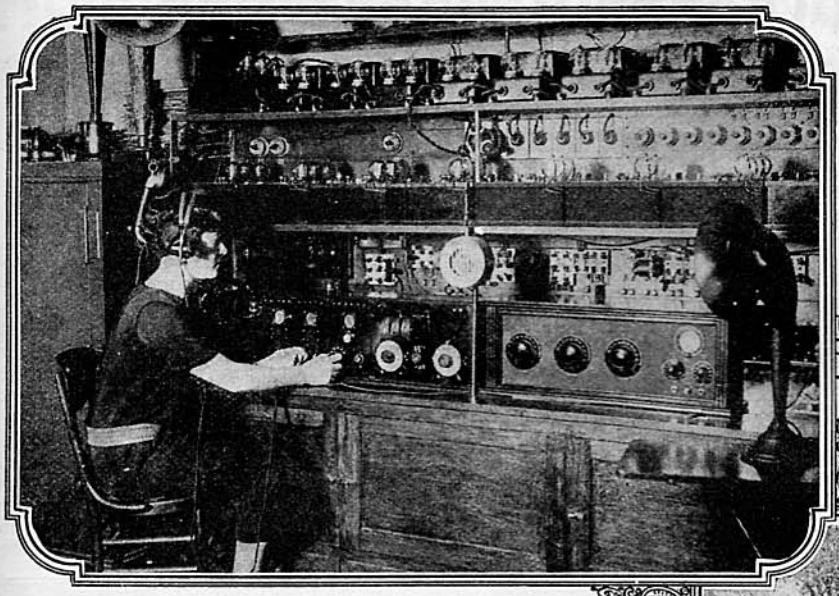

throughout the country will follow Fredonia and bring to their telephone subscribers a service that furnishes radio programs with the least possible effort and expense.

At the start of this service there were many technical problems to be overcome, as well as many practical difficulties. For instance in the case of the loud speaker operation, it is easy to understand that before the number of units that would operate successfully from one output was determined, an enormous amount of experimenting was necessary. There was also the problem of interference to be considered, both from the viewpoint of telephone and radio reception. If a person were speaking over a long distance line any interference from radio signals would be extremely annoying, as sometimes the connections made are not of the best and it is difficult to understand the person at the other end of the line.

"Using this system of ours," says Gustafson, "it would be possible to connect every town in the United States possessing a telephone exchange. Think of how the people could be reached by fine lectures and other educational material. Keep on thinking and you will see new possibilities."

Miss Ruth Fuegham is the radio telephone operator for the new system, and the entertainment of the subscribers is dependent upon her tuning in. So far, she has never failed to give the best presentation possible of any program.

Gustafson himself is in doubt as to just what the future of his development will be. Although he sees its ultimate possibilities, he does not claim that it will bring any such revolutionizing changes in radio. He does believe, however, that many more towns

Above: The radio equipment of the telephone company at Fredonia, Kan. Miss Fuegham the radio-telephone operator, is responsible for the radio entertainment of people of three or four lines.

Right: "The Gang" installing wires for the connection of the loud speaker, which is being held by J. A. Gustafson, manager of the company.

Survey of Progress In Radio Engineering*

By DR. J. H. DELLINGER

A SURVEY of progress in radio reveals that this is the era of radio engineering. This statement does not refer to the importance or extent of radio engineering, but to the type of development now going on in radio as compared with that of past years. Relatively speaking, radio has been crude heretofore, whereas the progress now being made is not merely empirical, but is more largely characterized by actual engineering development. We now have, not so much the invention of devices, as the perfection of them. This statement is very general. There have, of course, been triumphs of engineering in the past history of radio, and on the other hand the process of "cut and try" will continue to be used in the future. Nevertheless, broadly speaking, radio engineering has now taken definite form and is the tool by which further progress in radio will be wrought.

While a number of outstanding recent developments arrest the attention, it is also true that very substantial progress is being made all along the line of radio engineering. Thus, in the development of new and improved radio communication methods of systems, we have marked extension of the available frequency range, great improvements in directive radio transmission, advances in the perfection of selective radio systems and engineering development of line-radio or carrier-current communication. Among radio services and applications of radio there is outstanding progress on radio beacons, on the uses of radio for aircraft navigation, on direction finders and on radio vision. In the field of research and study of the problems of radio, we have important progress now going on in radio measurements, in standardization of apparatus, in the study and mitigation of the vagaries of wave propagation and atmospheric disturbances, and in the wide reaches of the interference problem.

