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NEW ZEALAND.

TELEGRAPH, TELEPHONE, AND WIRELESS SYSTEMS OF EUROPE AND AMERICA

(REPORT OF THE CHIEF TELEGRAPH ENGINEER ON).

Laid on the Table of the House of Representatives by Leave.

The CHIEF TELEGRAPH ENGINEER to the Hon. the MINISTER OF TELEGRAPHS.

(Memorandum). General Post Office, Wellington, 9th June, 1921.

I BEG to submit a report of my recent trip abroad inquiring, on behalf of the Department, into telegraph, telephone, and wireless matters.

In making this report I have endeavoured not to burden you with details of the many inquiries I made in reference to miscellaneous engineering matters.

I also brought back with me a large amount of information as to the methods adopted by the various overseas Administrations for collecting, handling, and accounting for revenue in connection with telegraph and telephone services.

I also collected valuable information as to methods adopted by the older countries for training telegraph and telephone operators. This information should be useful to all interested in post and telegraph business.

E. A. SHRIMPTON.

The Hon. the Minister of Telegraphs.

REPORT.

The CHIEF TELEGRAPH ENGINEER to the Hon. the MINISTER OF TELEGRAPHS.

SIR,— Wellington, 9th June, 1921.

In accordance with your instructions, I left Wellington on the 17th June, 1920, for Europe and North America to study recent developments and the present position of telegraph, telephone, and wireless services, and in addition to facilitate as far as possible the supply of outstanding orders for telegraph and telephone materials.

Apart from my personal investigations much valuable information on these and kindred matters was obtained. The Engineering Department of the British Post Office and several other Administrations and companies in Europe and America issue valuable bulletins and technical instructions on new discoveries and inventions. I was successful in making arrangements for this Department to be furnished with regular copies of those bulletins, which will serve to keep the Department's Engineers more closely in touch with the latest technical developments. On my journey abroad I met several Chief Engineers of oversea British dominions, including those of the Union of South Africa, Ceylon, and the Malay States, and made arrangements for the exchange of information and ideas.

I also completed negotiations with the Engineer-in-Chief of the British Post Office and the heads of several companies for more satisfactory arrangements for securing apparatus and material—especially in the direction of inspection before leaving the manufacturers—and arrangements that will tend to a more satisfactory delivery than we have experienced in the past. Through being on the spot I was able to secure for the Department several lines of material at very favourable rates. On one particular much-needed line—insulators and bolts for minor exchange lines and farmers' lines—a saving of £4,000 was effected.

I was received everywhere with the greatest cordiality, and every facility for inspection and inquiry was placed at my disposal. The chief officials of the following showed every desire to assist me: The British Post Office Engineering and Traffic Branches throughout Great Britain, Messrs. Siemens Bros., Marconi Company, Reid Bros., Donald Murray, the General Electric Company, C. F. Elwell, Automatic Telephone Manufacturing Company, Western Electric Company of England; also the officials of the Eastern, Commercial, and Western Union Cable Companies in London. In America: American Telephone and Telegraph Company (the A T. & T. Co.), Western Electric Company, International Western Electric Company, New York Telephone Company, Automatic Electric Company (Strowger), North Electric Company, Morkrum Company; Southern Californian Telephone Company, Los Angeles; Mutual Telephone Company of Honolulu—the two last-named operating in wireless telephony.

It is difficult to single out individuals, but I feel it is incumbent upon me to say that Sir William Noble, Engineer-in-Chief, British Post Office, and C. M. Yorke, Esq., Chief Engineer of the Western Union Telegraph Company, New York, went out of their way to make it easy for me to secure information. I should also like to record my appreciation of the assistance rendered me by the High Commissioner, the Assistant Commissioner, and staff at the New Zealand Offices, London.

TELEGRAPHY.

In all European countries machine-printing telegraphy is gradually replacing manually and automatically operated Morse apparatus. London has direct circuits to practically every important city—certainly every capital city—on the Continent, and all of these circuits are worked by machine-printing apparatus. The "foreign gallery" in the Central London Telegraph-office greatly interested me, especially having in mind the war. There were direct circuits to Berlin, Vienna, Petrograd, and other places. The circuit to Petrograd was carrying a very small volume of traffic—in fact, it was quite idle for long periods during the day.

All the important circuits within Great Britain also work machine printing, with the result that wire-capacity for traffic-carrying has been largely increased, and the output per operator compared with Morse working has also been increased, with less physical and less mental strain on the operators. Machine printing also reduces the office delay to telegrams: for instance, formerly Wheatstone (automatic Morse) worked the London–Dublin traffic with an average office delay of half an hour; since the adoption of machine-printing multiplex the office delay has been reduced to under ten minutes.

Shortly after the declaration of war between Great Britain and Germany a complete "all-red" route from London to Australasia was inaugurated. Germany owned a cable which was laid from Emden to the Azores and from the Azores to New York. With creditable despatch after the declaration this cable was cut on the English side of the Atlantic and brought into Penzance, and on the other side of the ocean New York was severed and the cable diverted to Halifax. This "all-red" cable is worked automatically throughout. Cable code from Halifax is received in London through repeaters at Penzance; this code is automatically translated into Wheatstone perforated forwarded tape, which in turn passes through what is known as "Creed apparatus," and issues a cablegram printed in Roman characters ready for delivery to the addressee.

Whilst on this subject I should like to mention the wonderful work done by British telegraph engineers and navigating officers on cable-ships, when one considers what an easy prey a cable-ship fast to cables is for submarines and drifting mines. On one occasion a ship hove up a mine with the cable. Despite all this, France, Belgium, Holland, and Norway were all kept in communication; and the cables to Ireland and the outlying islands all round the United Kingdom were regularly repaired throughout the war. In addition to the British Post Office engineers' cable-ships "Alert" and "Monarch," the Department at one time or other chartered every available cable-ship, including the largest in the world; also, one was brought from Canada. During the war three cable-ships were lost, including the British Post Office "Monarch," which was mined in the English Channel and sank, entombing three of her crew.

The modern machine-printing telegraph apparatus, which telegraph engineers to-day are convinced is rapidly ending the reign of Morse working, is a development of principles discovered by Monsieur Baudot, a French telegraph engineer, over forty years ago. The signal for each letter, figure, or symbol is made up of five units, which are transmitted to a telegraph-line. A five-lever key is used. These electrical impulses on being received at the distant end are mechanically translated into letters, which are printed on paper tape or slip, which in turn is gummed to a telegraph form and delivered to the addressee. Such a system has been very largely used in France for forty years, and to a lesser degree and for a lesser period in England.

To operate the five-lever key an operator had to learn what is known as the "Baudot code." A few years before the war Donald Murray brought out a "keyboard perforator," which punched holes in a paper tape. This tape, on being passed through a "transmitter," sent signals to the line in the same manner as an operator does with the five-lever key. Murray also brought out a "page-printer" to replace the "tape-printer." The key-board perforator has keys, &c., exactly after the style of a typewriter, and the page-printer is really a typewriter minus the keys. By using a keyboard perforator the capacity of an operator sending telegrams is increased 100 per cent.

In April, 1914, the Department ordered from Donald Murray the apparatus referred to above, which, owing to the war bringing about difficulties in manufacture, has not yet been delivered. On reaching London I found that Mr. Murray had all the instruments—minus the printers—ready for shipment, and that there was no chance of his being able to supply printers within nine months or more. As all the Department's main telegraph circuits were becoming badly congested, it was faced with the problem either to erect additional wires and lay more cables across Cook Strait, or to increase the carrying-capacity of its existing wires.

