.

There are a number of factors which will influence the growth of a telephone system, the more important of these are as follows :

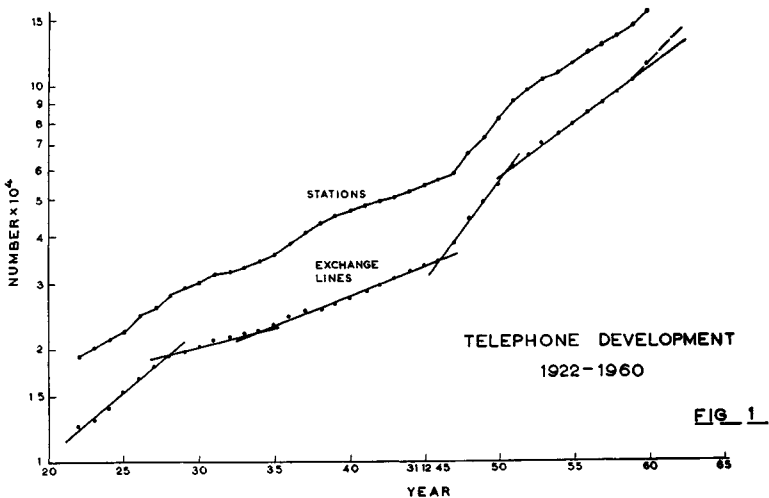
- (1) The level and well-being of the National Economy as a whole.
- (2) The relative cost of the service compared with the general level of prices prevailing.
- (3) The sales effort made to induce people to become subscribers.
- (4) The quality of service offered. This factor, it should be noted, is interdependent on (2), for example, if circuits were to be provided on such a scale that at all times and under all conditions a free circuit was always available, or if the quality of transmission materially improved, the relative cost of the service would rise disproportionately.
- (5) The number of existing subscribers.

It would be difficult to evaluate factors 1 to 4 either absolutely or relatively, but they can be taken, in general, as constant over a period of a few years and they can be combined into a constant  $k$ . As far as factor (5) is concerned it will be appreciated that the telephone is a commodity which increases in value in proportion to the number in use. In fact as the system grows there are fewer people who can afford not to have a telephone provided always that saturation has not been reached. The urge to become a subscriber on this account may therefore be written as  $J_s$ . Where  $J$  is a constant and  $s$  the number of subscribers at any time. The rate of growth of subscribers' lines may now be expressed by the equation—

$$\frac{ds}{dt} = kJs$$

from which  $\log s = kJt + C$

This solution supports the practical experience that growth follows a logarithmic law, the actual rate depending on the constants  $k$  and  $J$ .



The actual number of exchange lines and telephone stations (a station is any telephone, such as an extension on a Private Branch Exchange from which a call can be made to any other telephone on the system) is given in Table 1, and in Fig. 1 the growth is shown graphically on a log scale. It will be seen from the graph that the growth is in fact logarithmic and is reasonably constant over five well-defined periods. The first of these is from 1923 to 1929 during which the rate of growth was 8 per cent. per annum. In this period the system was extended to parts of the country hitherto without service and there was a certain back-log due to almost a decade of war when development was impossible. Six lean

years caused by the world depression of the late twenties and early thirties ensued when the rate of growth fell to 2·6 per cent. In 1934 the rate again increased to 3·4 per cent. and maintained this level until 1947 despite the brake on expansion that had to be applied due to shortage of materials during the war. From 1947 to 1951 the pent-up demand was met to a large extent as equipment became available and the rate of growth rose to no less than 12·3 per cent. In the fifth period a growth of 7·2 per cent. was maintained for nine years and it would now appear to be rising again due to the increased national income and the extension of the local call fee area under group charging. The variation in the rate of growth of telephone stations is less marked than in the case of exchange lines but the same general pattern is followed, the average rate of expansion from 1939 up to the end of 1960 being just 6·7 per cent. per annum.

A feature of the development is the steady increase in the proportion of "residence" lines as compared with those rented for business purposes. The percentage of such lines is shown in Table 1 from which it will be seen that they rose from 31·8 per cent. in 1940 to 48·6 per cent. in 1960, the rise in 1959 being due mainly to the concession given to certain farmers whereby their rentals were changed from business to residence rates. In the United Kingdom and United States of America residence lines amount to 44·4 per cent. and 72 per cent. respectively of the total connections.

The distribution of lines and telephone density varies widely between various parts of the country. The number of lines and stations in each county is given in order of density of exchange lines in Table 2 and for comparison purposes the density of motor vehicles has also been shown. It will be noted that the latter is, except for Dublin, considerably greater.

As might be expected the telephone density in Dublin at 9·25 per cent. for lines and 12·9 per cent. for stations far outstrips any other county; actually about 57 per cent. of all telephones are in Dublin. Longford, with 450 lines, has fewer than any other county, although the density is 0·5 per cent. greater than that in Roscommon, which has only one line per 100 of population.

In fact the telephone has up to the present at least been very largely an urban amenity. The fifteen urban areas with over 10,000 inhabitants account for about one-third of the total population but have 70 per cent. of the telephones. The number of farmers who have telephones is small; in 1959 it was estimated that only about 3,000 were then subscribers. It is difficult to determine with any pretence to accuracy what the potential number might be, but an approximate figure could be arrived at from the valuation of holdings as given in the Statistical Abstract (1960) as follows:

Valuation	Number of Holdings
Over £200	2,958
£100 to £200	8,775
£50 to £100	22,705

It could be assumed that all farmers with holdings valued over £200 have, or will get, a telephone, that virtually all with valuations between £100 and £200 are at least potential subscribers, and that of those with holdings valued between £50 and £100 about half might possibly become subscribers in the not too distant future, in view of the facilities now offered in rural areas. An estimated potential of 20,000 lines would, on this basis, be reasonable.

#### *Telephone exchange growth*

As exchanges are necessary before subscribers can be interconnected and make calls consideration of their growth and development would now be appropriate

The growth in actual numbers since 1926 is given in Table 3 (a) from which it will be seen that on the 31st March, 1961 there were a total of 1,012 exchanges. The question now arises as to what is the possible ultimate number as there is obviously some limit. The total area of the State is 26,700 square miles, of which 21,000 may be taken as inhabitable. If it is now assumed that the ideal exchange area is hexagonal in shape with a distance between the centre and mid-point of the side equal to three miles (the free mileage radius) each exchange should serve an area of just 31 square miles. There will of necessity be some overlapping and many exchanges will have their service area limited by the coast; in order to cover such conditions 60 per cent of the ideal area or 18.6 square miles can be taken as the average area served. It may, therefore, be concluded that about 1,100-1,200 exchanges will meet all eventual needs.

