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RADIO

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Edited By

IRWIN STEWART, PH. D., LL. B.
University of Texas

Formerly, Assistant Solicitor, Department of State,
Texas

EUROPEAN AGENTS

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FOREWORD

RADIO began its commercial development as a medium through which communication might be carried on with ships at sea. As a means of communication it has steadily increased in scope and importance. It was not until broadcasting, initially a by-product, appeared upon the scene, however, that public interest became manifest. The phenomenal growth of the radio industry since that date is almost without parallel. Public interest, at first almost wholly confined to broadcasting, is at the present time being intrigued by the possibilities of television and the discussion of the allocation of short wave channels. An increasing interest in the huge field outside the broadcast band is becoming apparent.

In the present volume a group of experts have attempted to portray in non-technical language a picture of the entire field of radio. As a background for the presentation, the development of radio from the laboratory to the broadcasting station is outlined and the more modern uses, such as television, trans-oceanic telephony, telephotography, etc., indicated. Then, preceding a study of the situation in the United States, a survey of the extent to which radio has come into use over the world is given. The services of the amateur, honored in radio circles but unsung by the public, are recounted by one of the most prominent of their number.

The unforeseen expansion of broadcasting presented a number of legal and administrative problems. Before Congress took definite action, chaos threatened if, indeed, it did not prevail. The legal situation prior to the enactment of a comprehensive statute is explained by an expert in legislation, who also analyzes the Radio Act of 1927. That act put a heavy burden upon the Radio Commission which it created. How the burden was discharged by the Commission is told by a member of that body.

One division of the *Supplement* is devoted to a discussion of the more important services performed by radio. Other services might have been included, but it is believed that those considered will serve to increase the appreciation of the benefits of the radio art.

The wide diffusion of radio waves introduces international complications as well as possibilities of greater international understanding. The regulation to which radio has been subjected in its international aspects and the part it has taken or may take in war, are pointed out. In the final article, the extremely important matter of the nationality of the control of existing international radio communication facilities—the more important because of the recent merger of British radio and cable companies to insure British dominance of the international electrical communication field—is presented.

That a single volume could tell the entire story of radio is not to be expected. Many volumes could be devoted to single phases treated in the present one, and others could be drawn from aspects necessarily omitted. It is hoped, however, that the accompanying articles will present a comprehensive view of the field of radio. If they do, the purpose of the volume will have been accomplished.

IRVIN STEWART,
Editor in Charge.

The Development of Radio

By Laurens E. Whittemore

Member, Engineering Staff, American Telephone and Telegraph Company; Secretary of the American delegation to the International Radiotelegraph Conference of 1927

RADIO as we know it today is not the invention of any one person or of any small number of persons. It is rather the accumulation of the results of the experiments, thoughts and practices of a large number of individuals, each stimulated to make his contribution to a sum total of knowledge.

Radio communication has evolved from beginnings embedded in the purest of mathematical and physical sciences to one of the most far-reaching and sociologically significant of modern industrial activities. It has become a means of communication which is employed for almost every conceivable purpose from the business affairs of the financier to the amusement of children.

As an industry it now gives employment in the United States alone to about 200,000 persons, and as a service it counts among its direct daily beneficiaries perhaps a third of our population.

The Beginning of Radio

Throughout the early and middle portions of the nineteenth century, workers in physics (then called natural philosophy) were learning some of the fundamental facts regarding the behavior of electric currents. Among these workers were some whom we now recognize as the outstanding physicists of their time, including such men as Ampere, Volta and Faraday. The fundamental work of these men led Clerk Maxwell, an English mathematician, in 1873, to the conclusion that high-frequency alternating currents, flowing in a circuit, would give rise to electric waves in the surrounding space. Maxwell's conclusion was based on an exact mathematical analysis which enabled him to predict the velocity of travel of the waves, as well.

These waves are the waves now used in radio communication and their existence was first experimentally detected by a German physicist, Heinrich Hertz, in 1887.

While most of the scientific effort before this time had been expended in the field of astronomy, this period witnessed a turning toward the study of electrical phenomena. The knowledge of laws of electricity, in conjunction with the fundamental laws of mechanics learned by the astronomers, has had a tremendous influence on the industrial history of the world since that time. Radio is but one of the examples of the complementary relation between mathematical and experimental effort in furthering human progress.

The contrast between these early beginnings and the present uses of the art is indeed tremendous. Hardly would Maxwell have believed that his mathematical theory would be used in the determination of the strength of signals to be expected at a particular distance from a broadcasting station of a given power. How difficult it would have been for Hertz to conceive of the use of the complicated electrical apparatus for the quantitative measurement of radio field intensities, his own equipment having been little more than a ring of wire broken by a gap at which a tiny spark was produced.

LONG DISTANCE RADIO COMMUNICATION

Perhaps the most important step, from the experimental use of high-frequency electric currents to the practical employment of these methods in long distance radio communication, was the adoption of a ground connection, thus making use of the earth as one portion of the transmission circuit. This was done by Marconi and others a few years before the beginning of the twentieth century.

At about that time, also, a device was developed which would detect the presence, in a receiving circuit, of high-frequency currents far too weak to produce a spark. This was the "coherer" devised by Branly, which consisted of fine metal filings loosely packed in a small glass tube. From that time on extended studies were made by many workers in an effort to develop a more sensitive receiving or "detecting" device. Among the devices subsequently developed were the various types of magnetic, electrolytic and crystal detectors.

Many people have the mistaken impression that the word "wireless" refers to telegraphic communication and that the word "radio" refers to telephone communication and in particular the broadcasting of voice and music as we have it today. In reality these two terms are interchangeable, neither one being exclusive of the other. The use of the term "radio" is becoming more general since it is more descriptive of what actually takes place in the radiation of electric waves from a transmitting antenna.

PRINCIPAL STEPS IN THE TECHNICAL DEVELOPMENT OF RADIO

In the early days of radio, something over 50 years ago, the laboratory research efforts were closely associated with the study of other natural phenomena, and experiments with high-frequency spark discharges were used as a means for confirming the validity of the electromagnetic theory of light. Even up to the present time, radio has maintained its community of interest with other physical sciences, for knowledge of radio transmission bids fair to be one of the most useful means of studying the nature of that part of the atmosphere which is beyond the reach of airplanes, balloons or kites.

The earliest technical methods employed in radio transmission were, naturally, relatively crude, the waves being sent out from a circuit in which a spark discharge was produced. The irregular and highly damped nature of these sparks resulted in the production of a relatively extreme amount of interference from a given transmission, and efforts were early made to minimize this undesired effect. The removal from the antenna of the effect of the spark after its initial occurrence was one of the means taken to reduce this interference. The comparative youth of radio is evidenced by the fact that a large number of radio stations, particularly in the marine service, still exist in which the earliest types of commercial equipment are employed.

The use of the electric arc as a means for converting direct current into high-frequency alternating current, developed in 1902, was a notable step toward the generation of radio waves which are much less productive of interference. Most of the high-power radio stations engaged in trans-oceanic communication, up to about 1915, employed this type of transmitter, and a number of arc stations are still in use.

By about 1915 improvements had been made in rotating electrical generators which made possible their adaptation, with suitable rather radical

changes in design, to the production of currents of much higher frequencies than had previously been developed from such machines. These high-frequency alternators, built to handle power of a few hundred kilowatts, contributed a reliability which, for 10 years or more, has made them the backbone of the long wave circuits forming the basis of the existing intercontinental radiotelegraph networks.

Up until about 1915, the receiving devices employed were comparatively simple and crude in the light of the performance of present-day vacuum-tube detectors and amplifiers.

VACUUM TUBE

The vacuum tube, having its beginning in the discoveries of Edison, Fleming, and DeForest, served first to provide a sensitive and reliable detector, and second to provide a satisfactory and easily controllable transmitting mechanism. Edison discovered the effect of the emission of electrons from a heated filament. Fleming, by inserting a plate with a heated filament in an evacuated glass tube, produced a vacuum-tube rectifier or detector for high-frequency alternating currents. DeForest inserted a third electrode, the grid, and thus produced a tube which serves also as an amplifier or as a generator of alternating current.

The use of the vacuum tube as a very powerful amplifier has made it possible to receive signals far weaker than those previously required. This advantage is accompanied, however, by a corresponding amplification of the noise associated with natural electrical disturbances or "static" and has thus put a greater emphasis on the problem of separating the desired signal from the undesired signals or effects.

The vacuum tube, first a small device employed for simply detecting the presence of radio waves, has taken on many forms and is used for detection, amplification, modulation and generation. The sizes in commercial use now range from those which will handle only a few thousandths of a watt to comparatively large water-cooled tubes which will handle power of 20,000 watts or more. Larger tubes have been made experimentally.

Relieved from the necessity of indefinitely increasing power at the transmitter, stimulated also by the increasing congestion in the portion of the radio frequency or wave-length range which had previously been usefully employed, and given a tool, the vacuum-tube detector and amplifier, by means of which quantitative measurements of radio transmission were made possible, workers in radio soon began to explore the region of higher frequencies or shorter waves. This region, while not employed for practical purposes up to about 1920, is, strangely enough, the very range in which the early experiments of Hertz and others were conducted.

FIELD FOR IMPROVEMENT

The most fruitful field for improvement at the present time is now recognized as in the ether itself, or, more concretely, in the design of the antennas which are used for getting the energy into and out of the ether. The improvements, which have already been made in this feature in the establishment of certain important radio communication systems, have been so great as to correspond in effect to a hypothetical increase in the power of the transmitter amounting to 20,000 times.

Every radio transmission occupies a band of finite width in the frequency or wave length spectrum. From the time, only 15 or 20 years ago, when the principal need was to enable ships to

make contact and practically all stations were required to operate on one wave length—600 meters in the marine radio service—the number of stations operating simultaneously has so increased that radio engineers are greatly concerned because of the limitations which are involved in the range of the useful frequency space available. In spite of the fact that there are perhaps 3,000 channels available in the frequency range now employed for radio communication, it has become necessary to allot portions of this range to various services by international agreement.

The fullest use of this crowded transmission medium requires the greatest possible constancy in the operating frequencies of radio transmitting stations. Perhaps there has been no single contribution to this important problem so effective as the development of the piezo-electric crystal for use at radio frequencies. Thus a minute slab cut from a quartz crystal has, since about 1925, become an essential part of most modern radio transmitters.

Those who are working in other fields of science, such as geophysics and meteorology, are finding radio methods and the results of measurements of radio transmission to be very useful in their efforts to learn more of the constitution of rock strata beneath the earth's surface and of the electrical characteristics of the upper atmosphere. Measuring devices, amplifiers and other instruments, whose development has been stimulated through their wide application in radio research, are proving valuable tools in the search for information in widely scattered fields ranging from biology to astronomy.

EVOLUTION OF PUBLIC INTEREST

Interest in the early experiments with radio or "Hertzian" waves was almost entirely of a scientific nature. The questions asked were: How are the waves radiated and transmitted? How do they affect the coherer or other receiving device? and, How can laboratory apparatus be arranged to "tune in" one wave and "tune out" another? The question was not: How can these phenomena be applied to certain practical uses?

This scientific interest in the mechanism of radio communication has never diminished, and even though later developments have made possible the wide application of radio to everyday affairs the scientist does not lack for problems—notably those of the transmission of radio waves through space—whose answers are still unknown. Fortunately, however, the present ability to make quantitative measurements both of high-frequency currents in radio circuits and of the intensity of radio waves received at any point, is now making the knowledge of these phenomena much more complete and is enabling workers in this field to draw conclusions and make estimates of probable performance in a way which was previously entirely impossible. This means that radio communication is now on an engineering basis and has progressed far from the empirical status of little more than a decade ago.

The first practical application of radio was for communication between ships and from ship-to-shore, and the public interest is still stimulated by every event which emphasizes the relation of radio to the safety of life at sea. From the time of the collision between the *Republic* and the *Florida* in 1909, to the loss of the *Vestris* in 1928, radio has played its part in bringing aid to those who would otherwise have been lost. The *Titanic* disaster served as the principal stimulus to the first international conference at which specific rules were set forth for the

equipment of vessels with radio as a safety device. To the satisfaction of all those who are working in radio, it may be truly said that with very few exceptions the radio operators on vessels in distress have shown their right to be listed among the heroes of the sea.

In 1910 only about 1,500 merchant vessels in the entire world were equipped with radio; the shore stations for communication with these ships numbered only a few hundred. By 1928, the number of ships equipped with radio had increased to over 12,000 and the number of shore stations to over 1,500, the latter being found in all parts of the world.

The formal recognition of the usefulness of radio as an agency of commerce is indicated by the succession of legal enactments of which it is the subject. The first general International Radio Treaty was signed in 1906. It was revised at a conference in 1912. It related almost exclusively to the use of radio on shipboard, primarily for insuring the safety of life and property at sea. The principal countries of the world have enacted national laws for the regulation of the use of radio on shipboard, the first general legislation on this subject in the United States having been the Ship Act of 1910 followed by the Radio Act of 1912. The most recent revision of the International Radio Convention and Regulations, signed at Washington in 1927, is still occupied to a major extent with provisions relating to the mobile radio service and an International Conference on Safety of Life at Sea, to be held in 1929, will have as one of its important problems the modernizing of the regulations which specify the classes of vessels upon which radio equipment shall be required.

The comparative ease with which simple radio transmitting and receiving apparatus can be constructed and the freedom from restrictions on its use in the United States and in some other countries have resulted in the widespread employment of radio as a means of amateur communication between individuals. While radio amateurs have, in the past, been required to operate on wave lengths or in frequency bands not considered the best for practical or commercial radio communication, they have become noted for their energy in taking this limitation as a challenge to do pioneer work. As a result the amateurs have been in a large measure responsible for focusing attention on the usefulness of the short-wave range which had previously been considered as waste territory. The number of licensed amateur radio transmitting stations in the United States has increased from 1,200 in 1913 to 17,000 in 1928.

The personal contacts developed through amateur communication, at first between persons in neighboring cities, later by those in widely separated parts of the country, and now between amateurs living on different continents, are playing a part in the social evolution of the world which, while intangible, may be extremely effective.

BUSINESS AND COMMERCIAL USES

The business and commercial uses of radio are more prosaic but, nevertheless, are extremely important. Transoceanic radiotelegraph communication over long distances between fixed points had its beginning in 1901, when the letter "S" was successfully transmitted from the station at Poldhu, Ireland, and received at St. John's in Newfoundland. From this simple beginning, a little over 25 years ago, there has developed a world-wide network of long-distance radiotelegraph circuits.

In 1904 radiotelegraph news service to ships was begun by which it became possible to publish daily newspapers on transatlantic liners.

During the World War excellent use was made of a number of transoceanic radio circuits which then existed supplementary to the cables. The military needs stimulated the development of portable equipment for field use, as well as equipment for use on aircraft and submarines. Stimulus was given also to the development of radiotelephony, particularly with low-power sets for short-distance communication.

The extent to which modern business will find it useful to employ the methods which have been developed for transmitting a facsimile or picture of the message, diagram or other material offered for transmission can only be foreshadowed at the present time.

The culmination of the accomplishments of radio, so far as the present popular interest is concerned, is in broadcasting. The programs, covering the range of music, dramatic and other literature, amusement features, and market and other news services, form a contribution of the most far-reaching nature to the solidarity of the people served by a given broadcasting system.

While there were a number of earlier tests of radiotelephone transmission of music and speech, it was not until 1921 that a broadcasting station in the United States began the transmission of regular scheduled programs intended for reception by the general public. The subsequent seven years have seen the springing up of some 700 broadcasting stations in the United States and have seen the establishment of broadcasting service in many other countries, first in Europe and later in other parts of the world. The supplementary use of short waves for broadcasting is developing a world-wide interest in the reception of programs from distant parts of the earth.

One of the outstanding applications to which radiotelephony has been put during the past few years is the establishment of commercial telephone circuits, connecting the telephone systems of North America and Europe so that two individuals whose telephones are connected to these systems may converse with one another as in the case of an ordinary long distance call. Additional circuits under development or in experimental operation will, undoubtedly, during the next few years, serve to establish telephone connections between all of the important continental areas of the earth.

Another important use of radiotelephony is for communication with aircraft. On account of the speed of travel of aircraft and the importance of communicating with the pilot himself, it seems probable that telephony will be largely used for the transmission of weather information and flying instructions from ground to plane.

The perfection of radio technique and the development of equipment for its principal applications have made possible the use of radio for still other purposes. Among these may be mentioned the transmission of radio signals for the determination of differences in longitude, the use of radio as an aid in geophysical explorations, its use for communication with railroad trains and other moving objects, and its use as an emergency means of communication as an auxiliary to ordinary wire communication systems.

What the future will bring forth as to television, no one can, at this time, predict with certainty. It is fundamentally true, however, that in addition to some apparatus complications, a much wider frequency band is necessary to secure results which are pleasing

to the eye than is required for satisfactory sound transmission.

As a consequence of the popular wonder at the accomplishments of radio there is a tendency on the part of some to make predictions that radio can be used for the most fantastic and unreasonable things, at least, they are unreasonable from the standpoint of present engineering knowledge. But when so much has been done, it does not seem unreasonable to expect that there will be some measure of advance from its present state of development. It seems to be axiomatic, however, that the increasing congestion in the use of frequency space will bring about correspondingly increased limitations on those radio services in which there is, comparatively, a smaller public concern or which can be carried on by other means.

THE GROWING INTERRELATIONSHIP OF RADIO AND WIRE COMMUNICATION

To an increasing extent, particularly where the ordinary commercial communication services are concerned, a given member of the public does not care so much whether his messages are sent by radio or wires as he does for a rapid and effective service. In the case of broadcast programs having a nation-wide coverage, the speech or music originating at a given point is transmitted by wire to the several broadcasting stations, where it travels by radio to numberless receiving sets. Part of the international telegraph business of the world consists of messages which travel part of the way by wire and part by radio. A substantial proportion of the messages originating on ships are transmitted to land by radio and are then carried to their final destinations over wire circuits. In the further progress of the development of communication each medium of transmission may be expected to be used primarily for those purposes for which it is best suited.

Radio employs throughout the world a common transmission medium which is subject to vagaries and irregularities not within the control of man. As a result, radio has some inherent limitations to offset in part its advantages of broadcast transmission and its ability to span great stretches of water or to reach mobile objects. Much has been learned of the usefulness of radio and also of its limitations. Its economics are being better ascertained, and knowledge of all of these aspects is essential in order to determine where radio can best play its part in the fulfillment of the communication needs of the world.

Recent Technical Developments in Radio

By Arthur E. Kennelly

Professor of Electrical Engineering, Harvard University; Member of the American delegation to the International Radiotelegraph Conference of 1927

RADIO communication has already exerted astonishingly great influences upon human affairs. Nevertheless, this influence has only recently become active, and it is probable that it will be still more marked in the future. In particular, the basic science of electro-magnetic waves, and the dependent applied science or technic of radio-communication, have been undergoing rapid development in recent years. Their effects on the world are likely to be very notable as time goes on. This article aims at presenting to non-technical readers, an outline sketch of recent technical developments. From this rough picture it may be possible to form some idea of not only what has already been technically accomplished, but also what may be coming through the picture in the near future, as time brings out the colors on the canvas. We can only expect to see but a little way into the forward scheme of things; because new discoveries and inventions may completely change both plans and progress.

Ocean Telephony

One of the outstanding technical developments during the last few years has been the successful establishment of radio telephony across the Atlantic ocean. Telegraph communication by submarine cable, between New York and London, was first established temporarily in 1858, and permanently in 1866. Transatlantic telephony, however, was never effected by cables as constructed during the nineteenth century. Short undersea cables were successfully employed for telephony; but the rapidly fluctuating electric currents carrying the voice, became too much attenuated or weakened in transit, to carry speech over thousands or even over hundreds of kilometers. The writer well remembers witnessing in 1877, an experiment in submarine telephony between Cornwall, England, and Vigo, Spain, a distance of about 900 kilometers over the surface of the sea. At that time the Bell telephone was a new scientific instrument, about which but little was accurately known; and only a few Bell telephone hand receivers were then in existence in Europe. One of these receivers was connected to the Vigo cable, at Porthcurno, a station near Land's End, Cornwall, and another was connected at the same hour to the other end of the cable in Vigo, without batteries, carbon transmitters, or other apparatus. A year or two later, the experiment would have been looked upon as amusingly hopeless; but at that time, lack of technical knowledge encouraged hope. After half an hour of testing and shouting into the hand-phones, supplemented by telegraph messages over an alternative route, it was quite evident that no speech could be received over that length of standard submarine cable, with the simple receivers thus connected.

Encouraged by partial success in 1915, to broadcast audible speech from Washington, D. C., to both Honolulu, Hawaii, and Paris, France, simultaneously, the American Telephone and Telegraph Co., after the close of the World War, developed the technic of long-distance radio telephony. Many difficulties had to be overcome on

both sides of the Atlantic before satisfactory radiotelephonic conversation could be exchanged between New York and London. Such communication varies from time to time, due not only to accidents, electrical defects and local disturbances, but also to atmospheric disturbances over the route, which may be collectively described as *radio weather*. In order to provide commercial telephone service, it was necessary to prepare for transmission on the reasonably worst day of the year, and not merely on the average day. After many months of daily testing, the service between London and New York was formally opened, with appropriate ceremonies, in January, 1927. It has since remained in regular operation, except for unusual meteorological conditions, such as those accompanying aurora borealis.

On any such radiotelephone circuit, there is always a certain amount of noise in the receiver, due to extraneous electrical disturbances, among which, "static" disturbances play a leading part. The voice has to be transmitted intelligibly through and over this noise; so that the signal-to-noise ratio is an important technical measure of such telephone circuits. In order to reduce the noise and static, the radio receiving stations have been carried up north.

The American Radio transmitting station is at Rocky Point on Long Island; while the receiving antenna is at Houlton, Maine, near the Canadian Border. The British transmitting station is at Rugby, near London; but the receiving antenna is at Cupar, near Dundee, Scotland. A person speaking from any city in North America, say San Francisco, is connected with the main terminal in New York, by ordinary wire telephone circuit, extended to Rocky Point. There the electric power of his voice is automatically magnified millions of times and delivered to the air. The radio waves spread over the seas, and an extremely minute fraction of this radiated voice power is picked up in the receiving system at Cupar. This is again automatically magnified, and carried by telephone underground wires to London; whence it may again be carried to the city of destination, where the other party is listening. His reply is carried back to London, by the regular telephone wire system, thence to Rugby, where it is enormously amplified and put upon the air. The radiated waves spread out in all directions. A minute fraction of the scattered wave energy is picked up at the receiving antenna in Houlton, Maine. This is again amplified and carried to the New York central office, after passing through several amplifiers on the way. From New York, the voice currents are led over the regular long-distance wire channels to San Francisco.

In this communication, the bee-line distance across the ocean, covered by the radio links, is about 5,000 kilometers. Moreover, not only can the communication be extended from London to any city in Great Britain within long-distance telephone range; but it is also often carried to the continent of Europe, through short submarine telephone cables and then extended to many European cities. It is thus possible to place a subscriber in Mexico City or in California, in conversation with a subscriber say in Berlin, Germany, via the transatlantic radio link between New York and London.

EARLY EXPERIENCES

In the earlier days of transoceanic radiotelephony, the drawback existed that the conversations were literally broadcast, and any person in the radio vicinity, which might have a radius of hundreds of kilometers, might listen in and enjoy the supposed private talk.

Not many years ago, before the Island of Santa Catalina, off the California coast near Los Angeles, was connected with the mainland by submarine telephone cable, it was possible to communicate by telephone with Santa Catalina through a radio link over about 50 kilometers of Pacific Ocean. Although the wave length used on this radio link was outside the regular broadcasting limits, any radiolistener could overhear the conversation, by the use of appropriate receiving apparatus. There used to be a telephone subscriber at that time in Santa Catalina, who occasionally put in a long-distance call for a member of her family in Los Angeles. She was very particular that the call should be made at a certain precise evening hour. The reason for this clock precision was not then apparent; but it transpired that another member of her family, living in Oregon, was a radio amateur with a good receiving set. By listening in at these clock times, on the radio wavelength of the Catalina link, he could overhear the family conversation on the coast of California. This may have been legitimate eavesdropping; but much mischief might evidently pour through the same opportunity.

The transatlantic radio link in telephony between Europe and America was, in its early stages, open to the same objection that eavesdroppers could listen in. More recently, however, this defect has been overcome, and the conversation over the Atlantic has been made very nearly eavesdrop proof. A listener may be able to recognize that conversation is going on; but it sounds like jargon. The received waves have to undergo a special process of electrical treatment before intelligibility is restored to them.

UTILIZATION OF SHORT WAVES

Prior to the World War, emphasis was placed, for effective long-distance radio communication, upon long waves; *i.e.*, on waves of say more than one kilometer in length. Wave lengths down to 200 meters were used; but these were regarded as more particularly applicable to short-range service. Below 200 meters, the wave lengths were left open to amateurs and experimenters. It was generally believed that such short waves were of little value for long-range service.

The amateurs and experimenters gradually developed the short waves below 200 meters. In the winter of 1922–23, the amateurs succeeded in receiving messages over the Atlantic, on wave lengths in the neighborhood of 100 meters, an achievement that aroused much surprise. Since that date much attention has been given to short waves down to 15 meters and even less. The international radio conference at Washington in 1927, allocated all wave lengths between the limits of 30,000 meters and 5 meters, assigning lengths below 5 meters, as well as certain bands below 22 meters, to amateurs and experimenters. Some of the short waves between 120 and 20 meters have proved very serviceable for long-range radio communication, using relatively short sending and receiving masts, and relatively little power; although the conditions of best operation for these shorter waves are somewhat different from those of the long waves.

CHANGE FROM WAVELENGTH TO FREQUENCY

Since the introduction of commercial radiotelegraphy, it has been recognized that waves might be defined either by their lengths or by their frequency of reversal. The speed of radio waves is accepted as nearly 300,000 kilometers per second. If the sending station emits waves at the rate of 300,000 complete reversals, or cycles

per second; then each wave will be one kilometer long; whereas if the emission frequency is raised to say 600,000 cycles per second, the emitted waves will be half a kilometer, or 500 meters in length. One of the two quantities—meters of wave length, and cycles per second of frequency—being given, the other is immediately known by the fact that the two multiplied together, give as the product, the transmission speed of 300,000,000 meters per second; or if greater precision is desired, 299,-820,000. In the earlier stages of the art and science, emphasis was placed upon the wave length, and the frequency was regarded as of secondary practical importance. More recently, however, it has come to be recognized that the allocation and separation of waves is more clearly and logically defined in terms of frequency, thus placing the wave length in the second place. A specified service, such as broadcasting, is better defined by a frequency band than by the corresponding wave length band. It has therefore been generally agreed to assign and specify waves in terms of their frequencies. Thus, the international call of distress at sea is on the frequency of 500,000 cycles per second or 500 kilocycles per second while the corresponding wave length of 600 meters is the subordinate factor. Again, broadcasting frequencies lie between 550 and 1500 kilocycles per second or approximately between 545 and 200 meters.

PIEZO-ELECTRIC OSCILLATORS

Not only are frequency meters in very general use for keeping radio stations on their proper allotted frequencies; but automatic devices have recently been developed for holding the emission frequency of a station at the correct number of kilocycles per second. A thin strip of quartz or rock-crystal, cut from the crystal at the proper angle, has the property of becoming electrified by mechanical pressure or squeezing. If the pressure is alternately applied and released, the crystal slab will develop an alternating voltage. But any voltage externally applied to the slab, compresses it very slightly by attractive forces. It thus becomes possible to harness such a crystal slab to a battery, with the aid of a vacuum tube, in such a manner as to cause the slab to set itself in vibration and to maintain this minute trembling movement indefinitely, the energy being derived from the battery or other electric generator. The vibration frequency of the slab depends upon its dimensions, and these can be adjusted within fairly wide limits, so as to permit the crystal to maintain just the right frequency. If the slab is kept at constant temperature, it can hold to its self-imposed frequency of vibration with extraordinary fidelity. This vibrating crystal can then be made to control and maintain the emission frequency of the station where it is kept.

TELEPHOTOGRAPHY

Portraits, drawings and printed or written matter are now transmitted electrically in commercial wire and radio service. In principle, the plan is by no means new; but the details of the modern method are novel and interesting. The picture to be transmitted is first photographed on a positive transparent film of standard size. Dark areas in the film are naturally more or less impervious to transmitted light; while light areas are, on the contrary, correspondingly transparent. The prepared film is of such a size that it folds around a horizontal glass cylinder which is driven at a fixed speed by a little electric motor in the transmitting apparatus. As the cylinder rotates, it also moves slowly in

an axial direction, by a screw feed. A narrow beam of light impinges on the rotating cylinder, so as to pass through a small area of the film. Inside the cylinder and film is a sensitive photoelectric cell, a device which emits an electric current only when light falls upon it, the emitted current being roughly proportional to the intensity of the light received. In all the clear areas of the film, a strong light can pass from an outside fixed lamp to the inside fixed photo cell; whereas the passage of dark areas in the film will intercept the light and momentarily shield the cell. The fluctuating current from the cell is amplified in the transmitting apparatus and sent out along a line circuit to the receiving station. Here there is also a horizontal electrically driven revolving screw cylinder, just like the first; but carrying a sensitive photographic film. A narrow beam of light from a fixed lamp near to the revolving cylinder is focused upon the surface of the rotating sensitive film. The intensity of the incident light is controlled by the current received from the line. The film in the receiving apparatus thus becomes photographically exposed, point by point in correspondence with the record on the film at the sending station, provided, of course, that the two cylinders are kept exactly in isochronism, or go round exactly in unison. The finished receiving film is then a photographic negative of the sending film. As soon as the receiving film is developed, fixed and dried, it may serve for the original of any desired number of positive photographic copies at the receiving station. Substantially the same process is used when the two stations are in radio communication, instead of being connected by wire.

Telephotography is very convenient and effective, when the message to be sent is in an unusual language, code, or hieroglyphics; also when columns of figures have to be transmitted with great care. Indeed there are some who predict that the standard telegram of the future will become the facsimile reproduction or telephotogram, whether by wire or wireless.

TELEVISION

Television is the instantaneous transmission to a distance, of the image of an object, so that the person at the receiver can see the reproduced image and thus, in a certain sense, see the object itself. As ordinarily understood, electric television is effected by radio. There is a crude resemblance between the principle of television and that of telephotography. In both there is a rotating pair of similar elements running in close synchronism, so that corresponding points in the sent and received pictures are simultaneously projected. Whereas, however, the photographic films in telephotography may take several minutes to execute from beginning to end, in the case of television, the two pictures must be completely covered in about one sixteenth of a second, in order that the eye may see the whole surface as a single picture.