The main telegraph circuits in New Zealand are worked on the manual Morse quadruplex system: this is four telegrams passing over a wire simultaneously, two being received at the same time as two are being sent. Machine printing will enable eight telegrams to pass over a single wire—*i.e.*, four going and four coming at the same time, and each telegram being despatched at double the speed possible with manual Morse signalling. In other words, the carrying-capacity of the lines will, with machine-printing apparatus, be increased by 300 per cent., and an operator's capacity for getting off work will be increased 100 per cent., with, as I have already mentioned, less mental and physical strain.

The Wanganui–Nelson cable, of 107 nautical miles, which has been out of action only about twice in forty years, is now worked only duplex—*i.e.*, one telegram sent and received simultaneously—and will with machine-printing apparatus be capable of carrying eight times the traffic it is now doing.

With a view to quickly increasing the carrying-capacity of some of our most-congested routes I sought to obtain sufficient Boudot tape-printers to bring this about. With the assistance of the British Post Office Engineering Department I managed to secure twenty tape-printers, which should arrive in New Zealand shortly. Some time must elapse before this apparatus is brought into practical use. Staff must be trained to work it, and different methods from those now in vogue for handling traffic must be organized.

In America Morse is now worked on local circuits only, the long-distance and the more important circuits being entirely equipped with machine-printing apparatus of the Western Electric Company's and the Morkrum types. Both these types are really identical with Baudot–Murray.

The Western Union Company is using page-printers only; but one of their prominent New York engineers informed me that the American public were used to typed telegrams—handwritten messages do not appear under any conditions, the reception of Morse at the Morse circuits being effected throughout by typewriters, of which only one pattern, the Underwood, is used. So the company started off with page-printers when it inaugurated machine telegraphy; but if it were going in for such a system to-day for the first time, and knew as much about it as it does now, it would not start with page-printers. He had data showing that a page-printer in comparison with a tape-printer wastes 13 per cent. of line time. Costs are higher for maintenance; a higher-class mechanic is required for adjusting them; and mistakes are more easily corrected on tape. He went on to say that an operator can just as readily gum tape and check telegrams as one watching signals being received on a page-printer. He also said that the company was considering a printer to do sixty words per minute, which can easily be got from a tape-printer; it could then work multiplex three channels at sixty words a minute instead of four channels at forty words a minute, thus saving line time, with fewer operators.

Line difficulties such as momentary contacts and varying insulation produce a larger reduction in output on the more complex systems than on simpler ones—that is to say, a page-printing multiplex will suffer more from these effects than a similar set using tape-printers. I saw a Baudot tape-printer at London which I was informed had been in use for thirty years.

We shall be in a position to try out both types of printers when the Murray page-printers come to hand.

There is a simpler type than the multiplex of machine telegraph apparatus used in America, which is known as the "start-stop" or the "Teletype." It will send signals for printing messages in both directions over a wire. It uses the same keyboard and signals as the Baudot, and can be used on a lot of our circuits with a considerable saving in man-power. I have secured a set for trial.

It should be noted that various instruments which go to make up machine telegraphy are interchangeable. For instance, on a London–Manchester circuit I saw working on one of the multiplex channels a Murray keyboard, a Western Electric transmitter, and a Baudot tape-printer. At the corresponding end at Manchester they had a Baudot five-lever key worked manually, and a Western Electric page-printer.

Start-stop or Teletype apparatus will work into a multiplex set. Duplex quadruple could be used over a wire from Wellington to Christchurch, and by means of simple repeaters at Christchurch channels for Greymouth, Oamaru, and Timaru provided, leaving the fourth channel for Christchurch–Wellington traffic. So Greymouth, Oamaru, Timaru, and Christchurch would be simultaneously sending and receiving a telegram to and from Wellington, so that in effect eight telegrams would be passing to and from over a single wire between Wellington and Christchurch. When such apparatus is installed throughout our country it does not require much imagination to see that working will be possible to all centres—*i.e.*, all centres will be in intercommunication, thus saving greatly in transmitting or relaying staffs, with a corresponding reduction in number of hands through which telegrams will have to pass, and a corresponding reduction in the chances of error. The apparatus at Timaru, Oamaru, and Greymouth would have no machinery moving when there is no traffic to be despatched or received.

In Great Britain accumulators are used at all the larger telegraph centres for providing the electric currents for working telegraph apparatus, and in America machines are universally used for this purpose. The Western Union Company used to have several machines working on one shaft, but found this arrangement caused too frequent and unduly long general stoppages when anything failed in power plant. The company now uses individual machines for its various voltages, and finds that four voltages satisfactorily meet all its requirements. The voltages are 110, 160, 240, and 320, the last for the "B" sides of Morse quadruplexes; but as quadruplexes are fast disappearing—I saw only two sets in America—there is not much demand for this high voltage. The company used to have 26 and 52 volts for local circuits, but nothing less than 110 volts is now used. The machines are various sizes, depending on the size of the office; they range in size from 100 to 2,000 watts, in jumps of 100. The company has just recently adopted double commutator generators,

known as the "double-current" type, so that in future it will have only one machine where it now requires two—one for positive and one for negative currents.

I obtained three of these motor generators, one each for Auckland, Christchurch, and Dunedin. I could not get a price for a set for Wellington, the manufacturers declining to depart from their motor standards and build a motor for the extraordinary frequency of 80 cycles supplied by the Wellington City Council. As the hydro-electric schemes develop here we can increase the use of machinery for generating telegraph currents, and thus save fully 80 per cent. of the large sum spent annually for primary cells.

When I was in Chicago the Western Union Company was in the process of transferring its large plant and staff into a new building. Chicago—owing to wires radiating in so many directions—is the largest telegraph centre in the world. New machine-printing equipment made by three concerns was being installed, and the officials gave me confidential information as to the merits and demerits of various pieces of the apparatus turned out by the various manufacturers. The Chicago officials confirm the New-Yorker's statement that they wish that tape-printers had been adopted by the company in place of page-printers, giving the same reasons—*i.e.*, tape-printers save line time, cost less for maintenance, &c. They are afraid it will be somewhat difficult to change, on account of the public being educated up to page-printers and would probably resent tape.

High-frequency telegraphy along wires often colloquially described as "wired wireless," and termed by the American Telephone and Telegraph Company's engineers "high frequency multiplex telegraph," is another interesting development I met abroad. Several of these equipments are being installed on lines of the above-mentioned company. As compared with multiplex telephony the apparatus is less expensive in first cost and maintenance, and the system as a whole is less liable to interruption by disturbance from outside sources.

One high-frequency circuit is superimposed on a No. 8 gauge copper loop from Chicago to Harrisburg, a distance of 450 miles, and a similar circuit 200 miles long is extended to Pittsburg by means of high-frequency repeaters. Ten telegraph-channels are provided, each being duplexed. The equipment for each channel includes thermionic valves for transmitting and receiving high-frequency currents, the necessary condensers, inductances, and transformers, all of similar type to those used in continuous-wave wireless telegraphy; a duplex telegraph repeater connecting the high-frequency channel with the metallic loop extended to the telegraph-station; and a Morse set for monitoring purposes.