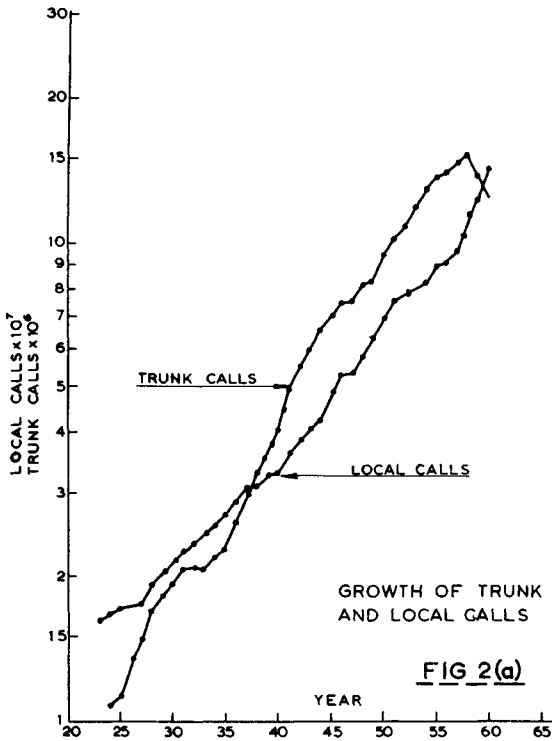
One feature of the system is the large proportion of small or very small exchanges. As will be seen from Table 3 (b) 306 or 30 per cent. have less than 10 working lines and 59 per cent. less than 20, on the other hand, only 115 or 11.3 per cent. have more than 100 working lines.

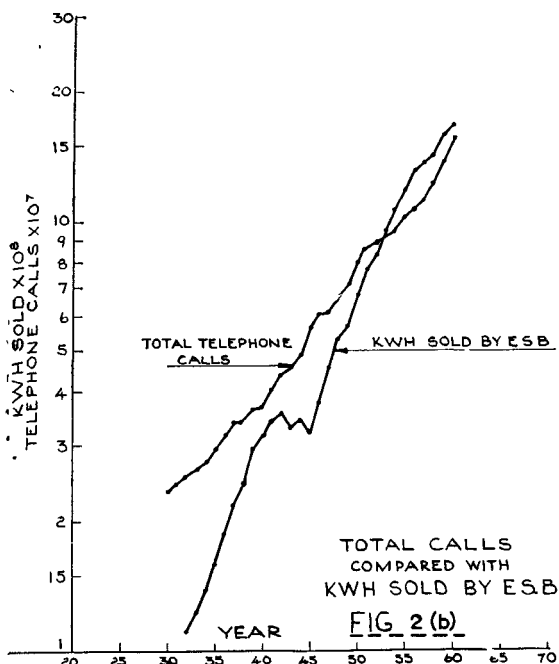
In June, 1960 404 exchanges had continuous service, 446 had service from 8 a.m. to 10 p.m. and 149 had service from 8 a.m. to 8 p.m., however, those with restricted service hours catered for only 5 per cent of the subscribers. It is clearly difficult and costly to provide a full and efficient service in the small exchanges installed in sub-offices where there is only a part-time operator, but, on the other hand, the heavy cost of line constructions has precluded the combining of many of them into larger units. The introduction of new techniques and devices such as "line concentrators" in conjunction with automatic exchanges should make such a development economically possible in the future.



*Use made of the system*

How is the system used by the subscriber? The number of local and trunk calls made each year since 1923 is given in Table 4 and is shown graphically in Figs 2 (a) and 2 (b). It should perhaps be explained here that a local call is one which is untimed and charged at unit fee, and was before 1959 limited to a radial distance of  $7\frac{1}{2}$  miles between the exchanges concerned. Calls outside the defined local area or up to 1959 over  $7\frac{1}{2}$  miles distance are or were classified as trunk.





The rate of growth in local calls has been reasonably steady over the years at between 5 and 6 per cent. The growth rate in trunk calls has in contrast varied considerably at various times. From 1923 to 1930 the rate was 10.6 per cent. per annum although the total number of calls was actually small, during the next few years the increase was very small, but following charge reductions in 1936 it rose sharply to 8.1 per cent. per annum, a rate which was maintained for 9 years. From 1945 to 1958 the rate fell back to 6.1 per cent.

Following the new concept of group charging introduced in August 1959 a completely new set of conditions arose which makes any direct comparisons with former years invalid. The total recorded calls do, however, show an increase of 29 per cent. between 1958 and 1960.

One point that does emerge from these statistics is the relative constancy of the calling rate, that is, the number of calls made per exchange line per annum; the number made in 1923 being equal to that in 1960 at 1,350 per annum. The calling rate in 1946 did rise to 1,750, but at that time there was a large pent-up demand for lines and those available were used more; as the telephone spreads and the proportion of residence lines increases a slight reduction in calling rate might be expected

The provision of adequate circuits to carry the traffic offered presents quite a difficult problem as a reasonable balance must be maintained between the quality of service and cost. If the quality of service is poor and sufficient circuits are not available so that subscribers frequently find that calls are delayed, or cannot be effected due to lack of circuits, complaints will ensue and traffic will be lost. On the other hand, if circuits are provided to meet fully all possible traffic conditions costs will rise materially and rates would have to be increased to meet them.

Telephone traffic is measured as the product of the number of calls over a given time, say an hour, and the length of time the circuit is held by each call, the unit of traffic is the "Erlang" which is defined as a call-hour. In order to design exchanges and trunk routes economically it is essential to know the traffic flow that can be expected at various times.

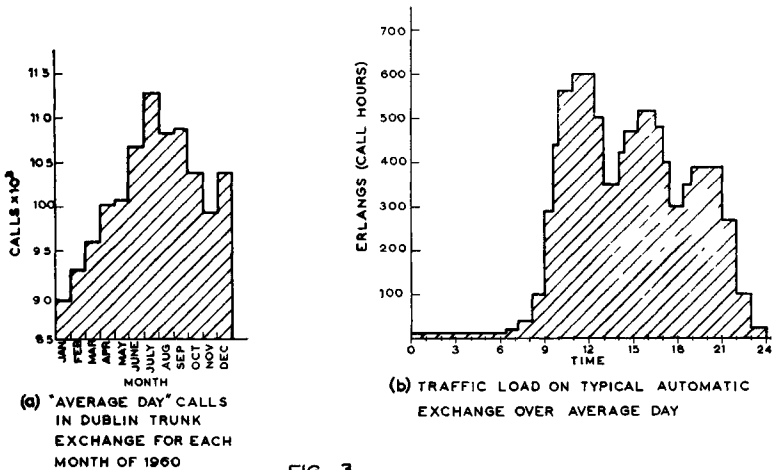
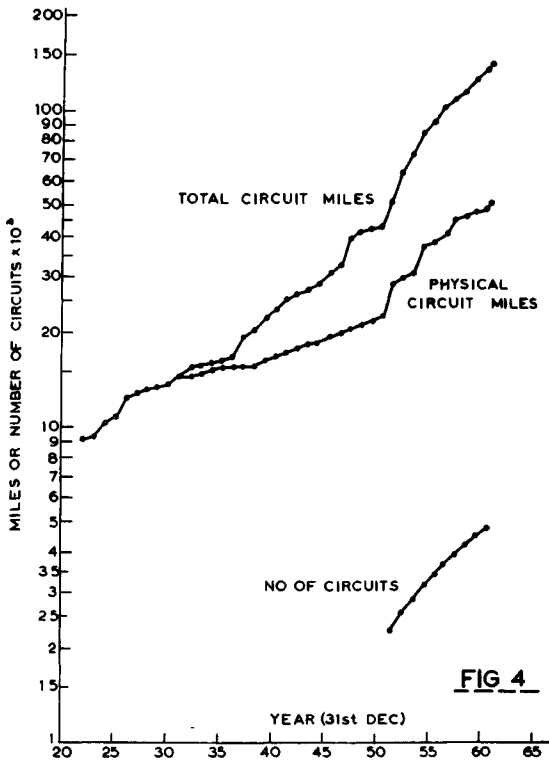


