SUPER BROADCASTING

The advantages and technical problems of long-wave super-power broadcasting were discussed in the April and June issues. This month the author continues with a discussion of the economic aspects of the proposed plan

By Lieut. William

IN two previous articles we have set forth at some length the possibilities of long-wave superbroadcasting—an idea which must be reckoned with in the broadcasting of the future. On our present wavelengths every transmitter, no matter how powerful, begins to fade at a distance of eighty or a hundred odd miles. As a result fifty kilowatts or so is the useful power limit, because true broadcasting service means non-fading service, and power increase is only useful to maintain an adequate signal within a service area arbitrarily limited by the inner fading ring. The first ten years of broadcasting have seen the amazing development of a complex transmitter network within these fading restrictions, which have not been severely felt because the structure was mostly metropolitan. It was tacitly assumed that the inhabitants of large cities, who represent the most concentrated buying power but who need radio least, must have whatever true service there is, and that the rural dwellers must be content with weak signals, fading, static, and all the other vagaries of doubtful space-ray service.

The next ten years should see the extension of true service, non-fading, night-and-day, summer-and-winter broadcasting to those who need it most—the isolated farmers, miners, ranchers, lumbermen, and the millions of town dwellers now beyond effective reach of the metropolitan system.

How is this desirable end to be accomplished? On present wavelengths scores of 50-kw. stations, evenly spaced across the country, would be required. On wavelengths around 1500 meters, on the other hand, the non-fading range to be expected of a transmitter is several hundred miles. Power can therefore be efficiently increased up to perhaps 1000 kw., giving true service to a half-million-square-mile area. About seven long-wave superstations should bring city standards of reception to practically every rural listener, making complete national broadcasting a uniform reality. Connected by wire lines with metropolitan studios, these national long-wave stations should become a powerful factor in the universal spread of culture, the enlightenment of public opinion, and the maintenance of government and national security.

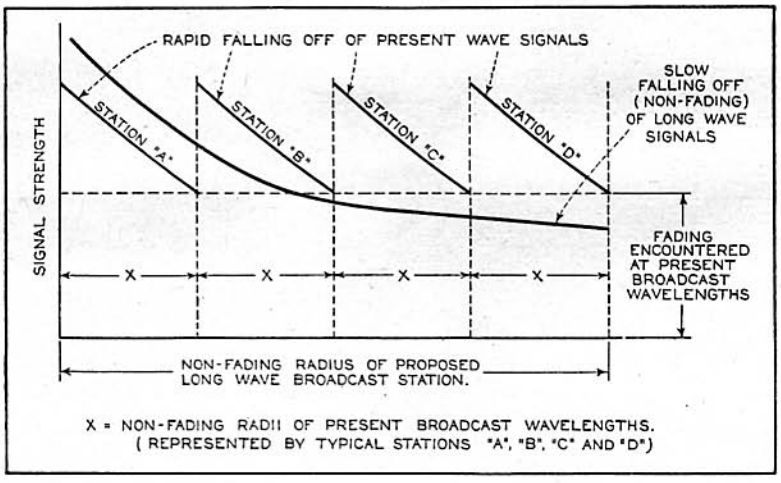

Figure 1. Coverage radius of long-wave, super-broadcasting station as compared with radii of several present wave broadcasters. The non-fading characteristics of the former would make its radius of coverage many times that of present-day broadcasters, even those employing the highest allowable power

No Receivers Exist Today

One of the most natural arguments against long-wave superbroadcasting is that in the United States there are no broadcast receivers capable of tuning to 1500 meters. Ten or twelve years ago, however, there were no broadcast receivers at all, while today they number some fifteen million. The mere fact that no long-wave receivers exist today, therefore, is no bar to the gradual inauguration of the long-wave system. Two-cylinder automobiles doubtless appeared to their late Victorian owners as the last word in transportation, but these proud owners would look somewhat silly today had they banded together in an effort to prevent automotive development in order to protect the value of their investment. The present radio receiver investment of the American people, about one and one-half billion dollars, is certainly large. But these millions of radio sets in use today are not going to last forever. Under any plan of broadcasting development, in ten years most of them will be obsolete. Since they will in any event be replaced by better sets in time, the inevitable change might just as well tend towards a full realization of all possible technical benefits. One of the most promising of these for the United States, judged from any viewpoint save that of ultra-conservatism or mere inertia, is long-wave, high-power broadcasting.