In one form of the apparatus, a bright beam of light is caused to travel in a definitely repeated manner, over the object to be televiewed, with the aid of a series of holes in a rapidly revolving disk. The light, reflected from successive areas of the object, is directed to a photoelectric cell, in such a manner that bright spots on the object stimulate strong currents in the cell, and dark spots feeble currents. These currents, greatly amplified, are delivered to the air at the sending mast. A minute fraction of the emitted wave energy is picked up at the receiving mast and delivered, after reamplification, to control the instantaneous intensity

of a beam of light from a local source, directed through holes in the receiving disk, to corresponding parts of the receiving picture. The bright and dark parts of the sending picture will then reappear as corresponding bright and dark parts of the receiving picture. In this way, several thousand successive points in the sending picture will, one by one, be reproduced in the received picture, all run over sixteen times per second. Changes in the form and brightness of the object will simultaneously appear in the reproduced image at the receiving station.

Although television has been repeatedly and strikingly demonstrated, it is still in an experimental stage. It remains to be seen how far it can be introduced commercially.

AIDS TO AERIAL NAVIGATION

The arch-enemy of airships is fog. Clouds lie in layers, and an airship can fly either above them or below them; but a thick fog covering the ground, and rising to a considerable height, makes landing fields invisible, and greatly adds to the difficulty of landing. Powerful searchlights may penetrate a fog for some distance; but the pilot must descend fairly near to the landing field in order to come within their range. The electric waves from a radiobeacon pass readily through fog, and thus offer much needed means for guiding a fog-enveloped airship.

A recently developed form of aerial navigation radiobeacon, consists of a pair of vertical loops of wire, erected together, crosswise or in two intersecting vertical planes, at or near the landing field. Suppose that the regular course of an arriving airship is from the northwest. The two loops may then be erected one north and south, the other east and west. The course of the arriving airship will then lie midway between them. Such radio loops emit electric waves that are strongest in the direction of their respective planes. The two loops, being actuated together into similar and simultaneous wave emissions, the oncoming ship, if provided with a suitable radio receiving antenna and apparatus, may begin to detect waves from the beacon at a distance of say 150 kilometers. If the pilot has wandered off the course towards the north, he will be approaching the plane of the north-south loop, and its signals will be louder; while he will be approaching more nearly broadside on to the east-west loop, and its signals will be fainter. He will therefore steer more to the west until both sets of loop signals come in equally strong, when he knows he is on the right bearing, midway between the loops. By keeping the two sets of signals in balanced strength, he can keep on the true course, even although the ground is entirely invisible from fog.

The acoustic reception of such radio beacon signals, has the disadvantage of claiming a considerable share of the pilot's attention. A visual form of receiving instrument has more recently been developed, which makes less demand upon the pilot's watchfulness. A pair of metal reeds are mounted side by side in the receiving set, behind a glass window, and in front of the pilot's seat. Each is arranged to be kept in visual vibration by a small electro magnet connected with the airship's antenna. One is adjusted to be resonant to say 65, and the other to 90, cycles per second. One of the radio beacon loops emits high-frequency waves carrying fluctuations of intensity at the rate of 65 cy. p. s., and the other loop similar high-frequency currents modulated at 90 cy. p. s. One of the two reeds in front of the pilot will then respond to waves from the north-south loop, and

the other to waves from the east-west loop. So long, then, as the pilot flies on the true midway course, the two reeds will maintain equal amplitudes of vibration; but if the ship deviates from the course, one reed will vibrate more and the other less.

AIDS TO MARINE NAVIGATION

In recent years, great developments have occurred in the technic of radio aids to navigation. These consist of various international services; namely, radiocompass stations, radiobeacons, time signals, and weather warnings.

Radio compass stations are radio stations situated upon the seacoast, and equipped to measure, with satisfactory precision, the direction or compass bearing of a ship at sea, emitting radio signals for that purpose. When two or more such radiocompass stations simultaneously observe and then report the observed bearing of the vessel seeking her position, this position can be found on the chart from the intersection of the bearings. There are now more than one hundred radiocompass stations listed in different parts of the world, available for this service. The ships requesting this information have ordinarily been unable to find their correct positions, owing to continued fog or heavy weather. They usually ask for their bearing when within about 100 nautical miles of a coast

Radiobeacons are coastal radio stations equipped to emit characteristic radio signals, either at regular time intervals, or on request; so as to permit ships at sea, in their radio vicinity, to measure the bearings of these signals and thence locate themselves on the chart. There are now more than one hundred radiobeacon stations listed in different parts of the world. In order to measure on board ship, the bearing of a distant radiobeacon, it is necessary for the ship to be equipped with a radiocompass apparatus. Ships so equipped ordinarily prefer to obtain their positions from observations made on board, of the bearings of beacon stations, than by bearings obtained from radiocompass stations on shore, and reported to them by radiograms.

Time signals are broadcast, at regular advertised hours, on specified frequencies, from nearly sixty radio stations in different parts of the world. Some of these stations have a long range. It is seldom that a ship equipped with a sensitive receiving set is out of effective range of all time-signal radio stations; while it frequently happens that several can be heard from, at different hours of the day. In this way, ships no longer fear the possible errors of their chronometers.

DEVELOPMENTS IN WAVE TRANSMISSION

Marked improvements in long-distance radio transmission have recently been effected, through increased knowledge of the science of electric waves. It is known that when the sending antenna consists of a simple vertical wire, any single radio wave emitted from this antenna has the form of an expanding hemisphere, like an invisible half soap bubble, shooting outwards in all directions, from the sending station, with the speed of light. The texture of the shell is an interweaving of electric and magnetic forces, the electric forces being disposed around the half globe, like meridian lines, shooting up from the ground towards the zenith over the antenna, and the magnetic forces being parallel expanding rings, disposed like parallels of latitude. If an observer could see such waves, and stood at a point on the ground say 30 kilometers from the sending station; then, when a single brief radio impulse was emitted, he

would expect to see a half globe rise from the antenna and radiate outwards in all directions at a speed of nearly 300,000 km. per second. In one ten-thousandth of a second, the expanding shell would strike him. Its height above the antenna, would at that instant be 30 km., and its diameter on the earth's surface 60 km. The density of the wave would be greatest at the ground surface, and the density would taper off as he cast his eyes higher up, until at the polar vertical axis, passing through the sending-mast zenith, the density would vanish, or the shell would be quite transparent. If the observer held up a vertical wire or antenna, an electric impulse or signal would be generated in this receiving wire at the moment that the wave encountered and passed beyond it. A certain small amount of electric energy will, however, have been abstracted from the rushing shell, by the receiving wire, and put into the signal, so that the shell will have been locally weakened by its contact with the receiver.

If we assume that the ground surface is perfectly conducting, from the electrical point of view; then it would be quite impervious to radio waves and none would penetrate the ground. But this is only partially true. By reason of imperfect conduction, the ground lets some of the wave go through and sink into the soil. Whatever share of the wave thus sinks down, is wasted and lost for the purposes of transmission. Besides, trees and vegetation, over the surface of the land, act like imperfect receiving wires and weaken the passing waves. The pipes and vertical metal work in city buildings, weaken the waves still more. On the sea, these obstructions are absent and the salt water is a fairly good conductor; so that the waves carry better over oceans than over land; but even if there were no losses at the surface, the advancing waves would weaken by mere expansion. When the radius of the hemispherical wave doubles, its surface will increase four fold, and the electric energy per square meter of surface will have fallen to one fourth. There is thus weakening by simple expansion, and also weakening by losses over and into the earth; but there will be no loss of wave energy in the substance of the air, provided that the air is a perfect nonconductor. Ordinary air at the earth's surface is practically nonconducting.

In 1901, Marconi announced the reception of radio signals in Nova Scotia, for the first time across the Atlantic, from a sending station in Southern England. A rough calculation then showed that, with the apparatus employed, the signals were stronger than could be reasonably accounted for after spherical expansion to a radius of some 4,000 kilometers. It seemed necessary to assume that spherical expansion had not taken place. It had already been found by English scientists that atmospheric air might conduct electricity better than ocean water, if rarified to such a low density as should exist at an elevation of about 80 kilometers above the earth's surface. The sun's rays, and particularly its ultraviolet rays, are known to ionize the air; *i.e.*, to break up its atoms into positive and negative constituents. An ionized layer should therefore exist in the upper atmosphere, capable of turning the radio waves back, like an inverted mirror. Such an ionized layer, with actual or virtual reflecting properties, is now believed to exist, and radio echoes have been obtained from it. This layer seems to descend during the day, under solar influences, and to ascend at night, to a height of perhaps more than 500 kilometers. The layer seems to improve the carrying power of the waves by

preventing their expansion upwards to a height of more than a few hundred kilometers.[1]

It is very difficult to secure direct information about the nature and properties of the atmosphere, above an elevation of say 20 kilometers, owing to the lack of access to higher levels. It now looks, however, as though it might be possible to gain much indirect information, from technical studies of radio wave transmission. These waves ascend to high levels and return to the earth. Such information may not only be of great practical value in improving the technic of international radio communication; but also of great scientific value in the investigation of solar, and meteorological phenomena. The sun is evidently the king, in those wide solitudes far above the earth; but there is evidently much to be explored in his majesty's realm, that only radio waves can reveal, when used coöperatively by observers in many different fields of enquiry.

[1] This layer is commonly called the Kennelly-Heaviside layer.—ED.

Broadcasting in Denmark

By Emil Holm
Director, Radio Programs, Denmark

THE first public wireless transmission in Denmark was broadcast on October 29, 1922.

It came about as the result of private coöperation and was transmitted by a quondam naval station which had been placed provisionally in a shed within the precincts of the Free Port.

It was received by a special set installed in a hall at the Technological Institute in Copenhagen, and was followed by a spell-bound audience assembled there for the purpose. It was, however, as its sponsors were the first to admit, not exactly a brilliant success.

Now, only six years after, wireless broadcasting has become a state institution. Its transmissions average some nine hours daily "upon the air," emanating, as they do, partly from the special studios for orchestras, soloists and lecturers; and partly from theaters, concert halls, churches and lecture halls all over the country; and they are followed by over 230,000 duly licensed listeners, from which it may be assumed that roughly three quarters of a million of the three million inhabitants of Denmark listen in daily—the highest percentage of listeners yet exhibited by any European country.

Difficulties

It is obvious that such rapid development has not been effected without meeting and surmounting innumerable difficulties.

The first point of all to be decided was: What was the best way to set about organizing the activities of the new art?

Private individuals—here as in other countries—were the first to take the matter up, and certainly, private initiative is of inestimable value in forwarding a new art, and especially one which can advance and develop only through experiment, and whose range and scope no one can even guess. But, on the other hand, it is difficult to prevent separate interests from embarking upon the matter in a competitive way, and that is to the advantage of nobody, besides rendering extremely problematical, the possibility of establishing that art upon a sound financial basis.

This was what happened in Denmark.

Various listener associations were formed—with or without the support of industrial interests, in the various branches of wireless. Money was collected by voluntary contribution, and broadcasting commenced.

The initial transmissions were relayed from the State Telegraph Service Station at Lyngby, first entirely gratis, and later on for a modest fee, but it soon became evident that neither studio nor technical plant was satisfactory.

A new station was therefore erected, by a number of private firms, in the center of Copenhagen (Yorck's Passage). About this time the military authorities also erected a station at Ryvang (a northeasterly suburb of the capital), and these stations became the broadcasting headquarters of competing associations.

The result, as might be expected, was chaos—a most unsatisfactory state of affairs from the point of view of the gradually increasing army of listeners.

Another great disadvantage entailed

by this arrangement was the consequent lack of financial support. It became increasingly difficult to procure really first-class talent—artists or lecturers—when all had to perform for little or no remuneration at all.

And finally the question of obtaining one—or preferably several—suitable studios became ever more insistent.

At New Year, 1924, the transmitting plant was installed in a diminutive room in a building in Købmagergade, then belonging to the telegraph authorities. This room measured 2½ by 3½ metres, and was expected to contain the administrative staff, the orchestra and solo performers, the control plant and the engineers on duty.

To continue in this way for long soon proved impossible. At the end of two months a studio was procured large enough to contain an orchestra of five or six performers, but it was not until the autumn of 1925 that a studio even relatively worthy of the name was secured.

This room contained as many as twenty-four musicians, and was equipped and arranged in accordance with the principles and knowledge of broadcasting that then obtained. About the same time it was at last acknowledged that broadcasting was an institution requiring ordered and systematic administration, and the most perfunctory of office premises and a skeleton staff were made available.

STATE RADIOPHONY

About that time, too, the state took over, experimentally, the institution and administration of broadcasting, and in April, 1926, state radiophony became an actual fact.

By an act passed in 1926 the supreme authority was placed in the hands of the first commissioner of public works, but broadcasting as an institution was subdivided into the purely technical department, superintended by the postmaster-general and the administrative staff; everything connected with the Program Service was placed under the control of a Radio Council consisting of nine members. This Council is appointed by the chief commissioner in accordance with the wishes of the various listener associations, the press, the Union of Manufacturers and Traders, etc., and is directly responsible to him for its administrative work. The present president of the Council is Mr. C. Lerche, Chamberlain.

An annual license fee or yearly tax upon every receiving set was legally enacted. At present this fee is 10 Danish kroner.

The advantages of the new system soon became apparent. The administration assumed a firmer and more concrete form. The program director, in collaboration with the Council "Program Committee," was, at last, in a position to plan and carry out satisfactory programs with some hope of being able to execute them in a satisfactory manner, for the means necessary to do so were now forthcoming.

When this improvement was effected it was thought by optimists—rational optimists, that is—that the number of listeners might very possibly reach a total of 100,000, thus yielding a budget of one million kroner yearly.

The actual figures, however, far exceed this figure. There are, as mentioned above, at present, some 230,000 listeners in all.

In short, the new system "caught on."

During the last couple of years two new stations have been built, a small one specially for Copenhagen (in the Post and Telegraph Administrative Building), and a larger one near Kalundborg to serve the remainder of the country. These two stations were

built by a Danish firm (M. P. Pedersen & Company) and by the Western Electric Company, respectively.

Unfortunately the latter station is the subject of much contumely among listeners all over Europe in that the old wave length, 1,153 metres, was within the frequency range which, by the decisions of the Washington Conference, is barred, at present at least, for civil broadcasting. We hope, however, that some acceptable solution of this difficulty will soon be arrived at, as both stations function otherwise in a fully satisfactory manner.

STUDIO PROBLEM

The problem of suitable studios has been solved—though not yet finally, as the advisability of erecting a special building to contain partly broadcasting premises, and partly a "spoken word" stage in conjunction with the Royal Theater is now under consideration. But in their present quarters at Axelborg in Copenhagen the present studios serve their purpose remarkably well.

First there is a large studio for orchestral items. The permanent station orchestra comprises 30 members, but may be augmented by some 60 performers when occasion demands. This studio is so arranged that by withdrawing some dividing curtains it becomes part of a large concert hall containing comfortable seating accommodation for 400 listeners. Thus, probably for the first time in Europe, a concert hall studio has been inaugurated possessing (1) plenty of room for a large orchestra, and (2) the added advantage that orchestra and soloists alike, being faced by an audience, are incited to do their utmost.

Secondly, there is a smaller studio for solo performers, small ensembles, sketches, plays, etc., and finally, a "talks" studio.

Lecture studios have also been installed all over the country, and, as already mentioned, the Royal Theater, several concert halls, and a number of churches have been fitted up with permanent relays. Microphones are often placed in other theaters, too, for it is proved beyond doubt that broadcasting, the former bugbear of all theatrical managers, is now, to a certain extent, their warmest supporter in that the broadcasting of suitable theatrical performances, *e.g.*, operas, operettas, musical comedies, etc., has been found to be an extremely useful advertisement for the theater in question.

PROGRAMS

The program director is the author, a royal opera-singer, whose heart and soul has been in radio from the very start. In 1923, by unanimous request, he took over the management of the artistic side of the new art and, in 1926, he was officially appointed station director, *i.e.*, director of programs, by Act of Parliament. During the whole period of his leadership, and without being deterred by the ever-increasing size and scope of the programs, the director has always followed his conviction that listeners should be given the very best in art and entertainment, whether grave or gay. He has followed the principle that it is the very special requirements of broadcasting that must always be considered first in deciding whether or not a performer or artistic contribution is suitable for acceptance.

The programs now comprise musical broadcasts (which are and always must be the main feature) of considerable artistic merit, as well as entertainment of a lighter nature—from symphonies and chamber music to songs and dance music; readings of extracts from the oldest classical up to the most modern of present-day writers, dramatic works

of Shakespeare, Molière, Goethe, Ibsen (adapted for broadcasting), to the airiest of musical comedies; several "talks" daily on the arts and sciences, on social and political questions, and on every possible subject of any real human interest: divine services, news bulletins, relays from concert halls, theaters and, as far as possible, of all the more important topical events—from a political meeting to a football game—anything, in fact, which may be considered of sufficient general interest to warrant its inclusion in the program. Indeed, things have now reached such a pitch that every time something only a little out of the ordinary occurs one or another section of the public is sure to ask: "Aren't you going to broadcast that?"

The Extent of the Development of Radio Over the World

By Lawrence D. Batson
Electrical Equipment Division, Bureau of Foreign and Domestic Commerce

THE history of radio development for the seven years during which broadcasting has been extending its influence is not the property of any one country or race. Advancement has been world-wide, even though few countries have produced original ideas upon which developments have been based.

In order that the story may be clearly understood regarding other countries it is necessary to consider what has taken place in the United States. It is in the United States that broadcasting has been developed to the greatest extent. It is in the United States that the use of receivers has become more common than in any other country. It is not surprising, therefore, that the newer equipment should originate in the United States, where the demand advances as rapidly as the course of radio history.

It is but a matter of a few weeks at most before equipment newly introduced on the American market finds both supply and demand in other countries. Radio literature is surprisingly international in its appeal, and the American publication dedicated to radio carries abroad the description and advertisement of the latest wrinkles, with immediate inquiry and demand on the part of foreign purchasers. Radio exporters early learned of this new force in radio trade, and are now usually prepared to introduce their equipment almost simultaneously in all world markets.

The universality of its history and of the current conditions affecting that history are most pronounced in the changes broadcast reception has wrought in the people, individually and collectively. In seven years the public has passed from dependence upon newspaper bulletins and extra editions to the radio for prompt information. It has passed from the theater for the introduction of the latest music to the receiving set; from guarded sectionalism in thought and loyalty to nationalism through mutual understanding. There has just come to a close the greatest presidential campaign this country has ever witnessed. The people were informed as to the issues at stake, by non-partisan radio; never before were such agencies available to spread this information, without at some place being subject to censorship by some strongly biased hand.

International tolerance is becoming more pronounced. This is felt less in the United States, where our neighbors are fewer and where we are already on a footing of understanding, than in Europe and other parts of the world, where races of differing language, history, and ideals have thrown about themselves frontiers effectively separating them into small units.

Seven years ago, amateur and professional experiment and marine communications appeared to be the limit of radio's usefulness, in the eyes of the general public. Today, families have adopted the receiving set as a piece of furniture hardly to be displaced for anything less necessary in the home than a dining table. The number of receiving sets has grown steadily; it is

now estimated that in the United States alone there are over 8,000,000; some estimates place this number as high as 15,000,000. The lower figure, using 5 as the average number of members to each family for a multiplier, indicates that 40,000,000 people, one-third of the total population of the country, have radio reception in the home, not including their unwilling neighbors. Seven years ago these numbers equalled zero.

MEASURING DEVELOPMENT

It is perhaps possible to gauge radio developments in different countries statistically, but the statistics vital to such calculations are not collected except in scattered cases. The few figures which are available are of such variety that no two countries could be subjected to the same formula.

The number of radio receiving sets in use, the number of sets per thousand population, the number and power of broadcasting stations, the importation of radio sets, are among the statistics which are available. This statement is made with reservations, as the accuracy of these statistics in developing a table is questionable. There is no more reliable method of determining the number of sets used abroad than of those in the United States. Even with license and registration systems, it is impossible to obtain reliable figures. The apprehension of users of unlicensed receiving sets is the most serious radio problem in many countries, and is something of a problem in all that have any sort of licensing or registration requirement. The result is that the licensing agencies' figures are but a minimum of the number of sets that have been used. Licenses are usually granted by the year; a set taken for a demonstration, if it is to be operated by the prospective purchaser, must usually be covered by a license for a full year, whether a purchase is made or not. If a separate license is required for each set, and a person tries out four or five sets before finally purchasing, the inaccuracy of the resulting licensing statistics can be readily seen, even though no accounting for illegally operated sets is made.

Statistics covering broadcasting facilities are usually more reliable, but cannot be claimed as accurate. The power of broadcasters was considered a military secret in one important country for several years after the advent of broadcasting. Stations are opened, wave lengths and power ratings are changed, operations are suspended, stations are closed and sometimes demolished, without recognition by their national governments so far as informing the public is concerned. Keeping track of such contortions in the number of stations and determining their value in radio developments is practically impossible.

Statistics in other respects are almost non-existent. There is no statistical method for measuring individual or collective purchasing power, because income statistics are not available. Legal control and regulations might be reduced to statistics, were it not for the fact that such regulations are subject to obscure interpretations and varying degrees of enforcement. License fees mean little, because of their relation or lack of relation to the purchasing power of the whole people or of that class of people who are likely to be interested in radio.

LEGISLATION

The outstanding feature of national legislation is the dissimilarity of the codes adopted. Each country appears to have considered that all existing codes were necessarily undesirable for its particular use, and that a new system hitherto untried must be the ideal

one for its adoption. This appears to be due largely to the fact that the problems have proved exceptionally difficult ones of solution, each code as adopted showing faults it was desired to eliminate.

Radio broadcasting is subject to all of the regulations provided for other kinds of radio transmission and reception, in addition to many additional specific regulations that govern broadcasting alone. Thus broadcasting may be prohibited; it may be permitted under monopoly, held either by the Government or by one or more private concessionnaires; or it may be permitted to any number of citizens showing proper qualifications, and these qualifications may vary.

Reception may be prohibited, and this has been done in some countries in the past though such rigid limitations are disappearing. It may be necessary to secure permission to receive, or at least to deliver a proper notification to a designated Government agency that the set is installed. The untrammeled use of receiving sets is permitted in very few countries, and but one or two others add only such requirements as are outlined above.

Most countries provide that the listener shall pay some fee. These fees are another basis for differentiation in the analysis of regulations. Installation fees, annual license fees, and subscription fees are common; these may be collected by the Government or by the broadcaster, and in either case may be shared with the other agency. They vary from 5 cents to $18 per year, and may or may not be expected to pay the cost of broadcasting.

Regulations provide for the financing of broadcasting, either by inclusion or omission. The cost may be borne by the broadcaster who uses it as a goodwill adjunct to another business, or operates in radio as an avocation; it may be borne by an advertiser or advertisers through fees for direct advertisements; it may be paid by the listeners through any of the multifarious systems indicated in the preceding paragraph; or it may be provided for through some form of Government subsidy. In this matter, too, various combinations are noted.

Governments generally receive a portion of the revenues from receiving license fees. The participation of the Government in the upkeep of stations through subsidy or tax remission is rare, excepting, of course, those stations which are operated by governments. Deficits in the case of Government broadcasters are usually made up out of the national treasury.

Where regulations specifically recognize the necessity of a financial return for broadcasters, the only solutions of the problem proposed are through advertising or receiving licenses. Few countries permit advertising of any nature, two methods being recognized when this permitted. The first is to provide for a program at the station's expense, with a certain amount of advertising interspersed, the limit usually being five minutes' advertising for each hour's broadcasting; the other is to permit an advertiser to provide program material of a general nature, of entertainment or instructive value, with advertising matter broadcast before and after each number. From the listener's viewpoint, the only difference lies in the fact that the former system limits the amount of advertising.

Receiving licenses under many guises are provided for in various ways. This depends mainly upon the form of the broadcasting system. In the United Kingdom, where the Government has a broadcasting monopoly, a fee of 10 shillings is collected each year from the owner of each receiving set, with deficits and surpluses being adjusted by

withdrawals from or deposits in the general treasury. In Italy and South Africa, there is a license fee collected by the Government, and a second—subscription—fee collected by the private broadcasting monopoly. Canada and France provide for receiving licenses collected only to defray the costs of collection and issuance of licenses, the broadcasters collecting from advertising sources. Australia collects fees which are turned in part over to the principal stations in the State in which they are collected, with other broadcasters defraying expenses from proceeds from advertising broadcasts.

Practically all of the radio apparatus entering into international trade originates in the United States, United Kingdom, and Germany, which are about evenly matched for first place. In measuring the development of radio broadcast developments in any country, one of the most convenient gauges is United States export statistics.[1]

DEVELOPMENTS IN FOREIGN COUNTRIES

Below are given the outstanding facts concerning radio development in the principal foreign countries. The number of sets for each country is taken from recent estimates and statistics made or published in that country. In nearly every case, figures given are as of some date between July 1 and December 1, 1928; this includes all of the countries of more than exceptionally minor importance. Lack of space forbids extended remarks, but it is considered that the data given are sufficient to provide a picture of conditions in each country.

[1] Tables showing exports by countries for the calendar years 1919 to 1928 are published as a mimeographed circular by Electrical Equipment Division, Bureau of Foreign and Domestic Commerce.

NORTH AMERICA

Canada has 230,000 receiving sets, 39.13 per thousand population, and 60 broadcasting stations divided among 38 cities. Radio is controlled by the Department of Marine and Fisheries. There are no exceptional restrictions on broadcasting, the only limitation being that broadcasters must be citizens of the British Empire. Receiving sets are licensed at the rate of $1 per annum, the fine for operating without a license being $50. There are no other restrictions on receiving, nor are there any on importing, manufacturing, or merchandising.

Costa Rica has 250 sets, .49 per thousand population. Costa Rica also has a broadcasting station, situated at San Jose. No regulations have as yet been reported. There are 250 sets in *Guatemala*, .12 per thousand population, and a broadcasting station just opened at Guatemala City. The only regulations of interest are the requirement of a $5 installation fee, and one that merchandisers must notify the Government of each sale of radio apparatus. *Honduras*, which has adopted no regulations, has 24 sets, .03 per thousand population. In *Nicaragua* there are 20 sets, likewise .03 per thousand population, and receiving licenses are required. The cost of these licenses has not been reported. The *Republic of Panama* has 800 sets, 1.81 per thousand population. Receiving sets are inspected when installed, a fee of $2.50 being charged for this. There is no annual charge. Broadcasting is prohibited through the treaty between the United States and Panama providing for the government, defense, and operation of the Panama Canal. *Salvador* has 250 sets, .16 per thousand population. In this country broadcasting is a monopoly of the Government. Receiving is permitted only to Salva-

doreans; foreigners will be issued permits if they renounce their right to present claims through diplomatic channels. The following rates are fixed by decree: Application for permit, 5 colons ($2.50); installation of receiving set, if made by Government, 30 colons ($15); monthly payment, 3 colons ($1.50). The use of regenerative sets is prohibited. Importing, manufacturing, and merchandising are Government monopolies, but the granting of concessions is provided for.

Mexico has 50,000 sets, 3.49 per thousand population. Broadcasting is administered through the Department of Communications and Public Works. Permits to broadcast are required, and the Government reserves the right of censorship. Broadcasting is supported by the owners and operators of broadcasting stations. There is no monopoly, and many of the stations are operated by Government departments, though the majority are privately owned. Licenses are required for receiving sets. Mexico has 19 broadcasting stations in 10 cities. Eight of these stations are in Mexico City.

Cuba reports 25,000 sets, 7.31 per thousand population. There are 40 broadcasters and amateurs occasionally broadcasting, in 16 cities; 17 of them are in Habana. Three broadcasting stations licensed as such are situated in Habana. Permits are required for regular broadcasting. Receiving is permitted without restriction.

The *Dominican Republic* has 550 sets, .61 per thousand population. No regulations for this country have been reported.

Haiti, with 750 sets, 3.26 per thousand population, has one broadcasting station, at Port au Prince. Broadcasting is a Government monopoly, but there are no restrictions on the use of receiving sets.

SOUTH AMERICA

Argentina has 525,000 sets, 52.05 per thousand population, standing high among the leading countries in this respect. There are 22 broadcasting stations in 7 cities, 14 being in Buenos Aires. Radio is controlled by the Government through the Chief of Naval Communications. Broadcasting is permitted freely, permits costing only a one-peso stamp tax on the application. Receiving sets may be installed by any one, the only requirement being that the Chief of Naval Communications be advised of the installation.

Bolivia, of all the countries of South America the one most cut off from outside influences, has some 25 receiving sets, .01 per thousand population. There are two small broadcasting stations in La Paz. Radio broadcasting is under the control of the Ministry of Communications, Director General of Telegraphs. Licenses are granted without any monopoly, only for the purpose of broadcasting gratuitous entertainment. Five minutes each hour may be employed in the broadcasting of advertising matter. Stations are licensed to operate certain hours daily. Receiving licenses will be granted to all applicants, an initial fee of 5 bolivianos ($1.70) and an annual license fee of 36 bolivianos ($3.85) being charged.

Brazil has 250,000 sets, 6.43 per thousand population. There are 15 broadcasting stations divided among 10 cities. Radio is administered by the Department of Public Works and Transportation, Department of Marine, and the Department of War. Concessions for the establishment of broadcasting stations are required. There is no broadcasting monopoly. Receiving is permitted, registration being required. The registration fee is 20 milreis, there being no annual charge.

Sets are subject to Government inspection.

In *Chile* there are some 30,000 sets, 7.62 per thousand population, and 8 broadcasting stations in 7 cities. Radio is controlled by the Ministry of Marine. The only regulations affecting broadcasting are those requiring registration and the ordinary precautions for the safety of the State and protection of public morals. Registration of receiving sets, without fee, is required.

Colombia has but 22 receiving sets, less than .005 per thousand population. There are no broadcasting regulations. Climatic conditions are responsible, as reception is impossible during most of the year, and never very satisfactory.

Ecuador has 150 sets, .10 per thousand population. Broadcasting has been declared a monopoly, but until there is some immediate possibility of a station being established, restrictions have been held in abeyance. It is the apparent intention of the Government to provide for a system of receiving licenses when this is done.

Paraguay has 150 sets, .18 per thousand population, and one broadcasting station at Asuncion. No regulations have been adopted.