FIG. 3

Fig. 3 (a) shows the seasonal variation in trunk traffic in the Dublin Trunk Exchange measured as the number of calls handled on "an average day" during each month, from which it will be seen that the traffic in July is about 6½ per cent. greater than that in September, the next highest month. Fig. 3 (b) shows the diurnal traffic variation in a typical automatic exchange which indicates a marked load peak for about an hour from 11 a.m. to noon, and that for about 8 hours out of the 24 there is very little traffic, so that much of the equipment is virtually idle over long periods. In order to induce subscribers to make fuller use of the longer circuits at off-peak times reduced charges are applied to trunk calls between 6 p.m. and 8 a.m. Some 26 per cent. of all trunk calls are made during this period, yielding 18.5 per cent. of total trunk revenue.

### Trunk circuits development

The number and mileage of trunk circuits has increased considerably over the years. Their growth is given in Table 6 and in graphical form in Fig. 4. Prior to 1932 all circuits were "physicals" on open wire pole routes, and except for a very few miles in the vicinity of Dublin there were no underground trunk cables. The first carrier system was installed in that year and since then the circuit mileage provided by this means has increased year by year and, in 1952, the mileage of carrier exceeded that of the physical circuits; it is now almost twice as great. The very rapid rise in carrier mileage since 1952 has been due in a large measure to the bringing of the co-axial cables into use.



As well as increasing in numbers circuits are tending to get longer. The average length of a circuit in 1952 was 28.5 miles compared with 29.4 in 1961. In the latter year the average length of a carrier circuit was 54 miles and of a physical circuit 16 miles.

*Telephone capital*

Money required for telephone Capital purposes, that is, for extension of the system, is not voted annually but is provided under the Telephone Capital Acts, which are introduced at intervals of usually from three to five years. Under these Acts the Minister for Finance is empowered to borrow money, up to a stated amount, to meet the capital requirements of the Telephone Service.

The Department of Posts and Telegraphs prepares annually an estimate of its Capital requirements for general approval by the Department of Finance, specific approval is in addition necessary for the larger projects before the work can be put in hands. When approval has been given money may be drawn as necessary from the exchequer to meet Capital expenditure. The Department of Finance borrows this money from the Post Office Savings Bank, and determines the rate of interest payable.

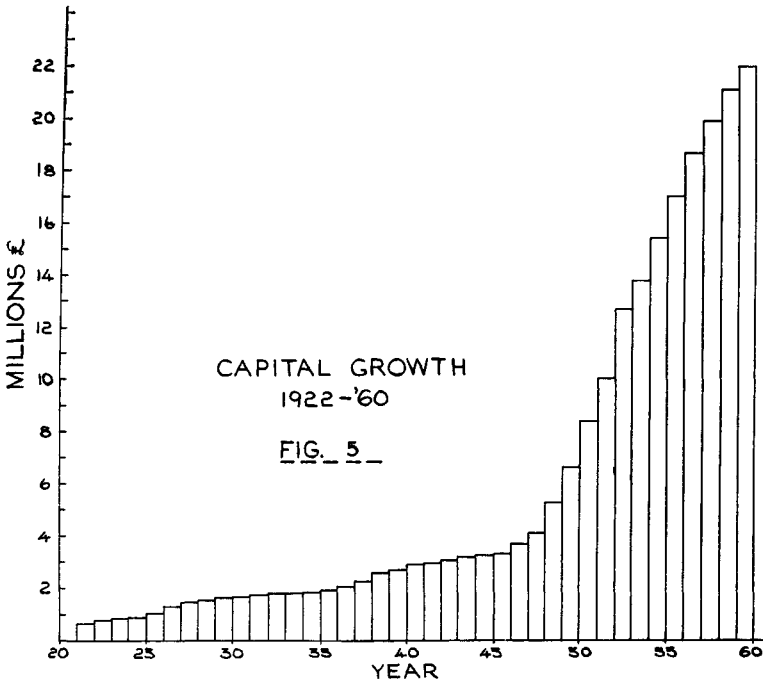
The Capital funds advanced each year are repaid to the Exchequer over a period of 20 or 25 years by a fixed annual sum or annuity sufficient to repay the Capital sum with interest at the rate current when the money was advanced. The sum required to pay the annuities is provided for annually in the Post Office Vote.

For the purpose of showing the financial position of the Post Office as if it were a business concern, a commercial account is prepared annually which shows theoretically the results of a year's trading. This account shows the expenditure under the various headings: administration, operation, and maintenance of the service, together with the provision made for interest, depreciation, pensions and all other charges. The expenditure is then balanced against revenue, and a balance sheet prepared in the usual commercial form. No allowance is made for Capital repayments in these accounts, the interest charges being calculated on the total capital issues less the credit standing in the depreciation account.

Although the commercial account is to a certain extent theoretical it is of considerable importance as it is used to determine financial policy, including the fixing of charges.

The total Capital expended on the telephone system amounted, on the 31st March 1960, to just over £22 m., the growth of this Capital from year to year is shown in Table 6 and is depicted graphically in Fig 5. The outstanding feature is the very rapid growth since 1946, in which year materials and equipment began to become again available after the war. The average capital expenditure per annum between 1923 and 1946 only amounted to just under £113,000; since 1946 it has been over ten times as great at £1,335,000, which represents a considerable increase in activity even when allowance is made for the decrease in money values.

This decrease in money values is exemplified by the fact that the total investment per exchange line was £81 in 1935 in contrast to £192 in 1960. It must, of course, be stressed that the



above figures do not give the cost of installing a subscriber's line but also includes the investment in the trunk network, private branch exchanges, extensions and all ancillary services.

The present capital assets (excluding buildings) may be divided proportionally under the following broad headings :

Overhead plant wires and poles	...	...	..	25.8%
Underground cables and ducts	...	...	...	36.2%
Switching, transmission and other internal equipment				37.0%
Submarine cables	...	..	...	0.7%
Other equipment	...	...	...	0.3%
				100.0%

The telephone service is by its nature such that capital must be provided constantly and continuously to meet development. Good and careful engineering can ensure that the amount and cost of plant and equipment is kept to a minimum and is efficiently used, but in the last analysis capital must be provided to meet the extension of the system. It is manifest that since growth is logarithmic, capital provision must increase more or less accordingly even though new inventions and techniques make it possible to do more with less money.

### *Depreciation*

The depreciation is calculated on a straight line basis for each of the broad categories of plant given above, a service life and salvage value being assigned to each. The total provision for depreciation for the year ending the 31st March, 1961 represented 4.4 per cent. of the gross capital. In determining the service life of plant not only must wear and tear or decay be taken into account but also obsolescence, and last, but not least, inadequacy. For example, a pole route which can carry no more wires would have to be retired and replaced by underground cables although its physical life may not be exhausted. In fact 75 per cent of all retirements may be due to this cause.