In addition to the receiver investment there is of course the present near billion-dollar annual income from receiver sales. On what does it fundamentally depend? *On the continual improvement and continual extension of true service broadcasting throughout widespread America, more than on any other single factor, rests the continued prosperity of the radio industry.*

If seven 1000-kw. long-wave transmitters were to be placed simultaneously in full-powered operation, results would naturally be disastrous in more than one direction. Collapse of receiver investment, stoppage of buying, embarrassment of industry—these and other effects would probably follow. Anyone can see that the immediate and complete exploitation of long-wave broadcasting possibilities at the expense of the present system is entirely out of the question.

The truth is that projects measured in importance by the expenditure of millions of dollars do not grow with anything like such startling suddenness. As the closest of parallel examples, it is only necessary to examine the development of our present broadcasting system from its beginnings in 1920. Its growth falls naturally into three stages, which may be classed as infancy, adolescence, and maturity.

The first stage began in 1920 when Frank Conrad played phonograph records over his amateur radio-telephone transmitter, and an enterprising department store offered curious Pittsburghers some receivers which would reconvert the city-wide ethereal vibrations back into sound. Through the foresight of H. P. Davis, Conrad was enabled to transfer his experimental efforts to what later became the Westinghouse station KDKA, beginning on election night a schedule which has continued with constant improvements to the present day. In 1921, WBZ at Springfield and WJZ in New York came on the air, KYW went into service at Chicago, and smaller transmitters began to spring up here and there over the country.

While transmitting stations were spreading their tentative signals over mountain and plain, most Americans turned an ear unwillingly deaf. The early radio sets were curiosities in

On Long Waves

What It Might Mean to the Radio Industry

H. Wenstrom

their neighborhoods, but they stimulated an increasing demand which soon outstripped the utmost capacity of the few receiver manufacturers of those days. The result was that most people had to build receivers themselves if they wanted them at all, and in addition the process of home building satisfied a natural mechanical craving. A great wave of public interest in radio, never since equaled, swept over the country. People cared little what they heard in the way of music or speech, so long as they were enabled to hear it by an electrical miracle.

Broadcasting passed from infancy to adolescence when, in 1924, the manufactured set business forged ahead of the parts business. Many people found that most of the widely hailed new circuits were merely old circuits in camouflaged form, and they began to realize dimly that no fundamentally new circuits had been devised since Armstrong had invented the superheterodyne during the World War. The early tinkerer, hearing manufactured sets which surpassed his uninstructed

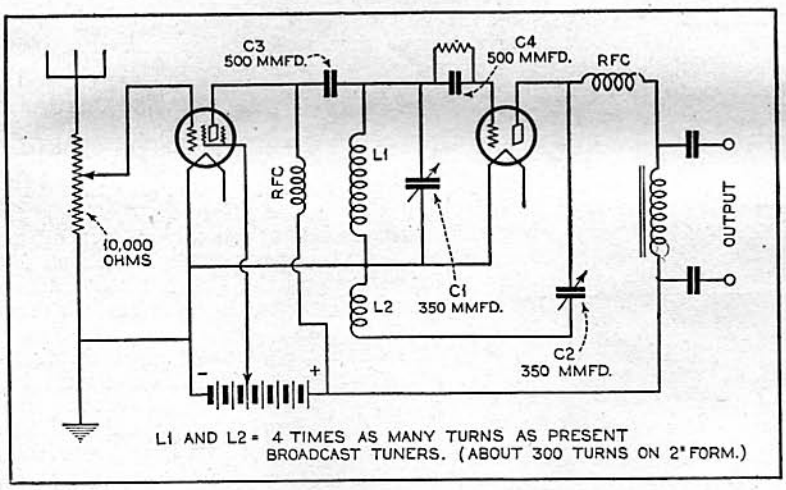

Figure 2. A simple type of tuner which could be used for reception of the long-wave broadcasting, preferably by plugging it into the audio amplifier of a standard broadcast receiver