Peru, with 18,000 sets, 3.27 per thousand population, has but one broadcasting station, at Lima. A broadcasting monopoly was declared, under which an agreement was entered into with the British Marconi Company, which then operated the postal and telegraph systems of Peru. This agreement provided that only the concessionnaire could legally broadcast, or import, manufacture or sell radio apparatus. It was further provided that a fixed percentage of the radio materials imported should be of English manufacture. Under this latter clause, importation settled into the proportion of the fixed percentage of British goods and the remainder of American. The American proving much the more popular, it soon developed that the company was forced to purchase extensive supplies of British goods of which it could not dispose, and at the same time was restricted in its purchase of American goods for which there was the greater demand. Under these circumstances most of the profits were eaten up by frozen merchandise. Another difficulty arose in the opposition of business men throughout Peru, who had expected to obtain merchandising licenses from the Marconi Company, but that company decided to establish its own branches throughout the country for retail sales. These conditions combined to bring about the cancellation of the agreement, for which one was substituted, providing that the Marconi Company should operate the broadcasting station for the account of the Government, while merchandising was provided for otherwise.

Uruguay has 17,000 sets, 10.01 per thousand population. There are 14 broadcasting stations in 2 cities, 12 of them being in Montevideo. Radio is under the control of the Division of Radio Communications Service of the Uruguayan Government. There are no exceptional restrictions on broadcasting, while receiving is freely permitted. Regulations in effect are similar to those applied in the United States before the rendering of the court decision under which it was found that the legislation was inadequate.

Venezuela has 2,000 sets, .66 per thousand population. There is one broadcasting station, at Caracas. Radio is regulated by the Ministry of the Interior. A monopoly on broadcasting, importing, manufacture, and merchandising has been granted to a Venezuelan concessionnaire. Receiving licenses costing $5 per month are required.

EUROPE

Austria has 325,000 sets, 49.79 per thousand population. There are 7 broadcasting stations in 5 cities. A broadcasting monopoly is held by the Oesterreichischer Radioverkehrs Aktiengesellschaft, a broadcasting corporation. This company is controlled by the State, which owns 60 per cent of its stock. Its activities are supported by the proceeds from license fees, the amount depending upon the use to which the set is to be put and the income of the licensee. Control over all activities is maintained through a system of licenses which include not only broadcasting and receiving, but importing, manufacturing, and merchandising as well. In addition to the license, importers must secure a special permit covering each shipment. Records of all sales must be kept; these are subject to inspection at any time. Merchants are held liable for sales made to persons not licensed to possess radio apparatus. In addition to duty, there is a 5.5 per cent turnover tax which is collected by the customs authorities.

Belgium and Luxemburg have 62,500 sets, 7.94 per thousand population. There are 5 stations in 4 cities in Belgium, and one station in Luxemburg City. Receiving licenses costing 240 francs ($6.62) per year are required. The use of regenerative sets is prohibited. A sales tax of 45 francs ($2.16) per tube socket is collected, but there are no exceptional restrictions on importing, merchandising, or manufacturing.

Bulgaria has 50 sets, .01 per thousand population. All means of communications, such as railways, telephones, telegraphs, and wireless stations are monopolies of the Government, which will not permit the private construction of broadcasting stations, and until recently, of receivers. Receiving sets may now be used by a very restricted class.

Czechoslovakia has 250,000 sets, 18.56 per thousand population. It also has 4 broadcasting stations in 3 cities. Radio control is vested in the Ministry of Posts and Telegraphs, which controls the concessionnaire holding the broadcasting monopoly. Broadcasting is supported by subscriptions collected from receiving set owners. This subscription is 10 crowns ($0.30) per month. Licenses are granted to Czechoslovak citizens and to the nationals of other countries which grant the same or greater privileges to Czechoslovak citizens. Importing is prohibited except under license, which is granted for a fee equalling 5 per cent of the value of the shipment. Duty is collected in addition. The provision referring to reciprocal granting of licenses is clearly directed at Germany, where certain nationals are prohibited the right to receiving licenses, but is equally effective in the case of the nationals of countries which prohibit the use of radio receiving sets.

Denmark has 215,000 receiving sets, 62.88 per thousand population. There are 5 broadcasting stations in 3 cities. Broadcasting is governed by the State Radio Council, and is supported by the proceeds from license fees, and all of the present broadcasting stations are Government-owned. No restrictions, except for the license requirements, have been imposed upon the owners of receiving sets.

France is reported to have 1,250,000 sets, rating 30.78 per thousand population. It also has 28 broadcasting stations in 21 cities. Broadcasting is permitted only by French citizens. Permits are sparingly granted. There has been considerable recent agitation for a national monopoly, and some legislative progress has been made in that

direction, but it is apparent that final decisions have not yet been made. The cost of operating stations is borne by the broadcasters. The Ministry of Posts, Telegraphs, and Telephones supervises the enforcement of regulations. Receiving licenses costing 1 franc per year are required in the case of French citizens. Regulations stipulate that foreigners shall pay 10 francs per year, but this requirement is often passed in particular cases. A luxury tax of 12 per cent on sets costing more than 500 francs and on parts costing more than 50 francs is now collected.

Germany has 2,350,000 sets, 37.69 per thousand population, and 30 broadcasting stations in 26 cities. Radio broadcasting is under the control of the postal authorities, who own the equipment of all stations. Broadcasting is done by corporations, each of which has a monopoly within defined portions of the country. These corporations are reimbursed from the proceeds from license fees collected within their respective territories. Receiving licenses are freely granted to all applicants except Russians, Poles, and Slavs. A fee of 24 marks ($5.60) per year is exacted, for which a person is entitled to operate one receiving set; regardless of the number of sets which he may have in his possession, additional licenses not being required unless more than one set is to be operated at one time.

Hungary has 13.54 sets per thousand population, the number of sets being 113,307. There are three broadcasting stations, all in Budapest. Radio is under the control of the Postal administration, which holds a monopoly on broadcasting. Stations are supported by proceeds from license fees. Licenses for receiving sets are issued to all applicants, and costs 30,000 crowns of the old currency, or 2.40 pengoes, equal to 45 cents per year, when the set is to be used only for amateur receiving. Higher fees are charged for sets to be used for business purposes. Government inspection and supervision of all sets is required. Manufacturing, importing and merchandising of radio apparatus are subject to permits issued by the Ministry of Commerce, and are under the supervision of the postal authorities.

In the *Irish Free State* there are 30,000 sets, 10.09 per thousand population. Two broadcasting stations are operating in Dublin and Cork. Broadcasting is a Government monopoly, and is supported by the proceeds from receiving licenses. Receiving regulations are very moderate, aside from the requirement of licenses, which cost 10 shillings ($2.43) per year.

Italy has 250,000 receiving sets, 6.17 per thousand population. There are 5 broadcasting stations in 4 cities. Broadcasting is a monopoly under the control of the Ministry of Communications. The monopoly is held by the Unione Radiofonica Italiana, a corporation organized for that purpose. Licenses costing 3 lire (12 cents) per year are required for the operation of receiving sets, the proceeds accruing to the national treasury. Subscriptions to broadcasting service are compulsory, the funds received being used for the purpose of supporting broadcasting stations and providing programs. Amateurs are required to pay 96 lire ($3.75) per annum for this service. Receivers employed for commercial purposes are assessed at varying rates, sometimes as high as 3,000 lire ($120) per annum. No set may be installed unless approved by the Ministry of Communications. Samples of manufactured sets may be deposited as a check against adherence to types in lieu of individual inspection of sets, which is otherwise required. Sales taxes are also assessed.

There are 150,000 sets in the *Netherlands*, 20.23 per thousand population. Six broadcasting stations are divided among 5 scattered cities. The postal authorities must be notified of the installation of a receiving set.

Norway has 70,000 sets, 26.42 per thousand population. There are 8 broadcasting stations in 7 cities. The control of broadcasting is vested in the telegraph authorities. The use of radio by amateurs is prohibited, and all of the stations at present operating are owned by the Government, though no monopoly has been declared. A license fee of 20 crowns ($5.36) per year is collected from receiving set owners, the proceeds being used to defray broadcasting expenses. A special Government authorization is required to import radio apparatus.

Portugal has 2,500 sets, .44 per thousand population. There are two broadcasting stations in Lisbon. No restrictions on either broadcasting or receiving have been reported.

Rumania, with 17,000 sets, has .98 receiving sets per thousand population. Broadcasting is supported by subscriptions, varying from 200 to 250 lei ($1 to $1.25), depending upon the size of the set. A special permit by the Home Office is required of foreigners. Regenerative sets are prohibited. The initial regulations having been issued late in 1925, there has as yet been little development of the market.

Spain has 75,000 sets, 3.45 per thousand population, and 14 broadcasting stations in 11 cities. Regulations in regard to broadcasting are liberal. Receiving licenses are liberal, and foreigners must obtain special permits. There are no restrictions on importing, merchandising, and manufacturing, except a requirement that salesman be licensed.

There are 365,000 sets in *Sweden*, 60.26 per thousand population. There are also 31 broadcasting stations, in 31 cities. Radio is under the control of the Telegraph Administration. A broadcasting-monopoly has been granted to a corporation known as "Radiotjanst," Government controlled, but transmitting licenses are freely issued to amateurs. The monopoly has provided facilities for the rebroadcasting of programs of its stations by amateur clubs in various cities and towns, many of them also broadcasting local programs. Permits to install receiving sets are issued at the rate of 40 crowns ($10.72), while receiving licenses cost 10 crowns ($2.68) per year.

Switzerland has 75,000 sets, 10.05 per thousand population. There are 6 stations in 5 cities. Radio is under the administration of the central telegraph office of the Postal Administration. Broadcasting by other than Swiss citizens is prohibited. Stations are supported by the proceeds from license fees after the Government has deducted 25 per cent for its own uses. Permits to operate receiving sets are granted to Swiss citizens only. A preliminary Government inspection of the installation, costing 3 francs ($0.60) is required, the annual assessment being 12 francs ($2.32).

The *United Kingdom* has 2,500,000 receiving sets, 56.48 per thousand population, and 21 broadcasting stations in 21 cities. Radio is controlled by the Post Office Department. Broadcasting is a monopoly vested in a subsidiary organization of the Post Office. To defray the costs of broadcasting, receiving licenses costing 10 shillings ($2.43) per year are required. No further restrictions are imposed under radio legislation, but recent decisions by British courts on patent matters have so involved not only British manufacturers but those of other countries exporting to the Kingdom that the

merchandising end of radio has come under many new restrictions.

Yugoslavia and Albania have a combined total of about 2,500 sets. The only broadcasting station is at Zagreb, Yugoslavia. In Yugoslavia, permits are required for broadcasting. Nothing but music may be broadcast. Private persons may not install broadcasting stations or other sending sets. The permission of the Ministry of Posts and Telegraphs is required before a receiving set may be installed. Theoretically, foreigners may not obtain this permission, although exceptions are made. In applying for a permit to install a receiving set the individual must describe his set in detail and indicate the room in which it may be found. Permits may be revoked at any time. No regulations for Albania have been reported.

EURASIA

Russia has 200,000 sets, 1.37 per thousand population. There are 45 broadcasters in 41 cities, scattered throughout both European and Asiatic Russia. No regulations have been reported, but the following are apparent: there is no broadcasting monopoly, though practically all of the broadcasting stations are owned by trade and local governments; no receiving licenses are collected; manufacture, importation, and merchandising are a Government monopoly, with importation only where domestic industries are incapable of supplying the demand.

Turkey has 175 sets, .02 per thousand population, and one broadcasting station, at Osmanieh, near Constantinople. Radio is under the control of the Administration of Posts, Telegraphs, and Telephones. Broadcasting is a monopoly. Receiving is permitted under license, but the licenses are costly and have been made difficult to get. Sets must be available for Government inspection at all times, and are subject to confiscation without warning, explanation, or indemnity.

ASIA

China has 15,000 sets, .04 per thousand population, and 7 broadcasting stations in 4 cities. Recent political developments have resulted in the ultimate granting of the right to use radio, to the public. So far as is known, complete regulations have not been issued, but the establishment of broadcasting stations and other acts encouraging the use of radio give promise of regulations under which radio should gain a high rate of development, as compared with other national activities.

Japan has 550,000 sets, 7.03 per thousand population. There are 7 broadcasting stations in 7 cities. Radio broadcasting is controlled by the Bureau of Communications, broadcasting permits being issued only to Japanese citizens. Each station licensed has a partial monopoly within certain bounds. Stations are divided into two groups, according to their power. Low powered stations have monopolies in certain small areas, while high-powered stations have monopolies in larger areas, which may include several of the areas assigned to local stations.

In theory, this would restrict the number of stations which might be received at any one point to one high- and one low-powered station. Broadcasting is supported from receiving license fees. Receiving sets may be operated upon payment of the license fee of 2 yen per annum and a subscription fee of 1½ yen per month. Permits to install are required, and only sets approved by the Bureau of Communications may be used. Manufactureres and importers may deposit sample sets, the approval of which will serve for additional sets of the same

type so long as none of the specifications are changed. Wave lengths of from 150 to 400 meters may be used, but none other. Recently the existing broadcasters agreed to form a central corporation which took over the stations and their business, the individual companies operating them under the control of the corporation. This system seems to have proved more satisfactory and economical than that formerly adopted.

Australia has 290,000 sets, 52.45 per thousand population, and 26 broadcasting stations in 12 cities. Broadcasting is under the control of the Postmaster General. Stations are divided into two categories, those of high and those of low power. There is no restriction as to the number or location of low-powered stations, but high power is permitted to but one station in each of the States except Victoria and New South Wales, each of which may have two. These stations are more strictly administered than those of low power, and participate in the proceeds from receiving license fees. There has been some movement recently toward the consolidation of the companies operating the high-powered stations, and in some cases combination of two or three have been reported. Receiving licenses are required. The cost of these licenses is determined by the distance of the set from the high-powered station for that State, a system of zones determining the rate. The fees range from 22½ shillings ($5.36) to 30 shillings ($7.30) per year, on sets for private use. Merchandising licenses are also required.

New Zealand has 55,000 sets, 39.09 per thousand population. There are 5 broadcasting stations in 5 cities. Broadcasting is closely supervised by the Government. While a monopoly has been declared, other stations may be licensed. The conditions governing this are not known, but probably are due to a provision permitting independent broadcasting stations to be installed in cities not provided for by the concessionnaires. Receiving licenses are required, costing 30 shillings per year. Regenerative sets are prohibited.

AFRICA

British Africa has 130,310 sets, of which 130,000 are in the Union of South Africa, giving a rate of 18.76 per thousand population. The Union has 4 stations in 4 cities. The Postmaster General has supervision over radio matters. Broadcasting is a regional monopoly, each station being licensed to operate exclusively within a certain territory for a period of five years. Receiving set owners are required to obtain licenses and pay subscription fees to the broadcasting companies. The licenses cost 5 shillings per year, while the subscription vary from 6 shillings 6 pence to 35 shillings, depending upon the distance from the broadcasting stations. Higher scales are in effect for sets to be used for commercial purposes.

Egypt has 4,000 sets, .20 per thousand population, with one broadcasting station. Radio is administered by the Ministry of Communications. The complete regulations have not yet been issued, but it is understood that receiving licenses are to be required. Receiving has been permitted in the past but broadcasting was prohibited, though a violation of the prohibition was permitted to continue without serious attempt to apprehend the broadcaster. This has now continued over two years.

Ethiopia has but two sets, less than .005 per thousand population. Both broadcasting and receiving are prohibited; both the sets in use are in the possession of high officials.

The Amateur in Radio

By Hiram Percy Maxim
President, American Radio Relay League, Inc.

MANY people seem to have the opinion that the radio amateur is a development of the last four or five years. Nothing could be further from the truth. The amateur has been an integral part of the radio picture since the very first days of "wireless"; it is a matter of record that at least one American amateur constructed a receiving set and attempted to receive the letter "s" at the same time that Marconi was making his epochal transatlantic attempt. From that time on an increasingly greater number of amateur stations was erected. Ten years later there were more amateur installations in the country than government and commercial combined.

It was about the year 1913 that amateurs awoke to the fact that there were a lot of them scattered over the country. The thing that woke them up was the Federal radio law of August 13, 1912. This law provided a call book that contained the names of all the amateurs who had passed the necessary tests to secure transmitting licenses. The astounding number listed in this book was a revelation, for it showed that instead of a few isolated individual experimenters, there were several thousand highly enthusiastic amateurs in the United States.

Radio Clubs

With this realization, a large number of radio clubs came into existence. The value of these clubs in the early days of amateur radio—or amateur wireless, as it was then called—was very great, for there were at that time practically no books that adequately handled the subject. By providing a meeting place where members could gather and exchange ideas and practical information, the early club did much to further the art.

The organization of the clubs was an organization having the characteristics of young men. The methods were positive and direct. I have attended a great many of these radio club meetings, and I can truthfully say that I have never attended a meeting of any of my engineering societies which can compare in efficiency and interest with those radio club meetings of those young men.

It was in the Radio Club of Hartford that the relay idea which finally became the American Radio Relay League first took form.

I remember the evening very well. One young man had electrified the meeting by saying that he had established communication with the neighboring town of Windsor Locks. If Hartford could reach Windsor Locks, why could not Windsor Locks reach Springfield, Massachusetts, and if this could be done, why would it not be posssible for an amateur in Hartford to send a message by relay to Springfield, and possibly receive the answer back inside of an hour? The idea fired the imagination of every person in the room, and aroused a determination to go home and sit up the rest of the night improving and perfecting the efficiency of his apparatus so that the next night he might be the first one to start a message to Springfield. It was a great conception in those early days. The intensity of purpose which was built up was destined to exert the most powerful influence in the whole art of radio

communication. I do not hesitate to say that many of the great advances that have been made in radio during the last ten years have come from this inspiration of the amateurs.

It was but a logical thing to take the next mental step, and that was to go beyond Springfield. Why not continue the scheme to Pittsfield, Massachusetts, and even to Albany? And why might we not expect the Albany fellows to work it out with the fellows of Utica? And what would stop them from getting all the way to Buffalo? And then a wonderful conception came into the minds of these young men. Why not apply the relay idea to the entire United States?

AMERICAN RADIO RELAY LEAGUE

They went ahead with this idea, and in 1914 the American Radio Relay League came into being as the national organization of all the radio clubs of the United States that stood for good organization, good government and good radio. A board of directors was organized, and shortly afterward publication was started of a magazine which should be the mouthpiece of organized amateur radio and the clearing house of the ideas and experiments of the members. This magazine was called "QST."

In order to further the handling of messages between members, a traffic system was devised, and the regular handling of traffic began. By the summer of 1917, messages had been relayed across the continent, and it was no unusual thing for an amateur to communicate directly between New York and Chicago, and to points in the far Southwest.

The war with the consequent closing down of all amateur stations, brought all development to an abrupt halt. The Army and Navy suddenly found themselves in need of hundreds of radio operators. To train this number of men from raw recruits meant months of work and study. Time was priceless. And so an appeal was made to the amateurs, through the League, and almost overnight the Army and Navy found themselves supplied with thousands of experienced young men who not only knew how to operate, but were entirely familiar with the principles of the complex apparatus in use. The War Record of these young men is one of the shining pages in the League's history.

Following the cessation of hostilities in 1919, the League again started operation. The military training received by so many of its members began to show at once in better organization, better coöperation, and greater loyalty. The relay traffic lines grew and grew, and the volume of traffic went to figures that far exceeded those of previous years. Long-distance records over the country were hung up nightly. A transcontinental test was arranged, and such was the organization that when the night of the test arrived, absolute quiet prevailed from coast to coast, so that there might be no interference. The message was started from the writer's own station, bound for Los Angeles, and the answer was returned in just six and one-half minutes. This was progress!

OUTSTANDING EXAMPLES OF AMATEUR ENDEAVOR

By this time, operation on 200 meters was proving so successful in this country that it became a matter of speculation whether it would be possible for the amateur, with his low powers, to transmit across the ocean to Europe. So the League sent one of its members to Scotland with the finest receiving equipment available, and in 1921 American amateur signals in great numbers were heard on 200 meters in Europe!

American amateurs now knew that their 200-meter sets were capable of

being heard in Europe, and for a year they tried to effect *two-way* communication with their European co-workers, but all efforts failed. Time and again tests were made with English or French stations, but the signals were erratic in their behavior, and although American signals were heard abroad, and the foreign signals were recorded here, the much desired two-way communication could not be attained.

Gradually, the amateur realized that 200 meters was not going to turn the trick. And so, early in 1923, a group of amateurs started some tests whose results have been far-reaching. These tests were to find out what could be done with the entirely neglected waves near 100 meters, and they had not progressed very far before it became apparent that in this new region lay the key to the ultra-long distance communication problem, for the signals transmitted on 100 meters were received many times louder than simultaneous signals on 200.

Quick to adapt himself to the new conditions, the amateur began to construct apparatus to operate on the lower waves, and to collect data on set and tube operation at those wave lengths. In the fall of 1923, a special test was arranged between an American station and a French station on 100 meters, and on the night of the test the two stations, for the first time in amateur history, talked with each other across the Altantic! The theories regarding the short waves were proved, for each station reported the signals of the other as being received with remarkable strength!

The development of the short waves is another of the outstanding examples of amateur endeavor. The success of the transatlantic test lent impetus to the short-wave movement, and by the summer of 1924 most of the amateurs of the country were operating not only on 100 meters, but still lower on 80, and 40, and even 20 meters. It was during these experiments that John Reinartz, a prominent amateur, made the discovery that certain short-wave signals were actually stronger in daylight than at night over given distances. Daylight communication across the United States on low power became a fact, where ten years before night communication over the same distance was regarded as a wild dream!

By the fall of 1924 the use of short waves had become universal for all long-distance work, and the American amateur began to extend his range daily. European communication had now become matter-of-fact; the Pacific was conquered, and regular communication established with Australia and New Zealand; South America was worked with the greatest ease; and finally remote South Africa was reached, and reached again and again.

SUCCESSFUL RESULTS

Today, the amateur can truthfully say that there is no earthly distance over which it is not possible for him to communicate.

Aside from his scientific attainments, the amateur has to his credit an enviable record of public service. When Commander MacMillan was organizing his Arctic Expedition in 1923, he came to the League for radio equipment, and a League member went North on the *Bowdoin* as operator. For the first time in history, regular communication with civilization was maintained. When the next expedition was organized in 1925, the assistance of the amateur was again asked, and Reinartz went North with MacMillan carrying the latest developments in short-wave transmitters and receivers with him. Again, through the assistance of League stations in the States, regular communication was maintained.

During this same year, too, the Navy

Department requested that the League grant leave of absence to its Traffic Manager, F. H. Schnell, in order that he might take charge of short-wave experiments to be conducted on the cruise of the battle fleet to Australia. The success of the small short-wave set that Lieutenant Schnell operated was phenomenal, and the results—far eclipsing anything that the high-power long-wave sets of the fleet could accomplish—created a profound interest in official circles.

When the Wilkins Arctic Expedition was organized in 1926, the amateur was again called on, and two League members went North with the planes carrying special short-wave equipment. Again, communication was maintained satisfactorily with the aid of other League stations in the States. The Byrd Arctic Expedition, also operating on short waves, handled the bulk of its traffic through amateur stations of the League, with 100 per cent success. The Amazon Expedition of Dr. Hamilton Rice, after vainly trying to maintain successful communication with long-wave commercial stations, went to short waves, and for months relied upon amateur contact in the States for ordering supplies, sending in reports, etc.

During 1928 a total of nine expeditions were depending upon amateur contact for communication with this country; most of them had amateurs as operators, and many of them had apparatus constructed by amateurs.

The Byrd Antarctic Expedition is carrying four radio operators, of whom three are amateurs, and amateur stations in this country are furnishing much of the communication. Amateurs are also holding regular schedules with the Wilkins Antarctic Expedition.

Since 1919, amateur radio has been the principal, and in many cases the only means of outside communication in more than sixteen storm and flood emergencies in this country. The most noteworthy were the Florida hurricane of 1926, the Mississippi and New England floods of 1927, and the California dam break and second Florida hurricane in 1928. In all of these amateur radio played a major rôle in the rescue work, and amateurs earned nation-wide commendation for their resourcefulness in effecting communciation where all other means failed.

Nor is amateur activity confined to the United States. In 1925, at Paris, occurred an event of the utmost significance, when the amateurs of thirty different nations sat down together and formed the International Amateur Radio Union, an organization whose aims are the furtherance of international amateur radio and the securing of legislation favorable to the amateur in all the nations of the world.

FUTURE DEVELOPMENT

What of the future?

It is a difficult question to answer. In the line of scientific development, it would appear that the next immediate step is a further investigation of the waves on the order of ten and five meters. Beyond this point, however, it is impossible to predict with any degree of assurance.

To me, however, amateur radio has a more important destiny to fulfill than mere scientific attainment, and that destiny is the furtherance of world peace. War is founded on hate, and hate, in turn, on ignorance. Peace is the result of understanding, and with hundreds of citizens of every country of the world conversing nightly with each other through the medium of privately-owned and operated radio transmitters and receivers, there will come about an international understanding and fellowship the like of which the world has never before seen.

Federal Radio Legislation

By Frederic P. Lee
Legislative Counsel, United States Senate

FEDERAL radio legislation had its beginning in Congressional attempts to further safety at sea. The Wireless Ship Act of June 24, 1910,[1] applied to any vessel of the United States or any vessel under a foreign flag navigating the ocean or the Great Lakes and licensed to carry or carrying fifty or more persons, including passengers and crew. Under the Act it was made unlawful for the vessel to leave any port of the United States unless equipped with an efficient apparatus for radio communication capable of transmitting and receiving messages over a distance of at least 100 miles. The vessel was further required to exchange, so far as the master of the vessel determined it to be physically possible, messages with shore or ship stations using different systems of radio communication.

The administration of the Wireless Ship Act was placed under the Secretary of the then existing Department of Commerce and Labor, that department (and subsequently the Department of Commerce) having charge of the execution of the marine navigation laws. The Act has served as a precedent for continuing in the Department of Commerce the administration of all laws relating to radio communication. The Act has never been expressly repealed though the greater part of its provisions is substantially reproduced in the Radio Act of 1927.

Authority of Interstate Commerce Commission

A few days prior to the passage of the Wireless Ship Act, Congress, in the course of amending the Interstate Commerce Act, vested the Interstate Commerce Commission with authority over "telegraph, telephone, and cable companies (whether wire or wireless) engaged in sending messages" in interstate or foreign commerce.[2] The principal regulatory authority given the Commission with respect to such companies was in the administration of the requirement that all charges for services rendered in the transmission of messages should be just and reasonable. This requirement has been continued in force until the present day,[3] and is not interfered with by the Radio Act of 1927. The Interstate Commerce Commission has, however, taken almost no action under the authority granted it. The Commission's duties with regard to the railroads are so extensive as to leave it few resources for full consideration of the communication problems. The existence of this situation has perhaps led to the proposals in Congress to create one agency combining the authority now vested in the Interstate Commerce Commission, the Radio Commission, and the Department of Commerce with regard to communication by wire or wireless.[4]

Radio Communication Act of 1912

With a desire to make further provision for safety at sea and to provide legislation necessary for carrying out

[1] 36 Stat. 629; amended 37 Stat. 199.

[2] Act of June 18, 1910, 36 Stat. 539, 544–5.

[3] See Transportation Act, 1920, 41 Stat. 474.

[4] See, for instance, the bill introduced by Senator Couzens of Michigan on January 4, 1928, S. 2041, 70th Congress, 1st Session, and the bill introduced by Senator Watson of Indiana on December 22, 1928, s. 5104, 70th Congress, 2nd session.

the Berlin Radiotelegraph Convention of 1906, to the ratification of which the Senate had consented a few months previously, Congress in August, 1912, adopted the first general legislation for the regulation of radio communication, the Radio Communication Act of 1912.[5] Of prime importance in forcing the enactment of the present Congressional statute for the governance of radio communication, was the rather ambiguous licensing provision for transmission stations in the 1912 Act.[6] The question soon arose as to whether the Secretary of Commerce had discretion to deny any applicant a license or whether the Secretary was subject to a mandatory duty of granting a license to each applicant. The Congressional reports upon the legislation would seem to indicate rather clearly the desire of Congress to afford no discretion to the Secretary of Commerce[7] and the Attorney General held to this view.[8] Shortly after the war the question arose in the courts. The Secretary of Commerce denied the Intercity Radio Company of New York a license on the ground that he was unable to ascertain a wave length for the company that would not interfere with Government and private stations. In a case during the consequent litigation the Court of Appeals of the District of Columbia followed the opinion expressed by the Attorney General and held that the duty of the Secretary of Commerce to issue a license was purely ministerial.[9] The court recognized, however, that while the Secretary of Commerce had no discretionary authority to deny the license, he had a discretion in the selection of the wave length within the limitations prescribed by the statute, such selection to be made in such manner as to result in the least possible interference.

Broadcasting was, of course, unknown at the time of the enactment of the Radio Communication Act of 1912. It was not contemplated by Congress. Nevertheless, the language used in the Act was broad enough to cover even noncommercial broadcasting, in that the Act required a license for the transmission of radiograms, the effect of which extended beyond the jurisdiction of the State in which sent forth, or of radiograms which would interfere with the receipt of messages or signals from beyond the jurisdiction of such State.

[5] 37 Stat. 302.

[6] Congress provided that no person could operate, except in accordance with a license granted by the Secretary of Commerce upon application therefor, any apparatus for radio communication (a) "as a means of commercial intercourse" in interstate or foreign commerce, or (b) "upon any vessel of the United States engaged in" such commerce, or (c) "for the transmission of radiograms or signals, the effect of which extends beyond the jurisdiction of the State or Territory in which the same are made, or where interference would be caused thereby with the receipt of messages or signals from beyond the jurisdiction of the said State or Territory." The license was required to state the wave length or lengths authorized for use by the station for the prevention of interference and the hours for which the station was licensed for work. Furthermore, the Act specified that the license was subject to certain regulatory provisions contained in the Act, among which were provisions that "every station shall be required to designate a certain definite wave length as the normal sending and receiving wave length of the station . . . in addition to the normal sending wave length all stations . . . may use other sending wave lengths: *Provided*, That they do not exceed 600 meters or that they do exceed 1,600 meters . . . such private or commercial shore stations as do interfere with the reception of signals by the naval and military stations concerned shall not use their transmitters during the first 15 minutes of each hour . . . in all circumstances, except in case of signals or radiograms relating to vessels in distress, all stations shall use the minimum amount of energy necessary to carry out any communication desired."

[7] Senate Report 698, 62d Congress, 2d Session; House Report 582, 62d Congress, 2d Session.

[8] 29 Op. Atty. Gen. 579, November 22, 1912.