The amount standing in the depreciation account on the 31st March, 1960 was approximately 18 per cent of gross capital assets, this proportion will naturally vary with the rate of capital spending, should this rise the proportion will fall and vice versa.

### *Revenue and expenditure*

With the general development the revenue and expenditure have increased enormously over the years, as shown in Table 7, and are 9.5 and 10.9 greater respectively in 1960-'61 than in 1935 or in terms of relative money values, 3.2 and 3.6 times greater. Apart from the years 1923-'24 to 1931-'32, when a loss was recorded, revenue has exceeded expenditure except for the two years 1951-'52 and 1952-'53, in which there was a small deficit.

The principal rates of charge which have been in force from time to time are given in Tables 8 (a) and 8 (b). In the early years the charging scheme could be very simple as the trunk service was virtually non-existent. A flat rate was also applied initially but it was soon found that this rate was very much in favour of the large user and tended to restrict development because the "residence" subscriber could not afford the comparatively high charge which had to be made.

As the trunk service grew the trunk rates became more and more complex, but as larger groups of circuits were provided, and carrier techniques introduced, the cost of a circuit no longer depends directly on its length and it became possible to make rates simpler by reducing the number of charging zones.

During the period 1935-'60 the number of telephone stations increased 4.4 times and the revenue per station per annum from £15.6 to £30, but because of the fall in money value the relative cost of the service to the user has actually fallen. This is shown in Table 9 (a) in which the average revenue per station has been adjusted to an equivalent value of the pound, 1935 being taken as unity. Even though the cost to the user in 1960 is relatively only about two-thirds of that in 1935 this does not give the complete picture as more use is now made of the service. In order to illustrate this point more clearly a notional bill for a year's service to a residence subscriber making 600 local calls and 20 trunk calls per annum has been prepared and costed at the rates obtaining in the various years the amounts being then multiplied by the

appropriate monetary factor. The results are given in Table 9 (b), from which it will be noted that the subscriber now pays in real value 60 per cent. of what he paid in 1936. Actually the subscriber is even better off now as many of the calls that would, prior to 1959, have been charged at trunk rates are now local calls

The components of revenue have not varied appreciably over the years and are as follows :—

Item of Revenue	1950 %	1955 %	1960 %
Rentals	29 1	30 0	28 0
Local Calls	22 2	20 3	25 4
Trunk Calls	46 3	48 6	45 3
Miscellaneous	2 4	1 1	1 3
<b>TOTAL</b>	<b>100 0</b>	<b>100 0</b>	<b>100 0</b>

The drop in percentage revenue derived from trunk calls and the increase in that from local calls between 1955 and 1960 was due to the advent of group charging.

An interesting aspect of the revenue is the relatively large yield from the 2,970 call offices and street kiosks, which in the year ending on the 31st of March, 1960 amounted to £295,271. This represents 6.9 per cent. of the total revenue, and very nearly £100 from each.

A feature of the trunk revenue is the continuous increase in the average value of trunk calls, as shown in Table 10, which is not altogether accounted for by increased charge rates, indicating that users are tending to speak for longer periods over longer distances.

The total expenditure divided into its various components is given for five yearly intervals in Table 11. As might perhaps be expected, interest forms an ever-increasing portion of the total expenditure and has risen from 15 per cent in 1945-'46 to 22 per cent. in 1959-'60. This rise is partially due to increasing capital but also a tendency for interest rates to rise. The interest paid in 1959-'60 represented 4.7 per cent on outstanding capital; the average rate payable on new capital is 5.6 per cent.

It might be anticipated that the cost of maintenance should also follow to some extent the increase in capital as it would be in proportion to amount of plant to be maintained. Actually the ratio of maintenance cost to capital has decreased in spite of continual increase in labour costs as shown below. This decrease is in large measure due to better organisation and control coupled with a greater concentration of plant

Year	1925-26	1945-46	1950-51	1955-56	1959-60
Maintenance Cost as % of Capital	8.2	5.2	3.8	3.8	3.5
Average man-hour rate in pence	16	22	28.75	40.5	50



To sum up the overall position of the telephone system it can be said that in spite of difficulties and extra costs involved in providing service in a sparsely populated country with few large centres, an adequate service has been and is being provided at a not unreasonable cost to the user. It has in addition since 1923 provided £4.575 m for the Exchequer after having met all commitments and expenses

### PART III—COMPARISON WITH OTHER COUNTRIES

If the telephone service in Ireland is to be truly appraised it must be viewed from outside and looked at in a world context. To this end an attempt has been made to compare it with that of a number of other countries whose way of life, cultural, and economic standards are more or less akin to those in Ireland.

In order to effect such a comparison the statistics published by the American Telephone and Telegraph Company under the title "The World's Telephones" have been drawn on. From these statistics the development figures for western European countries, the United States of America, Canada, Australia and New Zealand have been extracted and are shown in Table 12.

Since there must obviously be some connection between the wealth of a country and the extent of telephone development, the national income per capita taken from O.E.E.C. sources has, where available, been added to the table. This relationship (correlation factor 0.9) has been shown graphically in Fig. 6 on which a regression line has been drawn. It cannot be said that in such company Ireland shows up too well, although the telephone density is not far below that which the national income would appear to warrant.

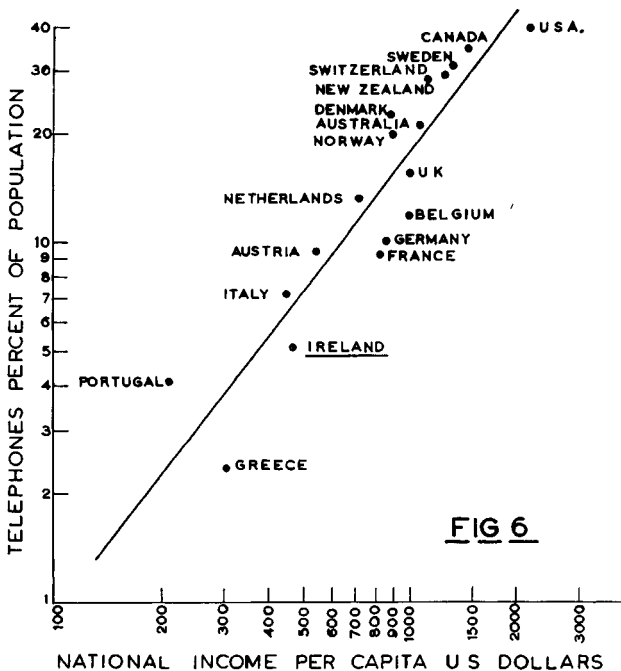
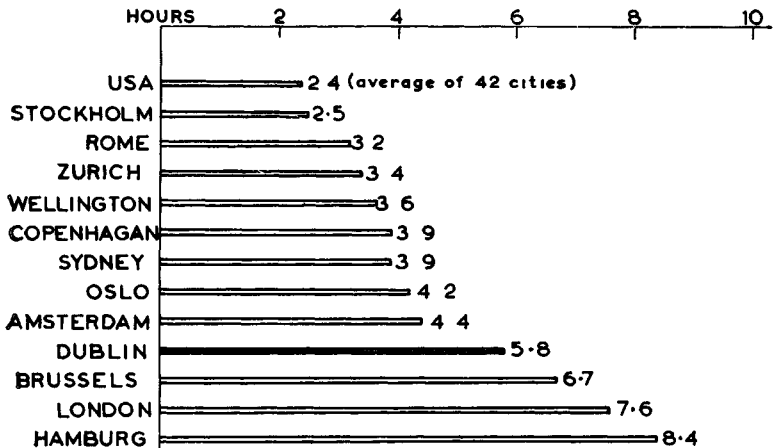