efforts, lost interest. The necessary year's delay in bringing out technical improvements in manufactured sets, however, still encouraged many experimenters to build their own sets. In addition, high-power metropolitan broadcasting began with WJZ's power increase to 50 kw. in 1926. City listeners, finding a high signal level necessary to override man-made static, shifted their interest from the technical means of hearing to the programs that they heard. In the rural districts where interference levels were lower, listeners were still interested in distance—for one thing, they could pick up better programs from New York and Chicago. In 1926, also, the antiquated governmental machinery for radio control provided under the Act of 1912 broke down completely, and for some months bedlam prevailed in the broadcast spectrum.

In 1927 broadcasting entered its mature stage with the resumption of control by the government through the medium of the Federal Radio Commission. Broadcasting, first the freak, then the free-for-all, was finally defined as a public service carried on in the interests of "public convenience and necessity." The listener was enthroned as the ultimate king of broadcasting. Two great broadcasting companies, the National and Columbia, began to distribute the best in metropolitan programs by way of wire lines to stations all over the United States. The stations, in turn, passed on these programs to their small but widely scattered true service areas. Radio manufacture achieved mass production, making complete receivers at far less than the cost of their parts individually purchased. The custom set builder and the experimenter now find in the broadcast field only the opportunity to build, by the use of lavish design where the big manufacturers skimp for economy, a set slightly better than the manufactured article. Design has stabilized. Aside from vacuum tube and loud speaker developments, there have been no great technical advances in the last few years.

Receiver technology appears to have reached an era of comparative stagnation. In this situation any real innovation which is technically sound should prove constructive rather than destructive. From this viewpoint alone long-wave broadcasting is worthy of careful consideration.

The interest of practically all listeners, even in the rural districts, is now beginning to center on the end rather than the means—on the program rather than receiver technicalities. The local program is giving way before the chain program. Standards of quality are increasingly critical. Fading is not tolerated by city listeners with a wealth of other amusements. Rural listeners have to put up with plenty of it, but they do not like it. Within the limitations of present frequencies, broadcasting has crystallized into the problem of bringing to the largest possible number of homes the nearest possible approach to sounds originating in large metropolitan studios. It is significant to note that even the approach could not be made without one or two great nationwide broadcasting companies necessarily somewhat monopolistic in nature if not in aim.

It is logical to assume that long-wave broadcasting, provided the required preliminary static and transmission experiments prove successful, may follow a somewhat similar course of development as regards listener psychology and receiver design. With the present advanced broadcasting technique as a basis, the evolution of the long-wave system will naturally be more rapid. There is no reason to repeat past mistakes. The development of the long-wave system must be governed by a single aim—the provision of true service broadcasting to the entire United States. The system must be designed and built by competent engineers under the direction of able and public-spirited executives. Every attempt to subordinate public service to local demands, political intrigue, egotistical urges or sordid commercialism must be ruled out.

An attempt to predict at this time the exact sequence of long-wave development is simply an exercise of the imagination. Actual events may prove very different. However, it is necessary to assume some development sequence in order to discuss possible receiver changes.

Let us assume that the long-wave system is inaugurated with a single transmitter radiating about 100 kw. It should be located preferably in the midwestern states, so that its true service area of a hundred thousand square miles or so may cover a large rural territory now without true service broadcasting.

The space-propagated night-time signals of this station should easily reach out fifteen hundred miles or so to both coasts. The location should preferably (*Continued on page* 166)

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be one that will fit into the national coverage chain to follow. During much of the first stage, however, this station will have to operate at a loss, considering total listener satisfaction against expense; and it might be preferable from an economic viewpoint to operate a temporary 100-200 kw. transmitter from an eastern point, such as Schenectady or Pittsburgh, already equipped for high-power broadcasting research. Such a station should supply fair space-ray service as far as the west coast on good nights.

