PROGRESS IN ELECTRONICS AND RADIO

By DR. E. F. W. ALEXANDERSON

PROGRESS marches on a broad front. Among the numerous ideas that are continuously being put forth by research and industry, there are only a few which become known as outstanding inventions, such as Edison's incandescent lamp, and the Wright brothers' first airplane.

But it must be remembered that the desire to produce an electric lamp and an airplane were very much in the minds of many of the scientists of those days. This does not detract from the merit of those who actually were successful. They won the race and proved thereby that they were the best men in their profession at that time. But we can be sure that there were some second-best very close behind.

It often happens that the pressure of the ideas of progress is so great that the same invention is made simultaneously in several places, and there is a margin of only weeks or days to determine who was the first inventor. The greatest single contribution to the use of electric power was the three-phase induction motor. It was invented simultaneously in three countries, by Tesla, Wenstrom and Dobrowolski.

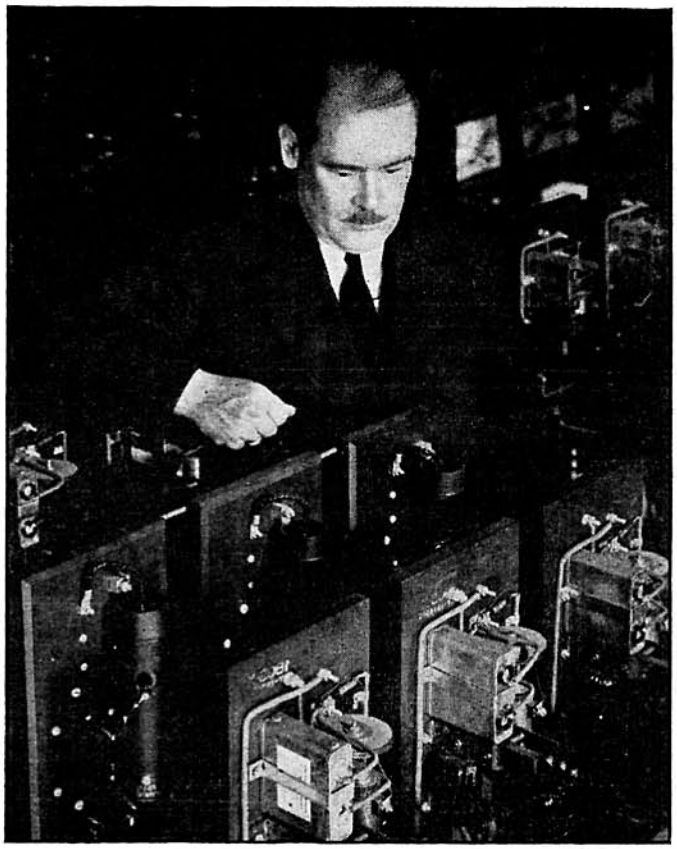
I mention these things because trails of progress in electronics and radio have followed different courses in the past, and seem destined to do so in the future. The immediate opportunities in electronics and radio are well-defined and known by many research workers. They are working toward a common objective but perhaps by different methods. At least this was the situation when the exigencies of war either modified or accelerated normal peace-time research.

If we wish to forecast the industries of tomorrow, then, we may well examine the unfinished developments of today. War is a tremendous stimulant of new discoveries and inventions and we can be sure that after this war there will be a new upsurge in all branches of technology.

The specific lines of research which are in progress now cannot be described at this time, because they are almost all military secrets, but we can illustrate the point by taking some examples of an earlier date from electronic and radio engineering.

Electronics is the latest branch of electrical engineering, but the ideas which are now coming to the fore can be traced as an evolution starting more than thirty years ago.

At that time, broadcasting as we now understand it, was simply an idea. We had an alternator, but not an amplifier, and an amplifier was needed—to build up words and music for transmission, and to build up the feeble signals at the point of reception, so that a listener might easily hear them.



Dr. E. F. W. Alexanderson, G.E. Consulting Engineer, in his laboratory, shown with test set for Thyratron power circuits. Three small metal Thyratron tubes shown on panels immediately in front of him.

One of the systems suggested was a vacuum tube with a mercury pool and an igniter. The function of the igniter was to control the power flow through the tube by a system of timing the spark. This may seem technical, but we are all familiar with the spark timer on an automobile engine, and you still use the timing lever to control the power of an outboard motor.