FIG 6

More use could, however, be made of the telephone as Ireland has the lowest number of calls per capita of any of the countries under review; on the other hand, the calls per telephone (station) are more than those in quite a few countries, notably the United Kingdom and Belgium. The progress and rate of development in various countries between the years 1952 and 1960, among which Ireland stands about midway, is shown in Table 13. (The years 1952 and 1960 were taken for no other reason than that the data for these years were readily available)

The average rates of increase in Italy, Spain and Portugal are quite remarkable, that of Italy being just twice the rate of growth in Ireland. It may be of interest to note that in these three countries the telephone system is wholly or predominantly owned and managed by private enterprise. In fairness it should be added that the Danish system which had the lowest rate of growth is also very largely in private hands.

As regards the automatization of the system Ireland is below the average, only four countries, Denmark, Norway, New Zealand and Portugal have a lower percentage of lines working on Automatic Exchanges. Switzerland is the only country with no manual exchanges although the Netherlands and Germany have less than one per cent. of their telephones connected to such exchanges.



HOURS OF WORK REQUIRED BY A SKILLED  
FACTORY WORKER TO PAY MONTHLY TELEPHONE  
BILL (RESIDENCE) IN VARIOUS CITIES MEAN 4.6

(SOURCE: AMERICAN TELEPHONE AND  
TELEGRAPH CO)

FIG. 7

It is not easy to compare the relative costs of the service in various countries as the absolute cost has little meaning because of the great differences in standards of living and wage rates. In

order to get some idea of the relative costs a comparison can, however, be made between the average number of hours of work required by a factory worker to pay a monthly residence telephone bill allowing, say, 50 local calls in the period. The amount of such a bill in terms of work hours has been published by the American Telephone and Telegraph Co. and is shown in Fig. 7 (the figures for Dublin have been inserted separately) It will be seen that the relative cost of a telephone in Dublin is, on this basis, 2.4 times that in the United States of America but only three-quarters of that in London. It should, however, be borne in mind that in the United States of America "flat" rates apply to a very large extent, rather than the message rate, which is universal in Europe, and the costing given is probably for a party line which is usual in that country for "Residence" subscribers. In the majority, if not all, European countries a connection charge is made when a line is installed, no such charge is made in Ireland.

#### ACKNOWLEDGMENT

In conclusion, it is desired to thank the Department of Posts and Telegraphs for permission to publish the paper.

TABLE I—GROWTH IN LINES AND STATIONS

Year as at 31 December	Exchange Lines	Stations	% Automatic	% Residence Lines	Stations as % of Population
1922	12,500	19,200			
23	13,000	20,100			
24	14,000	21,100			
1925	15,300	22,900			0.77
26	16,900	25,000			
27	18,000	26,000			
28	19,000	28,100			
29	19,900	29,200			
1930	20,600	30,600			1.03
31	21,500	32,000			
32	21,700	32,650			
33	22,000	33,500			
34	22,600	34,800			
1935	23,200	36,000			1.21
36	24,700	38,400			
37	25,260	41,344			
38	25,817	43,623			
39	26,986	45,425			
1940	27,392	46,340	59.0	31.8	1.55
41	28,754	48,100	61.0	32.0	
42	29,929	49,621	61.0	32.5	
43	31,034	50,578	61.5	31.4	
44	32,364	52,631	60.5	32.3	
1945	33,471	54,105	60.0	32.6	1.93
46	34,667	56,356	59.0	32.0	
47	38,091	58,759	59.5	31.0	
48	44,277	66,589	59.5	32.0	
49	48,982	73,431	65.0	33.0	
1950	54,972	82,031	66.0	34.3	2.08
51	60,672	90,307	67.0	36.0	
52	65,495	97,388	69.0	36.2	
53	70,267	103,792	69.5	36.5	
54	74,368	109,734	70.5	39.0	
1955	79,166	116,224	71.0	39.5	4.0
56	85,043	123,619	70.5	40.8	
57	89,896	129,553	75.5	42.0	
58	96,291	137,587	76.5	43.7	
59	102,652	145,881	76.5	46.5	
1960	114,731	158,840	76.0	48.6	5.65

TABLE 2—TELEPHONE DENSITY IN EACH COUNTY, ARRANGED IN ORDER OF DENSITY OF EXCHANGE LINES AND COMPARED WITH DENSITY OF MOTOR VEHICLES.

County	Exchange lines as at 31 March, 1961	Stations as at 31 March, 1961	Population 1961	Lines as % of population	Stations as % of population	Motor Vehicles (Note 1)	Motor Vehicles as % of population
Dublin	66,464	92,250	716,156	9.25	12.9	61,753	8.6
Wicklow	3,170	3,960	58,449	5.4	6.8	5,728	9.8
Cork	12,140	16,700	330,106	3.7	5.1	32,393	9.8
Waterford	2,506	3,530	71,343	3.5	5.0	6,547	9.2
Louth	2,135	3,170	67,284	3.2	4.7	5,987	8.7
Kildare	1,860	2,730	64,346	2.9	4.3	7,662	11.9
Limerick	3,760	5,165	133,025	2.8	3.9	10,317	8.1
Carlow	930	1,245	33,345	2.8	3.7	3,628	10.8
Meath	1,670	2,230	65,106	2.6	3.4	7,145	11.0
Westmeath	1,245	1,790	52,774	2.4	3.4	4,227	8.1
Tipperary	2,885	3,745	123,779	2.3	3.2	13,343	10.8
Wexford	1,905	2,820	83,259	2.3	3.4	9,691	11.6
Galway	2,906	3,950	149,800	2.0	2.6	9,146	6.1
Laoise	915	1,190	45,062	2.0	2.6	5,402	12.0
Donegal	2,112	2,725	113,815	1.9	2.4	8,166	7.2
Clare	1,370	1,920	73,710	1.9	2.6	4,755	6.5
Kilkenny	1,195	1,630	61,670	1.9	2.6	7,060	11.4
Cavan	1,050	1,340	56,579	1.9	2.4	4,604	8.1
Sligo	1,015	1,490	53,558	1.9	2.8	3,686	6.9
Mayo	1,945	2,690	123,180	1.8	2.2	6,447	5.2
Kerry	1,840	2,700	116,405	1.8	2.3	8,020	6.9
Offaly	860	1,230	51,532	1.7	2.4	4,843	9.4
Monaghan	704	940	47,077	1.5	2.0	4,407	9.4
Longford	450	600	30,642	1.5	2.0	2,422	7.9
Leitrim	465	595	33,468	1.4	1.7	2,478	7.4
Roscommon	600	820	59,215	1.0	1.4	3,712	6.3

NOTE 1—Only 4-wheeled vehicles are included, i.e., motor cycles excluded. Figures are taken from the Statistical Abstract, 1960.

TABLE 3 (a)—GROWTH IN TELEPHONE EXCHANGES. NUMBER OF EXCHANGES AS ON 31 MARCH OF EACH YEAR.