The launching of such a station on the air would of course be attended by widespread publicity. To preserve stability in the receiver industry, and to maintain the whole fabric of radio broadcasting at its present high standard of excellence, it must be made clear to the public that the existing broadcast facilities will not be disturbed in any way by the new system. A new service is being provided without taking anything away from the old.

Several thousand experimenters scattered over the country, who now possess either long-wave receivers or the requisite knowledge and materials for building them at short notice, would begin to listen to the new signals. Even at long range some advantages of the new system should be apparent, chiefly in slower fading and less of it. Within three or four hundred miles of the station, where existing service is being markedly improved, there should be some demand for custom built adapters, particularly where they can be added without destroying the attractive appearance of the original set. Even at the 400-mile limit of non-fading service, the signal from a 100 kw. 200 kc. transmitter should be around one millivolt per meter. This is ten times as strong as what most rural listeners consider "good broadcasting service," according to a paper by C. M. Jansky, Jr., in the October, 1928, issue of the proceedings of the Institute of Radio Engineers.

Another advantage of the long waves should be mentioned at this point. It is well known that while a broadcast transmitter signal falls off rapidly near the station, the amplitude curve flattens out so that there is little difference in signal strength between a point one or two hundred miles distant and a point several hundred miles distant. On present waves, as shown in Figure 1, the fading radius is so short that this low attenuation region, represented by the flat part of the curve, is not useful, and high attenuation from transmitter to limit of service area is the rule. On long waves, however, the signal of a high-power transmitter, after dropping off sharply for a hundred miles or so, should remain fairly constant throughout the rest of its enormous service area.

Designing and building tuners and adapters for listeners within the true service area of the first long-wave station should be a simple matter. Selectivity and sensitivity requirements will not be nearly as rigorous as those which govern broadcast receiver design at present. Great numbers of people will be able to pick up programs with a simple crystal detector, or a single tube, used in conjunction with a single tuned circuit. If a regenerative detector is used, it should be preceded by an amplifier tube to block occasional oscillations from the antenna.

Probably the most universally popular long-wave tuner during the first stage would be the circuit used in most short-wave sets. An untuned tetrode is excited from a resistance directly in the antenna circuit; and its output, excluded from the plate lead by a radio-frequency choke coil, is fed by means of a coupling condenser to the grid of a triode detector. The detector grid circuit is tuned, and its plate circuit includes a fixed tickler coil which makes it regenerative. Regeneration is controlled by a variable condenser or a variable resistance. This type of tuner, illustrated in Figure 2, should do not only for listeners in the service area, but for distant experimenters as well. Since the latter have only a space-ray signal available, more complicated and expensive tuner arrangements are scarcely justified during the first stage.

Meanwhile the long-wave transmitting engineers should constantly use the 100 kw. transmitter and its service area as an open-air laboratory. Mobile field strength measurement sets must scurry around the country until the area is completely mapped in terms of the normal signal found in each receiving locality. Fixed observing stations at selected locations must keep a continual record of signal strength and its day-to-day and hour-to-hour variations, as well as the more rapid changes which, if exaggerated, are noticed by the listener as fading.

Outside the service area of the first station, in other parts of the country, transmission tests should go forward with low-power portable stations. These should be set up at various locations and in various districts. If experimenters are kept informed of these tests, they may be of some help. Thus when the time comes to extend the long-wave chain to medium-power national coverage, the best station locations will be available.

In his next and last article of this series Lieutenant Wenstrom will go further into the matter of long-wave broadcast receiver design. He will also discuss the cost of transmission equipment as compared with the cost of present-day broadcast transmitters providing equal coverage; and will demonstrate that better coverage with less cost is entirely possible under his proposed plan.—THE EDITORS.

Photo-Cell Amplifier

(*Continued from page* 149)

of light through a hole the size of a No. 60 drill. The circuit is extremely simple and is very stable in operation. When used without a shield, hand capacity of the cell interferes with the proper working of the device.

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