The system cannot at present be worked through cables, or even moderate lengths of covered wire, so it is not likely to be used to any extent in this country. It may be considered later on for the Auckland–Wellington superimposed loop. The long open lines connecting the large cities in Australia would appear to offer ideal conditions for the exploitation of the "wired-wireless" multiplex. I shall refer to "wired-wireless" again under the "Telephony" heading of this report.

The company at Chicago telephones all telegrams received for subscribers on the local telephone-exchange system, and posts a copy of the message only if the addressee asks for it to be done. The company says it costs on an average only 3 cents to telephone a telegram, whereas the cost is 10 cents if delivery is by messenger. The messengers are supplied with two uniforms on appointment, so as to enable cleaning and repairs to be done monthly; the company has its own tailors and tailoresses for repairs, and sends the clothes to a cleaning company for pressing and cleaning. The boys have 40 cents a week deducted from their wages for clothes cleaning and repairing. The company provides boot-brushes and boot-polish for the boys. I noticed that the lads on returning from a delivery invariably gave their boots a rub. The boys are also provided with rest and eating rooms, shower baths, and a gymnasium. Food for all the staff is obtainable on the premises on the cafeteria system at actual cost, which does not include overhead expenses. I found this practice standard with all large telegraph and telephone companies throughout the United States of America.

TELEPHONY.

I found that the telephone service throughout Europe and America was passing through a period of unsettlement, caused by the direct effect of the war on the supply of materials. Shortage of skilled labour during the war, and unrest in the labour world since the war, have affected not only the output of factories, but the work of the switchboard operators and of workmen generally. In the United States of America the telephone service rendered to the public did not, however, suffer so seriously as was the case in countries which entered early into the war; development and production of telephone material did not entirely cease in the United States even when that country was actually engaged. In spite of this, one large company in the United States remarks in a recent annual report: "This has been from every standpoint the most strenuous and difficult year in the whole history of the telephone. It has been impossible to maintain standards, and difficult to meet the increasing demands of service. It is a matter of satisfaction that the telephone service has maintained its standards as well as it has when we consider the general letting-down there has been in all services, particularly private service where intimate relations between employee and employer should be a warrant for good service." If people next door to the sources of production of apparatus and material have this experience, is it any wonder people like us, so far afield, should be similarly situated? Under the circumstances, and from what was seen and heard in other countries, I am satisfied that the Engineers and workmen in this country rose splendidly to the occasion to give the public the best service possible during this trying time.

Great Britain and North America are now convinced that machine-switching (automatic) telephony is the only economical system of meeting the future needs of telephone service. This conclusion was arrived at in New Zealand in 1911. The Engineer-in-Chief and others of the British Post Office, in a recent report and recommendation to the British Government, said: "The

introduction of machine switching in telephony is justifiable because—(*a*) Little or no improvement which will result in a better or more economical service can be visualized in connection with manual exchange plant. (*b.*) Difficulties in obtaining, training, and retaining efficient operators are so formidable in large cities that the future outlook is one of insecurity and increasing anxiety. (*c.*) The public and Press are demanding a better service. Owing to the increased cost of operating, and labour conditions generally, this demand cannot be satisfied in large cities under manual conditions unless an undesirable increase in the tariff is imposed. Even then, with the unstable operating conditions, the attainment of improved service will be problematical. Moreover, its permanency could not be guaranteed, whereas with a machine system a good service, once attained, would be free from violent disturbing influences. (*d.*) It would facilitate the introduction of increased rates in future if the Department could allay public criticism by promising a grade of service superior to that hitherto given, and not inferior to that which will shortly be available in the United States. We have no hesitation, therefore, in recommending the adoption of full automatic working as the only reliable method for notably improving the telephone service."

Until recently the policy of the American Telephone and Telegraph Company and the associated Bell companies in regard to providing for future expansions to their systems, and particularly their views on machine switching, had not been clearly understood. I venture to say—having in view the fact that the Bell companies and the American Telephone and Telegraph Company have the manufacturing organization of the Western Electric Company to supply their needs—that the announcement of this policy was delayed until the Western Electric Company was in a position to manufacture apparatus on a scale large enough to show reasonably rapid progress after the first installations were commenced.

The American Telephone and Telegraph Company has decided to install what is known as the Western Electric Company's "panel system" in all large multi-office areas in the United States. In fact, it is claimed that this system is the only one yet produced that can efficiently handle such services. Arrangements have been made by the Western Electric Company to manufacture this equipment on a large scale in its factory at Hawthorne, Chicago, and the American Telephone and Telegraph Company has prepared a programme of installation in various areas throughout the United States. Owing, however, to the increased troubles with the operating staff, particularly the difficulty in training and retaining them, as well as the greatly increased wages, it has been compelled to enlarge considerably its automatic programme. The output of the Hawthorne Factory is expected to be—in 1921, 230,000 lines; in 1922, 300,000 lines. The quantity of equipment required to carry out the enlarged programme is, however, greater than the anticipated output of the Hawthorne Factory, and arrangements have therefore been made with the Automatic Electric Company of Chicago for the supply of Strowger type apparatus to equip at least 75,000 lines per annum during the next five years: the Strowger equipment to be confined to areas with an ultimate of about 10,000 lines.

I found that the Automatic Electric Company had added a large extension to its factory, and was organized to manufacture Strowger type equipment at the rate of 75,000 lines per annum for the associated Bell companies, in addition to an output to meet the demands for independent companies and foreign business. I learnt from American engineers that it was not anticipated that any further large manual exchanges would be installed, but there would still, of course, be requirements for manual equipment for extensions of existing plant, but its cost will be relatively high on account of manufacturers having to maintain expensive machine tools for a relatively small output.

In America some States agreed to increases rates when an automatic system was promised, and others agreed to increase rates on condition that this system would be installed. For the large multi-office areas in the United States and for the five largest cities in Great Britain the Western Electric panel system has been adopted. The system being installed in our four chief centres and several provincial towns is the Western Electric rotary, and it is already giving service in several European cities and one or two towns in England. The panel and rotary are both "impulse-storing" systems—*i.e.*, the impulses are received and stored in "registers." The panel, because of its being manufactured in 500-line units, is considered more suitable for large areas; some authorities go so far as to say that no other existing system is capable of handling telephone traffic in such large multi-office areas as London and New York.

From what I have seen of the Western Electric Company's panel and rotary machine-switching telephone exchanges, I am of an opinion that in some respects the rotary has advantages over the panel, especially for conditions existing in New Zealand. Rotary is cheaper to install, and costs less to maintain. Before the war the rotary was being manufactured at Antwerp. Just prior to the Germans entering that city the Western Electric Company hurried the tools necessary for the production of this apparatus to its factory at Woolwich, London. The tools and machinery were no sooner set up than that portion of the factory was taken for the manufacture of munitions. The tools and machinery were again dismantled, packed, and shipped to the company's Hawthorne Factory at Chicago. On the declaration of peace arrangements were made to retransfer this tool equipment to Belgium. The transfer was practically completed when I visited Antwerp. For the future, all the rotary apparatus necessary for completing the contract the Government has with the Western Electric Company, and for future extensions to this system at the various places where it is installed, will be supplied from Antwerp. It will be noticed that all our equipment for automatic telephone exchanges is of foreign manufacture.