[9] *Hoover* v. *Intercity Radio Co.* (1923), 286 Fed. 1003, dismissed as moot (1924), 266 U. S. 636.

Furthermore, the Senate Committee in its report clearly contemplated not only the regulation of radiotelegraphy, but also the regulation of radiotelephony of which broadcasting is but one phase. Senator Bourne, Chairman of the Senate Committee on Commerce, in his report to the Senate upon the Radio Communication Act of 1912, said:

> The term "radio communication," instead of "radio telegraphy," is used throughout the bill so that its provisions will cover the possibility of the commercial development of radiotelephony. Experiments have been made here and abroad for some years in carrying the human voice on Hertzian waves, but with only limited and occasional results. Radiotelephony involves the application of the same principles as are involved in inventions to enable apparatus to select and record accurately one message on a given wave length out of a mass of messages on various lengths. When this latter result has been attained—an unfulfilled promise of some years standing—radiotelephony will quickly follow. The bill is framed to be adjustable to that improvement when it comes, but in the meantime it deals with the art as it exists today.[10]

The Secretary of Commerce set aside 360 meter, and later 400 meter, wave lengths for broadcasting purposes. Application for broadcasting licenses increased so speedily, however, that following the decision of the Court of Appeals for the District of Columbia and the National Radio Convention called in 1923, the Secretary of Commerce abandoned the policy of allocating all broadcasting to two wave lengths and established the system whereby each applicant for a broadcasting license would have assigned to him an individual wave length specified in the license.

This system, however, was disrupted by a decision of the Federal District Court for the Northern District of Illinois.[11] The court held that the Radio Communication Act of 1912 laid down no standards for the restriction by the Secretary of Commerce of operations under a license and that in the absence of any such standards, the Act, if construed to give the Secretary authority to impose restrictions, would then be unconstitutional as delegating to the Secretary legislative power. In casting doubt on the power of the Secretary to impose restrictions not specified by Congress, the decision was contrary to that of the Court of Appeals of the District of Columbia. In view of the conflict, the Secretary of Commerce asked the advice of the Attorney General, who gave it as his opinion[12] that the Secretary had no administrative discretion in assigning wave lengths or hours of operation, or limitations on power. Following that opinion licenses issued by the Secretary of Commerce merely stated whatever wave length, hours, or power the applicant designated.

As a result of the judicial decisions and the opinions of the Attorney General, the Radio Communication Act of 1912 was found to be ineffective to prevent interference between various broadcasters and other transmitters of radio communications. Licensing under the Act became a mere matter of registration similar to that of the registration of vessels under the marine navigation laws.

MISCELLANEOUS FEDERAL RADIO LEGISLATION

In the interval between the Radio Communication Act of 1912 and the

[10] Senate Report 698, 62d Congress, 2d Session, pp. 7–8.

[11] *United States* v. *Zenith Corporation* (1926), 12 F. (2d) 614; see also *Carmichael* v. *Anderson* (D. C. 1926), 14 F. (2d) 166.

[12] 35 Op. Atty. Gen. 126; see, in accord, unreported opinion in *Chicago Tribune Co.* v. *Oak Leaves Broadcasting Co.* (Circuit Court of Cook County, Ill., 1926); Gen. No. B-126864.

Radio Act of 1927, Congress enacted several minor measures relating to radio communication. One class of these was attributable to war-time conditions, as, for instance, the censorship of messages,[13] the taking over by the President of radio systems of communication,[14] and the taxation of radio communications.[15] Another type of legislation was that providing for the use of the naval radio stations for the transmission of press dispatches and private communications. This enabling legislating made provision for protection from governmental competition of companies affording adequate privately operated facilities.[16]

THE RADIO ACT OF 1927

In his Annual Message[17] to the Second Session of the 69th Congress, President Coolidge stated:

> Due to decisions of the courts, the authority of the department under the law of 1912 has broken down; many more stations have been operating than can be accommodated within the limited number of wave lengths available; further stations are in course of construction; many stations have departed from the scheme of allocation set down by the department, and the whole service of this most important public function has drifted into such chaos as seems likely, if not remedied, to destroy its great value. I most urgently recommend that this legislation should be speedily enacted.

It was in response to the necessity outlined by the President that the Radio Act of 1927 was enacted.[18]

The Federal Radio Commission.—The administration of the Radio Act of 1927 is divided between the Federal Radio Commission and the Secretary of Commerce. The Act created a commission to be known as the Federal Radio Commission composed of five commissioners appointed by the President by and with the advice and consent of the Senate, the appointments to be distributed one from each of the five zones into which the country was divided by the Act. For a period of one year from the first meeting of the Commission, the Commission had, among other matters, authority, from time to time as the public convenience, interest, or necessity required, to classify radio stations; prescribe the nature of service to be rendered by each class of licensed stations and each station within any class; assign bands of wave lengths to each class of stations and each individual station and determine the power which each station shall use and the time during which it should operate; determine the location of classes of stations or individual stations; regulate the kind of apparatus to be used with respect to its external effects and the purity and sharpness of the emissions; and make special regulations applicable to stations engaged in chain broadcasting. At the expiration of the one-year period all authority vested in the Commission, except as to revocation of licenses, is to be transferred to the Secretary of Commerce, and the Commission is to be vested with certain advisory and appellate functions. However, this period, which expired March 16, 1928, was extended by Congress until March 16, 1929.[19]

Right to Station License.—Under the Radio Communication Act of 1912 the licenses granted for the use of radio

[13] 40 Stat. 413.

[14] 40 Stat. 904; repealed 41 Stat. 157.

[15] 40 Stat. 315, 40 Stat. 1102, 42 Stat. 284.

[16] 41 Stat. 1061; amended 42 Stat. 495; amended 43 Stat. 1091. Continued in Section 30 of the Radio Act of 1927.

[17] 68 *Congressional Record* 32, December 7, 1926.

[18] 44 Stat. 1162.

[19] 45 Stat. 373. At the time of writing of this article bills have been introduced in Congress for the further extension of the period of the commission's activity.

apparatus or station licenses were limited by the Secretary of Commerce to periods of two years for ship stations and amateurs, one year for point-to-point telegraph, and ninety days for broadcasting. In the opinion of the Attorney General, however, such limitations could not be sustained under the authority granted by the 1912 Act.[20]

In order to meet the dangers to effective Federal regulation, that might flow from the acquisition of vested rights under station licenses of indefinite term, Congress enacted on December 8, 1926, a Joint Resolution—

> That until otherwise provided by law, no original license for the operation of any radio broadcasting station and no renewal of a license of an existing broadcasting station, shall be granted for longer periods than ninety days and no original license for the operation of any other class of radio station and no renewal of the license for an existing station of any other class than a broadcasting station, shall be granted for longer periods than two years; and that no original radio license or the renewal of an existing license shall be granted after the date of the passage of this resolution unless the applicant therefor shall execute in writing a waiver of any right or of any claim to any right, as against the United States, to any wave length or to the use of the ether in radio transmission because of previous license to use the same or because of the use thereof.

The above Resolution remained in force only for the few months preceding the enactment of the Radio Act of 1927 on February 23, 1927. The 1927 Act does not expressly terminate the existing station licenses acquired under the 1912 Act. However, it does in effect reach that result by repealing the 1912 Act and by providing [21] that no person may use or operate any apparatus for the transmission of energy, or communications, or signals by radio (a) in interstate or foreign commerce, (b) upon any vessel of the United States or any aircraft or mobile station in the United States, or (c) within any State when the effects of the use extend beyond the borders of the State or when interference is caused by the use or operation with the transmission or reception of energy, communications, or signals from any place within the State to any place without the State, or vice versa—"except under and in accordance with this Act and with a license in that behalf granted under the provisions of this Act."[22] Licenses are to be issued for broadcasting for terms not longer than three years, and for other purposes for terms not longer than five years, whether the license is issued originally or by way of renewal.[23] Finally, the 1927 Act repeats substantially the waiver provision above quoted except that the waiver shall be only as to the use of any "particular" wave length.

The proper construction of the waiver provision of the 1927 Act would seem to be that the station owner does not waive all rights that he may have in law to operate, but only any right he may have to operate on any particular wave length. In other words, the owner must be afforded some wave length on which to operate, but the selection of the particular wave length is left to the discretion of the licensing authority. The owner of the station acknowledges the power of the licensing authority to change his wave length. Furthermore, it is doubtful if the waiver provision should be construed to deny an existing licensee under the 1912 Act the right to object, on the ground of the denial of due process of

[20] 35 Op. Atty. Gen. 126, July 8, 1926.

[21] Sec. 1.

[22] Sec. 1. See also Sec. 39.

[23] Sec. 9. Under the amendatory Act of 1928, 45 Stat. 373, 83, these periods are made three months and one year, respectively, for licenses issued prior to January 1, 1930.

law, to a decision of the licensing authority denying the existing licensee the right to continue operation or to use an existing wave length. The authority to grant privileges only on condition that the grantee relinquishes constitutional rights has been denied by the Supreme Court.[24]

Whether or not a licensee under the 1912 Act has such a property right to continued use of his apparatus or to its continued use in operating on any particular wave length or at any particular time, that the denial by the licensing authority of the privilege of continuing such use under the 1927 Act would constitute a "taking" of property in violation of the due process clause of the Fifth Amendment to the Constitution, is a constitutional problem, the solution of which presents many difficulties. It has been comprehensively discussed, however, by Judge Stephen Davis, former Solicitor of the Department of Commerce, in his able volume upon the Law of Radio Communication and by the Federal Radio Commission in its statement of September 1, 1928.[25] The problem is further complicated by the fact that the licensee under the 1912 Act must not only execute the waiver in order to obtain a renewal license for continued operation under the 1927 Act, but must also be able to establish that "public convenience, interest, or necessity" will be served by the continued operation. The same requirements as to waiver and as to public convenience, interest, and necessity, apply also to persons contemplating the operation of new stations.

The 1927 Act does not define the term "public convenience, interest, or necessity." However, the Federal Radio Commission specified certain standards in its statement of August 23, 1928.[26] In the view of the Commission the setting aside of a substantial band of frequencies for the exclusive use of broadcasting stations and the radio listening public, the bringing about of the best possible broadcasting reception conditions, and a fair distribution of frequencies among the different types of service, that is, those serving a large territory including rural and sparsely settled regions and those serving intermediate areas and areas local in character, are in the public interest, convenience, and necessity. The commission also makes its allocations in such manner as to avoid too much duplication of programs and types of program, services readily available to the public in any other form, such as, the use of the ordinary phonographic record, broadcasting of an excessive amount of direct advertising and of matters of a distinctly private nature. Finally, the character of the licensee, his financial responsibility and past record, his maintenance of regular schedules and of an adequate control or check on the frequency of his transmitter, and the location of his transmitter within any given region so as to avoid interference, are other considerations.

In addition to the requirement of public convenience, interest, or necessity, the Davis amendment of 1928 requires the allocation of licenses, wave lengths, times for operation, and station power so as to give each of the five regional zones established by the 1927 Act equality of radio broadcasting service, both of transmission and of reception.[27]

[24] *Terral* v. *Burke Construction Co.* (1922), 257 U. S. 529; *Frost* v. *Railroad Commission* (1926), 271 U. S. 583.

[25] Davis, Law of Radio Communication. Pp. 65–9; Annual Report of the Federal Radio Commission for the year ending June 30, 1928, pp. 163–5. See also 27 *Columbia Law Review* 730.

[26] Annual Report of the Federal Radio Commission for the year ending June 30, 1928, pp. 166–70.

[27] 45 Stat. 373, §5.

Revocation of Station Licenses.—The station license is revocable by the Federal Radio Commission for false statements made in the application or in the accompanying statement of facts upon citizenship, moral, financial, and technical qualifications, or for conditions revealed in the statement of facts which would have warranted the licensing authority in refusing the granting of the license in the first instance, or for failure to operate substantially as set forth in the license, or whenever the Interstate Commerce Commission or any other Federal body, in the exercise of its lawful authority, finds and certifies to the Federal Radio Commission that any licensee bound so to do, has failed to provide reasonable facilities, or has made unjust or unreasonable charges, or has been guilty of any discrimination in charges or services, or has made any unjust and unreasonable classification, regulation, or practice with respect to transmission of communications or service. Notice and opportunity of hearing are provided for before the order of revocation takes effect.[28]

Appellate Procedure.—Any applicant for a station license, or for the renewal or modification of an existing station license, whose application is refused, has a right of appeal from the decision of the Commission to the Court of Appeals of the District of Columbia. Any licensee whose license is revoked by the Commission has the right of appeal from the decision of the Commission to the same court or to the United States District Court for the district in which the apparatus licensed is operated. The court may alter or revise the decision appealed from in such manner as it may seem just. The revision of the court is confined to the points set forth in the reasons of appeal. The Act apparently contemplates that the court will substitute its judgment for that of the licensing authority. This amounts to the placing upon the court of an administrative or nonjudicial function, rather than a judicial function. While non-constitutional courts, such as the District of Columbia courts, may constitutionally be vested with nonjudicial functions, this is not true of constitutional courts such as the United States district courts.[29] The same principle would also seem to deny a right of review in the Supreme Court by certiorari of the decisions of the lower courts.

Monopoly and Restraint of Trade.—The Radio Act of 1927 contains numerous provisions directed to the elimination of monopoly and the restraint of trade. Provision is made for special regulations to cover chain broadcasting.[30] No station license is to be granted to any person found guilty by a Federal court of monopolizing or attempting to monopolize radio communication through the control of the manufacture or sale of apparatus, or through exclusive traffic agreements, or by any other means, or to any person found guilty by any such court of having used unfair methods of competition.[31] The anti-trust laws are declared applicable to the manufacture and sale of, and to trade in, radio apparatus, and to radio communications. Furthermore, whenever in any proceeding under the anti-trust laws enforcement or review of orders under laws relating to the Federal Trade Commission or any other governmental agency, any station licensee is found guilty of violation of any of these laws,

[28] Sec. 14.

[29] *Gordon* v. *United States* (1864), 117 U. S. 697; *In re* Sanborn (1893), 148 U. S. 222; *Keller* v. *Potomac Electric Co.* (1923), 261 U. S. 428; *Postum Cereal Co.* v. *California Fig Nut Co.* (1927), 272 U. S. 693; 68 *Congressional Record* 3181–2.

[30] Sec. 4.

[31] Sec. 13.

the court may revoke the station license.[32] Finally, no person in the business of transmitting or receiving for hire radio communications under a license shall directly or indirectly acquire control or operate any interstate or foreign cable, wire, telegraph, or telephone line, if the purpose or effect is to substantially lessen competition, or restrain foreign commerce, or create a monopoly in any line of commerce.[33] The power to revoke station licenses in case the licensee is found to have violated the anti-trust laws, is of present importance in view of the pending court proceedings declaring unlawful certain existing radio patent cross-license agreements.

Miscellaneous Provisions.—Among the minor provisions of the Radio Act of 1927 several merit enumeration. Construction permits are required for the building of new stations.[34] No person may operate transmitting apparatus without a license from the Secretary of Commerce.[35] Foreign ships are not required to be licensed, but must observe the regulations designed to prevent interference.[36] Stations designated as liable to interfere with distress signals must have a radio operator listening in on specified wave lengths whenever the station is in operation.[37] All stations must give priority to signals of distress.[38] The uttering or transmitting of false or fraudulent signals of distress, or communications relating thereto, is made unlawful.[39] Whenever a licensee permits a candidate for public office to use a broadcasting station he must afford other candidates for that office equal opportunities. The candidates' communications may not be censored by the licensee.[40] Matter broadcasted for pay must be announced as such at the time of broadcasting.[41] The privacy of communications is protected.[42] Rebroadcasting must be expressly authorized.[43] The licensing authority has no power of censorship or power to interfere with free speech, but no person may utter any obseene, indecent, or profane language by means of radio communication.[44] Other minor provisions are substantially repetitions of some of the safety-at-sea provisions of the Wireless Ship Act of 1910 and the Radio Communication Act of 1912.

UNREGULATED WAVE CHANNELS

Electric waves whose existence have been ascertained vary in wave length from a twenty-billionth of a centimeter to 2,000,000 centimeters. In this vast spectra radio waves constitute only a small portion of the longer waves. Among other waves are the waves transmitting ordinary electric energy, infra red waves, visible light waves, ultraviolet and X-ray waves, and the gamma waves from radium. These involve the waves which transmit electric power, visible light, heat, the chemically active rays of photography, the X-rays of photography, the radium waves of therapeutics, and other waves whose practical uses have not yet been ascertained.[45]

Of these many classes of electric waves the Radio Act of 1912 regulates only the use of those waves available for radio communication, whether telegraphic or telephonic. Telegraphic

[32] Sec. 15.
[33] Sec. 70.
[34] Sec. 21.
[35] Sec. 5.
[36] Sec. 8.
[37] Sec. 22.
[38] Sec. 23.
[39] Sec. 28.
[40] Sec. 18.
[41] Sec. 19.
[42] Sec. 27.
[43] Sec. 28.
[44] Sec. 29.
[45] See Nichols and Tear, "Joining the Electric Wave and Heat Wave Spectra," Annual Report of the Smithsonian Institute, 1923, p. 175 ff.

communication would include picture transmission and television. Telephonic communication would include broadcasting.

The Radio Act of 1927 defines "radio communication" as—

> any intelligence, message, signal, power, pictures, or communication of any nature transferred by electrical energy from one point to another without the aid of any wire connecting the points from and at which the electrical energy is sent or received and any system by means of which such transfer of energy is effected.[46]

The 1927 Act would seem by reason of the above definition to have added to those channels previously regulated under the 1912 Act, the electric waves available for the transmission of electrical power by wireless. There seems to be no logical reason, however, for assuming that radio and power waves are the only classes of electric waves whose use it will be of practical importance in the future to subject to governmental control. The necessity for regulating the use of other classes of electrical waves may arise not only by reason of interference within any class but by reason of interference between those classes or between any one of the classes and the radio or electric power waves. If the practical uses of other classes of electric waves develop with as much rapidity as did the use of radio waves, the Radio Act of 1927 may prove but the beginning of Federal legislation that will in time cover many other channels within the electric wave spectra.

[46] Sec. 31.

The Administration of Federal Radio Legislation

By O. H. Caldwell
Federal Radio Commissioner

IN July, 1926, the Attorney General of the United States issued his famous opinion that under the Radio Act of 1912 the Secretary of Commerce was without authority to control wave lengths or powers of broadcasting stations, but must, upon application, issue licenses to any existing or new stations for such wave lengths and powers as the stations themselves requested. With no supervising hand to control interference, many broadcasting stations immediately "pirated" wave lengths in use by or near to other stations, while other broadcasters "jumped" their power, causing cross talk and hetrodyne whistles.

Proper separation between established stations was destroyed by interloping stations camping in the middle of any open spaces they could find, each interloper thus impairing reception of three stations—his own and two others. Instead of the necessary 50-kilocycle separation between stations in the same community, the condition soon developed where separations of 20 and 10 kilocycles, and even 8, 5, and 2 kilocycles, existed. Under such separations, of course, stations were soon wildly blanketing each other while distracted listeners were assailed with scrambled programs.

Wave lengths assigned to Canada were violated, in spite of repeated warnings from the Government and even personal appeals from members of the President's Cabinet that national good faith and international good will were at stake.

Some of the older stations also jumped their power, increasing five to ten times their watts output, and as a result delivering terrific heterodyne interference to distant stations that had been previously undisturbed under the orderly radio pattern developed by the former supervising authorities.

New Stations Crowd Ether

Meanwhile 250 new broadcasting applicants, who had hitherto been denied licenses by the Commerce Department, because the ether lanes were already manifestly full, now demanded and received permits to broadcast, and these 250 stations, coming on the air, worse confounded the interference already set up by the "pirates" and power jumpers.

So bad had these conditions become by February, 1927, that Congress passed an act setting up a Federal Radio Commission of five members to be appointed by the President and confirmed by the Senate, this Commission to take supervision over the radio situation for one year. At the close of this initial one-year period, the Commission was to transfer its administration function to the Secretary of Commerce, and itself become only an appellate body, meeting upon call to hear appeals from the Secretary's decisions. Later the administrative function of the Commission was extended for a second year, and now a bill has been introduced into Congress extending the Commission for a third one-year period.

The first steps taken by the new Commission in March and April, 1927, were (a) to transfer all stations to authorized channels on "even tens" of kilocycles, (b) to clear the Canadian

waves, and (c) by time-sharing to combine interfering stations and tuck them in wherever possible in the spectrum, in order to keep them in operation without interfering with those stations which had remained faithfully on their assigned channels.

THE REALLOCATION OF 1927

During the meantime, with the public given partial relief it was possible for the Commission to make a careful study of the whole situation, and, by painstaking planning, arrange for the second big step—a reallocation of all stations in the best interests of the listening public. When this reallocation took effect in June, 1927, listeners found that (a) for each locality local stations were well distributed along the dial, with minimum separations of 50 kilocycles; (b) stations were recognized in terms of position and time on the basis of their demonstrated capacity to serve the public; and (c) heterodyne interference between distant stations, in general, was diminished. These improvements were accomplished by repacking the channels according to an orderly plan, actually increasing the capacity of the 90 channels available.

Sixty-day licenses were issued and the operation of the new allocation carefully watched in the light of actual experience so that necessary changes could be made where interference was experienced. Such actual experience is always necessary in view of the irregular and unpredictable transmission in different directions which almost every station sends out. If the station's radiation went out equally in all directions, making the station's interference area a circle, the task of fitting stations together without interference at minimum distances would be simple. But as every listener knows, some stations are unaccountably heard for many miles in one or more directions, while being shut off by natural "barriers" in other directions. Advantage must be taken of all these curious unpredictable phenomena and adjustments made before any new station setup can be really working at its best. Here only actual experience, and not engineering theory, can be the guide.

MEMBERSHIP AND ORGANIZATION OF THE COMMISSION

When first appointed, the Federal Radio Commission was composed of the following members: Admiral W. H. G. Bullard, Chairman (Second Zone), Orestes H. Caldwell (First Zone), Eugene O. Sykes (Third Zone), Henry A. Bellows (Fourth Zone), Col. John F. Dillon (Fifth Zone). Commissioner Dillion died on October 8, 1927; Commissioner Bellows resigned on November 1, 1927, and Commissioner Bullard died on November 24, 1927. The loss of each of these three men was severely felt by the Commission, all three of them being of exceptional ability and having expert knowledge in radio matters over which the Commission has jurisdiction.

Mr. Sam Pickard of Manhattan, Kansas, who had theretofore served as Secretary of the Commission, was appointed Commissioner from the Fourth Zone on November 1, 1927. Mr. Harold A. Lafount of Salt Lake City, Utah, was appointed Commissioner from the Fifth Zone in November, 1927. Judge Ira E. Robinson was appointed Commissioner from the Second Zone in April, 1928.

ENGINEERING AND LEGAL DIVISIONS

Prior to August, 1928, the Commission had no regularly organized Engineering Division. It had had generous assistance from the Bureau of Standards of the Department of Commerce and, particularly, of Dr. J. H. Dellinger, Chief of the Radio Division

of that Bureau. It had the assistance, until July 30, 1928, of Captain S. C. Hooper of the United States Navy (recently appointed Chief of Naval Communications) who, at the request of the Commission, was detailed to assist in a study of the complex technical problems arising in connection with the allocation of channels in the short-wave band. The Commission also had the assistance of Captain Guy Hill of the Signal Corps of the United States Army, and Commander Tunis A. M. Craven, of the United States Navy, who were similarly detailed. On August, 1928, Dr. Dellinger was offered and accepted the position of Chief Engineer of the Commission.

The Commission had no Legal Division until June 25, 1928. The Department of Justice had from time to time detailed Mr. Bethuel M. Webster, Jr., Special Assistant to the Attorney General, to assist the Commission in the handling of particular hearings. On June 25, 1928, the position of General Counsel was offered to and accepted by Mr. Louis C. Caldwell of Chicago, Illinois, a brilliant young attorney with a unique insight into the technical problems of radio. General Counsel Caldwell now has three lawyers assisting him.

COMMITTEES OF THE COMMISSION

At an organization meeting of the Commission early in 1928, the Commission determined upon the following special assignments and classification of responsibilities among the individual commissioners:

Judge Ira E. Robinson, law and forms.
Judge Eugene O. Sykes, hearings and docket, short and long waves.
Commissioner O. H. Caldwell, technical advances, short and long waves, broadcast reallocation, foreign relations, television.
Commissioner Sam Pickard, broadcast reallocation, studio announcing, aviation uses of radio, relations with press.
Commissioner Harold Lafount, budget and finance, office employees, licensing routine, coöperation with Commerce Department, broadcast reallocation, television.

CHANNELS RESERVED FOR USE BY CANADA

One of the first acts of the Commission on assuming office was to clear six channels, which, under an informal understanding arrived at between the Department of Commerce and Canadian representatives, had been reserved for exclusive use by Canada. At that time there were 41 American stations on those channels or so close thereto as to cause fatal interference with the Canadian stations.

Since that time the Commission has maintained the policy of keeping these channels clear and of regulating the use of eleven other channels shared by Canadian and American stations. The proper regulation of the shared channels necessitates a limitation on the power of stations assigned to these channels on either side of the boundary line. Obviously stations located relatively close to the boundary line can be assigned only a very small amount of power, while stations located at greater distances, such as the south of the United States, can safely be authorized to use as much as 500 watts.

The question of the allocation of broadcasting channels between the United States and Canada cannot as yet be regarded as definitely determined. During the past year representatives of Canada have strongly protested against the present basis as being unfair to Canada, and there seems to be a disposition to press a demand for an increased assignment on the part of that country. The present allocation, however, is based on the respective populations of the two coun-

tries, and there is considerable evidence that the programs of American stations are very popular in Canada. The Commission believes, therefore, that the allocation as it now stands is fair to Canada and should not be changed. A more scientific choice of frequencies for the purpose could be made than that now in force. So far there has been no serious problem of interference with broadcasting stations of other countries including Mexico and Cuba.

Radio reception conditions were far from satisfactory as the result of the Commission's reallocation of June 15, 1927. The reallocation had succeeded to a marked extent in reducing interference arising from congestion in the larger metropolitan centers, where the stations were crowded together without adequate frequency separation. It had not, however, succeeded in remedying the heterodyne interference (resulting from two or more stations operating on the same channel) which was ruining reception in rural areas and in all parts of the country not in the immediate vicinity of any stations. The complaints which deluged the Commission soon made it apparent that drastic changes would eventually have to be effected.

THE DAVIS-DILL AMENDMENT

Meanwhile, the problems of the Commission in endeavoring to achieve better radio reception and at the same time to work toward the "fair, efficient and equitable radio service," as between the different states and communities, as required by Section 9 of the Radio Act of 1927, were multiplied by the Amendment of March 28, 1928. This Amendment, known as the Davis Amendment, requires that the radio supervising authority

> shall as nearly as possible make and maintain an *equal* allocation of broadcasting licenses, of bands of frequency or wave lengths, of periods of time for operation, and of station power, *to each of (the five) zones*, and shall make a fair and equitable allocation of licenses, wave lengths, time for operation, and station power *to each of the states* . . . within each zone, *according to population.*

The proportion of the total national radio facilities due each state is, therefore, fixed by law, and is shown in the appended table by the percentages in Column B—based upon official estimates of 1928 populations (Column A) prepared by the U. S. Census Bureau.

MAXIMUM OF SIMULTANEOUS BROADCASTING

The maximum of total broadcasting service which can be simultaneously carried on without interference, under the present status of the law and the radio art, has been determined by the Radio Commission and its engineers, after exhaustive study and experiment, as comprising the simultaneous operation of 40 stations of 5 kw. and upwards, on cleared channels; 125 regional stations of 500 to 1,000 watts; and 150 local stations of 10 to 100 watts.

By time divisions, a larger number of actual transmitters can, of course, be operated at different times on those "assignments," but the total stations running at any one moment during the night hours must not exceed the above limit, if good radio reception is to be preserved.

Dividing this national maximum into five equal parts for the zones, and also applying the state percentages of Column B, we obtain the number of each class of station "assignments" due each state.

Obviously, a given number of broadcasting stations of given power will give much better service to a zone which is small in area than to a zone which is large in area. The Amendment made it very difficult for the Commission to

take advantage of the difference in time between the Atlantic and Pacific coasts, of the daytime operation of stations, of the greater use of Canadian-shared channels which is possible in the South, and other considerations which could not easily be accommodated to rigid mathematical equality. The "borrowing" clause proved to be of practically no assistance in solving the problem because all channels were in demand in their zones of original assignment.

There was in the Commission a difference of opinion as to the intention of Congress with regard to the method of putting the Amendment into force. A majority of the Commission construed the Amendment as requiring an immediate reallocation of broadcasting facilities so as to attain the prescribed equality. There has also been a difference of opinion as to whether the Amendment, properly construed, requires an equality in number of licensed broadcasting stations by zone without regard to division of time or whether two or more stations dividing time in one zone may be balanced as against one station occupying full time in another zone.

The difficulty in the way of an immediate compliance with the Amendment is apparent from an inspection of the following table showing the distribution of broadcasting facilities of the United States on June 30, 1928:

Zone	Total Number of Stations	Total Frequencies in Use	Total Power (Watts)
1.....	128	64	228,135
2.....	112	53	109,990
3.....	116	54	59,535
4.....	206	73	162,605
5.....	134	74	67,145

The Commission held a hearing on April 6, 1928, which was attended by a large number of radio engineers. Dr. J. H. Dellinger, of the Bureau of Standards, acted as Chairman of the Conference. The engineers present adopted a resolution favoring an allocation calling for 50 cleared channels and 36 regional channels. The broadcasting committee of the Institute of Radio Engineers also submitted a report, likewise favoring the plan of allocation with 50 clear channels.

The Allocation Plan, as finally adopted by the Commission, was drawn up with six purposes in mind:

1. To arrange for the maximum total use of the broadcasting channels.

2. To divide such total use with exact equality among the five zones (and within the zones proportionally among the states according to population) as required by law.

3. To secure good radio reception in all parts of the country, and particularly to bring a fair diversity of programs to every home in the United States, including the remote 50,000,000 of our population on farms and ranches, in the mountains, along the coasts, and in towns, villages and cross-roads, more than 100 miles from any broadcasting station.

4. To provide for a large number of local broadcasting stations of limited power, so that communities not now equipped with stations, may have opportunity to broadcast local and neighborhood events and features within the restricted range of local interest, without interfering with the widely popular regional programs which are the backbone of broadcast-listener interest today.