Year	Number	Year	Number	Year	Number	Year	Number
1926	444	1935	740	1944	832	1953	964
27	516	36	753	45	836	54	972
28	617	37	774	46	841	55	980
29	654	38	779	47	869	56	972
1930	683	39	789	48	893	57	968
31	711	1940	824	49	900	58	967
32	723	41	829	1950	906	59	968
33	725	42	832	51	917	1960	964
34	732	43	831	52	956	61	1,012

TABLE 3 (b)—TELEPHONE EXCHANGES GROUPED ACCORDING TO NUMBER OF WORKING LINES AS ON 31 MARCH, 1961

Number of working lines	Automatic	Manual	Total	% of Total Exchanges	Cumulative %
1-4	—	69	69	6.8	6.8
5-6	6	96	102	10.1	16.9
7-9	6	129	135	13.3	30.2
10-19	11	230	291	28.8	59.0
20-35	3	138	141	13.9	72.9
36-50	3	75	78	7.7	80.6
51-100	13	68	81	8.0	88.6
101-200	13	33	46	4.5	93.1
201-400	10	27	37	3.7	96.8
401-1,000	10	2	12	1.2	98.0
over-1,000	20	—	20	2.0	100.0
Total	95	917	1,012	100.0	—

TABLE 4.—GROWTH IN LOCAL AND TRUNK CALLS EACH YEAR AND COMPARED WITH E S B ENERGY SALES

Year ending (31 Dec)	Local Calls (million)	Trunk Calls (million)	Total Calls (million)	Calls per Exchange line per annum	Calls per head of population	E S B K W H sold (million)	K W H per head of population
1923	16 052	0 948	17 000	1,350	5.7		
24	16 699	1 067	17 766	1,350	6.0		
25	17 158	1 162	18 310	1,300	6.2		
26	17 231	1 311	18 592	1,100	6.3		
27	17 345	1 481	18 826	1,050	6.4		
28	19 088	1 689	20 777	1,090	7.0		
29	20 166	1 839	21 005	1,060	7.5		
1930	21 569	1 914	23 483	1,140	7.9	43.2	14.6
31	22 490	2 069	24 568	1,150	8.3	85.5	28.8
32	23 000	2 088	25 088	1,150	8.5	110.7	37.5
33	24 250	2 073	26 323	1,200	9.9	120.1	40.7
34	25 109	2 181	27 290	1,210	9.3	138.5	47.0
35	26 901	2 299	29 200	1,250	9.9	157.0	53.5
36	28 864	2 568	31 432	1,270	10.7	187.0	63.5
37	30 920	2 996	33 916	1,330	11.4	218.8	74.0
38	31 321	3 297	34 618	1,340	11.7	244.5	83.0
39	32 549	3 657	36 206	1,340	12.2	295.3	100
1940	32 646	4 039	36 785	1,340	12.4	318.6	108
41	35 969	4 966	40 935	1,420	13.7	345.2	117
42	38 235	5 499	43 734	1,450	14.7	357.3	124
43	40 366	5 944	46 310	1,490	15.6	323.1	111
44	42 412	6 565	48 977	1,510	16.3	346.9	117
45	49 17	7 12	56 29	1,700	19.0	319.0	108
46	52 88	7 45	60 33	1,750	20.4	379.1	123
47	53 80	7 46	61 26	1,610	20.8	453.7	153
48	57 71	8 11	65 82	1,580	23.3	492.1	167
49	62 61	8 34	70 95	1,450	24.0	469.3	193
1950	69 29	9 43	79 72	1,450	27.0	626.2	212
51	75 53	10 12	85 65	1,410	28.8	770.4	251
52	77 34	10 64	87 98	1,435	29.6	835.3	281
53	80 32	11 77	92 09	1,310	31.0	920.6	313
54	82 42	12 79	95 21	1,300	32.9	1,051.7	363
55	89 05	13 64	102 69	1,300	35.5	1,192.2	412
56	91 37	13 97	105 34	1,245	36.0	1,306.6	452
57	95 85	14 54	110 39	1,230	38.1	1,352.6	467
58	107 18	15 43	122 61	1,270	43.8	1,424.6	491
59	123 43	14 56	137 99	1,340	47.7	1,549.4	535
1960	142 14	12 44	154 58	1,350	53.2	1,692.2	585

TABLE 5.—GROWTH IN TRUNK MILEAGE AND NUMBER OF CIRCUITS

Year 31 Dec	Physical Circuit 10 <sup>3</sup> miles	Carrier Circuit 10 <sup>3</sup> miles	Total Circuit 10 <sup>3</sup> miles	Number of Circuits at 31 March
1922	9 3		9 3	
23	9 4		9 4	
24	10 4		10 4	
1925	10 9		10 9	
26	12 6		12 6	
27	13 0		13 0	
28	13 2		13 2	
29	13 4		13 4	
1930	13 9		13 9	
31	14 5		14 5	
32	14 8	0 3	15 1	
33	14 9	0 3	15 2	
34	15.1	0 5	15 6	
1935	15 2	0 8	16 0	
36	15 4	1 3	16.7	
37	15 5	3 8	19 3	
38	15 8	4 7	20 5	
39	16 5	5 7	22 2	N A
1940	16 8	7 0	23 8	
41	17 4	8 0	25 4	
42	17 9	8 6	26 5	
43	18.1	8 9	27 0	
44	18.7	9 4	28 1	
1945	19 1	11 9	31 0	
46	20 0	12 8	32 8	
47	20.5	19 2	39 7	
48	21 0	20 2	41.2	
49	21 6	20 6	42 2	
1950	22 3	20 6	42 9	
51	28 6	22.2	50 8	
52	29 8	35 3	65 1	2,283
53	30.6	43 4	74 0	2,563
54	37.7	47.6	85 3	2,882
1955	38 1	54 2	92 3	3,165
56	40.9	60.2	101 1	3,420
57	45 9	64 1	110 0	3,668
58	47 0	68 5	115 5	3,936
59	48 5	77 1	125 6	4,227
1960	49 5	86 0	137 4	4,560
*61	50 3	90 7	140 0	4,775

\*to 31 3 '61

TABLE 6.—GROWTH IN TELEPHONE CAPITAL

Year	Capital Expenditure During Year £000	Total Capital £000	Capital Borrowing Authorised Under Telephone Capital Acts £000
1922	—	772	772
23	53	825	
24	25	851	500
1925	126	977	
26	206	1,183	
27	154	1,337	
28	128	1,464	
29	78	1,542	
1930	97	1,639	
31	84	1,722	250
32	49	1,771	
33	32	1,803	

TABLE 6—(contd.)