There are two concerns making tried automatic-telephone apparatus in England—*i.e.*, the Automatic Manufacturing Company, Liverpool, and Siemens Bros., London—both turning out apparatus on what is known as the Strowger principles. The former company, owing to an agreement with the parent American company, is unable to do business with Australasia. Siemens

Bros., I believe, are not debarred from supplying equipment for New Zealand, but from what I learn they are so full of orders that they are not in a position to do so. This is confirmed by the fact that Siemens Bros. were not among the tenderers for equipment recently called for by the Commonwealth of Australia. There is a possibility of another concern in England, in about two years, being a competitor and supplying automatic-telephone apparatus.

Automatic apparatus for telephony is rapidly being standardized. The "dial" or "sender," is standardized as far as numbering and impulses are concerned.

New Zealand is in an ideal position for the introduction of modern machine-switching apparatus. We have only three of what may be termed modern manually operated exchanges—viz., Invercargill, Timaru, and Hastings. The branching multiple magneto switchboards in the cities and larger towns have, in the majority of cases, reached a condition where they are both difficult and expensive to maintain. Under the conditions existing to-day in the country it will be economical to install automatics in quite small communities, especially in localities adjacent to centres where the exchanges can be unattended, only visited at regular periods for charging batteries and a little routine testing. Automatics would provide continuous service at places where the number of lines is so small that even if the rates were very high the exchanges, if operated manually, would show a serious loss. Even in our small localities where we have a comparatively large number of party lines automatics could be installed.

The magneto telephones on the long party lines would not have to be changed to enable these subscribers to enjoy automatic service; dials for calling could be attached to the magneto telephones. The party-line subscribers under this system would be given individual numbers, and thus called by automatic code ringing. The magneto ringers of these party-line telephones would be used for calling from one to another party on the same line. This would avoid the necessity for placing expensive revertive ringing-apparatus in the automatic exchanges.

High-frequency Carrier System.

Startling announcements have frequently appeared in the public Press referring to a sensational discovery whereby several independent telephone conversations are possible over an existing metallic circuit without in any way impairing the efficiency of that circuit for the purpose for which it was being used. The system is known as "multiplex telephony"; and is brought about by superimposing a number of telephone channels on an ordinary metallic circuit. The underlying principles of the system are in many respects identical with those of radio-telephony, but in adapting those principles to wire telephony it has been necessary to carry out a vast amount of laboratory and field research work.

The system used on one circuit in the United States of 250 miles in length provides four multiplex channels, and the efficiency of transmission between terminals is equal to five miles of standard cable. The articulation on these channels is remarkably good, and the circuits are peculiarly silent. The special apparatus is elaborate, and its high cost of installation and maintenance precludes its use for distances under 250 miles. For shorter distances it is at present cheaper to provide additional copper conductors, although the American engineers expect the evolution of a system requiring simpler and less-costly apparatus.

I do not anticipate that the system will have much field for employment in New Zealand, as our distances are comparatively short. The successful commercial development of the telephone repeater, with the introduction of the high-vacuum three-electrode thermionic valve, will enable the more distant centres to be provided with telephone facilities by means of a lighter-gauge copper than hitherto was thought possible. High frequency cannot as yet be used over cables, or even comparatively short lengths of covered wire, and on one set can be used on a pole line.

It perhaps would not be out of place to mention here that "high-frequency carrier" or "wired wireless" is looked upon by some American engineers as a means of transmitting power to a distance. A light-gauge wire would be used from the source of the power to a point where the power can be utilized; the wire to be used merely for directional purposes, and the ether the medium through which the power will be transmitted. We have seen such startling radio developments in the last few years that I would not predict that such a dream will not come true.

Inter-island Telephonic Communication.

There are two mediums by which a toll service can be established between the North and South Islands: these are—(1) Submarine cable, (2) wireless. If such a service is opened to the public, at least three channels must be available—*i.e.*, provision made for three pairs of persons to hold simultaneous conversations.

Submarine Cable.

To meet this provision a submarine cable will require to have four continuously loaded conductors, giving two metallic circuits, and a phantom circuit superimposed. The only country making such a cable at present is Great Britain. The cable would weigh from 800 to 1,000 tons, and would have to be brought to New Zealand and laid by a special ship—*i.e.*, a cable-ship. The cost of the cable, including the cost of freight, laying, cable-huts, and land line from huts at each side of the strait to Wellington and Blenheim respectively would be quite £100,000. In the absence of trunk lines from Blenheim to Christchurch, the cable would serve only Marlborough and Nelson in the South Island. The cost of erecting the necessary trunks from Blenheim to Christchurch, and strengthening the existing poles to carry the extra wires, is estimated to cost £26,000; therefore, before Wellington and other centres in the North Island could have telephone talks to the chief centres in the South Island it would involve the country in an expenditure of £126,000. I have considered the

fact that Christchurch has telephone facilities to and from Dunedin, but the trunk circuits between these places are already quite loaded, and if they are asked to carry additional traffic it could only be done with a large delay—in other words, the waiting-time may run into two or three hours during the height of the daily busy hours.

Wireless.

Catalina Island, lying about forty-five miles off the Californian coast, has a three-channel wireless telephone service to Los Angeles, and provision is made for repeating the wireless speech over the wire system to practically any place in the United States. The average daily traffic to and from Catalina is 150 messages. The wireless speech is remarkably clear, and comparatively great in volume. I heard speech passing to and from Catalina at Los Angeles, and when at San Francisco I spoke to Catalina over a circuit made up of over 800 miles of trunk line to Los Angeles and thence by wireless. The speech was perfectly articulated, without any attenuation.

As far as the toll operators at Los Angeles are concerned, they have three physical circuits, which are operated in the same manner as a wire circuit. Ringing and speaking keys are used exactly the same for wireless as for wired circuits. When Los Angeles toll operator presses a ringing-key it drops a shutter at Catalina the same as if it were a wire circuit. Pressing the ringing-key sends the ringing-current of ordinary-telephone-ringing frequency through a relay at the aerial, which in turn places voice frequency ringing on to the aerial. This at Catalina on a valve amplifying-set causes sufficient energy to pass through an indicator coil to operate it. Of course, any licensed amateur, or a ship's wireless operator equipped with a valve receiver and tuning-coils, can tap wireless telephone speech; secrecy, therefore, by the nature of things, is impossible.

Hitherto it has been generally accepted that there is a large amount of interference caused to wireless-telegraph stations working on wave-lengths near that of wireless telephony, and for that reason it was considered that the use of wireless telephony would probably be confined to cases where wire telephony cannot be used, such as transoceanic communications, communications with aircraft, or very long land lines where maintenance would be difficult or impossible. When I was in London the Marconi Company was conducting experiments with wireless telephony with speech superimposed on 3,500 metres wave-length, and were stopped, excepting for a few hours after midnight, on account of the interference their experiments caused with communications to aircraft working on 900 metres wave-length. In spite of this there is a wireless-telegraph station quite close to the telephone aerial on Catalina Island, and I am informed no interference at all is experienced.

From what I saw and heard in the United States, I feel confident that wireless telephony will provide a practical proposition for opening up inter-island telephone service. The cost of a three-channel wireless installation, including the aerials and repeating-apparatus, is estimated to be a tenth of the cost of a submarine cable giving equal facilities—*i.e.*, about £10,000. It is a difficult matter to compare the annual maintenance charges of the respective systems, because the maintenance of the cable is an unknown quantity, but the cost of repairing one break in the cable would equal many years' maintenance of the wireless equipment.