5. To continue the operation of all present licensed transmitters under some basis of time-sharing in the cases of stations in localities where the quota is insufficient to care for the existing number of transmitters.

6. To minimize so far as possible the upsetting or modification of as-

signments of popular stations having great followings of listeners.

ASSIGNMENT OF THE NINETY BROADCASTING CHANNELS

Under the plan adopted by the Commission, the 90 channels of the broadcasting band (exclusive of the Canadian channels) are assigned as follows:

1. Forty rural service channels providing full-service-range operation of stations, for the benefit of remote, as well as nearby listeners. On these 40 channels, by taking advantage of time differences, it has been possible to obtain the equivalent of 42 to 43 full-time assignments for stations of 5,000 watts and above, thus affording more than eight full-time positions for each zone. (The word assignment as used here, refers to the equivalent of full-time operation for a station of the power designated. Actually, of course, such an assignment may be shared by two or more stations, sharing time.) A large number of additional "daylight-only" positions are also assignable to these channels, perhaps ten or more stations per zone. With these daylight stations added to the 60 different transmitters assigned to share the 40 full-time positions, it becomes apparent that these 40 channels will be subject to use each day by more than 100 different transmitters or stations,—an average of nearly three stations per channel.

2. Four 5,000-watt limited-service channels, each channel carrying two to three 5,000-watt stations, each operating full time. With ten total positions of this class available, each zone has two assignments. These assignments are at the 200-meter or 1,400-kilocycle end of the spectrum. While of limited service range on many nights, owing to the presence of another 5,000-watt station half way across the Continent, these channels can be operated in a clear condition by time-sharing or by synchronizing.

3. Forty regional-service channels for stations of 250, 500 and 1,000 watts. By wave-sharing, 125 full-time positions are obtained on these 40 channels, or 25 full-time positions per zone for stations of 250, 500 and 1,000 watts. Each such assignment may be occupied by either one or two or more actual licensed transmitters. Thus, by time-division, the actual number of transmitters to be licensed can be increased to the limits desired.

4. Six local-service channels for stations of 10 to 50 to 100 watts power. Each such channel will carry 30 full-time 100 watt positions, making 180 in all. Each zone will have 30 full-time 100-watt positions, each position subject to time-division. With local stations dividing time, say three transmitters per position, it will be seen that space is provided for 450 small stations of the 100-watt local class.

By the arrangement above outlined a total of 315 full-time positions for broadcasting stations of all ratings is carried on the 90 channels. Or, phrased differently, 315 different stations (including locals) may operate simultaneously on these 90 wave lengths. With time-divisions, the total number of transmitters that will be licensed will, of course, exceed this figure, since every present licensed transmitter is being extended by the Commission under the new allocation to operate part-time or full-time.

ASSIGNMENTS TO EACH ZONE

Recapitulating now, by zones, the above analysis of channel assignments, it will be seen that each of the five zones will have full-time positions on the air assigned to it, as follows:

1. Eight rural-service positions, suitable for stations of unlimited power—5,000 to 50,000 watts.

2. Two limited-service positions for 5,000-watt stations at 1,460 to 1,490 kilocycles (the range of which stations may be greatly increased to

full-service-range by mutual time-sharing or mutual synchronizing between the stations sharing the channel).

3. Twenty-five regional positions for stations of 250, 500 and 1,000 watts.

4. Thirty-three local-service positions for stations of 10 to 50 to 100 watts. By sharing time, three transmitters to a position, since most such local stations desire to run only one or two nights each week, 75 such local stations can be accommodated in each zone,—although the number to be licensed in each zone will be limited to such number as will equalize the total number of station licenses per zone. These "local" stations are designed for assignment to towns and communities not already having a broadcasting station.

As before explained, by time division on these positions the total number of actual transmitters to be licensed may be increased within the limits of the equality of licenses between zones prescribed by Congress.

In addition to the night-time positions already listed, a number of daylight-only stations can be successfully operated without interference, up to nightfall. The limiting number of such stations is dependent upon the powers authorized.

IMPROVES SITUATION FOR RURAL LISTENERS AND SMALLER STATIONS

General Order No. 40, embodied the November 11th allocation listings as above outlined. Engineers who have examined the allocation declare that the plan offers a comparatively high grade of reception on at least 75 channels out of the 90 on the listener's dial. In contrast, the set-up of last winter showed only 20 channels offering a similar standard for winter-night reception.

Millions of rural listeners in the agricultural sections and in remote towns and villages are the chief beneficiaries of the new arrangement,—especially in their ability to hear clearly smaller stations in their own neighborhoods and states.

Improved service to farm listeners is also being obtained on the high-power rural-service channels. On each such channel only one station is permitted to operate at any one time during night hours, thus insuring clear reception of the station's program, up to the extreme limit of its service range. And since eight "high-power" rural-service channels will be assigned to each of the five zones, wide geographical distribution of the country's higher-power broadcasting facilities will be assured to reach rural audiences in all sections.

On 34 of the 39 channels shared by 1,000-watt and 500-watt regional stations, limits of two or three stations per channel have been placed, while between stations spacings generally of 1,200 to 1,000 miles have been observed, with few spacings less than 1,000 miles. Many of these 500-watt regional stations furnish important services to farmers and rural residents in their own and neighboring states, and the new operating conditions will extend the service areas of these worthy transmitters to the full reach of their signals on what are essentially "cleared" channels.

Throughout the whole allocation, the matter of wide geographical spacings between stations on adjoining channels has been carefully watched, in this way eliminating the objectionable "cross-talk" in the receivers of rural listeners.

The smaller broadcasters also enjoy improved operating conditions under the November 11th allocation, for channels on which such regional stations operate will be largely cleared of interference, enabling 500-watt and 100-watt stations to reach out further than has been possible since 1926. The local 100-watt stations have also

been given particular consideration, since the plan provides for full-time assignments for such local community broadcasters practically equalling in number the total of all the larger classes of broadcasters put together.

OUTSIDE THE BROADCASTING BAND

So much for the broadcasting wave lengths. Outside of broadcasting, the Commission has many other responsibilities. To investigate these other wave lengths, let us start with the listener's own home radio set. As you turn your dial back and forth you "tune in" different broadcasting stations. But now suppose you turn it to the right, past WEAF,—finally you come to a dead stop.

What is beyond that barrier?

If your home set could tune further up the scale in that direction, you would find yourself listening to airplanes communicating with their ground stations; then would come ships calling each other at sea,—even perhaps a faint S. O. S.,—and radio compasses, airplane beacons, and other aids to navigation. Then turn the dial further and you would listen in on the great trans-Atlantic high-speed circuits communicating with Europe, and also the trans-Atlantic telephone conversations linking New York with London and Paris. These are the so-called "*long waves*"—up beyond the upper end of your dial.

Now turn back your imaginary dial (for no single radio set will actually listen to all these widely different wave lengths), and once more swing down through the broadcast band—way down—and finally you enter the unclaimed stretches of the "short waves." Here is a new wide field for which a variety of commercial applicants are now contending. Once the playground of the amateur only, now some of the most valuable parcels of the whole radio spectrum are believed to be numbered among these short waves or high frequencies.

Television, when it comes, will probably be quartered here.

Some of these short waves are transoceanic in reach, and are wanted by the regular communication companies, by newspaper services, and others. Some are most suitable for shorter distances, and are in demand by a host of public-service and private interests. The simple if paradoxical rule to remember here is that while the shorter waves work best over longer distances, the longer short waves are good for the shorter distances.

Among those who have appeared before the Commission applying for channels in this short-wave field, are: newspaper services; communication companies—domestic and transoceanic; airplane operating companies; navigation companies; railroads; department store chains; electric railways; interurban bus systems; electric power transmission systems; mining and oil companies; lumber companies; farm cooperative organizations; motion picture producers; police and fire alarm systems; forest and watershed patrols; ranch owners; remote resorts and hotels; operators of facsimile transmission services; radio manufacturers; television inventors; radio broadcasters; packers and shippers; and geologists.

In addition, representatives of the Army and Navy and of other Government services which operate or supervise short wave communication systems, ship compasses, ship beacons, fog signals, airplane services, airplane beacons and miscellaneous short-wave systems have coöperated with the Commission in outlining the developments which they are making and which might be affected by assignment of nearby short-wave channels to commercial services.

Representatives of each class of com-

mercial service applied for have been particularly invited to discuss: (1) the dependence of such service upon short-wave radio rather than wire or other means; (2) the humane, social and economic importance of their proposals; (3) the number and position of channels believed available for such service; (4) the power required and interference likely to be caused to other services and other countries; and (5) the probable total number of applications which will be made for such service within the next five years by all applicants in their class.

While no licenses have yet been granted in the short-wave region, except to transoceanic companies doing a communication and newspaper business and to the amateurs and experimenters, the Commission will shortly take up the licensing of some five hundred channels in this new field. These short-wave assignments will be in addition to the existing station licenses on other frequencies now in force under the Commission's authority, for we have already licensed operations on all the various waves of the spectrum:

600 Broadcasting stations
2,166 Ships
65 Shore-to-ship stations
85 Transoceanic stations
280 Point-to-point, continental
17,000 Amateurs
203 Experimental
31 Trade and technical schools

Thus it will be apparent that although the broadcasting field may occupy the center of public interest, it is in the other divisions of the radio spectrum and particularly in the short waves that the responsibilities of the Radio Commission are greatest, in number and undoubtedly in economic importance.

APPENDIX

RADIO FACILITIES DUE EACH STATE
As Required by the "Equitable Allocation" Clause of the 1928 Act of Congress
FIRST ZONE (O. H. Caldwell, Commissioner)
Number of Full-time "Assignments" Due States (See Notes, page 12)

	A Population of State (1928)	B Percentage of Total National Facilities Due State	C Rural Service, 5 kw. and Above	D Regional Service, Chiefly 500–1,000 w.	E "Local," Chiefly 50 w. and 100 w.
Maine	795,000	.6	...	.7	.9
New Hampshire	456,000	.3	...	.4	.5
Vermont	352,428	.3	...	.3	.4
Massachusetts	4,290,000	3.1	1.2	3.9	4.7
Connecticut	1,667,000	1.2	.5	1.5	1.8
Rhode Island	716,000	.5	...	.7	.8
New York	11,550,000	8.4	3.5	10.6	12.7
New Jersey	3,821,000	2.8	1.1	3.5	4.2
Delaware	244,000	.2	...	.2	.3
Maryland	1,616,000	1.2	.5	1.5	1.8
District of Columbia	552,000	.4	...	.5	.6
Porto Rico	1,299,809	.9	...	1.2	1.4
Virgin Islands	26,051	.02	...	...	...
	27,385,288	20.00%	8.0	25.0	30.0

SECOND ZONE (Ira E. Robinson, Commissioner)
Number of Full-time "Assignments" Due States (See Notes, page 12)

	A Population of State (1928)	B Percentage of Total National Facilities Due State	C Rural Service, 5 kw. and Above	D Regional Service, Chiefly 500–1,000 w.	E "Local," Chiefly 50 w. and 100 w.
Pennsylvania	9,854,000	7.0	2.8	8.8	10.5
Virginia	2,575,000	1.8	.7	2.3	2.7
West Virginia	1,724,000	1.2	.5	1.5	1.8
Ohio	6,826,000	4.9	2.0	6.1	7.3
Michigan	4,591,000	3.3	1.3	4.1	4.9
Kentucky	2,553,000	1.8	.7	2.3	2.7
	28,123,000	20.0%	8.0	25.0	30.0

THIRD ZONE (E. O. Sykes, Commissioner)
Number of Full-time "Assignments" Due States (See Notes, page 12)

	A Population of State (1928)	B Percentage of Total National Facilities Due State	C Rural Service, 5 kw. and Above	D Regional Service, Chiefly 500–1,000 w.	E "Local," Chiefly 50 w. and 100 w.
North Carolina	2,938,000	2.1	.8	2.6	3.1
South Carolina	1,864,000	1.3	.5	1.7	2.0
Georgia	3,203,000	2.3	.9	2.9	3.4
Florida	1,411,000	1.0	...	1.3	1.5
Alabama	2,573,000	1.8	.7	2.3	2.7
Tennessee	2,502,000	1.8	.7	2.2	2.7
Mississippi	1,790,618	1.3	.5	1.6	1.9
Arkansas	1,944,000	1.4	.5	1.7	2.1
Louisiana	1,950,000	1.4	.5	1.8	2.1
Texas	5,487,000	3.9	1.5	4.9	5.9
Oklahoma	2,426,000	1.7	.7	2.2	2.6
	28,088,618	20.0%	8.0	25.0	30.0

FOURTH ZONE (Sam Pickard, Commissioner)
Number of Full-time "Assignments" Due State (See Notes, page 12)

	A Population of State (1928)	B Percentage of Total National Facilities Due State	C Rural Service, 5 kw. and Above	D Regional Service, Chiefly 500–1,000 w.	E "Local," Chiefly 50 w. and 100 w.
Indiana	3,176,000	2.4	1.0	3.0	3.6
Illinois	7,396,000	5.5	2.2	7.0	8.3
Wisconsin	2,953,000	2.2	1.0	2.8	3.3
North Dakota	641,192	.5	...	.6	.7
Minnesota	2,722,000	2.0	.8	2.5	3.0
South Dakota	704,000	.5	...	.7	.8
Iowa	2,428,000	1.8	.7	2.3	2.7
Nebraska	1,408,000	1.1	...	1.3	1.6
Kansas	1,835,000	1.4	.5	1.7	2.0
Missouri	3,523,000	2.6	1.1	3.3	4.0
	26,786,192	20.0%	8.0	25.0	30.0

FIFTH ZONE (H. A. Lafount, Commissioner)
Number of Full-time "Assignments" Due States (See Notes, page 12)

	A Population of State (1928)	B Percentage of Total National Facilities Due State	C Rural Service, 5 kw. and Above	D Regional Service, Chiefly 500–1,000 w.	E "Local," Chiefly 50 w. and 100 w.
Montana	548,889	1.0	...	1.2	1.5
Idaho	546,000	1.0	...	1.2	1.4
Wyoming	247,000	.4	...	.5	.7
Colorado	1,090,000	2.0	.8	2.4	2.9
New Mexico	396,000	.7	...	.9	1.0
Arizona	474,000	.8	...	1.0	1.2
Utah	531,000	.9	.4	1.2	1.4
Nevada	77,407	.1	...	.2	.2
Washington	1,587,000	2.8	1.1	3.5	4.2
Oregon	902,000	1.6	.6	2.0	2.4
California	4,556,000	8.2	3.3	10.2	12.1
Territory of Hawaii	255,912*	.5	...	.6	.7
Alaska	55,036*	.1	...	...	.2
	11,266,244	20.0%	8.0	25.0	30.0

* 1920.

Notes on accompanying figures showing "Radio Facilities Due Each State":

"ASSIGNMENTS"—The figures in Columns C, D and E do *not* show the total number of stations to be licensed. They show *only the number of full-time (24-hour) "assignments" due the various states.* Each such assignment may be occupied either by one full-time station, or by two, three or more stations *sharing time.* Such time-sharing of assignments will be necessary in states and localities where the number of licensed stations exceeds the number of "assignments" available.

RURAL SERVICE—Column C, it will be noted, lists assignments for stations of 5 kw. and upwards, only where the state's quota is approximately *half-time or more,*—on the basis that the great expense of building or operating a 5-kw. station would not be justified for less than half-time operation. States whose quotas on these Rural Service channels are small fractions will presumably be served by stations in neighboring states (with which their fractional quotas may be combined).

REGIONAL SERVICE—Column D lists assignments for regional stations, including under the allocation plan, chiefly 500-w. and 1,000-w. stations, but also a limited number of 250-w. stations (principally on Canadian-shared channels) and also ten 5-kw. limited-service stations in the 1460–1490-kc. range, having regional service.

LOCAL SERVICE—Column E lists assignments for "local" community stations with ratings of 10 w. to 100 w. These assignments provide primarily for communities having no other broadcasting stations; hence such local assignments are automatically not fully available in regions and communities having extensive broadcasting facilities in other classes. "Local" assignments are, however, always fully available in all sections and communities having no other nearby stations.

DAYLIGHT SERVICE—The allocation plan is essentially built upon the requirements of night time, when transmission distances are greatest, and interference is at a maximum. In the daytime, on account of the reduced transmission distances obtainable, simultaneously-operating stations can be closer together. In consequence, a number of additional stations for daylight operation only (equally divided between the zones) can be incorporated into the broadcasting set-up here shown, without causing any interference.

The Commercial Uses of Radio

By General J. G. Harbord
President, Radio Corporation of America

TO a surprisingly large number of people, radio is an awe-inspiring subject. While true that its technique is a highly complicated one, nevertheless the question, "What is radio?" can be answered simply and directly. Radio is an up-to-date means of flashing intelligence through space. If we couch this intelligence in the dots and dashes of the coded message, we have wireless telegraphy; if we transmit sound itself, either in the form of the spoken word or as vocal or instrumental music, we have broadcasting; if we flash a "still picture" through space as the facsimile of the printed page, signature or legal document, we have photo-radio; and when we are able to send the moving image—as we are now doing on a small scale in the laboratory—we shall have achieved the ultimate in radio transmission and reception—television.

Radio Development

Commercially, radio has developed along three major lines as follows:

(a) *Marine Radio.*—This was the initial as well as the most logical application of radio to the field of commercial activity, and it speedily fulfilled a need which was at once obvious and vital. For the first time in the history of the world, it placed at the disposal of the navigator a genuinely reliable means of communication with other ships and the shore.

(b) *Transoceanic Radio.*—As the commercial possibilities of radio became manifest, new and improved apparatus made possible the establishment and maintenance of uninterrupted, economical communication between points separated by thousands of miles of ocean wastes, and even across entire continents.

(c) *Broadcasting.*—Without question, this is the most conspicuous and popular phase of the radio art. It has aptly been called the "surprise party" of radio. In the beginning, it was a mere experiment in radio-telephony, but such was its appeal to the public fancy that it developed, almost overnight, into one of the country's most powerful and flourishing industries.

Each of these three commercial phases of radio contains the elements of a story of absorbing interest. Space limitations prevent us from going into them in any considerable detail. Nevertheless, we shall attempt to outline the salient and arresting features of all three.

Marine Radio

As long ago as 1895, Marconi had demonstrated, with conclusive finality, that intelligible, coded signals could be flashed through the ether. Further, the utter indispensability of radio on shipboard had been forcibly and almost tragically impressed on the public mind at the time of the collision between the steamships *Florida* and *Republic* in January of 1909. Nevertheless, during all these years and, indeed, for many years thereafter, maritime radio was left, for the most part, to its own devices. Yet in spite of this, there had been developed, by 1920, a chain of

coastal stations which, taken together, formed a genuinely efficient marine radio service. These stations, twelve in number, were situated along the Atlantic seaboard from Bar Harbor, Maine, to Cape May, New Jersey, and all operated on a wave length of either 450 or 600 meters.

If we stop to consider that these restricted channels handled approximately 90 per cent of all marine telegraphic traffic, we can better visualize the confusion which must have obtained. And, to further complicate matters, broadcasting made its début about this time. As the hundreds of broadcasting stations which sprang up throughout the country made haste to occupy all possible wave lengths on either side of the two channels set aside as the special province of marine radio, matters grew steadily worse. The opportune advent of the vacuum-tube transmitter, however, averted chaos.

The first vacuum-tube transmitter was installed at Marion, Mass., and operated by remote control from the Chatham Marine Radio Central, 55 miles away. The success of the new transmitter was immediate and astounding. It not only set new records in long-distance communication, but also gave marine radio the added feature of multiplex operation. Chatham, for example, was equipped to receive from three ships and transmit to a fourth at the same time. Six of the scattered twelve coastal units heretofore serving the coastwise and transatlantic shipping suspended operation indefinitely, and the use of those land spark stations, which had hitherto interfered with broadcast entertainment, was discontinued as speedily as possible.

During the past few years, hundreds of vessels have adopted the vacuum-tube transmitter in place of the obsolete spark type. The transition has necessarily been and must continue to be gradual, for although the superiority of the former is everywhere recognized, the investment represented in the old equipment is considerable. Nevertheless, approximately 30 per cent of our merchant marine has effected the change, while in all, more than 550 American vessels are now equipped with transmitters of the improved vacuum-tube type. Indeed, we may safely assume that within a very few years, the spark transmitter will be a thing of the past on all vessels flying the Stars and Stripes.

A few years ago, the range of our marine coastal stations was so limited that it was virtually necessary to broadcast messages to ships at sea, or to relay messages from ship to ship, to their destination. Today, there are few ships indeed which our land stations cannot reach directly. As a result, the cost of marine radio service has been materially reduced. Again, the sharp tuning which goes hand in hand with continuous-wave operation has made it possible for us to establish many channels within a narrow wave band. Lastly, interference has been reduced to a minimum, due, in large part, to the choice of several channels as against the limited channels available with the old spark apparatus.

So great were the demands of Great Lakes shipping, for example, that two new stations had recently to be erected at Buffalo and Duluth to assist those already in operation at Chicago and Cleveland. Today, these four units are handling, with consummate ease, an amount of traffic far in excess of that which formerly taxed the facilities of no fewer than fourteen spark stations.

Before we complete our brief survey of marine radio, I should like to make some reference to the part which it has played in navigation and transoceanic flying. At the beginning of 1928,

some 300 American ships were equipped with the RCA direction finder, or radio compass, while the Bureau of Lighthouses had established radio beacons at various danger points along our coasts. Thanks to the radio direction finder, no navigator need henceforth be in ignorance of his true bearing or position at any time; and thanks to the radio beacon, ships can now proceed in the densest fogs with safety.

Although radio did not itself participate in some of the early transoceanic flights, it nevertheless played a most important rôle in all of them. For weeks and even months before the aviators "hopped off," the U. S. Weather Bureau leaned heavily upon radio in gathering invaluable meteorological data and in preparing accurate weather forecasts by means of bulletins received from ships at sea along the proposed route. In more recent flights, however, aviators have taken the precaution to equip their planes with radio apparatus. This has made it possible for them to maintain contact with ships and shore during their hazardous undertakings.

TRANSOCEANIC RADIO

The story of transoceanic radio properly begins with man's first attempt to enlist the aid of electricity in the solution of his communications' problems. This dates back to the year 1837 when Samuel F. B. Morse evolved the first practical telegraph. The expansion and development of this instrument is too well known to be repeated here. Suffice it to say that the first major obstacle which it encountered, water, paved the way for the introduction of a second system of communication which was soon to become a dominant factor in international trade—submarine telegraphy.

It was a comparatively simple matter to link Greak Britain and France by means of the submarine cable, but when pioneer experimenters tried to span the whole breadth of the Atlantic, they encountered innumerable difficulties. The history of these early attempts is a record of bitter disappointments and failures, and it was not until 1866 that nearly twenty years of constant effort yielded success. Great Britain speedily took the lead in the development of the submarine cable; and this, for two reasons: first, international trade was and is of prime importance to the growth and existence of the British Empire; second, the supply of gutta percha, the only known insulator for submarine cables, was a British monopoly. So thoroughly did England apply herself to the problem in hand that within the short space of five decades, her domination of the submarine cable field was virtually absolute. At the outbreak of the Great War in 1914, practically all the cable lines in the world converged in the city of London.

Unchallenged though she was in this field, England had strenuous and somewhat unexpected competition from another quarter; for, in an attempt to solve their own individual and pressing communication problems, the other nations of the world had turned to radio. France and Germany in particular had ambitious plans for world-wide networks of radio. England, too, did not intend to be taken unawares; in an "All-Red Chain," she had a similar project of her own quite as comprehensive as that of any of her neighbors. For the most part, these pre-war networks were purely theoretical. Viewed dispassionately in the light of the development of the radio art up to that time, they were altogether too presumptuous. Furthermore, the motives behind many, if not all of these circuits, were military rather than commercial.

To the nations of Europe, the out-

break of the Great War caused the temporary abandonment of their radio schemes. To the United States, however, it signalized a revolution in industrial methods and processes, and for the first time in its history, the research laboratory was elevated to the position of importance which it deserved in our national life. It was in this spirit that the problem of a high-frequency alternator, capable of producing 50,000- to 100,000-cycle alternating current, was approached. Radio engineers had long realized that if practicable transoceanic radio were ever to be achieved, constant and reliable high-frequency energy was absolutely essential.

The problem finally succumbed to the genius of Dr. E. F. W. Alexanderson of the General Electric Research Laboratory. Due to the exigencies of the war, the development of the Alexanderson alternator was pushed with all possible speed, and the device saw constant transoceanic radio service during the closing months of the conflict. Settling new standards for reliability and economy, the Alexanderson alternator attracted the attention of the world-famous British Marconi Company which, at the conclusion of the war and after an interval of four years, was about to resume work on the "All-Red Chain." This great organization was prepared to place $5,000,000 worth of orders with the General Electric in return for the *exclusive* rights to the use of the new alternator.

The British Marconi Company was the only logical customer. The General Electric was on the point of accepting its offer, when something happened which changed the course of the communications' history of both this country and the world at large. President Wilson, then in Paris for the Versailles Treaty, realized that if the British were to secure the Alexanderson alternator on their exclusive terms, they would soon enjoy a lead in the radio field comparable with the domination which they already exercised over the submarine cables of the world. He therefore sent the late Admiral Bullard and Captain Hooper to the General Electric with the request that this organization decline the offer.

By complying with this request, the General Electric Company left itself without an outlet for one of the most expensive pieces of equipment it had undertaken to develop. Further, although the British had failed in their attempt to obtain the alternator rights, America was without a communications organization to employ them. Thus, in an effort to clarify the situation the American Telephone and Telegraph Company, the Western Electric Company, the Westinghouse Electric and Manufacturing Company, and the United Fruit Company joined with the General Electric in the formation of a completely American-owned and operated communications organization, named the Radio Corporation of America. The property and rights of the British-owned Marconi Company of America were taken over by the new organization. For the first time, therefore, the control of American radio was in American hands.

Today, the RCA world-wide wireless service offers direct communication between New York City and England, France, Germany, Portugal, Italy, Holland, Belgium, Sweden, Norway, Poland, Turkey, Liberia, Cuba, the Argentine, Brazil, Colombia, Chile, Venezuela, Porto Rico, the Dutch West Indies and Dutch Guiana. From San Francisco, circuits reach to Hawaii, China, Japan, the Philippines, Dutch East Indies and French Indo-China. Future projected networks will link this country with Spain, Czechoslovakia and others.

Short-wave transmission and the

directive or beam systems are receiving increasing attention from communication engineers. While the Alexanderson alternators still shoulder their share of the overseas radio communication load, many short-wave channels have recently been opened. These have proved economical as well as productive of marked gains in speed. The peculiarity of the directive, or beam, system lies in the fact that the signals may to some degree be aimed directly at a distant receiving station, thus effecting a very considerable economy in the power required for spanning great distances.

Perhaps the most salient feature of present transoceanic circuits is their remarkable general efficiency. A few years back, a speed of 20 words per minute was considered highly creditable; yet today, in clearing radiogram traffic, improved short-wave circuits maintain speeds well in excess of 200 words per minute hour after hour, and automatic transmitters and receivers practically preclude the possibility of error by reducing the human element to an almost irreducible minimum.

BROADCASTING

In the introduction, we referred to broadcasting as the "surprise party" of radio. Such a statement requires some explanation.

To begin with, the technical basis of broadcasting is the radiotelephone. This instrument was originally intended as a point-to-point communication means. For many years, experimenters had worked with the radiotelephone in the hope that it might eventually be developed as a rival of the wire telephone. Always, however, they had worked under difficulties.

Nevertheless, when put to a test, the radiotelephone at the time proved unsuitable for point-to-point communication because it lacked the vital element of secrecy. Those in charge of its development were forced to bow to the inescapable fact that traffic over the radiotelephone as developed up to that time was public property. And then it was that they decided to undertake a great experiment. The thought came to them that they might possibly make use of the fact that anyone who wished to listen in on a radiotelephone conversation might do so. Briefly, they decided to give mass telephony a trial.

Organized broadcasting made its début in the United States on November 2, 1920, when Westinghouse station KDKA transmitted bulletins on the result of the Presidential election contest of that year. Thus was born "The Pioneer Broadcasting Station of the World." From this humble beginning, there has developed our present vast broadcasting structure which comprises upwards of 700 stations and which is virtually a national institution.

It is not our intention here to give a detailed survey of the astonishing growth of broadcasting. Doubtless the reader himself has lived the story and is quite familiar with the fact that the KDKA station's lead was speedily followed by a host of other stations in all sections of the country. Indeed, for a short time, it seemed that there was no limit to the number of those who, for some reason or other, wished to broadcast. By August, 1924, a total of 1,105 stations had been licensed. Soon, however, various economic factors, heedlessly ignored by those who had rushed blindly into the new enterprise, began to exert an influence on the situation.

The economic factors were three in number. One was the crushing financial burden involved in the maintenance of a good broadcasting station. Few, if any, of the hundreds of those who were so anxious to "get on the air" had any conception of the factor which

they were soon to recognize as "the high cost of broadcasting." The second was the fact that the radio audience, now grown to enormous numbers, had also become discriminating, and completely reversing its attitude of the early days, looked to the broadcasters for a high class of entertainment service. The third was the fact that the smaller stations, although they had started with an apparently inexhaustible supply of program material, were now being hard pressed to hold the interest of their listeners in competition with the programs broadcast by leading stations in the great metropolitan centers.

It was at this point that the General Electric Company, the Westinghouse Electric and Manufacturing Company and the Radio Corporation of America decided to take a bold step. They realized that their commercial interests were bound up with the permanence of the idea and the institution of broadcasting. More than this, however, they appreciated their responsibility to the American public which had invested heavily in radio receiving equipment, believing broadcasting to be permanent. These three organizations, therefore, joined forces in the formation of the National Broadcasting Company in September, 1926, for the double purpose of supplying the two great perquisites of adequate financial strength and ample program material on a nation-wide scale.

The new company first purchased station WEAF, one of the leading stations, and made arrangements with the American Telephone and Telegraph Company for the lease of extensive wire line facilities to be used in broadcasting through a large group of scattered associated stations in a network. A short time after the formation of the National Broadcasting Company, the foundation of another network was laid when this organization took over the management and operation of stations WJZ and WRC from the Radio Corporation of America. A Pacific Coast network has also been formed, with programs radiating from the key stations in San Francisco. Now, 58 stations utilizing over 10,000 miles of especially engineered circuits are associated with the National Broadcasting Company's networks.