THE USE OF HIGH FREQUENCIES

The most conspicuous recent development in radio engineering is the conquest of the new domain of ultra-radio or very high frequencies (short waves). Even the existence of the vast range of frequencies above 2,000 kilocycles (below 150 meters) was hardly suspected, and certainly was generally forgotten until less than a year ago. One curious reason for the subordination of this range of frequencies has been the erroneous use of wave-length in meters as an expression of radio frequencies. Radio egineering actually deals with currents which have a certain frequency. The length of the wave as it travels along in space can be calculated from the frequency, but it is a derived and an artificial concept.

Frequencies up to 20,000 kilocycles have come into extensive use. Actual radio services are being conducted in this region by broadcasters, trans-oceanic communication companies, military services, amateurs; in short, every important radio interest has begun operations between 2,000 and 20,000 kilocycles. Even higher frequencies have been used in experiments, but there is every likelihood that in the development of frequencies above 20,000 kilocycles directive transmission will predominate and the problems will be of a distinctly different character.

So important are these high frequencies now, the Third National Radio Conference, held in October, 1924, parcelled out the high frequency territory among the various radio services, thus reaching a solution of a problem which only a year ago was regarded as insoluble, that of finding more communication channels. Alternate frequency bands approximately 10 per cent. wide were assigned to the following different services: Land point-to-point, aircraft, ship, relay broadcasting, public service, amateur and army mobile. An important principle was followed in this assignment, viz, each service was protected from possible harmonic interference from stations of other services by placing the several frequency bands of any given service on its own harmonics.

BEAM TRANSMISSION

Great improvements are in progress in directive or "beam" transmission. It is accomplished by using a number of transmitting antennae and so adjusting the phases of the current in each, in relation to their distances apart, that re-enforcement of radiation is obtained in one direction and more or less neutralization of radiation in other directions. An obvious advantage of beam transmission is that much lower power is required than in ordinary radio transmission, since the transmitting power is all utilized in sending the waves in the desired

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*Address delivered before Am. Inst. of Elec. Eng.

nary channels of communication without any special arrangements being made.

As it later developed, her communications, most of which were with inland stations, proved to be not so much a test of the Naval Communication System as a test of her ability to maintain communication at all times with the various inland stations.

The Commander-in-Chief, U. S. Fleet, in comment upon communications during this flight, emphasizes the necessity of dirigibles becoming proficient in communicating with government radio stations on standard frequencies. Noteworthy results were obtained by the *Shenandoah* and the Radio Laboratory at Bellevue on high frequency. During almost the entire cruise, the *Shenandoah*, on 90 meters, was in reliable communication with the laboratory at Bellevue, at 50 meters, every night for about seven hours.

Even the layman can realize to what great advantages radio can be applied. A thorough study of the resumé on the wonder of the day, the trans-continental flight of the *Shenandoah*, would make the most inactive imagination active. With all these things for which radio is responsible to show, there is little doubt but that the next 14 years will disclose even greater wonders in the field of radio than the last 14 years have uncovered.

Survey of Progress in Radio Engineering

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direction instead of all directions. This important advantage, which means reduced cost, will probably not be fully realized because the great ratio of transmission in the desired to undesired directions is probably reduced as the wave spreads out to great distances. The undoubtedly great directivity for relatively short distances from the transmitting station, however, offers highly important advantages in another particular, the reduction of interference caused by the transmitting station.

One of the principal means of overcoming interference between the transmissions from simultaneously operating radio stations is obviously the increase of selectivity or narrowing of the band of frequency which each station uses. Progress in this direction is being made in all the various types of transmission, as, for example, through the use of filtering devices for radio telephony and coupled circuits in spark apparatus. The principal advance, however, is the increasing adoption of continuous-wave transmission for radio telegraphy.

We also have the advent of strictly constant frequency systems. A striking means of accomplishing this is furnished by the piezo-electric oscillator. A new radio communication system of the utmost selectivity and precision is made available by this new device, and services which require the operation of a large number of transmitting stations spaced as closely together as possible in frequency and taking full advantage of C.W. transmission will find this a great improvement.

The various causes of interference divide into two great classes, natural and man-made. As to the natural interference, there will always be a certain residum of atmospheric disturbances and fading which will limit the distance at which reliable reception will be possible. The various kinds of man-made interference, on the other hand, are curable and are of local character; it can be expected that more and more localities will be freed from the various types of this pest.