The estimated cost for the wireless-telephone equipment given above is for a three-channel service from Wellington and Blenheim, with repeating-facilities for intercommunication between the wire and wireless systems. Wireless equipment giving two channels each to Christchurch and Blenheim from Wellington should not cost more than an additional £2,000. The Department has suitable land at Lyall Bay and New Brighton for the erection of wireless aerials; the Blenheim aerials could be erected over the Chief Post-office building.

The American Telephone and Telegraph Company is laying what I shall call "mystery cables" from Key West to Cuba. These cables are to provide telephone and telegraph facilities, and are not metallic for the whole of the distance—about one hundred miles—but have an uninsulated return for the greater portion of their lengths. The insulated portion is continuously loaded. The cables are being manufactured in England, and the first one was expected to be laid in February. What the American Telephone and Telegraph Company expects to get out of these cables has not been disclosed by its engineers; indeed, from what I heard in America I believe exactly what facilities these extraordinary cables will provide is really unknown, and will only be determined after they are laid and tried out. I certainly would recommend deferring consideration of laying a submarine-telephone cable across Cook Strait until the result of these Cuban cables is known. The cost of such cables will be considerably less than the class of cables usually considered essential for telephone purposes under such waters as in the strait. The cost of materials is coming down, so we have everything to gain in delaying the consideration for a submarine cable.

Specifications are being prepared for a three- or four-channel wireless telephone installation for working from Wellington to Blenheim and Christchurch, and when these are ready they will be submitted to one or two companies specializing in such equipment. The results will be communicated to the Minister with a recommendation.

COMMUNICATION BY WIRELESS TELEGRAPHY AND TELEPHONY.

Due to the exigencies of the war and the great demand created thereby for communication by radio telegraphy and telephony, an abnormal development took place in these means of communication during that period. Upon returning to normal conditions this development was pushed forward with a view to its utilization for commercial and social ends. Although great strides have been made, much has yet to be done before the general application of radio-telephony to commercial problems can be said to have reached a satisfactory position. It is, however, clear that the older spark method of transmitting wireless-telegraph signals is fast becoming obsolete, particularly in stations using considerable power. The spark method is at present employed in the New Zealand

radio coast stations, and in fact in most of the smaller and many of the larger wireless coast and ship stations all over the world. The development of other methods of transmission such as the arc, the valve, and the high-frequency generator are destined to replace spark methods by reason of their greater efficiency and economy of operation. Valve transmission has recently been adopted for all the new stations required for the Imperial wireless chain, and it is claimed among other advantages that the greatest efficiency will thereby be attained. Moreover, valve transmission is peculiarly well suited for use in connection with wireless telephony to which the spark method of transmission does not lend itself. The principal advantage of the spark method for use at coast stations engaged in communication with ships is that a less complicated and more robust type of wireless receiver can be used aboard ship than would be necessary if the coast station were equipped with more modern apparatus. This advantage is gradually disappearing with the introduction of more stable types of receiving circuits and apparatus designed for reception from modern transmitting-stations.

It should be pointed out that older countries are gradually becoming more exacting in their demands upon shipping with regard to the compulsory installation of wireless apparatus and the extension of the prescribed hours of watch. In this connection the New Zealand legislation under which the Marine Department requires ships to be equipped with wireless apparatus and determines their status as to hours of watch is comparatively lenient.

The practicability of establishing wireless-telephone stations in such situations as lighthouses and the remote island dependencies of New Zealand received careful investigation. While such communication is quite practicable under certain conditions, it was found that development work along these lines had not yet reached that degree of finality which could be desired. Most of the wireless-telephone equipments that would otherwise be suited for such situations lack that robustness and freedom from complications which are essential to the successful operation of wireless telephony at isolated stations by an untrained personnel. Rapid strides are, however, being made in this direction. I am keeping in touch with the same, and confidently anticipate being able shortly to make definite recommendations. To enable the Post and Telegraph Laboratory to carry on research work in this fast developing branch of radio science I have secured a limited amount of apparatus to enable experimental work to be done.

The radio station at Awanui, by reason of its semi-isolation, is comparatively more costly to run than would be the case if it were situated nearer to the main lines of communication and the main centres of civilization. Its situation is such that it is easily vulnerable from the sea, which is an undesirable feature when it is considered that this is our most important long-distance transmitting-station, and is responsible for maintaining communication with Samoa and the Cook Islands. This is a subject which, while abroad, I discussed with a number of interested authorities, and it was generally recognized that if placed, say, in the centre of the North Island, near to the Main Trunk Railway, its reliability of operation, particularly in time of war, would be greatly enhanced, and at the same time the station would be brought closer to the main centres. This would be a distinct asset both from the point of view of annual charges and of linking up the station with the principal land lines of the North Island. If New Zealand is ultimately to form an efficient link in the Imperial wireless chain this station will have to be modernized, and such an occasion might well be regarded as a favourable one for its removal to a less vulnerable locality.

SYSTEM OF CHARGING FOR TELEPHONE SERVICE.

The New Zealand system of charging for telephone service, based on conductor length, or, as it is termed, "by the nearest practicable route," is unique in that it is not used in either Europe or America. In discussing rates with a prominent telephone official in the United States I explained our system of charging to him. He seemed amused, and asked me whether the same system was adopted for all public-utility services. For instance, he asked whether a person living near a gasometer got his gas at a cheaper rate than one living two miles from it; also whether a consumer adjacent to the electric-power station paid less for electricity than the others located some distance away.

Before going abroad I was of the opinion that "measured rate" was the most equitable one for telephone service, but after careful study of the various systems in Europe and America my opinion has changed.

Measured rates are the exception rather than the rule in the American telephone service. Expert opinion is divided on the subject, but is generally in favour of flat rates for small towns and residential areas. Opinion has been influenced by the fact that the introduction of machine-switching is facilitated by the existence of a flat rate.

Whilst it is desirable to maintain the principle of measured-rate service—namely, to charge for service on a quantitative basis—it cannot be overlooked that existing systems of recording and collecting the charges are cumbersome, expensive, and more or less unreliable, thus causing disputes which waste time and money making inquiries. It involves not only complex accounting, but also increased capital expenditure, maintenance costs, and traffic charges. To equip all the subscribers' lines in New Zealand with meters would cost something like £90,000.

Measured rate is in vogue in New York, but the American Telephone and Telegraph Company's officials informed me that wholesale introduction of automatic telephone switching will no doubt cause them to materially revise their policy, and the result will probably be that flat rate on the zone system will be adopted, measured rate being retained only for business connections in large multi-office areas having, say, over fifty thousand lines.

The flat rate on the "zone" or "area" system is generally the most popular in the United States, with both companies and subscribers. Los Angeles Exchange, with as many as eighty-five thousand subscribers connected with it, charges for service under this system. The system referred to, briefly

put, is as follows: An area known as the "base charge" area is determined for all cities and towns. This area is enclosed in a map of the respective city or town. The "base area" need not necessarily be the city area proper nor the town boundary. In determining this area several factors are taken into consideration so as to assist in the study of development of the wire plant and cabling to provide a service which will pay interest on capital, working-expenses, depreciation, and obsolescence. Some of the factors used for arriving at this "base area" are density of population, the class of residences from a telephone point of view, the natural barriers to overcome for cable distribution, &c.—generally, factors to assist one to arrive at an area so that the greatest number possible may be served at an equitable flat rate—one for private residences and another for businesses, the business rate in the larger areas being at least double the private-residence rate. All subscribers outside this area are charged an additional mileage rate to the nearest quarter of a mile, the air-line distance being taken. If a fair number of subscribers can be secured in a township adjacent to a city, this township is mapped out to include an area for a mileage charge to be paid in addition to the city's base charge.