We have intimated that the question, "Who shall pay for broadcasting?" threatened for a time the foundations of the art. Fortunately, this problem is, today, well on the way to satisfactory solution. Our great manufacturing concerns saw in radio a national good-will medium of unlimited possibilities. These great commercial organizations, realizing that radio has become an invaluable supplementary force in public relations, have united with the broadcasters in the creation of the so-called "sponsored program." This institution has proved itself a blessing to all concerned. In it, the manufacturer has found a means of appealing to that tremendous purchasing power represented by the listening audience, and of establishing that goodwill which is so essential to the successful merchandising of any nationally advertised product. The broadcaster has discovered in it a means of achieving his long-cherished goal of financial independence. The listening public benefits in that it is assured of the highest possible grade of entertainment.

THE FUTURE

Following in the wake of broadcasting has come the radio industry which, in a few short years, has developed into one of the most powerful in the country. Starting out, first as a laboratory experiment and later branching out as a commercial enterprise, it has, today, virtually hemmed us in on all sides

with signs of its manifold activities. Thousands of factories; hundreds of thousands of workers; millions of sets, parts, and accessories; thousands of retail outlets; an aggregate trade which, during 1928, will pass the half-billion dollar mark; and a broadcast audience grown to perhaps fifty millions—these are some of the concrete evidences that broadcasting is the young giant of American industry.

What of the future? Patrick Henry once said: "I know of but one lamp by which to guide my feet and that is the lamp of experience." If this is so, then we can see in the phenomenal development which has taken place within the last few years in marine radio, in transoceanic radio and in broadcasting but the small beginnings of the unparalleled expansion and growth which the future must inevitably bring.

Nor is radio destined to develop only along its three established lines of service. Indeed, the shadows of its new expansion have already been cast before it. It has gone afield and, coöperating with the phonograph industry in the perfection of electrical sound reproduction, has produced an instrument whose striking realism has given new life to that industry. Likewise, it has come to the aid of the motion picture industry and, giving it the "talking-movie," set its foot upon a path of development whose possibilities are limited only by the imagination.

And, to crown all, television, that branch of the radio art which will bring to our homes the visual as well as the aural record of stirring scenes and events, is already giving promise for the future so far as the laboratory is concerned.

Radio Meteorological Services

By C. F. Marvin
Chief, United States Weather Bureau

THERE have been three stages in the development of existing methods of predicting weather from charts showing the meteorological conditions prevailing at a given moment over an extensive area of the earth's surface. In the first stage the results of observations taken simultaneously at various points were assembled months or years after the time of the observations and charted for the purpose of scientific investigation. This process was fruitful in revealing the fundamental facts regarding traveling weather systems that underlie present methods of forecasting, but was too slow to be utilized for practical purposes. The earliest synchronous weather charts of which we have any knowledge—those drawn by Brandes in 1820—were based on observations taken in the year 1783.

The second stage became possible with the advent of the electric telegraph, and became a fact soon after the middle of the nineteenth century. In this stage weather charts were drawn from telegraphic reports of observations, weather forecasts were made from the charts, and these announcements were disseminated by telegraph and otherwise; the whole process occupying only a few hours. Thus weather prediction becaem a practical art.

The third stage, after a number of experimental and small-scale undertakings during the early years of the present century, was definitely entered at the close of the World War. In this stage the radiotelegraph and the radiotelephone tend to become the main reliance of the meteorological organizations in collecting the information embodied in weather maps and in disseminating forecasts and warnings. Not only has radio greatly accelerated the interchange and diffusion of weather information, but it has brought within the sphere of these operations vessels on the high seas, craft navigating the air, and localities on land far outside the network of wire communication.

The radio meteorological service of today is essentially international in scope and character, and it tends to become world-wide. The interchange of weather reports between countries is under the general supervision of a body known as the Commission for Synoptic Weather Information appointed by the International Meteorological Committee. This body, which includes representatives from the principal meteorological services of the world, makes recommendations concerning hours of observation, contents of reports, hours of transmission and codes to be employed.

Radiotelegraphic Weather Reports

The international system of radiotelegraphic weather reports has been standardized and systematized to a remarkable degree. According to a plan that was worked out at a conference held in Paris just after the war, the reports of observations in each country are assembled and broadcasted at prescribed hours in a collective message. The time-table now in force begins at Greenwich midnight with a broadcast from Julianehaab, giving the results of observations at that place and three others in Greenland. A similar broad-

cast from Greenland is made at Greenwich noon. The whole daily program calls for about 250 separate broadcasts of meteorological information in the countries of Europe and north Africa, together with Greenland, Iceland, the Azores and Syria. Though these emissions are spread over the twenty-four hours as well as practicable, it has been necessary in some cases to assign the same broadcasting time to three and even four stations. The use of different wave lengths prevents interference but complicates the problem of reception.

A majority of countries begin their meteorological broadcasts with the word "meteo" (or "météo"), and the messages themselves are now commonly called "meteograms." Though these broadcasts generally have certain fundamental features in common, some are much more comprehensive and elaborate than others. This statement applies both to the amount of information given for each weather station and to the number of stations whose reports are included in the broadcast.

In many cases a broadcast comprises reports from more than one country. Thus the daily broadcasts from Casablanca, Morocco, include reports from Algerian as well as Moroccan stations; also from the city of Tunis, and from ships on the western Mediterranean. Ismailia, Egypt, broadcasts reports from about 60 stations in Egypt, the Near East, northwestern Africa, the Mediterranean islands and the continent of Europe. More comprehensive broadcasts, known as "international collective messages," are issued by high-power stations at Paris, Hamburg, London and Leningrad, which contain reports from selected stations, not only in Europe, but also in various other parts of the world, including North America.

RADIO WEATHER REPORTS

Though the United States Weather Bureau collects reports from its own stations and those of Canada by wire, the radiotelegraphic services of other countries furnish material for weather maps, drawn twice a day in Washington, extending far around the globe. Radio weather reports from the Far East are transmitted from Cavite, relayed from Midway Island and Honolulu to San Francisco, and thence forwarded by wire to Washington. Weather reports from ships on the Atlantic, Gulf, and Caribbean are radioed to Washington and San Francisco. The Weather Bureau broadcasts a number of collective bulletins of observations taken in the United States and elsewhere. These are mainly for the information of mariners, and are issued from more than 40 radio stations along the seacoasts and on the Great Lakes.

Special broadcasts are made twice daily from San Francisco and Washington on short-wave radio for the benefit of aviation. These broadcasts contain the coded weather reports received from all the stations in the United States and Canada, and are sent out as soon as received. In this way airports all over the country may procure the same early weather reports about as soon as they are received by the Weather Bureau itself.

Broadcasts by radio at San Francisco and Washington on twice-daily schedules provide marine and aviation interests with detailed coded and simple language bulletins. By means of these bulletins mariners may prepare their own weather maps at sea, and the forecasts and warnings are invaluable for careful and safe navigation of vessels. These bulletins, and especially the Washington bulletin, are well known to every radio ship operator on the Atlantic and Pacific.

The coming of the radiotelephone brought to the Weather Bureau a powerful means of disseminating weather information to the public. This information is of great value to those who live in the rural and greatly isolated districts of the land. Coming weather changes are announced by radio to these far-off people as quickly as they are distributed to the citizens of the great population centers by newspapers and mail. At the close of the year 1928, the Weather Bureau had the coöperation of nearly 200 radiophone stations which broadcast daily forecasts on regular schedules. No one, no matter where he may live, is beyond the range of some radiophone station broadcasting weather information for the region in question.

The people and meteorological services of Europe need weather reports from America. In order that they may be promptly furnished with such reports the Weather Bureau transmits twice each day a special coded bulletin by radio. This contains reports from about 50 selected places in Alaska, Canada and the United States. After broadcasting from Washington it is picked up in France and rebroadcast under renewed strength and power from the Eiffel Tower radio station in Paris for the benefit of all European weather services.

The radio services of the United States Weather Bureau are unknown to many, and few realize to what proportions this service has developed. The Weather Bureau, without owning a single transmitting station, has the coöperation of hundreds of radiophone and telegraph stations all over the country, in our island possessions, and in Alaska.

While the lands and seas of the Northern Hemisphere have now been linked up into a nearly coherent system of weather-reporting services, there is a much less general interchange of reports among the meteorological establishments of the Southern Hemisphere, and there is, as yet, very little exchange of current weather information between the two hemispheres. Brazil, Argentina, Uruguay, Chile, South Africa, Australia, New Zealand, Samoa and a few other regions in southern latitudes issue more or less comprehensive broadcasts of weather reports. A daily weather chart published in Buenos Aires tabulates data received by wire or radio from most countries of South America, and there is a daily telegraphic weather map of Australasia, published at Melbourne. Daily weather maps of the globe are well within the range of possibility, and this long-cherished dream of meteorologists bids fair to be realized within a few years.

Radio and Safety

By C. B. JOLLIFFE

Physicist, Bureau of Standards; Technical Adviser to the American delegation to the International Radiotelegraph Conference of 1927

SINCE the first use of radio for communication purposes, the radio has been largely applied as an instrument of safety. In the past this has been chiefly in connection with the safety of ships at sea, but recently other applications have become of increasing importance. The importance of a means of communication for ships at sea is apparent. Radio is the only means of communication by which a ship can continually keep in contact with other ships or with stations on shore.

COMMUNICATION WITH SHIPS

It was early recognized that in order to make for maximum safety it was necessary that all ships equipped with radio be able to communicate with each other and with shore stations at any time. At first, to accomplish this, all operators when on duty listened on a common frequency. Five hundred kilocycles per second (600 meters) was chosen as this common frequency and in 1912 was accepted by international agreement as the calling and distress frequency.

When radio communication was used only occasionally by a few ships and with relatively low power, it was possible for all the ships equipped with radio to use the common frequency for all communications. As more ships were equipped with radio and communication became more complex, the common frequency became crowded and interference resulted. To eliminate this interference other frequencies were used for general communications and 500 kilocycles was kept open for distress messages and calling purposes, that is, for establishing contact for starting a communication. At the present time all ships which are required to be equipped with radio must, by international agreement, listen on 500 kilocycles for certain specified intervals. Thus any ship has a potential audience of all ships within range of its transmitter at certain periods of each hour.

DISTRESS MESSAGES

The signal ···———··· (SOS) has been chosen as the distress signal, and international conventions have specified under what conditions and how this signal shall be sent, as well as how messages relating thereto shall be handled. The procedure is such as to insure that the information can be sent in a short space of time and be readily interpreted by all persons receiving it regardless of nationality. The distress signal and messages concerning it have absolute priority, and all radio stations which may cause interference with such traffic must stop sending immediately. Broadcasting stations along the coasts are frequently required to stop transmitting because of distress signals. Radio has been used frequently in bringing aid, thus saving a large number of lives and frequently the ships themselves.

AUTOMATIC ALARM SIGNALS

In the last two years there have been under development devices designed to respond automaticaly to a signal which

is used in addition to the distress signal. The International Radio Convention of Washington, 1927, specified the signal to which such a device must respond and the general requirements of operation which it must meet. The device must be such that it responds to the special signal and to no other. The automatic alarm devices ring several bells when the special signal is received; the radio operator can then adjust his set and get the messages pertaining to the distress call. On ships which do not carry a sufficient number of operators to maintain a continuous watch this device serves to furnish continuous listening on the distress frequency. When connected to an auxiliary receiving set it is also useful in providing continuous attention for distress calls while the operator on duty is carrying on regular communications on other frequencies. The devise is still in the experimental stage and is being tested under actual service conditions.

AIDS TO MARINE NAVIGATION

While the use of the distress signal has been widely advertised, there are other uses of radio by ships which are nearly as valuable but much less spectacular. Many vessels now use a radio compass in addition to other navigating instruments. This instrument consists essentially of a coil antenna and receiving set. When a transmitting station is being received the coil antenna is turned until it gives no signal. The transmitting station is then in the direction at right angles to the plane of the coil. The apparatus has been developed to such an extent that in the hands of a person familiar with its operation it is as reliable a navigating instrument as the magnetic compass.

The Bureau of Lighthouses of the Department of Commerce has installed automatic radio beacon stations at certain of the lighthouses and light vessels. These beacons send out, intermittently in clear weather and continuously in bad weather, radio signals with a simple characteristic code. The code identifies the station, and lists are furnished giving the exact position of the stations. There are a large number of these beacon stations located along the Atlantic and Pacific coasts and on the Great Lakes, and more are being erected. To get his direction, the navigator tunes his receiving set to the proper frequency and then turns the coil until he gets a point of no signal, while a slight rotation in either direction brings in the signal. The position of the indicator then gives him the direction from which the signal is coming. When he has secured his direction with respect to two of these beacon stations, his position can be obtained by simple triangulation. In case radio beacon stations are not available, other shore stations or ship stations, the positions of which are known, may be used as radio beacons.

A radio beacon may be used as a course indicator in case the ship using a radio compass, is headed toward or away from it. In that case the course of the ship is kept in such a direction that the radio compass receives minimum signal when set with the indicator parallel to the axis of the ship.

In case a ship is in distress in bad weather, it may be difficult for the navigator to determine his position accurately, and so the position given along with the distress signal is often wrong. There have been several instances where a ship coming to the aid of another in distress has been unable to locate it at the position given. If the rescuing ship has a radio compass, it is only necessary for the ship in distress to send continuously; and by means of the radio compass the aiding ship can set its course and go directly toward the one in distress. This use

has been demonstrated repeatedly. In case of fog in busy ship lanes the radio compass can also be used to locate other ships and thus avoid collisions.

The United States Navy Department has established for its own use a somewhat similar system which it has made available to all ships. The Navy has located along the Atlantic and Pacific coasts a large number of radio compass stations on shore having the same type of radio compass as those on board ship. The stations are arranged in pairs, the two being located several miles apart, with one designated as the control station. In order to obtain its position a ship need only have a radio transmitting set. It calls the radio compass station and asks for its position. The two compass stations obtain the direction from which the transmissions come and then plot these directions on a chart. The position of the ship transmitting as thus ascertained is sent back to the ship by radio. The International Convention has designated 375 kilocycles (800 meters) as the frequency on which this service is to be given, protects this frequency from all other communications, and specifies the procedure by which the service shall be carried on.

Following the *Titanic* disaster the International Ice Patrol was established in the North Atlantic Ocean. At the season when icebergs begin to come into the shipping lanes of the North Atlantic the United States Government sends out ships to patrol the shipping lanes during the ice season and locate the icebergs. These patrol ships transmit by means of radio at definite times daily the position, rate and direction of drift, and any other pertinent information concerning icebergs which may come into the shipping lanes. This makes it possible for ships to alter their courses so as to avoid collisions.

Radio has also made possible an extension of medical service at sea. Many ships with relatively few men in the crew do not carry physicians. A definite procedure has been established whereby a ship without a physician may call one which has, and request medical advice. Treatment can thus be given to the sick under the direction of a physician.

AIDS TO AIR NAVIGATION

With the increase in the use of aircraft the applications of radio to safety of airplanes in flight were investigated. Here the use is similar to use in marine work, as it is the only means of communication between airplane and ground and between airplanes in flight. Information concerning weather, landing facilities, etc., given to airplanes in flight enables them to make proper choice of courses and landing fields. The Department of Commerce is establishing radio transmitting stations along the civil airways and will broadcast to airplanes in flight information concerning the weather and other information of interest.

The limitation of the carrying capacity of small airplanes is such that it is not usually possible to put a radio compass on board the airplane. Because of this and other difficulties inherent in such an installation, directive radio beacons have been developed. These beacons mark out in space a definite course. On board the airplane it is only necessary to have a receiving set and either a pair of headphones or an indicator, depending on the type of directive beacon used. One type gives a continuous dash when the airplane is on its course; when the airplane deviates from its course it receives a signal which is broken up into separate dots and dashes. More recent developments make possible the use of a simple indicator located on the instrument board of the airplane. This

connects to the output of the receiving set. When the airplane is on its course, the indicator shows two white marks of equal length. When the airplane deviates from its course, one line becomes shorter and the other longer. In order to return to the course the pilot need only turn in the direction of the shorter line of the indicator. These directive beacons which are very reliable, are being installed on the civil airways.

Other radio aids to air navigation are under development. Among these are devices to assist a plane in landing, radio altimeters which give the height of an airplane above ground instead of above sea level, and field localizers.

USE IN OTHER EMERGENCIES

Radio has also demonstrated its usefulness in case of emegencies. In time of great disasters, such as floods, hurricanes, etc., it is often the only means of communication with a stricken area. By means of radio, qualified persons in the stricken area are able to direct relief and give information concerning the distress.

In case of severe storms, when wire lines are broken down, radio provides means of emergency communication. it has been used by railroads for dispatching trains and by power companies for directing repair crews. Radio has been used by city police departments to direct their forces and also to broadcast information concerning criminals. This use was recognized by the International Radio Convention of Washington, in which provision was made for setting aside in Europe a frequency to be used only for the dissemination of information concerning criminals.

While the uses of radio are many, it is recognized by international treaty and by national law to be primarily useful as an agency for safety; and all other services must be arranged so as not to interfere with this major function. When new applications to safety are found, other services must yield to them.

Radio in the American School System

By J. J. TIGERT

President, University of Florida; until recently United States Commissioner of Education

TEN years ago the progressive school teacher gave a basket social and spelling bee to "raise money" to put a victrola into the schoolroom to be used for opening exercises, and the rudiments of music appreciation. Five years ago the up-to-date teacher gave a play, the proceeds from which supplied the school with a stereopticon lantern for visual instruction. This year, the modern rural school is installing a radio receiving set for use in a score of different ways, not only to supplement the work in the schoolroom, but to draw the community to the school as a center of interest.

And with radio about to bring sight as well as sound into those same schoolrooms, the possibilities for instructive value are more than doubled.

The schoolroom equipped with radio is not uncommon today, and while the larger cities expectedly have led with the installation of sets for experiment, many rural and consolidated schools have been quick to recognize their value.

Whether in their connection with elementary, secondary or higher education, educators, with few notable exceptions, declare their conviction that radio as a force in education will go much further in the future than it has progressed up to the present time. Most of the schools which have done anything with radio, either from the standpoint of broadcasting or receiving, label their efforts frankly as "experimental." But these experiments, as they take form more and more definitely, become increasingly valuable and interesting.

A questionnaire to state superintendents of public instruction in all states shows that New Jersey schools have installed the greatest percentage of receiving sets. Somewhat fewer than 50 per cent of the schools have sets, and the number is increasing rapidly. Nebraska apparently has the second largest number of receiving sets, placed at 25 per cent of the schools. In most other states, state superintendents replied that there were very few receiving sets used for instructional purposes, although the trend all over the United States is toward installation of sets, especially in the junior and senior high schools.

While the field of education, in its formal sense, has scarcely been touched by radio, most educators have very decided reactions as to its value—both present and future. The general concensus of opinion has it that while radio may be of use in the high school and even in the junior high school, it can be of little value in the first six grades.

Many educators go further, and declare that radio has no place in formal education, although all admit that its value as an entertainment and cultural feature is infinite. However, many would confine the efforts entirely to the home, restricting the field of the school entirely to the teacher. Mr. C. A. Howard, State Superintendent of Public Instruction of Oregon, declares that the "education of youth calls for self-activity" and places the big field of the radio in adult education.

"Radio in education has its greatest possibilities in the field of inspiration, interpretation, orientation and educa-

tional guidance," in the opinion of Dr. W. H. Lighty, Director of the Department of Extension Teaching of the University of Wisconsin, and Chairman of the Radio Committee of the National University Extension Association, which represents the largest state institutions in America. "It arouses and stimulates curiosity, breaking down error, prejudices and other evils through the broadening and illumination of men's horizons. It is this, rather than direct instruction, that is the big thing. Solid results in education are still as they always have been—a matter of achieving and not of receiving."

There are many other educators, however, who insist that the possibilities of the radio in formal education have only begun to be appreciated. The east and west coast states, especially their larger cities, desire only to be let alone. They are sufficient unto themselves, both in their superior teaching forces and in the material ordinarily used as supplementary. It is in the central and southern portions of the United States, where cultural resources are more limited, and where distances are great, that school administrators and teachers look to the radio for supplementary material in cultural and instructional fields.

MUSIC INSTRUCTION BY RADIO POINTS THE WAY

America's ever moving frontier has always carried music with it. In colonial days, singing schools were common, often with no other instrumental accompaniment than a tuning fork. Westward bound, pioneers carried the wheezy organ to the homestead shanty. And, naturally enough, the universality of the taste for music, together with the ease of its adaptability for broadcasting, made it one of the first developments for popular radio entertainment. It was a perfectly logical step from there to the conception that people needed to be taught to understand music, since the so-called "musical population" has numbered about one per cent in the cities, and much less, of course, in country districts, where, before broadcasting made it possible, good music was almost never heard, except on the concert, lyceum and chautauqua stages. These agencies, replaced by the radio as a means of cultural entertainment superior in most ways, are undoubtedly declining.

Last year the Radio Corporation of America outlined three programs for music appreciation, which were broadcast by Walter Damrosch and his orchestra. The success was sweeping and this year a series of twenty-four educational orchestral concerts are being broadcast. Mr. Damrosch, himself, outlined the lessons, which are especially designed for particular grades, and include a definite study of instruments. A series of questions, with answers, sent out to teachers, supplements the program so that the teaching may be more adequate, and the results more definitely beneficial. Twenty-eight stations, the Blue Network and associated stations, are broadcasting the series during school hours. The radio audience for these orchestral concerts is estimated at twelve to fifteen millions of children of school age.

Damrosch said in a recent newspaper release:

> If I could bring the "little red schoolhouse" all over the country within the sphere of our activities, I should consider it the crowning arch of our building.
>
> I confidently hope that the proposed educational concerts will lay the foundation for a nation-wide perception and love of music among the youth of America, the like of which in its scope and importance has never been seen before.

The effort of the Radio Corporation of America at formal musical education is among the earliest which have been made. Although there is a great mass of material broadcast from the stations of the United States, both commercial and institutional, which may be called instructive and informative, little of it is what is called by the profession, "formal education." In other words, virtually none of the material is adapted to use in the classroom.

"AGGIE" AUDIENCE BENEFITS BY INFORMAL BROADCAST

The service rendered their communities by the agricultural and mechanical college over the radio stations is probably the most definitely valuable of all educational efforts, whether the college is a part of the university or a separate institution. There are three main reasons for this. First, the type of information disseminated lends itself readily to informal lectures, which are immediately and practically usable, without a basis of college credit as consideration; second, the audience which is interested in this information is definite, numerous and comparatively stationary; third, certain features of the program, such as market reports and weather forecasts are so immediately necessary as to have actual monetary value to a great proportion of the audience.

The United States Department of Agriculture, by sending its timely printed material to the various broadcasting stations, assists appreciably in making the programs universal in appeal, while direct telegraph service to certain of them lends prestige and value to their programs.

Iowa, Kansas, Oregon and South Dakota are among the states whose agricultural colleges are broadcasting programs of a nature calculated to interest the farmer and certain groups of mechanical men, who may be held by lectures on subjects of concrete importance to their daily work.

A LESS TANGIBLE FIELD IS OPEN TO UNIVERSITY STATIONS

The field of education which is covered, then, by the agricultural and mechanical college is concrete, and considerably more tangible in its entirety than that which must be covered by the university without the agricultural college. Some indicative facts concerning work at many of our universities and colleges are revealed in the following information, based on replies to questionnaires returned from these institutions.

The Ohio State University broadcasting station, WEAO, has built its service around the lecture, using it to form the backbone of every program. During the spring quarter this year, as a new feature, entire courses were broadcast directly from the classroom, giving the radio audience at first hand exactly what was going on in the classroom at the University.

The University of Iowa has offered some courses by extension over the radio, giving lectures once a week, with an examination at the end of the course. Alabama Polytechnic Institute broadcasts technical short courses as an educational feature, but did not regularly enroll students for them. The University of Minnesota, after attempting courses in foreign languages, has discontinued the practice. Many "listened in," it was found, but few enrolled and paid their fees. Again, reception was found to be too uncertain. Nebraska Wesleyan enrolled 130 students in the first formal course which it offered. Of these, 80 completed the course, and received certificates of award. Examinations were given on the honor system.

South Dakota State College, among

others, plans to offer a "college on the air" course this year, in which regular enrollment will be encouraged, and certificate awards made.

The double nature of the new State and University Station of Florida permits any informational material of the state departments to be broadcast, as well as the educational program of the university and other state institutions of higher learning, administered by the same Board of Control.

Very few colleges and universities which offer formal instruction (unless it is simply to supplement correspondence courses) approve of giving credit for work done, because they find that few students are able to follow the course through in its entirety. This certainly is due to some extent to uncertainty of reception; and usually when college credit is given for work done in radio courses, very complete check is kept by mail.

The general opinion of colleges and universities where there are broadcasting stations, however, is that informal lectures, without credit award, are still all that is suitable for radio instruction.

UNIVERSITY-OWNED STATIONS

Virtually every college which has a broadcasting station considers its expenditure warranted. The budgets range from $25 to $12,000 a year. In the former case, however, the money from the college fund is supplemented by Chamber of Commerce donations. Usually the budgets appear pitifully small.

Money for maintenance of stations is frequently found in the budgets of the University Extension Divisions or Publicity Departments. In some cases the radio station is maintained by a special radio fund, found in the university budget. Wherever the radio station fund may be found in university budgets, it appears to be insufficient to enable educational stations to compete with the commercial stations, because these stations are usually backed by big business for advertising purposes, or are selling advertising, which materially contributes to their support. Selling advertising is not yet considered ethical for the strictly university station.

Some of the college broadcasting stations have been gifts from friends or organizations. A few have been authorized by their states, and built with funds appropriated especially for that purpose. In rare instances, the colleges of engineering, extension divisions or publicity departments have had sufficiently generous budgets for building radio stations. In Florida the budget for both the building and maintenance of the State and University station was made entirely separate from the regular university appropriations, and seems to have many advantages as a result of this plan.

UNIVERSITY PROGRAMS ON COMMERCIAL STATIONS

A number of prominent universities and colleges have broadcast their programs over borrowed commercial stations. This, however, has not always proved satisfactory, because the commercial stations themselves are sometimes so limited by the Radio Commission as to find it necessary to discontinue lending time.

One handicap which the educational station must consider, and which does not admit of easy solution, is that of the daylight broadcast. As the result of the study of the programs of twenty-seven leading broadcasting stations of the country, Mr. George H. Zehmer, Director of Extension of the University of Virginia, announced before the last meeting of the National University Extension Association:

It seems to be pretty generally conceded that the best radio hours for general educational programs are from around seven o'clock to nine or ten o'clock in the evening. A study of the programs submitted indicates that in many instances the value of these hours for purposes of education are largely disregarded in planning programs. The hours assigned advertising generally are the most desirable periods of the radio day. The educational talks which were given in the evenings during the periods indicated were obviously sandwiched in between most of the programs which were devoted to advertising.

Educational material is necessarily of restricted interest, and the more formal the lecture, the more limited is its scope. The only possible substitute is the so-called informal lecture, sugar-coated with a variety of scientific facts unusual enough, and yet common enough, to catch the interest and intrigue the imagination of the casual listener. Unfortunately, this handicap will continue, and will limit considerably the educational program of any station. No educational station, however ambitious and earnest may be its aim, will dare, under present conditions, to broadcast, any evening, an instructional program of more than an hour in length.

Recent decisions of the Federal Radio Commission handicap educational stations by daylight broadcasts, division of time, and undesirable wave lengths. Educators are chafing under this restraint, believing that big business has brought about the impression that the general university station cannot render a service distinct from that of the commercial station.

USE IN THE PUBLIC SCHOOLS

The public schools of the country, despite the fact that the university and college stations have not been able to work out a definite, coöperative program of any magnitude for them, have, nevertheless, realized some of the possibilities of radio.

There is a surprisingly small number of high schools with broadcasting stations, usually operated in an effort to keep in touch with the school patrons. A few school systems have put in small sets for direct communication among its units, while a large number have receiving sets to pick up whatever the university and commercial stations can give them.

The experiment in radio instruction in the public schools of Oakland, California, yields most interesting and valuable information for the subject in hand.

About ten of the Oakland schools had radio sets installed for the project, two of the schools having a complete system of radio connected with all of the rooms.

The purpose, according to Mr. Virgil E. Dickson, director of the experiment, was

> to see if we could develop actual classroom instruction in which pupils in widely distributed centers of the city would participate. . . . To develop demonstration lessons for teachers to observe children in directed activities as nearly as possible parallel to regular classroom procedure. We wanted to know if anything approaching a common classroom lesson could be sent over the air to many classes at once.

As early as May, 1924, the committee began planning the work. The subjects selected for the first series of eight demonstration lessons of twenty minutes each, were English, counseling of classes going into high school, geography, literature, history, arithmetic, penmanship and physical training.

A member of the committee visited each schoolroom where students were participating in the lesson, to make observations. After each lesson, the committee compared notes and made

efforts to improve the next unit of the experiment.

The first trials were considered successful, and the work was continued in the fall, when a series of fifty-six lessons, covering vocational counseling, how to read a book, drawing, penmanship, science, singing, thrift, composition, arithmetic and manual activities were broadcast, and careful tabulation made of results. Each lesson was adapted for a particular grade, ranging from the fifth to the tenth.

It is perfectly possible to get reception so that a class of any reasonable size can hear every word and every direction of the instructor who is broadcasting, Mr. Dickson reports. It is also possible, he says, to plan a lesson that will interest, and keep active, any number of classes that have been properly prepared for its reception. The experiment proved that certain lessons taught before the microphone produce class and individual results that cannot be distinguished from those gained by the same instructor teaching in person before the class.

The replies to a recent questionnaire to educators in large school systems indicate that music appreciation and current events are popularly believed to be about the only subjects which are readily adapted to radio teaching. The Oakland experiment, however, shows, unexpectedly enough, that art and arithmetic are among the subjects which lend themselves most readily to successful treatment in radio lessons. These facts lead one irresistibly to the conclusions that radio instruction has not even begun to develop, and that subjects will not be restricted to the narrow fields which have generally been considered necessary.

Here, then, is the answer to those who maintain that formal education in the grades cannot be had by radio. Experiments such as the foregoing are bound to be supplemented in other parts of the country. The great difficulty to date has been that no one has given attention, first, to the scientific development of the lessons, and second, to the definite checking of results. It has been practically impossible to say whether formal education could be successful by radio, largely because most of the efforts at instruction have been purely informal. There seems to be no reason why radio instruction, too, should not be based on the "self-activity" necessary to the education of youth.

Benton High School at St. Joseph, Missouri, is equipped with apparatus under direct control of the principal. The central set is in the office of the principal, with a fifteen-inch loud speaker connection in each room. A microphone permits him to make announcements, and the teacher can reply by means of the loud speaker, which also acts as a microphone. There is a victrola attachment for playing records, which may be broadcast to any room at will.