Year	Capital Expenditure During Year £000	Total Capital £000	Capital Borrowing Authorised Under Telephone Capital Acts £000
34	31	1,834	
1935	50	1,884	
36	84	1,968	500
37	117	2,086	..
38	261	2,347	1,000
39	260	2,607	
1940	151	2,759	
41	192	2,951	
42	116	3,067	
43	70	3,137	
44	80	3,217	
1945	54	3,271	
46	94	3,365	6,000
47	381	3,746	
48	440	4,186	
49	1,087	5,273	
1950	1,357	6,630	
51	1,834	8,465	8,000
52	2,384	10,849	
53	1,914	12,763	
54	1,078	13,841	
1955	1,588	15,429	..
56	1,655	17,084	6,000
57	1,627	18,711	
58	1,207	19,918	
59	1,418	21,336	
1960	1,722	22,057	10,000

TABLE 7—EXPENDITURE AND REVENUE

Year ending 31 March	Expenditure £000	Revenue £000	Surplus + Deficit— £000
1924	276	230	— 46
1925	284	259	— 25
26	295	292	— 3
27	319	285	— 34
28	338	294	— 44
29	364	315	— 49
1930	381	346	— 35
31	383	367	— 14
32	394	386	— 8
33	375	414	+ 39
34	385	427	+ 42
1935	394	438	+ 44
36	386	491	+105
37	408	482	+ 74
38	450	511	+ 61
39	487	553	+ 66
1940	517	597	+ 80
41	557	648	+ 91
42	573	753	+180
43	593	835	+242
44	638	886	+248
1945	676	944	+268
46	725	1,023	+298
47	810	1,063	+253
48	964	1,129	+165
49	1,130	1,253	+123

Year ending 31 March	Expenditure £000	Revenue £000	Surplus + Deficit - £000
1950	1,279	1,393	+114
51	1,458	1,526	+ 68
52	1,835	1,767	- 68
53	2,146	2,112	- 34
54	2,413	2,522	+109
1955	2,582	2,810	+228
56	2,834	2,968	+134
57	3,079	3,334	+255
58	3,294	3,660	+366
59	3,519	3,932	+413
1960	3,876	4,272	+396
61	4,286	4,721	+435
		Net Surplus	4 575

TABLE 8 (a) —RENTALS AND LOCAL CALL CHARGES AT VARIOUS TIMES

Year	Rental	Local Call (0-5m) charge pence	2nd1 Area (5-7½m)	Remarks
1897	½ m radial distance £8, ¾ m £9, one mile £10	Flat rate	Flat rate	
1900	½ m radial distance £7 10 & £1-5-0 for each addi- tional ¼ mile	Flat rate	Flat rate	
1902	£3 within ½ m radial dis- tance	1d.	2d	With minimum charge of 30/- for calls.
1907	£4 up to 2 m. radial dis- tance	1d.	2d	Rate also adopted by National Telephone Co 30/- minimum call charge
1922	£7 10 up to 1 m radial distance 25/- per ¼ mile over	1½d.	3d.	
1925	£6 10 Business £5 Resi- dence up to 1 mile radial distance	1½d	2d.	Reduction only applied to exchange existing prior to 1922.
1936	As above but free mileage increased to 3 miles	1d	2d.	All rentals other than specially assessed ren- tals for small ex- changes brought to 1925 figures
1946	As above +5%			
1951	As 1936 +25%			
1953	£10 Business, £7 10 Residence.	1½d.	2d.	Free mileage reduced to 2 except in Dublin, Limerick and Cork. All special rentals abolished.
1956	As above	2d.	2d	
1959	As above	2d	—	Large extension of local call area by group charge mileage no longer criterion. Free mileage increased to 3. Certain Farmers' lines regarded as residence.



TABLE 8 (b)—PRINCIPAL TRUNK RATES AT VARIOUS TIMES

YEAR	Radial Distance between Exchanges (MILES)															REMARKS	
	7½/10	10/12½	12½/15	15/20	20/25	25/35	35/50	50/75	75/100	100/125	125/150	150/200	200/250	250/300	over 300		
1897	3d					6d		9d	1/-	for every additional 40 miles or part 6d							Prior to 1936 a local call was also charged in addition to the Trunk fee
1916	Day	4d					8d		1/-	1/4	2/- up to 140 miles		for every additional 40 miles or part 8d				
	Night	4d					half day rate										
1922	Day	3d	4d	5d	7d	9d	1/-	1/6	2/-	2/6	3/-	3/6	4/6	for every 50 miles or part 1/-			There was also an intermediate rate between 2 p m and 7 p m
	Night	3d	3d	3d	4d	5d	6d	9d	1/-	1/3	1/6	1/9	2/3	do 6d			
1925	Day	3d	4½d	6d	7½d	9d	1/-	1/6	2/-	2/6	3/-	3/6	4/6	5/6	6/6	7/-	Where day and night rates were the same a 6 min call was given at night
	Night	3d	4½d	6d	6d	7d	8d	9d	1/-	1/3	1/6	1/9	for every 50 miles or part 6d				
1936	Day	3d	4d	5d	7d	9d	1/-	1/3	1/6	1/9	2/-	2/3	2/6*	3/-	3/6	4/-†	*max within State †max to 6 Counties max to G B 5/-
	Night	3d	3d	3d	4d	5d	6d	9d	9d	1/- within State or 6 Counties 1/6 to G B							
1940	1936 charges increased by 5%																
1951	1936 charges increased by 25%																
1953	Day	4½d		6d		9d	1/-	1/4	1/9	2/3	3/-					Charges shown apply within Ireland, higher charges to G B	
	Night	4½d		6d		9d	9d		1/3	1/6							
1956	Day	6d			10d	1/2	1/6	2/-	2/6	3/6							
	Night	6d			10d	1/-	1/6			2/-							
1959	Group Charging introduced Radial distances no longer measured between individual exchanges but between charging points in each area Several ranges of trunk calls became local Trunk rates are as follows Up to 35 miles 1/- day, 8d night, 35-50 miles 2/- day, 1/- night Over 50 miles 3/- day, 2/- night																

TABLE 9 (a).—RELATIVE COST OF TELEPHONE SERVICE IN VARIOUS YEARS

Year	Telephone Stations '000	Revenue	Revenue per Station	Relative value of £1* 1935=1	Relative cost to User
1925	22 9	292	12 7	1 2	10 5
1930	30 6	386	12 6	1 1	11 5
1935	36 0	491	15 6	1 0	15 6
1940	46 34	648	14 0	1 3	10 8
1945	45 11	1,023	19 0	1 9	10 0
1950	82 03	1,526	18 6	2 1	8 9
1955	116 22	2,968	24 6	2 6	9 5
1960	158 8	4,271	26 9	3 0	9 0

\*The index is based on the amount of money required to purchase the same quantum of goods and services as £1 in 1935.

TABLE 9 (b).—RELATIVE COST OF TELEPHONE TO A RESIDENCE SUBSCRIBER

Year	1925	1936 <sup>1</sup>	1945	1960
	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Rental	6 0 0	5 0 0	6 5 0	7 10 0
Local calls (600)	3 2 6	2 10 0	3 2 6	5 0 0
Trunk calls <sup>2</sup> (20)	1 12 0	1 6 0	1 10 0	3 1 8
TOTAL	10 14 6	8 16 0	10 17 6	15 11 8
Relative cost	9 0 0	8 16 0	5 16 0	5 2 7

<sup>1</sup>Year 1936 taken as rates were reduced in this year.

<sup>2</sup>Cost of trunk calls based on average value of calls in particular year.