Take the Hutt, for instance: a person or business located in what would be known as the "Hutt area" would have intercommunication with all the city exchanges, and the charges would be the charge for Wellington "base area" plus the Hutt area charge. There would be an area charge for Petone, Eastbourne, and perhaps as far away as Upper Hutt.

Take the Auckland multi-office area: the base-charge area would include all lines connected with the Wellesley Street, Ponsonby, Mount Eden, Remuera exchanges. Devonport and Takapuna would have another area for charging purposes, and so would Onehunga. Subscribers connected with the Devonport and Takapuna exchanges could communicate with all the city exchanges by paying a sum equal to the Auckland base charge plus the North Shore area charge. Subscribers at Onehunga would have similar facilities and similar charges. In arriving at the North Shore area charge, consideration would have to be given to the expensive cable necessary to provide trunk circuits to the Auckland City exchanges.

I recommend charging for telephone service by an area rate in place of the conductor length of circuit rate now in existence, such areas to be defined by maps or plans with lines enclosing multi-office and single-office areas as outlined above. The following classes of services to be provided for:—

Within base area for multi-office areas	One-party line	Business.
	One-party line	Residence.
	Two-party line	Business (both subscribers to be in the same city or town block).
	Two-party line and four-party line	Residence.

Outside the base-area rate, lines for single office areas, and connections to exchanges, to be designated "rural exchanges": One-party, two-party, four-party, six-party, eight-party, ten-party: The Department to have the right of arranging the parties.

ACCOUNTS.

Telephone officials generally attach great importance to the American practice of rendering monthly accounts to subscribers. It is maintained that this practice, combined with other attractive features in the way of party-line accounts, fosters the telephone habit among smaller users, particularly in residential areas. I was informed also that the monthly account system is favoured by the business houses. The monthly accounts are a complete statement of all charges against the subscriber—*i.e.*, rental charges, toll talks, &c. It must be admitted that our system of rendering accounts—half-yearly for rentals and monthly for toll charges—is most unsatisfactory. A large percentage of the accounts is for such small amounts—as small as 3d.—that the subscribers neglect to pay them, and on demand frequently ask that the amounts be included in their half-yearly accounts. I strongly recommend rendering accounts monthly for all telephone service, the accounts to be a complete statement of all charges against the subscriber.

The method adopted by us to facilitate collecting telephone tariffs is so well known that I need not describe it. Briefly put, it is to disconnect all subscribers who do not pay up by a certain date I may say that the same action is taken in Australia, but there a defaulting subscriber has to pay an additional 5s. before his severed connection is completed again. The 5s. is termed a "joining-up fee."

In America the accounts are rendered monthly, and payment has to be made before the 10th of the following month. All those not having paid on that date are reminded by telephone to do so. A week later those subscribers who still have their accounts unpaid are visited by a man who has to either collect the account or remove the telephone from the subscriber's premises. If the subscriber elects to pay the man, he may do so provided he pays an additional 50 cents for the man's time in making the visit.

At one city I got the following information: At the end of the month 83,000 accounts were rendered; 2,500 telephone requests for payment were made; 300 subscribers were visited; 25 telephones were removed.

ADVERTISING IN TELEPHONE DIRECTORIES.

New Zealand is unique in another direction in connection with its telephone business, inasmuch as it does not accept advertisements for publishing in its telephone directories. Every country in Europe and America—indeed, I may say, every country in the world other than New Zealand—accepts advertisements, and in all cases the advertisements more than pay for the cost of production of the directories. The telephone directory everywhere is considered the best advertising medium there is, especially when a classification of trades and businesses advertising in the directory is appended.

The cost of printing the various New Zealand telephone directories and exchange lists in 1920 was £7,936 1s. 6d. The whole of this amount would be recouped if we accepted advertisements. The advertisements, if properly arranged, do not at all interfere with the primary purpose for which a directory is issued, nor cause any inconvenience. On my travels abroad I made a point of collecting telephone directories, all of which show the extent which advertisers use them as an advertising medium. I was also supplied by the British Post Office, and several telephone companies in the United States of America, with particulars describing the various conditions and rates under which advertisements are accepted.

The Department certainly should accept advertisements for printing in its telephone directories, and thus get into line with other administrations adopting this businesslike method of paying for the cost of producing and distributing telephone directories.

TELEPHONE RATES.

The following are schedules showing the rates charged for telephone service in several European countries and in North America, together with the existing New Zealand rates.

British Telephone Rates.

Ground-rent plus a local-message fee for every outgoing message as under :—

——	London.	Birmingham, Glasgow, Liverpool, and Manchester.	Provinces.
	£ s. d.	£ s. d.	£ s. d.
Exclusive line	8 10 0	8 0 0	7 10 0
Auxiliary line	7 10 0	7 0 0	6 10 0
Private branch exchanges—			
First line	8 10 0	8 0 0	7 10 0
Additional lines (each)	7 10 0	7 0 0	6 10 0
Extensions (each)	2 5 0	2 5 0	2 5 0

Local-message Fees.—Local messages, London and Provinces, 1½d. each.

Subsidiary Services.		Annual Rental. £ s. d.
Two-party lines (for subscribers beyond one mile from the nearest exchange) ..	(each)	6 0 0
Rural party (farmers') lines :—		
When three or more subscribers per route-mile of circuit	(each)	4 0 0
When less than three but not less than two subscribers per route-mile of circuit	,,	4 10 0

Toll Rates (*i.e.*, Calls not covered by the Local-message Fee).

Three minutes conversation (or part thereof)—	Fee. s. d.
Over 5 miles and not exceeding 7½ miles	0 1½
,, 7½ ,, 10 ,, ...	0 3
,, 10 ,, 12½ ,, ...	0 4½
,, 12½ ,, 15 ,, ...	0 6
,, 15 ,, 20 ,, ...	0 7½
,, 20 ,, 25 ,, ...	0 9
,, 25 ,, 35 ,, ...	1 0
,, 35 ,, 50 ,, ...	1 6
,, 50 ,, 75 ,, ...	2 0
,, 75 ,, 100 ,, ...	2 6
For each additional 50 miles	1 0

In addition to the above fees a special charge of 1s. per message is made for calls between Great Britain and Ireland.

The minimum charge for a call to or from the Isle of Wight is 6d.

European Telephone Rates.

(Note.—Foreign currency has throughout been converted into its English equivalent at the par of exchange.)

AUSTRIA.

All local exchanges as well as the interurban or trunk lines connecting them are provided and worked by the State Telegraph Administration.

Revised Rates, introduced on 1st January, 1919.