The central set is tuned in at the principal's office, and at the proper moment, by the turn of a switch, all rooms are cut in on the program, with perfect reception for small groups, under teacher control, and with no loss of time.

At present, most high schools are not equipped with receiving sets because there is little material being broadcast during school hours which can be used to supplement the regular curriculum. School men state that when the college and university stations supply work of use to them, they will install radio receiving sets. However, until schools install the receiving sets and make it possible, universities and colleges probably cannot afford to put on an elaborate experimental educational program. The public schools and universities

must get together on a coöperative plan for satisfactory experimental work.

To assist in the promotion and development of radio in education, the college and university broadcasting stations have banded themselves together in an association, headed by Dr. Arthur M. Harding, Director of University Extension, University of Arkansas.

The purpose of this organization as expressed by its constitution is to "promote by mutual coöperation and united effort the best interests of those college and university stations which are members of the organization, to the end that both the technical and educational features of broadcasting may be properly safeguarded and extended."

The fact that the development of radio in education presents great difficulties certainly is no excuse for educators to evade their responsibility. Radio, as a present force in education, is an actuality. But, more important, radio, as a future force in education, is a potent possibility.

The International Regulation of Radio in Time of Peace

By Irvin Stewart, Ph.D.

Associate Professor of Government, University of Texas; Technical Adviser to the American Delegation to the International Radiotelegraph Conference of 1927

THE fact that radio waves travel without regard to national boundaries makes international regulation indispensable. The chief reason for the earliest international regulation was not this characteristic, however, but the refusal of some radio companies to permit stations employing their apparatus to receive messages from stations employing competing systems. For instance, Marconi instruments were installed upon the condition that they should not be used to communicate with stations equipped with instruments of other manufacture. Even messages relating to obstructions to navigation were refused because of the wireless system employed by the stations sending the messages.

The Preliminary Conference of 1903

As rivalry between private enterprises limited the usefulness of radio, the Governments concerned recognized the necessity of reaching an agreement relative to the principles upon which regulation should be based. A preliminary conference met in Berlin, August 4–13, 1903, to draft the basis of a convention to be submitted for the consideration of the various governments. Germany, Austria, Spain, United States, France, Great Britain, Hungary, Italy, and Russia were represented. All of the participating states, except Great Britain and Italy, favored the adoption of the principle that communication could not be refused solely because of differences in the wireless systems employed.

The Italian Government was bound to use the Marconi system exclusively for a period of years by a contract which prevented the adoption of the principle of intercommunication between systems. The Italian delegation vigorously opposed the adoption of that principle and as an alternative, proposed the temporary world-wide adoption of the best developed single wireless system—which was believed to be the Marconi system. Failing in the attempt to obtain the world-wide adoption of the Marconi system, the Italian delegation maintained that upon the adoption of the principle of intercommunication, provision should be made for the indemnity of existing wireless systems of high order. The British delegation opposed the requirement of indemnity but advocated a surcharge on messages exchanged with systems which had not reached the highest stage of development. The other delegations strenuously opposed both the indemnity and the surcharge, and no such arrangement was incorporated into the draft convention.

There was unanimous agreement that the convention should be limited to traffic exchanged between coast stations and ship stations. It was pointed out that the time was not ripe for the regulation of communication between coast stations and that communication between ship stations was of comparatively little importance and

would be exceedingly difficult of regulation.

The final protocol, as signed by all of the delegations except those of Great Britain and Italy, provided that coast stations open to general telegraph service were bound to receive and to send telegrams originating on or destined to ship stations without regard to the wireless system employed by the latter. Each government was to publish all technical information of a nature to facilitate communication between coast stations and ships at sea. A general basis for the determination of rates was laid down. Priority for distress calls was provided and provision made that the service of stations should be organized, so far as practicable, in such a manner as not to interfere with the service of other stations. Stations not open to general telegraph service were to be bound only by the provisions regarding distress and interference. Detailed provisions covering the exchange of traffic were to be provided in general regulations.

The British delegation made a general reservation, as well as specific reservations to those provisions requiring intercommunication regardless of system and requiring the service of stations not open to general telegraph service to be organized in such a manner as to minimize interference.

The Italian delegation signed a declaration stating that it could adopt the principle of intercommunication only as between systems of highest development. Reservation was also made on other clauses conflicting with the Marconi contract.

THE BERLIN CONFERENCE, 1906

The final protocol signed at the preliminary conference served as the frame for a draft convention and regulations presented by the German Government as the basis for the deliberations of the International Conference concerning Wireless Telegraphy which opened in Berlin October 3, and closed November 3, 1906. Thirty states participated in the work of the conference.

Early in the proceedings, the British delegation provisionally accepted the principle of intercommunication between coast stations and ship stations without distinction of system.

The Italian delegation informed the conference that Italy was bound by the contract with Marconi but that the delegation would propose that Marconi be requested to agree to the modification of the contract where necessary or advantageous to facilitate international agreement.

The greater part of the convention adopted by the conference applied only to stations (coast stations and ship stations) open to public correspondence between the shore and ships at sea. British acceptance of the convention was obtained by the insertion of a provision in the final protocol that each government might designate certain coast stations exempt from the obligation to communicate regardless of system, on the condition that one or more coast stations, assuring a satisfactory service of public correspondence in the region, should be bound by the obligation. Eighteen of the twenty-seven states signing the convention stipulated in the final protocol that they did not avail themselves of this exception.

The United States delegation proposed to extend the obligation to communicate regardless of system to communications between ship stations open to the service of public correspondence. Considerable support was mustered for this proposition; but the British delegation stated flatly that it had been instructed not to sign the convention if such a provision were con-

tained therein. To meet the situation created by the position of the British delegation, the United States proposal was placed in an additional article, which was signed by all of the signatories of the convention with the exception of Great Britain, Italy, Japan, Mexico, Persia, and Portugal. That twenty-one states should agree in 1906 to a regulation thought undesirable in 1903 is an indication of the progress of radio in the interval.

The draft convention provided that each government should have a single vote in future radio conferences. In opposition to this provision, it was pointed out that in the administrative conferences of the Telegraph Union and of the Postal Union, each administration had one vote. Great Britain proposed that where different administrations pertained to the same government, each administration should be considered, upon request, as a country, provided that the number of votes at the disposal of a single government should not exceed seven. The proposal was supported by the assertion that it was to the advantage of the conference to have colonies adhere to the convention, and such adherence was doubtful if the colonies were not given the right to vote. The British proposition was opposed on the ground that the number of votes to be cast by a government should not depend upon the internal organization of that government.

The problem of voting was discussed for the entire conference. The provision finally adopted was that when a state adhered to the convention for its possessions, later conferences should decide whether the possessions, singly or together, should have a vote, with the maximum number of votes of a single government fixed at six. The final protocol outlined the procedure to be followed in requesting votes.

To facilitate the exchange of information relative to radio and to provide for the administrative work incident to international regulation, the International Bureau of the Telegraph Union was made a central office for radio.

The primary objects sought to be attained by the Berlin Convention were: (1) establishment of the principle of intercommunication without regard to system employed; (2) the greatest practical elimination of interference between stations; (3) opening of radio services to the public upon reasonable terms; and (4) adequate provision for the assistance of vessels in distress. These objects have persisted through subsequent conferences; changes have been directed largely toward means to achieve the desired objects rather than to the objects themselves.

The convention was completed by regulations containing detailed provisions designed to make it effective. As was to be expected, the development of radio caused these regulations to become antiquated while most of the basic convention articles continued satisfactory. The greater part of the proposals for amendment which confronted the International Radiotelegraph Conference of London, June 4–July 5, 1912, related to the regulations.

THE LONDON CONFERENCE, 1912

The most important change in the convention made by the London Conference related to its scope. Due to changed conditions, Great Britain, Italy, and Japan announced early in the conference that they were prepared to accept the principle of intercommunication between ship stations regardless of system; and that principle was therefore embodied in the text of the 1912 convention. The convention was further enlarged to forbid

fixed stations (stations for service between fixed points) to refuse to exchange messages because of differences in system, though each country was left free in organizing the service and determining the correspondence of such stations.

As in the Berlin Conference, the most difficult non-technical problem confronting the London Conference was that of determining the basis of voting. Pursuant to the final protocol to the 1906 convention, Germany had claimed on behalf of its colonies, 8 votes; Belgium, 1; France, 5; Great Britain, 5; Japan, 1; Netherlands, 2; and Portugal, 2. These requests were granted by the conference. Requests made on the floor of the conference by the United States, Russia, Italy, and Turkey for additional votes were refused as not having been made in accordance with the provisions of the protocol.

After prolonged debate the matter of distribution of votes for the succeeding conference was finally decided at the session of July 8. Designated dominions, colonies, etc., were declared to be countries for the purposes of the application of the article on voting. Under the article as adopted, Germany, United States, France, British Empire, and Russia received 6 votes each; Italy, Netherlands, and Portugal 3 votes each; Belgium, Spain, and Japan, 2 votes each; and the remainder of the contracting states, 1 vote each.

The 1912 regulations differ extensively from those of 1906 in the attempt to keep pace with the development of radio.

At the time the London Convention and Regulations were adopted, it was expected that a conference to be held in Washington in 1917 would continue the process of development. But 1917 found the world at war; and it was not until 1927 that the Washington Conference met.

THE SAFETY OF LIFE AT SEA AND AIR NAVIGATION CONVENTIONS

Between the London and Washington Conferences there were two other conferences whose labors involved some regulation of radiotelegraphy. The first of these was the International Conference on Safety of Life at Sea, as a result of whose labors the International Convention for the Safety of Life at Sea was signed on January 20, 1914. That conference discharged a duty to which the 1912 conference had found itself incompetent in imposing the obligation to install radio equipment on vessels of certain categories. The radio provisions of the Safety of Life at Sea Convention were closely interrelated to the relevant parts of the London Radio Convention. The regulations annexed to the convention contain detailed provisions relating to the part to be played by radio in the safety of navigation. The international conference to be held in London in 1929 to revise the Safety of Life at Sea Convention will doubtless make the radio provisions of that convention and regulations responsive to the provisions of the most recent radio convention and regulations.

The Convention for the Regulation of Aerial Navigation signed at Paris October 13, 1919, provides for the licensing of radio apparatus carried on aircraft and lays the foundation for a requirement compelling certain types of aircraft to be fitted with radio apparatus. The radio provisions of the convention and annexed regulations are not nearly so detailed as are those of the Safety of Life at Sea Convention.

THE WASHINGTON CONFERENCE, 1927

The scope of the convention drafted by the International Radiotelegraph Conference which met in Washington, October 4–November 25, 1927, is

wider than that of the preceding conventions. Its provisions are designed to apply to all radio communication stations open to the international service of public correspondence. In addition to the stations covered by the London Convention this includes aircraft stations and stations engaged in communication service between countries. The convention, which had seventy-eight signatories, became effective January 1, 1929.

The standards set in the new convention are higher than those in the earlier ones, responding to the advance in the radio art. Stations covered by the convention must, so far as practicable, be established and operated under the best conditions known to the practice of the service and must be maintained abreast of scientific and technical progress.

As in the two preceding radio conferences, the determination of the basis of voting caused great difficulty. The principle of multiple votes was challenged by a number of delegations at Washington; at the same time the number of countries demanding multiple votes was greatly increased. Unable to solve the problem, the conference passed it to the foreign offices by omitting all mention of votes from the convention. It is hoped that the solution will be reached through diplomatic negotiations before the next conference meets in Madrid in 1932.

The Washington Convention is accompanied by two sets of regulations: general regulations containing provisions for carrying the convention into effect, and supplementary regulations, containing additional material to which the United States, Canada and Honduras could not subscribe. The supplementary regulations deal largely with rates, the relation between the Radio Convention and the Telegraph Convention, and procedure in radiotelephony.

The general regulations contain a thorough revision of the London Regulations, to bring them abreast of the radio art without stifling future progress. In several major respects they differ from the London Regulations: for the first time there is an allocation of frequencies to types of service; there is definite provision for the regulation of radio service with aircraft; provision is made for the eventual prohibition of the use of damped wave apparatus; special services are defined and regulated to a greater extent than before; the rights of amateurs are recognized; the basis is laid for the regulation of radiotelephony; and provision is made for an International Technical Consulting Committee of a purely advisory character.

The most serious danger involved in the international regulation of radio is that some conference may indulge in a type of regulation which will hamper the progress of the art. Thus far, the danger has been recognized, and ample freedom has been left for development. Should some future conference so far forget the proper scope of its labors as to depart from this practice, the result must inevitably be chaos.

The Division of Radio Services of the International Bureau of the Telegraph Union *

By Ernest Rusillon

Secretary, International Bureau of the Telegraph Union

THE International Telegraph Union has maintained since 1868 a central office, the "International Bureau of the Telegraph Union," with its seat at Berne, under the authority of the chief administration of the Swiss Confederation. This bureau is charged with the duty of collecting, combining and publishing information of every kind relative to international telegraphy, of circulating in due form requests for modifications of the tariffs and service regulations annexed to the international telegraph convention, of announcing the changes adopted, and, in general, of undertaking all the studies and carrying out all the tasks assigned to it in the interests of international telegraphy.

Draft of 1906

The draft of the International Radiotelegraph Convention of Berlin, 1906, provided likewise for the creation of an international bureau having, for radiotelegraphy, duties similar to those of the International Bureau of the Telegraph Union. The Berlin Conference of 1906 taking into consideration the fact that the radiotelegraph service is, in the final analysis, only an extension of the telegraph service, and that it would be more economical to attach the new central organ to the already existing Bureau, adopted the following solution:

> The International Bureau of Telegraphs [the present International Bureau of the Telegraph Union] shall be entrusted with the duties specified in Article 13 of the Convention, subject to the consent of the Government of the Swiss Confederation and the approval of the Telegraph Union.

(The duties outlined are similar to those of the central organ of the telegraph union.)

The consent of the Swiss Government and the approval of the Telegraph Union having been obtained, the new organ was attached to the International Bureau of the Telegraph Union and began to function early in 1907, *i.e.*, before the coming into force of the Berlin Convention of 1906—set for July, 1908—in conformity with the desire of the conference which had instituted it. Today it is the organ of the 105 parties to the international radiotelegraph convention.

Duties and Activities

The Washington Convention, which became effective January 1, 1929, defines the rôle of the central office as follows:

> Art. 16, §1. The International Bureau of the Telegraph Union shall be charged with collecting, coördinating, and publishing information of all kinds relative to radio services, with examining the requests for changes in the Convention and the Regulations annexed thereto, with promulgating the amendments adopted, and generally with performing all administrative tasks with which it shall have been charged in the interest of international radio services.

* Translated from the original French by the editor of this volume.

As a matter of fact, the International Bureau may not examine requests for changes in the international radiotelegraph convention and regulations as the question of the right to vote was not settled at Washington.

The greater part of the duties of the central office are stipulated in detail in the general regulations annexed to the Washington Convention. They are chiefly the following, having varied little since the beginning:

The International Bureau prepares for the radiotelegraph conferences by assembling, translating where necessary, coördinating and publishing the proposals which administrations and companies desire to submit to these conferences. Ordinarily acting as the Secretariat General of the conferences, it prepares the *procès verbaux* of the plenary sessions and provides for their printing as well as that of the reports of the various committees. It publishes, after each conference, the collection of its documents, as well as the convention and regulations. The Director of the Bureau assists in the sessions of the conferences and takes part in debates, but without the right to vote.

The bureau is called upon for its opinion on questions of interpretation of the radiotelegraph convention and regulations, but the opinion is not binding upon the parties.

It publishes the following documents:

(a) Nomenclatures of all fixed, land and mobile stations having a call signal from the international series, whether or not open to public correspondence, as well as a nomenclature of broadcasting stations.

(b) An alphabetical list of call signals of all fixed, land and mobile stations assigned a call signal from the international series.

(c) Notices and information for the use of central administrations.

(d) A table and a chart indicating the zones and the hours of service of ships not operating a continuous radio service.

(e) General statistics relating to radiotelegraphy.

(f) Opinions issued by the International Technical Consulting Committee on Radio Communications.

(g) Charts of radiotelegraph stations.

All of these documents are sold to administrations, companies and individuals at cost.

Moreover, the bureau collaborates in the publication of the *Telegraph Journal* established by the international telegraph service regulations. In addition, it makes an annual report of its activities which is communicated to the administrations of states parties to the International Radiotelegraph Convention.

EXPENSES

The expenses resulting from these activities are borne by all the contracting governments. In the apportionment of expenses, the governments are divided into six classes, each contributing in proportion to a certain number of units, as follows:

First class	25 units
Second class	20 units
Third class	15 units
Fourth class	10 units
Fifth class	5 units
Sixth class	3 units

The administrations inform the International Bureau of the class in which they wish their countries to be placed.

The coefficients above are multiplied for each class by the number of states in the class, and the sum of the products thus obtained furnishes the number by which the total expense must be divided, to determine the amount of the unit of expense.

The expenses of the International Bureau resulting from the radio service

must not exceed 200,000 gold francs per annum, not including expenses pertaining to the work of conferences and expenses pertaining to the work of regularly constituted committees when, according to the provisions of the general regulations or the decision of a conference, these expenses are to be borne by all of the contracting states.

The chief administration of the Swiss Confederation is charged with the organization of the Division of Radio Services of the International Bureau; it exercises supervision over the division, controls its expenses, makes necessary advances and makes the annual accounting. This accounting is communicated to all of the other administrations.

The accounts of the International Bureau as well as the reports of its activities, are also submitted for the approval of the conferences.

As a matter of information, the following table gives for several years the amount of the expenses of the central organ, to which was allocated a credit of 40,000 gold francs at first—a credit which was increased to 80,000 gold francs in London in 1912. These figures do not include expenses pertaining to the conferences.

1907	4,018 francs
1910	19,620 francs
1915	66,450 francs
1920	75,416 francs
1925	136,444 francs
1926	146,577 francs
1927	161,340 francs

The personnel, under the authority of a single director for telegraph and radio, comprises for the latter service a vice-director, a secretary and three other officials. In addition, the two services use four agents in common. Supplementary assistance is engaged whenever need for it arises.

Army Radio in Peace and War

By William R. Blair
Major, Signal Corps, United States Army

IN his annual report for the fiscal year 1897 and 1898, the Chief Signal Officer, General A. W. Greely, makes the following statements:

The policy pursued in the past by the Chief Signal Officer in experimental work along lines of prospective value to the Army has naturally been interrupted by the war. Nevertheless, it has progressed as far as existing conditions have permitted. Colonel James Allen has devoted much attention to the system of wireless telegraphy with a view to adopting a suitable system whenever the progress of invention and the conditions of the military service shall warrant such progress.

Experimental Communication

The following year experimental communication by "wireless" was established by the Signal Corps of the Army between Fire Island and Fire Island Light Ship, a distance of 12 miles. In April, 1900, radio stations were installed by the Army at Governor's Island and at Fort Hamilton, and a daily communication schedule established. Later in 1900 a similar radio circuit was put in operation between Fort Mason and Fort Alcatraz, San Francisco Harbor. These installations were made under the direction of Lieut.-Col. James Allen and Capt. George O. Squier, each of whom later became Chief Signal Officer of the Army.

Difficulty was experienced by the Signal Corps in maintaining its submarine cable across Norton Sound between Nome and St. Michael. This cable, which formed part of the Alaskan Telegraph System, was invariably carried away when the ice broke up in the spring. Because of the success of the radio circuits established in the New York and San Francisco Harbors it was decided to employ radio in place of this cable. A contract was let for the required radio installations, but the contractor was unsuccessful. In the later part of 1902 the Signal Corps undertook to make these installations itself and in August, 1903, the system was placed in successful operation. This is one of the first long distance radio circuits to regularly handle commercial telegraph business. The distance between the two stations is approximately 110 miles.

Rapid Increase

The use of radio by the Army for communication between fixed stations and between ship and shore stations increased rapidly, so that by 1912 there were in operation by the Army 36 fixed stations and 26 ship stations, the latter distributed as follows: 14 transports, 3 cable ships, and 9 Coast Artillery tugs. The fixed stations ranged in power from one to ten kilowatts and were located in the United States, Alaska, Cuba and the Philippine Islands.

At the present time the Army is operating a total of 208 radio stations, 107 of which are fixed stations located at Army establishments throughout the United States, the foreign departments and China. Thirty-three are fixed stations of the Alaskan Communication System maintained by the Army. Sixty-eight are ship stations. The Army carries on practically all types of radio communication over the cir-

cuits established by means of these stations, including point to point, ship to shore, ground to plane, intership and interplane communication. Army stations are equipped to operate on low, intermediate or high frequency, depending on the length and type of circuits established.

ARMY DEVELOPMENT OF RADIO COMMUNICATION

These Army radio stations not only provide means of essential communication between Army posts including channels of command throughout the Army, but they serve as a laboratory in which radio equipment, personnel and methods of procedure may be tested and improved. It has also occurred on a number of occasions when interruption of wire communication resulted from floods, storms, or other unusual phenomena, that Army radio circuits have supplied the much needed communication facilities. Within the past year or two such essential service has been rendered in the region of the lower Mississippi, Omaha, New England and in Florida. Army radio circuits are also made available to other Government departments. It is estimated that approximately 40 per cent of the traffic handled on these circuits originate in other departments of the Government.

From the earliest time the Army has been a pioneer in the development of radio as a means of communication, and more especially in the development of radio equipment for use by military forces in the field. The design of field radio equipment is complicated by the fact that such equipment must be portable, the more easily portable the better. It was not until 1906 that the first successful field radio equipment was built. Two types of portable stations were designed: a wagon set and a pack set that could be carried on three animals. By 1908 the Army was well supplied with these radio sets and had tested them under actual combat conditions in Cuba and in the Philippine Islands. These first portable sets were of the induction coil type. They were soon abandoned for quenched gap spark sets operated by 500-cycle alternators. The spark type of installation was adopted in 1911. The pack and wagon sets continued to be the two types of portable Army radio equipment until our entry into the World War.

During the World War there was intensive development along all lines that appeared to make for the success of armies in the field. Radio was not overlooked in this development. The armies of all powers involved, our own included, were quick to recognize its value and to expend funds and energy lavishly in scientific radio research. One of the biggest improvements which resulted was the design of more sensitive receivers by using vacuum tube detectors and amplifiers. Another was the development of the transmitting vacuum tube and the design of vacuum tube transmitters. The two types of portable equipment heretofore employed by the Army were no longer adequate, either from a tactical point of view or as radio apparatus. The tactical use of radio lead to the equipment of smaller tactical units with low-powered, short-range sets, the next larger units were given sets somewhat higher powered and longer range and so on. Radio for aircraft was designed and came into general use. The need for many types of radio sets became apparent.

LABORATORY WORK

The research organization set up by the Army during the war included radio laboratories at Camp Alfred Vail, now Fort Monmouth, N. J., the Signal

Corps Laboratory at the Bureau of Standards, and the laboratories and Field Test Section of the American Expeditionary Forces. The work of these laboratories was, of course, supplemented by commercial companies working under contract. A rather comprehensive program of research and development was carried out by this organization. Many improvements were made to available radio equipment and much new equipment was designed. The Armistice found us near the completion of the program which included a series of radio sets specially designed to meet the requirements of our Army. The time was so short, however, that very little of this new equipment had at that time been produced and placed in the hands of troops.

During the demobilization period, research and development work in radio as well as along other lines practically ceased. The war experience had, however, clearly demonstrated the possibilities of radio as a means of communication between headquarters in the field as well as the need for continued research and development in order to keep pace with progress in the radio art.

The design of radio equipment for use by troops in the field presents problems very different from those encountered in the design of fixed station or ship radio equipment. The requirements of portability, ruggedness, power and range limitations, are peculiar to their military use. This, together with the fact that the amount of such equipment needed by the Army in time of peace is small from the point of view of commercial production, hardly justifies commercial companies in voluntarily undertaking the design and development of such equipment. It seemed wise, therefore, to continue the Signal Corps Radio Laboratory at Fort Monmouth, N. J. In addition to the Fort Monmouth Laboratory, the Signal Corps Aircraft Radio Laboratory at Wright Field, Dayton, Ohio, has been organized especially for the design of radio equipment for use on and by aircraft. This laboratory has been located at Wright Field because of the facilities afforded there for the testing of new equipment. An important adjunct of the Signal Corps Aircraft Radio Laboratory is its flying laboratory. The flying laboratory is installed in a three-motored cabin plane which affords plenty of space for flight tests of experimental layouts of all types of radio and auxiliary equipment needed on planes.

These laboratories make a continuous study of all radio equipment in use in the Army with a view to its improvement as the art progresses, in addition to keeping efficient modern radio equipment in the hands of troops. Much of the results of radio development in the Army is available for civil or commercial use. Among these by-products of military radio development, two or three may be mentioned as indicative of the value of the research work done by the Signal Corps of the Army to the radio art in general. During the war development was begun on a very light portable high frequency radio set for use by lower units in the field. The development of this set was soon successfully completed in the laboratory at Fort Monmouth and shortly afterwards put in the hands of troops. This is one of the first pieces of practical high frequency radio equipment working above 4,000 Kcs. This, together with the early work of Army radio personnel in the high frequency field, contributed greatly to the progress of high frequency radio. Radio equipment for use on airplanes developed by the Army has been given careful consideration both by the Depart-

ment of Commerce and by commercial companies as a basis for the equipment of planes flying the civil airways. The SCR-134, a combined telegraph and telephone transmitting and receiving set, has been found especially adaptable to commercial use.

The equi-signal radio beacons installed by the Signal Corps of the Army at Crissy Field and in the Hawaiian Islands were placed at the service of the participants in the Dole flight from San Francisco to the Hawaiian Islands and were employed by Mr. Goebel throughout his flight. It is an interesting fact that of the two planes completing the course, the slower plane following the great circle course marked by the Army beacon was the first to reach the Hawaiian Islands. This type of beacon is the result of a number of years' research and development work in the Signal Corps Aircraft Radio Laboratories at McCook and at Wright Fields near Dayton, Ohio. The Department of Commerce has had a number of these Signal Corps radio beacons built and installed on commercial airways as aids to air navigation. Other illustrations might be given of how the results of radio research and development by the Army have been made available for civil and commercial use.

Much improvement in radio equipment and method of operation still remains to be made in order to get maximum communication efficiency in the use of the radio spectrum. Recognizing this, the Signal Corps of the Army is continuing to maintain and improve its research and engineering laboratory facilities. The fact that many of the problems involved are physical rather than engineering has lead to the recent establishment of a physical research section in the laboratories. The effect of the work of this section in the general laboratory output is already making itself felt.

Naval Radiotelegraph in Peace and War

By CAPTAIN S. C. HOOPER[1]

United States Navy, Director of Naval Communications; Technical Advisor to the American Delegation to the International Radiotelegraph Conference of 1927

IN handling the subject I will divide the article into two parts. The first will be a brief discussion of the application of radio to the Navy. In this part the treatment will be based on the United States Navy, although it can be understood that in its essentials it applies to any navy. The second part will contain a review of international law as it exists with respect to radio.

FUNCTIONS AND SERVICE

Naval radio functions under the Naval Communication Service. Its activities are coördinated with those of other departments of the Government by the Interdepartment Radio Advisory Board and conform to the International Radiotelegraph Convention of 1927, of which the United States is a member. In this connection I draw attention to Article 22 of this Convention. This article allows the contracting governments

entire liberty regarding radio installations not covered in Article 1, and especially with reference to Naval and Military installations.

The article directs compliance, in so far as practicable, with regard to help in cases of distress, and regarding types of waves and frequencies to be used and measures to prevent interference. It will be seen that the convention recognized the importance of radio to the national defense and did not attempt to regulate its use for this purpose.

The Naval Communication Service carries out the Navy's communication policies:

(a) To maintain and operate a naval communication system based on the requirements of the forces afloat in a campaign in either or both oceans.
(b) To provide adequate radio communication facilities to mariners along the United States coasts where privately-owned facilities are not made available.
(c) To promote harmony and cooperation between naval radio systems and all other radio systems, and to define the areas of their activities.
(d) To watch and guard the radio and cable interests of the United States.
(e) To provide and operate radiocompass stations as required.
(f) To develop and coördinate all systems and methods of communication required for battle efficiency.
(g) To develop within the fleet, the uses of all forms of communication required for battle efficiency.
(h) To use the naval radio communication system in time of peace to assist in the development of American interests abroad.

The supply of material satisfactory to meet the Navy's requirements is a complex and difficult technical problem. Intrafleet communication demands the simultaneous use aboard ship of several frequencies. High powers must be handled with limited antenna characteristics available. Ashore, the power needs and necessity of avoiding interference with other services make an equal demand on apparatus. To obtain material to meet its requirements

[1] Lt. A. T. Sprague, U. S. Navy, assisted in the preparation of the present article.

the United States Navy has always been in the forefront of radio research and has contributed greatly to the progress of the art. It has maintained its own laboratories and has coöperated to the greatest extent with commercial research.

The extremely high standards set by naval specifications for material have in themselves aided progress in design, and the rapid progress made in the radio art in the last few years has been in no small part due to development work in fulfillment of these specifications.

Organization within the fleet and equipment aboard ship is maintained and operated in time of peace adequate for war-time needs. The shore establishment maintained is adequate for peace-time needs, and contemplates that the Navy assumes control of such non-military R/T stations as may be allocated to it by the President to augment its facilities for war. Such was the case during the World War when the Army and the Navy assumed control over all R/T stations during the period of hostilities.

Mention has been made above with regard to the main function of the peace-time Navy—preparation for war. This is a purely military function and is prosecuted to the limits of the Navy's ability. In addition to this, a very considerable service is rendered by naval radio to other departments of the Government and to the country at large, in addition to the indirect benefits conferred by progress in technical development:

1. Use by other departments of the Government of Naval Communication Service for transaction of Government business.

2. Time signals.

3. Weather broadcast to *all* ships.

4. Use of Navy shore stations by commercial shipping where private companies do not offer adequate service. This includes maintenance of their facilities at points where service would otherwise be unavailable.

5. Maintenance of radio compass on our seacoasts, the facilities of which are extended gratuitously to all shipping.

6. Use of transpacific circuit by press associations, etc., for press dispatches to Hawaii and Far East.

COMMISSION OF JURISTS

At the Conference on the Limitation of Armaments at Washington, the powers then represented adopted a resolution for the appointment of a commission representing the United States, Great Britain, France, Italy and Japan to consider:

(a) Do existing rules of international law adequately cover new methods of attack or defence resulting from the introduction or development, since the Hague Conference of 1907, of new agencies of warfare?