TABLE 10.—AVERAGE VALUE OF TRUNK CALLS

Year	Call value	Year	Call value	Year	Call value
	d		d.		d.
1946	14 93	1951	16 74	1956	25 78
47	15 09	52	17 66	57	27 6
48	15 60	53	21 25	58	28 13
49	16 18	54	24 6	59	28 75
50	16 71	55	25 1	60	37 0

TABLE 11—BREAKDOWN OF EXPENDITURE

	1925-26		1940-41		1945-46		1950-51		1955-56		1959-60	
	£000	%	£000	%	£000	%	£000	%	£000	%	£000	%
Administration and operation	117 6	36 7	175 4	31 5	251 7	34 2	532 5	36 5	911 0	32 2	1,103 4	28 6
Maintenance	82 7	26 0	113 7	20 4	168 8	23 1	333 9	23 9	654 6	23 1	781 4	20 4
Accommodation, Rent and Rates	10 8	3 4	24 1	4 3	32 6	4 4	73 4	5 1	104 4	3 6	180 7	4 7
Pension Liability	18 6	5 8	20 5	3 7	25 4	3 4	51 3	3 5	106 9	3 7	146 7	3 3
Depreciation, on plant and buildings	43 6	13 6	126 8	22 7	152 5	20 1	272 5	18 7	528 5	18 7	808 5	21 0
Interest on Capital	45 6	14 3	96 8	17 4	94 5	15 0	194 3	13 3	528 6	18 7	855 4	22 0
Totals	318 9	100 0	557 3	100 0	725 5	100.0	1,457 9	100 0	2,834 0	100 0	3,876 1	100 0

TABLE 12 —NUMBER OF TELEPHONES IN VARIOUS COUNTRIES AS AT 1 JANUARY 1960 ARRANGED IN ORDER OF DENSITY

Country	Number of Telephones '000	Telephones as % of population	Calls per head of population per annum	Calls per telephone per annum	†National Income per capita US \$
U S A	70,597	39 52	496 1	1,250	2,222 (1)
Sweden	2,637	35 3	337 1	955	1,381 (2)
Canada	5,439	30 85	530 3	1,700	1,500 (1)
Switzerland	1,562	29 65	216 7	725	1,308 (2)
New Zealand	686	28 95	N.A.	N.A.	1,166 (1)
Denmark	1,019	22 17	288 3	1,290	906 (1)
Australia	2,122	20 88	152 1	725	1,117 (1)
Norway	694	19 50	159 7	816	914 (2)
U K	7,848	15 03	81 3	540	1,019 (2)
Netherlands	1 501	13 15	121 9	921	745 (2)
Finland	571	12 89	N.A.	N.A.	N.A.
Belgium	1,085	11 88	74 3	596	1,027 (2)
Germany (F R )	5,516	9.98	75 2	746	870 (2)
Austria	653	9 25	N.A.	N.A.	559 (1)
France	4,085	9 06	N.A.	N.A.	866 (2)
Italy	3,518	7 15	110.5	1,540	457 (2)
Spain	1,641	5 47	85 2	1,550	N.A.
IRELAND	146	5 13	47.7	915	482 (2)
Portugal	365	4 01	48 0	1,180	202 (1)
Greece	191	2 30	55 7	2,400	304 (2)
WORLD	133,600	4 6	—	—	—

†Source O E E C. (1) Year 1958. (2) Year 1959.

TABLE 13  
DEVELOPMENT IN VARIOUS COUNTRIES ARRANGED IN ORDER OF RATE OF GROWTH

Country	1 January 1952		1 January 1960		Average Rate of Growth	Difference in % Automatic
	No of Telephones '000	% Automatic	No of Telephones '000	% Automatic		
Italy	1,382	92 9	3,581	96 5	12 6	3 6
Spain	742	77 3	1,641	79 0	10 4	1 7
Portugal	168	49 1	365	72 8	10 2	23 7
Greece	88	93 8	191	92 9	10 1	-0 9
Germany (F.R.)	2,700	87 3	5,516	99 0	9 3	11 7
Netherlands	821	90 8	1,501	99 2	7 8	8 4
New Zealand	304	59 1	686	71 3	7 2	12 2
Canada	3,140	63 6	5,439	84 5	7 1	20 9
Australia	1,259	64 0	2,122	76 5	6 8	14 5
Switzerland	952	97 3	1,562	100 0	6 4	2 7
IRELAND	90	65 3	146	76 5	6 3	8 1
France	2,521	62 4	4,085	77 1	6 2	14 7
Finland	359	57 6	571	78 5	5 9	10 9
U S A	45,636	72 1	70,597	94 2	5 6	22 1
Austria	427	76 0	653	93 6	5 4	17 6
Belgium	715	75 5	1,085	86 2	5 4	16 7
Sweden	1,789	62 2	2,637	86 4	5 0	24 2
Norway	477	59 2	694	69 3	4 8	10 1
U K	5,724	72 8	7,848	81 7	4 0	8 9
Denmark	760	40 6	1,020	55 4	3 8	16 8

References.

- "An Historical Summary." HMSO 1911.  
*The National Telephone Magazine.* N.T. Co. 1900-1912.  
 J. Lee. *The Economics of Telegraphs and Telephones.* Pitman 1913.  
 J. H. Robertson. *The Story of the Telephone.* Pitman 1947.  
 J. W. O'Neill. "Telecommunication in Ireland during the first half of the 20th Century." I.E.E. Irish Branch paper 1951.  
*The World's Telephones.* American Telephone and Telegraph Co., published annually  
*Statistical Abstract of Ireland 1960.* Stationary Office, Dublin  
*The Telephone Directory,* for various years Available in National Library.  
 The Department of Posts and Telegraphs, Commercial Accounts. Stationary Office.

## DISCUSSION

*Mr B Ó Mongáin* paid a tribute to the immense amount of detailed information contained in the paper and the care and research given to its compilation.

As regards traffic and number of circuits, those familiar with statistical theory will recognise the mention of Erlang in this relation, and will be aware that another way to express the value of traffic flow on a route is by the average number of simultaneous calls in progress during the period under consideration. This average gives the same result in Call-hour units as the product of the number of calls effected during an hour by the average length of time in hours that a circuit is held by each call. The telephone traffic problem is to provide economically not alone for the peaks of daily or weekly occurrence as indicated by Fig 3 but for the peaks within hours during which calls may fail to be connected owing to all the outlets being engaged simultaneously. To indicate the relation between the expected average of simultaneous calls and peak provision considered reasonable in automatic switching, representative values would be

7 circuits for 2 simultaneous calls (average)  
 70    "    "    40    "    "    "    "    "    "

showing the low efficiency of circuits in small groups, and the magnitude of peak traffic in relation to average

Mr Litton's comparative tables of Motor Vehicles against telephone density and E S B. energy sales against telephone calls give rise to some reflections on the development of telecommunications in parallel with transport and electric power distribution. To take the second one first, without a public power supply available in all parts of the country, the provisions of trunk and local telephone service would have been slow and costly, as the exchanges and repeater stations would have required local sources of power with all the problems of running and maintenance. On the score of development of telecommunications in relation to transport it would be fair to place the telegraph in association with railways and canals, and the telephone in association with the automobile—in the first group we have point-to-point services, in the second mobility is the keynote. Radio takes us off the land and belongs to the same generation as the aeroplane, and with the development of space vehicles we are hearing of the utilisation of frequencies in the light spectrum for telecommunications