Group.	A. Exclusive Line.	B. Two-party.	C. Four-party.	D. Rural Rate.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Exchanges with more than 20,000 subscribers ..	20 0 0	11 13 0	7 18 0	..
5,001 to 20,000 subscribers	15 16 0	10 0 0	6 13 0	..
2,001 „ 5,000 „	13 6 0	8 15 0	6 5 0	..
501 „ 2,000 „	11 13 0	7 18 0	5 17 0	..
201 „ 500 „	10 0 0	7 2 0	5 8 0	5 8 0
51 „ 200 „	8 15 0	6 13 0	5 0 0	5 0 0
21 „ 50 „	7 10 0	..	..	4 12 0
20 or less subscribers	6 13 0	..	..	4 3 0

Tariff A covers 12,000 calls per party, Tariff B covers 6,000 calls per party, Tariff C covers 3,000 calls per party.

Rates for Toll Service.

The rates for urgent calls taking precedence of ordinary calls are thrice the ordinary rates, which are as follows :—

For a call of three minutes' duration—	s. d.
For a distance up to 31 miles	0 10
„ „ 62 „	1 3
„ „ 186 „	2 1
„ over 186 „	3 4

DENMARK.

(Telephone Company of Copenhagen.)

Scale of Charges.	Per Annum.
	£ s. d
1. Business telephones (connections with central exchange)—	
Including 8,000 originating calls	22 1 0
(If 8,000 calls are exceeded the company may require the subscriber to take another line)	
Including 5,500 originating calls	16 10 0
2. Business telephones (connections with subsidiary exchanges)—	
Including 1,200 originating calls	8 5 0
For a further 1,000 calls	2 15 0
In addition an initial establishment charge of £5 10s. is payable in the case of rates (1) and (2).	
3. Two-party telephones—	
Including 2,000 originating calls	7 3 0
(If more than 2,000 calls are originated the subscriber must take a direct line.)	
4. Four-party telephones	2 15 0
(No calls included in subscription, each originating call being charged 1¼d.).	
In addition, an initial establishment charge of £3 6s. is payable in the case of two-party lines, and £1 2s. in the case of four-party lines.	

Rates for Toll Service.

The rates for urgent calls taking precedence of ordinary calls are thrice the ordinary rates, which are as follows :—

For a call of three minutes (day service)—	s.	d.
For distance up to 31 miles	0	6½
,, ,, 124 ,, ...	1	1½
,, ,, 248 ,, ...	2	3
,, over 248 ,, ...	3	4

Plus ground rate of 6½d.

FRANCE.

Rates for Unlimited Local Service.

Paris—	£	s.	d.
Ordinary lines	27	15	0
Immeubles*	39	13	0
Hotels, cafes, &c.	47	12	0
Lyons—			
Ordinary lines	20	16	0
Immeubles*	29	15	0
Hotels, cafes, &c.	35	14	0
Other towns with more than 25,000 inhabitants	£13 18s. to £23 16s.		
Towns with 25,000 inhabitants or under	£10 8s. to £17 17s.		

Message Rate for Local Service.

(Applies only to towns with a population of 80,000 or less.)

Annual subscription—	£	s.	d.
First year	11	18	0
Second year	7	19	0
Each subsequent year	4	19	0

Charge for each originated call, 2½d.

Extra Charges.—Unlimited-service subscribers contribute towards the cost of erecting their line. Message-rate subscribers only contribute towards the cost of that section of their line which is outside a radius of one mile and a quarter from the exchange. Unlimited-service subscribers have to provide their own telephone apparatus.

GERMANY.

Unlimited-service Rate.

In areas with over 20,000 inhabitants, £17 13s.; in areas with 5,000 to 20,000 inhabitants £16 13s.; down to £7 17s. for areas with not more than 50 subscribers.

Message Rates.

In areas of 20,000 subscribers and over, £11 15s.; in areas with 5,000 to 20,000 subscribers, £10 16s.; in areas with 1,000 to 5,000 subscribers, £9 6s.; and in areas with 1,000 subscribers or less, £7 17s. The rates include a minimum of 400 calls. Local calls, 1¼d.

A capital charge of £49 is now levied on subscribers in the form of a loan repayable when the service is discontinued, and as from the 1st July, 1920, these rates will be again doubled.

Rates for Toll Service.

The rates for urgent calls taking precedence over ordinary calls are three times the ordinary rates, which are as follows :—

For a call of three minutes—	s.	d.
For distance up to 15½ miles	0	9½
,, ,, 31 ,, ...	1	0
,, ,, 62 ,, ...	2	0
,, ,, 186 ,, ...	3	0
,, ,, 310 ,, ...	4	0
,, ,, 465 ,, ...	5	0
,, ,, 621 ,, ...	6	0
,, over 621 ,, ...	8	0

SWEDEN.

Annual Charges.

	£	s.	d.
Including up to 1,200 calls (private houses only)	4	8	0
,, ,, 2,500 ,, ...	7	3	0
,, ,, 5,000 ,, ...	11	11	0
,, over 5,000 ,, ...	16	10	0

* Houses where the proprietor subscribes for the benefit of a number of his tenants (flats, &c).

SWITZERLAND.

(Message Rate only.)

New Tariff, 1st March, 1920.

In systems—	£	s.	d.		
Up to 300 subscribers	2	16	0	within $1\frac{1}{4}$	miles of exchange.
With 301 to 1,000 subscribers	3	3	0	„ $1\frac{1}{4}$	„
With 1,001 to 5,000 subscribers	3	11	0	„ $1\frac{3}{4}$	„
With over 5,000 subscribers	3	19	0	„ 3	„

Plus 1d. each for all originating calls.

NEW ZEALAND TELEPHONE RATES.

	Per Annum: Not exceeding								
	Half-mile.			Three-quarter Mile.			One Mile.		
Business Rate.									
For an exclusive circuit—	£	s.	d.	£	s.	d.	£	s.	d.
At Auckland, Wellington, Christchurch, Dunedin ..	9	10	0	9	10	0	9	10	0
At other exchanges open continuously	8	0	0	8	15	0	9	10	0
At exchanges not open continuously	6	0	0	6	15	0	7	10	0
Private-residence Rate.									
At all exchanges	6	0	0	6	0	0	6	0	0

At all exchanges: Additional exchange connections to the same premises £1 per annum less.

Party Lines.

In cases where from two to six subscribers use the same circuit the following charges are made:—

	Each, per annum. £	s.	d.
For 2 subscribers, 1 mile or less from the exchange	4	10	0
„ 3 „ $1\frac{1}{2}$ miles „ „	4	0	0
„ 4 „ 2 „ „ „	4	0	0
„ 5 „ $2\frac{1}{2}$ „ „ „	4	0	0
„ 6 „ 3 „ „ „	4	0	0

Only one entrance fee is required for each circuit.

Where continuous service is provided: For each party line, for four subscribers or less, £1 per annum additional; for each subscriber beyond four, 5s. per annum additional.

For each business connection on a party line: At an exchange open continuously, £2 extra per annum; at exchanges not open continuously, £1 extra per annum.

NOTE.—Party-line rentals are based on the total length of circuit required to give the joint service.

POPULATION, TOTAL STATIONS, AND MONTHLY RATES FOR LOCAL TELEPHONE SERVICE IN TYPICAL EXCHANGES OF THE BELL SYSTEM IN THE UNITED STATES.