(b) If not so, what changes in the existing rules ought to be adopted in consequence thereof as a part of the law of nations?

The above commission met at the Hague 1922–1923. At the unanimous invitation of these powers, the Government of the Netherlands was invited to participate and accepted.

This commission of jurists adopted as a part of its work a set of rules for the control of radio in time of war. In its deliberations, due consideration was given to existing pacts in which the control of radiotelegraph was mentioned. Among them were:

1. Land War Neutrality Convention —No. V of 1907.

2. Convention for the Adoption of the Geneva Convention.

3. Convention Covering Neutral Rights and Duties—No. XIII of 1907.

4. Declaration of London, 1909.

5. Convention of Safety of Life at Sea, 1914.

The rules recommended follow:

Article 1. In time of war the working of radio stations shall continue to be organized, as far as possible, in such manner as not to disturb the services of other radio stations. This provision does not apply as between the radio stations of opposing belligerents.

Article 2. Belligerent and neutral powers may regulate or prohibit the operation of radio stations within their jurisdiction.

Article 3. The erection or operation by a belligerent Power or its agents of radio stations within neutral jurisdiction constitutes a violation of neutrality on the part of such belligerent as well as on the part of the neutral Power which permits the erection or operation of such stations.

Article 4. A neutral Power is not called upon to restrict or prohibit the use of radio stations which are located within its jurisdiction, except so far as may be necessary to prevent the transmission of information destined for a belligerent concerning military forces or military operations and except as prescribed by Article 5.

All restrictive or prohibitive measures taken by a neutral Power shall be applied impartially by it to the belligerents.

Article 5. Belligerent mobile radio stations are bound within the jurisdiction of a neutral state to abstain from all use of their radio apparatus. Neutral governments are bound to employ the means at their disposal to prevent such use.

Article 6. 1. The transmission by radio by a vessel or an aircraft, whether enemy or neutral, when on or over the high seas of military intelligence for the immediate use of a belligerent is to be deemed a hostile act and will render the vessel or aircraft liable to be fired on.

2. A neutral vessel or neutral aircraft which transmits, when on or over the high seas, information destined for a belligerent concerning military operations or military forces shall be liable to capture. The Prize Court may condemn the vessel or aircraft if it considered that the circumstances justify condemnation.

3. Liability to capture of a neutral vessel or aircraft on account of the acts referred to in paragraphs (1) and (2) is not extinguished by the conclusion of the voyage or flight on which the vessel or aircraft was engaged at the time, but shall subsist for a period of one year after the act complained of.

Article 7. In case a belligerent commanding officer considers that the success of the operation in which he is engaged may be prejudiced by the presence of vessels or aircraft equipped with radio installations in the immediate vicinity of his armed forces or by the use of such installations therein he may order neutral vessels or neutral aircraft on or over the high seas:

1. To alter their course to such an extent as will be necessary to prevent their approaching the armed forces operating under his command.

2. Not to make use of their radio-transmitting apparatus while in the immediate vicinity of such forces.

3. A neutral vessel or neutral aircraft, which does not conform to such direction of which it has had notice, exposes itself to the risk of being fired upon. It will also be liable to capture, and may be condemned if the Prize Court considers that the circumstances justify condemnation.

Article 8. Neutral mobile radio stations shall refrain from keeping any record of radio messages received from belligerent military radio stations, unless such messages are addressed to themselves.

Violation of this rule will justify the removal by the belligerent of the records of such intercepted messages.

Article 9. Belligerents are under obligation to comply with the provisions of international conventions in regard to distress signals and distress messages so far as their military operations permit.

Article 10. The perversion of radio distress signals and distress messages prescribed by international conventions to other than their normal and legitimate purposes constitutes a violation of the laws of war and renders the perpetrators personally responsible under international law.

Article 11. Acts not otherwise constituting espionage are not espionage by reason of their involving violation of these rules.

Article 12. Radio operators incur no personal responsibility from the mere fact of carrying out the orders which they receive in the performance of their duties as operators.

EFFECT OF RULES

The background of these rules will be discussed briefly and their influence shown:

Article 1. Article 10 of the International Radiotelegraph Convention of 1927 provides that the operation of radiotelegraph stations must be organized, in so far as possible, not to disturb service of other stations. Article 1 makes this applicable during time of war except between belligerents.

Article 2. This article similarly extends Article 15 of the 1927 Convention to time of war.

Article 3. An adaptation of Articles 3 and 5 of the Land Warfare Neutrality Convention. It is to be noted that the neutral state is bound to use the means at its disposal to prevent breach of neutrality under the article.

Article 4. Covers the same ground as Articles 8 and 9 of Land War Neutrality Convention, adding to the neutral the duty of prevention of transmission by radiotelegraph of information destined for belligerents covering military forces or military operations.

Neutral restriction to be applied to all belligerents impartially. This article does not render necessary a censorship in every neutral country during every war. The character of the war and the position of neutral may render this unnecessary. However, a neutral government is bound to use the means at its disposal adequately to comply with this article.

Article 5 in enacting a continuation during war is in harmony with the Convention Concerning Rights and Duties of Neutral Powers in Maritime Warfare.

Many of the Powers, notably those represented on the Commission of Jurists, prohibit use of radiotelegraph on vessels within their jurisdiction.

Article 6. The transmission of military intelligence for the benefit of a belligerent constitutes an active participation in hostilities and, therefore, merchant vessels or aircraft in so doing immediately lose their non-combatant status and its immunities. Members of crew or passengers, if implicated, are regarded as having committed an act in violation of the laws of war.

Extending the liability of capture beyond the immediate voyage and for a period of a year takes into account the time necessary in some cases to establish a case, such as the examination of message logs of a great many vessels or aircraft.

It will be noted that this article imposes no obligation on the neutral government inasmuch as its control over a mobile station on the high seas is not immediate.

Article 7. This article essentially supplements Article 6. In addition to any question of the acquisition by the enemy of information, the use of their radiotelegraph by merchant ships or aircraft might well be a great embarrassment to a fleet commander because of the interference occasioned his communications. He is, therefore, given power to warn merchant vessels and private aircraft away from the scene or to impose radiotelegraph silence if they are within the theatre of operations.

This article presupposes the actual presence of naval or aerial force engaged in operations and intends that the powers given be limited to the actual duration of operations. Powers herein granted are not applicable to widely extended zones.

The terms in which this article, and

also Articles 6 and 8, is drafted would cover neutral public vessels or aircraft. No intention to encroach upon the rights of neutral states is implied. It is assumed no such neutral public vessels would attempt to interfere with the operations of a belligerent.

Article 8. This article is aimed to avoid the eventuality of one belligerent acquiring information by finding in the radio log of a neutral vessel copies of the other belligerent's dispatches.

Examination of that portion of the offender's log would attract attention of the offender's administrative agent to his violation of this article.

Articles 9 and 10. These articles are self-explanatory.

Article 11. The purpose of this article is to show clearly that the question of whether an act in violation of these rules is also espionage cannot be answered except by reference to those provisions of international law defining espionage.

Article 12. This article was included to clarify the position of the actual operator and not render him liable for acts committed in execution of orders from his superiors.

The Land Warfare Regulations and Naval Bombardment Convention of 1907 permit the bombardment of coastal radio stations by land or naval forces. Also the Land Warfare Regulations authorize the seizure by a belligerent in occupation of enemy territory of coastal radiotelegraph stations, even if privately owned.

The report of this commission has not been adopted by the participating governments and so cannot be said to be an international agreement. The trend of international thought is, however, clearly shown by the report and belligerents' conduct in future hostilities will probably be along these lines. As has been stated, many of the above articles restate existing agreements which bind the contracting parties.

With regard to Articles 6 and 7, which are of principal interest to a naval commander, it may be assumed that upon occasion the naval commander will consider himself duty bound for the success of his mission to assume control over his theatre of operations in such manner as to insure that the action or presence of other vessels does not jeopardize his mission. Secrecy of movement, and composition of force will always be a necessity in the naval campaign. Yet on the high seas a fleet may be subject to frequent observation by commercial shipping. There can be no question as to a belligerent's right to immediate and effective action to protect his interest against unneutral service by such observers. These articles outline the commission's judgment as to effective action. Undoubtedly they will be a guide to the Powers in writing instructions for the conduct of war, and will be essentially followed unless proved inadequate. It is the writer's opinion that Article 7 offers the greatest safeguard to a fleet commander and that action similar to its provisions will be taken in most cases. Such action is a safeguard against the possibility of unneutral use of such information as might be obtained by observation. It is this safeguard that the fleet commander desires and will maintain.

The Control of International Radio Communication

By G. Stanley Shoup
Chief, Communications Section, Transportation Division, United States Department of Commerce

WE hear considerable today about mergers, and as competition increases the tendency in practically all lines appears to be toward that end. The year 1928 was an unusually active one in this respect, probably more so than any preceding year, such fusions running the gamut of virtually all lines of human endeavor. Public utilities, particularly telephone, telegraph, cable and radio companies, have not escaped the fever, as is testified by the recent merger of communications companies in both America and England. It was these combines which set both sides of the Atlantic agog with rumors, and precipitated considerable discussion regarding the probable effect of these mergers upon world communications, and their admitted importance in the control of international communication, both radio and cable.

In many countries, the internal telegraph services are operated as Government monopolies, international services usually being operated by private companies through concessions, although in some cases the Governments also operate and control services extending beyond their frontiers. With the aid of Government subsidies totaling well over $10,000,000 England has dominated the field of submarine cables from their very inception. The United States, on the other hand, has always been averse to Government ownership and operation of communications facilities and to granting them subsidies.

Development

Although our privately owned cable systems are as well operated as the British, and equally as efficient, they are not as extensive. With the advent of radio, however, the center of influence in world communications has gradually shifted from the Old World to the New. In no country in the world has radio made such remarkable strides as it has in the United States, where in the past five years it has possibly made more progress than other branches of science have attained in twice that span.

The countries dominating the international radio channels of the world today are the United States, England, Germany, and France, with a struggle for supremacy imminent which, according to some writers, may, in its own sphere of action, rival the great struggles for commercial expansion during the mercantilistic era. Long-distance wireless communication is preponderantly in the hands of four companies: the Radio Corporation of America; the Marconi Wireless Telegraph Company, Ltd. (British); the Cie. Generale de Telegraphie Sans Fil (French); and the Gesellschaft fur Drahtlose Telegraphie (German), usually referred to as "Transradio A. G." These companies have formed what is known as the Commercial Radio International Committee, generally known as the "A. E. F. G. Consortium," which provides for the interchange of patents and the allotment of spheres of exploitation. Under this agreement, radio companies have been formed in various countries of South America and stations are now in operation at Rio de Janeiro, São Paulo, Buenos Aires, and Santiago in Chile, with additional sta-

tions soon to be opened in other important Brazilian cities.

The United States has attained an exceptional position in the history of nations. Our total foreign trade has more than doubled since 1913, the figure for that year being $4,277,000,000, while in 1927 it amounted to slightly more than $9,000,000,000. This expansion in overseas trade required a corresponding expansion in the channels for international communications. Adequate and reliable communications facilities are as essential to the conduct of foreign trade as are ships and banks, and if our exporters were to retain the markets gained it was apparent that American communications should be expanded.

Prior to the war, the application of radiotelegraphy had been confined largely to ship-to-shore and shore-to-ship (marine) services, and the stations operating transoceanic commercial services could be literally counted on the fingers of one hand.

Radio, which had been developed into such an important medium of communication under pressure of the exigencies of war, was looked upon as a possible solution for carrying the heavy increase in overseas telegraph traffic. It was a question which deeply concerned certain officials of the American Government, who visualized the great importance and need for a system of overseas radio communication owned and operated by American companies, and which would to a certain extent perhaps offset the dominating influence of Great Britain over submarine cables.

OVERSEAS RADIO COMMUNICATION

How was this to be accomplished? In 1901 there had been formed the Marconi Wireless Telegraph Company of America, which was really a branch of the British Marconi Company. By 1903 it had opened what was intended to be a transoceanic station at Cape Cod, Massachusetts, and although some traffic was handled it was not powerful enough for work of this nature and was accordingly used for marine service.

The first practical transatlantic commercial radio service was the British circuit opened the latter part of 1907 between Clifdon, Ireland, and Glace Bay, Nova Scotia, the majority of traffic over which consisted of press material destined for a group of New York newspapers. This circuit continued in operation until August, 1909, when fire destroyed the Glace Bay station, but it was rebuilt and service resumed the following year.

The first transatlantic circuit between New Brunswick, New Jersey, and Carnarvon in Wales was almost ready for operation at the outbreak of the war, when all existing stations of the American Marconi Company, as well as those under construction, were placed under the supervision of the United States Navy, and were not returned to the company until February, 1919. American electrical companies and engineers had made notable contributions to the radio art during the war, chief among which was the Alexanderson high-frequency alternator. But at the close of hostilities there was no American organization that could utilize these developments, and since the high-frequency alternator represented a large capital outlay, there loomed the possibility of its being used exclusively by a foreign company.

At this stage there came upon the scene two officials of our Government who had already done much for the cause of radio. They were the late Admiral W. H. G. Bullard, Director of Naval Communications, and Captain S. C. Hooper, present encumbent of

that office. So ably did these gentlemen plead their case before representatives of the General Electric Company on April 5, 1919, that negotiations for the sale of the Alexanderson alternator to foreign interests were cancelled. The opportunity existed for the United States to develop under private enterprise a transoceanic system of radio communication. At the suggestion of Admiral Bullard and Captain Hooper, Owen D. Young took upon himself the responsibility which led to the formation of the Radio Corporation of America in December, 1919. The new company promptly acquired the property and rights of the American Marconi Company and entered into traffic agreements with British, French and German companies.

In March, 1920, the newly formed Radio Corporation of America inaugurated commercial service between New York and London, and by 1921 it had established circuits with Norway, Germany, France, and through Hawaii, with Japan. Additional circuits to other countries increased rapidly, as a consequence of which there are at least as many commercial transoceanic radio services extending from the United States today as radiate from any other country, representing station investments in excess of $20,000,000. We are in daily touch—one might say constantly—by radio with Argentina, Australia, Belgium, Brazil, Canada, Chile, China, Colombia, Cuba, Dutch East Indies, Dutch Guiana, Dutch West Indies, England, France, French Indo-China, Germany, Hawaii, Italy, Liberia, Japan, Netherlands, Norway, Philippines, Poland, Porto Rico, Portugal, Sweden, Turkey, and Venezuela. Additional circuits are projected for communication with Czechoslovakia, Mexico, New Zealand, Russia, South Africa, Spain, Switzerland, and Syria.

REVOLUTIONIZATION

It was the practical development and consequent application of short-wave transmission and reception that revolutionized the art of long distance radio communication. As early as 1910, the British had considered plans for a chain of radio stations linking the empire, but little had been accomplished. In July, 1924, the British Marconi Company concluded an agreement with the British Post Office for the erection of beam stations for direct communication with the Dominions and India, the rates to be lower than the cable rates, except between England and Canada. By the end of 1927 two-way beam communication was in existence between England and Canada, Australia, South Africa, and India, and during 1928 a circuit was opened between Canada and Australia.

Aided by a schedule of lower rates, the system is now handling in excess of 35,000,000 paid words annually, and has cut heavily into the traffic of the British cable companies. The British cable companies are, of course, privately owned and operated, whereas the beam stations in England are owned and operated by the British Post Office. It was a case of a Government-owned and operated radio system competing not only with the private cable companies, but with the State-owned cables of the Pacific Cable Board and the two Imperial cables across the Atlantic owned and operated by the British Post Office. The result was inevitable. Cable stocks depreciated and the revenues of the cable companies declined. The financial position of the British cable companies, however, with reserves amounting to over £20,000,000, was so strong that they could, had they been so inclined, under-cut any rates the wireless services might establish, but rather than

do that they preferred to go into voluntary liquidation, and so notified His Majesty's Government.

But it was not alone the competition between British radio and cable services that led to the fusion of these interests. Great Britain feared the commanding lead which other countries had assumed in radio and considered it a challenge to British cable supremacy. Then, of course, there was the threat of the cable companies to dispose of their assets, a course which if pursued was fraught with the grave danger of foreign interests gaining control of the British cable system, or at least certain units of that system. In addition, there are many parts of the empire which are not served by radio, and as existing radio services are at times subject to fading, it was desirable that Britain retain control of its cables.

An Imperial Wireless and Cable Conference, composed of representatives of the various Governments of the British Empire, accordingly convened in January, 1928, "To examine the situation which has arisen as a result of the competition of the Beam Wireless with the Cable Services, to report thereon and to make recommendations with a view to a common policy being adopted by the various Governments concerned." Coincident with the meetings of this conference, representatives of the British cable and radio companies conducted negotiations, and on March 15, 1928, the Eastern and associated cable companies and the Marconi Company jointly announced a provisional merger, involving a total capitalization of £53,700,000.

MERGER

The combine of British cable and radio interests will become effective April 1, 1929, if ratified by Parliament, and there seems to be every indication that the necessary ratification will be forthcoming. From the merger company there will be formed a communications company with a capital not to exceed £30,000,000 at its inception. The formation of this company is made necessary by reason of the fact that both the cable and radio groups have large investments and manufacturing interests not directly concerned with communication activities, and the sole function of the communications company, therefore, will be the operation of communication services. The salient points of this fusion may be summed up as follows:

The communications company will acquire the two imperial cables across the Atlantic, now operated by the British Post Office—at a deficit; the cables of the Pacific Cable Board connecting Canada with New Zealand and Australia, a route which when linked with the two Atlantic cables mentioned above and Canadian land lines, provides an all-British system, no part of which passes through foreign territory; the West Indian cable and wireless system, operated by the Pacific Cable Board; and the lease for 25 years of the profitable beam radio circuits of the Post Office, at an annual rental of £250,000 in addition to other monetary considerations.

A standard net revenue of £1,865,000, exclusive of non-telegraphic investment revenue, will be fixed to the purposes of the communications company. Half of any excess revenue will go to the communications company and the other half will be devoted to reduction of rates. The board of directors of the merger company, the communications company, and the cable and Marconi companies will be the same, two of whom shall be approved by the Government. Provision is made for an Advisory Committee, composed of representatives of the Governments who were parties to the Wireless and

Cable Conference. This committee shall be consulted by the communications company about all questions of policy, including any alteration in rates.

It is agreed that British control must be guaranteed; that the Governments may assume control of the cable and wireless systems during national emergencies; and that the army and navy are entitled to construct and operate cable and wireless stations for their own needs, but not for commercial purposes. The British Post Office may reserve the right to operate the external telephone services from Great Britain, but must agree with the communications company upon terms for utilizing company radio stations for telephone transmission and reception.

Thus it will be seen that this combine or regulated monopoly will give a rapid, efficient and cheap telegraphic service to the British Empire, with the public adequately protected by an Advisory Committee. It insures the maintenance of both cable and radio communication, and, most important of all from the standpoint of international communications, it will eliminate competition within the empire and provide a unified system for competing with foreign companies, and may conceivably result in a reduction of rates.

AMERICAN SYSTEM

What is the position of American communications in contrast with the new alignment soon to take effect in Britain, and how can the United States maintain its leadership in international communications? Within the past few years, through the medium of the International Telephone and Telegraph Corporation and the American Telephone and Telegraph Company, the United States has become the acknowledged leader in the field of international telephony. In the case of transatlantic telephony, for example, development work has been in progress by the latter company for nearly 15 years, resulting in the opening of commercial service in January, 1927. The former company, which was organized in 1920, with its cable, telegraph, wireless, telephone and manufacturing plants, connects, operates or manufactures in virtually all countries in the world. During 1927 the company expanded tremendously and the consolidated net income of the system more than doubled that of 1926, the consolidated plant and property account increasing from $53,000,000 to $99,000,000.

The acquisition of telephone companies in Brazil, Chile, Argentina and Uruguay presaged in intensive development of telephone systems in South America, and was the forerunner of international telephone service between Argentina, Chile, and Uruguay, which together with other achievements, such as the establishment of telephone service from Cuba and Mexico to the United States and Canada, has clearly established American telephone supremacy south of the Rio Grande. Through a Spanish subsidiary, a modern telephone plant has been installed throughout Spain, which in October, 1928, was linked with the transatlantic radiotelephone. Associated manufacturing plants of the corporation are located in Antwerp, Peking, Buenos Aires, Paris, Tokyo, Oslo, Madrid, Milan, London, Sydney, Budapest, and Vienna. Their position was immeasurably strengthened in April, 1927, when All America Cables, Inc., with its 27,000 miles of cables and landlines serving Central and South America, merged with the International System.

America partially met the British fusion of radio and cable interests when in March, 1928, the country was startled by the announcement that the International System had merged with the Mackay interests, which includes

ownership or operation of over 36,000 miles of cables connecting principally the United States with Europe and the Far East; the Postal Telegraph system serving the United States; and the Mackay Radio and Telegraph Company which owns and operates a radiotelegraph service on the West Coast and intends to establish international radio communication with Europe and the Far East.

The guiding spirit of American ingenuity made possible the transatlantic radiotelephone that now links the United States, Canada, Cuba, and Mexico, with many European countries. This service is established between the system of the American Telephone and Telegraph Company in this country and the system of the British General Post Office in England. Extensions from both terminals are made over the regular long-distance telephone circuits through the coöperation of the respective telephone administratons of the countries through which the circuits extend. The International Telephone and Telegraph Corporation has cooperated in the extension of the service to Cuba and Mexico on the American side and to Spain on the European side.

It is well to bear in mind that these two American companies, the American Telephone and Telegraph Company and the International Telephone and Telegraph Corporation, are separate and distinct entities; the former being concerned with telephone systems in the United States, including the establishment of foreign connections, while the latter is engaged in the operation of telephone properties in other countries and in the establishment of international communication connections rather generally, including both cable telegraphy and radio circuits. Both companies are keenly interested in the development of international radiotelephone facilities. The International Corporation has acquired a site near Paris where a large group of engineers are devoting their entire time to experimental work in radio. With the stations and experimental laboratories of the Mackay Radio Company available, obtained when that company absorbed the Federal Telegraph Company of California, as well as the former Navy station at Sayville, L. I., as a nucleus, coupled with its extensive manufacturing plants abroad, it is only reasonable to assume that the International System will make a substantial contribution to the radio art, particularly in its international application.

The United States has the most efficient and highly developed telephone system of any nation in the world, due in large measure to the benefits derived from unified and intelligent administration. In pondering this fact, it might be well to pause for a moment and reflect what this telephone service would be were it to consist of countless independent companies, each serving relatively small areas, with little or no coördination between them. In fact, the history of communications in the United States is filled with instances of small and poorly organized companies which, for various reasons were unable to survive, and either expired or were acquired by others.

Sentiment in the United States has always held that there must be competition, a policy that was affirmed in the Radio Act of 1927. Many now question whether this element of competition should remain and be made applicable to our system of international communications, especially in the light of present day developments in other countries.

FUTURE EXPANSION

Disregarding the United States and Great Britain for the moment, we find that virtually all countries of commer-

cial importance are endeavoring to effect direct radio communication with other countries. Germany and France have long had well-developed systems of radio communication now utilized for commercial work and being extended wherever possible. Communication developments in the United States and Great Britain are being followed with interest, and it should not cause much surprise, therefore, if other countries should elect to combine their international radio and cable services, at present operated by private enterprise through concessions.

With these facts in mind, it is hardly probable that American companies will undertake an extensive program of cable expansion that would result in a parity with the cable mileage of Great Britain. On the the other hand, there is every evidence that American cable companies will expand their systems. New cables will be laid, and as older ones become obsolete they will be replaced by cables of the most improved type, assuming such replacements to be justified. In 1924 the Western Union laid the first permalloy cable to the Azores, providing direct service to Italy and Germany, as well as giving American cable users a far better outlet to Spain and South Africa. A new permalloy cable was laid between the United States and Great Britain in 1926, and only within the past few months the Western Union completed the laying of 1,341 nautical miles of the most improved type of cable between Newfoundland and the Azores, at a cost of approximately $1,800,000. From the foregoing it is apparent that cables have not become passé; in fact it is said that radio will not entirely supplant the submarine cable.

SHORT WAVES

The success attained in the use of short waves, however, has revolutionized long range wireless communication to such an extent that radio is now in a position where it can compete and is seriously competing with cables, as a competitor of which it has greatly stimulated the volume of international telegraphic correspondence. This is evident when it is realized that the total radio traffic from and to the United States amounted to 38,000,000 paid words in 1927, as compared with only 7,000,000 in 1920, cable correspondence showing proportionate increase. Short-wave transmission in its present state of development, is subject to periods of fading; however, as it becomes constantly perfected and increasingly reliable it seems destined to be a still greater force in world communications.

The rapidity with which the nations of the world are allocating short waves is a barometer of the growing importance attached to this method of communication. So rapid is the radio art moving that no one can prophesy what the future of radio communication will be.

Professor Michael I. Pupin, of Columbia University, one of America's foremost inventors in the electrical field and inventor of the Pupin loading coil which made long-distance telephony possible, in discussing the relation between cable and wireless communication, is quoted as follows by the *New York Times* of February 19, 1928:

> Competition is a splendid thing, but if the two competing methods of communication are used in a way to wreck one another, that competition would be a bad thing. Why should two individuals whose virtues supplement each other be enemies? The two methods of communication are natural friends and should act in concert. Coöperation between wireless and wires will be advocated by every sensible man. The best engineers in Europe recognize the limitations of each method and recognize also that these limitations practically dis-

appear when they are made to supplement one another.

It is well to remember that the initial cost of a transoceanic cable is high when compared with the initial cost of a radio link. This is particularly true now that short wave beam and projector systems are available. Furthermore, the annual operating costs of a radio station are also somewhat less than those of a modern submarine cable. According to some authorities, however, a purely economic comparison of the relative costs of radio and cable systems is not conclusive because of the lesser reliability of radio circuits. It does seem clear, however, that for circuits required on some routes, considerations of economy will require the use of radio for a substantial proportion of the total facilities.

COÖPERATION AND CONSOLIDATION

Many believe that Congress may remove certain features of the present radio law and enact legislation permitting the merging of our wire and radio companies into one great consolidation, in which the public would be protected by probably both Government representation and regulation. particularly in the matter of rates.

Only recently statements appeared in the press to the effect that officials of the Western Union and Radio Corporation were negotiating for a merger of the two companies. If this occurs, upon passage of necessary legislation permitting it, our international and domestic communications activities, excepting, of course, domestic telephones, will revolve around two large companies and thus retain that element of competition which would call for only a minimum of Government regulation. By coöperation they should be in a position to meet the competition which they will undoubtedly have to face from like interests abroad.

On the other hand, there are those who believe, particularly with reference to international communications, that existing cable and radio companies in the United States should all be consolidated into one organization under Government regulation, on the theory that if there are several companies in this country with which a foreign communications company has to deal it will thus be in a position to play competing American companies against each other, whereas if our communications activities were concentrated under one company a situation of that nature would not exist. Proponents of a unified system claim that it will substantially reduce overhead and operating costs, the benefits of which may be passed along to the public in the form of cheaper rates. They contend that although competition does result in a higher quality of service, in that each company constantly strives to surpass every other company, it has little or no effect upon tariffs. In other words, rates being equal, communication companies are competing solely on the basis of service, but under a regulated monopoly it is said that rates could be substantially reduced.

The conception of a perfect system of modern communications is a radio and cable network so coördinated that if transmission difficulties occur in one method traffic can be immediately routed by the other with no delay. Each perform services for which the other is unsuited and there should be close coöperation between them.

As pointed out earlier, our foreign trade has reached enormous proportions. With the economic recovery of Europe, its increased production and purchasing power, it appears that the next few years will witness unusually keen rivalry in foreign commerce; therefore, it is essential that our com-

munications system, which are the very nerves of trade, be fortified to meet this situation.

In an address delivered before the students of the Harvard Business School on April 23, 1928, General James G. Harbord, President of the Radio Corporation of America, made the following pertinent statement:

During its 150 years of existence, the United States has never had but one consistently maintained foreign policy, namely, the Monroe Doctrine. Great Britain, on the other hand, in more than a thousand years has probably had more than a thousand such policies. The British system of government seems far better adapted to a continuity of foreign policy than our own, which is not saying that our own system is not the best in many other respects.

In discussing the unification of cable and radio interests in Great Britain, General Harbord said:

The American answer to this challenge can only be made by submitting the great communication companies, both cable and radio, to proper government regulation as to rates while exempting them from the operation of the anti-trust laws and permitting unification here and thus meeting the thrust of unification from abroad.

In this connection, it is interesting to note an article that appeared in a leading London journal:

America, the journal declares, referring to what it terms "a bold and magnificent policy, . . . has now carried out, through its commercial cable and wireless corporations, far-reaching schemes for direct cable and wireless communication with every country in Europe, with Japan, and with the whole of the Far East. The American Government have had the wisdom, of course, to realize that, acting as a Government, they would have no chance of acquiring any position in the communication systems of other countries; but, acting through their financial and commercial organizations . . . they already have acquired a dominating position, and are steadily increasing its strength. The field of international communications is one in which it is hopeless for disorganized units . . . to compete against powerful combinations under unified direction, and having at their disposal capital resources of fabulous amount and the best technical equipment in the world.

Apropos of the question of international competition, and more particularly from the angle of an impending international "communication war," there probably has been somewhat of a tendency towards exaggeration. There are many acreas throughout the world which still offer a fertile field for the improvement and development of communication facilities. The extension of services by a foreign company to the Far East, for instance, is likewise valuable to the American business man, because the development of cable or radio traffic in the sphere of one communication company adds to the business handled by other companies which interchange traffic with it without regard to the nationality or ownership of the companies interchanging traffic. There is no disputing the fact that competition does exist on certain routes, but as there develops greater intensification of industry and commerce, together with improved transportation and communication facilities, it follows that there will be a resultant increase in the volume of cable and radio correspondence, and there seems to be no reason why cable and radio companies should not look forward to greater traffic in the future.

Aside from the material aspects of a coördinated or unified extensive system of communications befitting a nation of our prestige in international affairs, there is the all important consideration of national defense. The average citizen has no conception of the utility of radio to the military services. The need for an all American system of

communications was never more apparent than upon our entry into the war. As the conflict progressed, the situation became more acute, but was later alleviated to some extent by the erection of the Bordeaux station and the development of other facilities by the Navy. And there is still another reason. News follows trade, and as the flow of news increases in proportion to trade expansion, we lay the foundations for that breadth of understanding and goodwill which electrical communication so ably engenders.

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