Exchange.	Population.	Total Stations.	Business or Residence.	Class.	Local Message per Month.	Rates for Urban Service.					Rates for Rural Service. Multi-party Lines unrestricted as to Message-use.
						One Subscriber per Circuit.	Two Subscribers per Circuit.	Four Subscribers per Circuit.	Six Subscribers per Circuit.	Addition Local Messages per Month.	
						$	$	$	$		
Harvard, Massachusetts ..	923	209	Bus. ..	Flat ..	Unrestricted	3·25	2·50	2·25	—	..	W 2·25 D 2·33
			Res. ..	,, ..	,,	2·25	2·00	—	1·75	..	W 1·75 D 1·83
Irwin, Pennsylvania ..	9,008	1,020	Bus. ..	,, ..	,,	4·00	3·50	3·00	..	..	3·00
			Res. ..	,, ..	,,	3·00	2·50	2·00	..	..	2·00
Naples, New York ..	3,050	521	Bus. ..	,, ..	,,	3·50	—	2·75	..	..	2·50
			Res. ..	,, ..	,,	2·50	—	2·00	..	..	2·00
Painesville, Ohio	5,606	1,808	Bus. ..	,, ..	,,	4·50	3·50	—	..	..	2·50
			Res. ..	,, ..	,,	2·50	2·25	2·00	..	..	2·00
Valdosta, Georgia ..	13,100	1,566	Bus. ..	,, ..	,,	4·50	4·00	3·50 (*a*)	..	..	..
			Res. ..	,, ..	,,	2·75	2·25	2·00 (*a*)	..	..	..
Bath, Maine	10,852	2,122	Bus. ..	,, ..	,,	3·75	3·00	—	—	..	W 2·50 D 2·58
			Res. ..	,, ..	,,	2·50	2·00	—	1·75	..	W 1·75 D 1·83
Hornell, New York ..	16,500	2,449	Bus. ..	,, ..	,,	4·50	3·50	—	..	..	2·50
			Res. ..	,, ..	,,	2·50	—	2·00	..	..	2·00
Lansdowne, Pennsylvania ..	10,469	2,696	Bus. ..	,, ..	,,	5·00	4·50	4·00	..	..	—
			Res. ..	,, ..	,,	3·25	2·75	2·25	..	..	—
Salisbury, North Carolina..	13,800	2,230	Bus. ..	,, ..	,,	4·00	3·50	3·00 (*a*)	..	..	—
			Res. ..	,, ..	,,	2·50	2·00	1·75 (*a*)	..	..	—
Bellingham, Washington ..	25,500	4,835	Bus. ..	,, ..	,,	W 5·50	4·75	—	..	..	W 3·50
						D 5·75	5·00	—	..	..	D 3·75
			Res. ..	,, ..	,,	W 2·75	2·25	2·00	..	..	W 3·00
						D 3·00	2·50	2·25	..	..	D 3·25
Billings, Montana ..	21,500	3,507	Bus. ..	,, ..	,,	7·00	—	W 6·00	..	..	W 4·00
								D 6·25	..	..	D 4·25
			Res. ..	,, ..	,,	3·00	—	W 2·50	..	..	W 2·00
								D 2·75	..	..	D 2·25
Fort Smith, Arkansas ..	29,800	4,189	Bus. ..	,, ..	,,	5·00	—	—	..	..	—
			Res. ..	,, ..	,,	2·50	—	2·00	..	..	—
Waukegan, Illinois ..	22,000	3,229	Bus. ..	,, ..	,,	5·00	4·0	3·50	..	..	W 2·50 D 2·75
			Res. ..	,, ..	,,	3·00	2·50	2·00	..	..	W 2 00 D 2·25

Galveston, Texas.. ..	44,000	7,733	Bus. ..	Flat ..	Unrestricted	6·00	4·50	—	..	..	2·50
			Res. ..	,, ..	,,	2·50	2·00	—	..	..	2·00
McKeesport, Pennsylvania	73,900	5,655	Bus. ..	,, ..	,,	6·00	5·00	—	..	..	4·50
				Msg...	50	—	—	3·50	..	4 per cent.	..
			Res. ..	Flat ..	Unrestricted	3·25	2·75	2·25	..	..	2·25
Mobile, Alabama.. ..	80,000	5,986	Bus. ..	,, ..	,,	5·50	—	3·50 (*a*)	..	..	—
				Msg...	100	4·00	—	—	..	3 per cent.	..
			Res. ..	Flat ..	Unrestricted	3·25	2·75	2·25 (*a*)	..	..	—
Watertown, New York ..	34,000	5,580	Bus. ..	,, ..	,,	5·50	4·50	—	..	..	2·75
				Msg...	50	—	—	3·50	..	5 per cent.	..
			Res. ..	Flat ..	Unrestricted	3·25	2·75	2·25	..	..	2·25
South Bend, Indiana ..	87,600	9,900	Bus. ..	,, ..	,,	6·00	5·00	—	..	..	..
			Res. ..	,, ..	,,	2·75	2·00	—	..	..	..
Troy, New York	133,200	9,335	Bus. ..	,, ..	,,	7·00	5·50	—	..	..	3·25
				Msg...	50	—	—	3·50	..	5 per cent.	..
			Res. ..	Flat ..	Unrestricted	3·50	3·00	2·50	..	..	2·50
Waterloo, Iowa	38,700	8,882	Bus. ..	, ..	,,	5·00	4·00	—	..	..	2·50
			Res. ..	,, ..	,,	2·50	2·00	—	..	..	2·00
Akron, Ohio	193,300	14,942	Bus. ..	,, ..	,,	7·75	6·75	4·75	..	..	3·50
			Res. ..	,, ..	,,	3·75	3·00	3·00 (*a*)	..	..	2·25
				Msg...	60	3·00	2·50	—	..	3 per cent.	..
Birmingham, Alabama ..	255,800	17,963	Bus. ..	Flat ..	Unrestricted	5·50	—	3·50 (*a*)	..	..	—
				Msg...	100	4·00	—	—	..	3 per cent.	..
			Res. ..	Flat ..	Unrestricted	3·25	2·75	2·25 (*a*)	..	..	—
Indianapolis, Indiana ..	322,000	56,496	Bus. ..	,, ..	,,	7·00	6·00	—	..	..	—
				Msg...	70	—	3·50	—	..	3 per cent.	..
				,, ..	100	4·50	—	—	..	3 ,,	..
			Res. ..	Flat ..	Unrestricted	3·25	2·25	—	..	..	—
Rochester, New York ..	301,000	22,534	Bus. ..	,, ..	,,	7·00	5·50	5·50 (*a*)	..	..	3·25
				Msg...	50	—	3·50	—	..	5 per cent.	..
			Res. ..	Flat ..	Unrestricted	3·50	3·00	3·00 (*a*)	..	..	2·75
Portland, Oregon ..	337,000	55,453	Bus. ..	,, ..	,,	W 8·50	7·00	—	..	..	W 3·50
						D 8·75	7·25	—	..	..	D 3·75
				Msg...	130	W 6·50	—	—	..	4 per cent.	..
						D 6·75	—	—	..	4 ,,	..
			Res. ..	Flat ..	Unrestricted	W 3·25	2·50	2·25	..	..	W 2·25
						D 3·50	2·75	2·50	..	..	D 2·50

NOTES.

Bus. = Business service.
Res. = Residence service.
Flat = Flat rate or unrestricted number of messages.
Msg. = Message-rate service, or charge varying with amount of use above the required guarantee.

W = Wall type telephone instrument.
D = Desk type telephone instrument.
— = No rate quoted.
(*a*.) Available only in nearby rural.

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