This trail of thought was not followed up for a while because, in the meantime, we became acquainted with the DeForest Audion tube, which was a much better amplifier for radio, and our efforts were concentrated on the development of radio tubes. Ten years later, however, when radio was going strong, our thoughts returned to the starting point. A vacuum tube was then manufactured containing mercury which could carry high currents. Such tubes were used to change—or, as we say, rectify—alternating current into direct current, but their application was limited because there was no way of controlling them. The normal control used in radio tubes, you see, did not work in the presence of mercury vapor. We therefore returned to the idea of the igniter with a timing control. If it could be adapted to the mercury arc rectifier, we would have a device of greatly increased usefulness.

The commercial rectifier tubes at that time were built in a characteristic shape resembling a big head with a pair of arms holding up hands on each side. Some investigations by Dr. Irving Langmuir indicated that it was possible to keep the arc burning in the bulbous head and ignite the arc in the side arms by a change in surrounding potential. Perhaps the idea of controlling the power flow by timing the igniter could thus be realized. It was certainly worth trying. So we wrapped the side arms of an old rectifier tube with ordinary tinfoil between the elbow and the wrist. For all the world, it looked like a Rube Goldberg device! Then we applied an alternating voltage, high enough to penetrate the glass. At the same time, a voltage of the same frequency was applied to the electrodes in the ends of the side arms. The experiment was very simple and it worked perfectly. By changing the time phase of the voltage applied to the tinfoil, we had a perfect control of the power flow. The principles had been established, and all we had to do to get a practical device was to have a glass blower insert a graphite block on the end of a wire at the bend of the elbow, to take the place of the tinfoil. This eliminated the necessity of applying a voltage high enough to penetrate the glass.

We had thus a device whereby we were able not only to control the power flow in a rectifier, but also to invert its functioning *so as to change direct current into alternating current,* whereas its original use was to change alternating current to direct current.

The inverter was thus born twenty years ago, but it is even now not much known because its usefulness in a large scale is still in its infancy. As a preview of the future, we are, however, operating a direct-current power transmission from a 40-cycle water power plant on the Hudson River, and delivering power at 60 cycles in a power house in Schenectady.

Whether our hopes of the future for the system will be fulfilled is still uncertain. We may foresee power transmission of 500 to 1000 miles. There is, however, another opinion in competent quarters, that it does not pay to transmit power more than 300 miles, because it is cheaper to build steam power stations and transport coal by railroad. It is not the place of us who do the developmental engineering to try to settle these questions beforehand. We are concerned in establishing the physical facts and are willing to let economic questions answer themselves.

To complete the cycle of evolution, we may point out that we have now reverted to the ideas of 30 years ago, of starting

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RADIO AND TELEVISION AFTER THE WAR

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technical books dealing with every phase of television broadcasting.)

Facsimile broadcasting, now in its infancy, will be a big business, for through it every variety of written matter can be brought by advertisers into the home at negligible cost.

F.M.'S FUTURE

More immediate is the opportunity for new F.M. stations. An ordinary station cannot broadcast Frequency Modulation. Public demand for static-free F.M. reception is enormous and will increase, especially in the cities. The local limitations of television will insure the continuance of regular broadcasting long enough to permit fortunes to be made in the F.M. field.

What will happen to our present radios when television and F.M. dominate broadcasting? One possible answer is—they can be sold to a vast European and Asiatic market, particularly short wave sets. A modernized China alone can absorb millions of used American radio sets.

Personal two-way radios are on the way for use in private cars, planes and boats, with special sets for campers, hikers, mountain-climbers, fishermen, etc. The manufacture and sale of these low-cost sets, using individual wave lengths (a certain development) will create new fortunes.

Soon after the war there will be new portable radios, as small as pocket-size and light in weight, with a new kind of miniature battery rechargeable at home.

You may carry a radio as casually as a watch, and it may not be much larger or heavier. There are 100,000,000 potential customers in the U. S. alone.—*Forbes Magazine*

SUBMARINE DETECTION

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the vagaries of granular microphones.

In order to be able to listen from a ship in motion and to reduce ship and water noises as much as possible, hydrophones, with the rubber block form or of one of the foregoing types, have been enclosed in fish shaped bodies and towed through the water some distance astern. The modern tendency, however, has been in the direction of inboard listeinng, by securing efficient acoustic insulation from the hull.

—*Purdue Engineer*

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the mercury arc at the beginning of each cycle by an igniter. Direct-current power transmission is executed in this way, and a large industry has grown up in building enormous rectifier stations for production of aluminum. In these, we use mercury tubes and control the power flow by igniters.

As another example of ideas which have been kept in cold storage for many years, we may mention tests made in 1928 with radio echo to measure an airplane's distance from the ground. The idea seemed very promising and tests were made to give the pilot a warning if he was flying into a mountainside. The aviation industry has shown repeated interest, but the finished device, which may be carried by every airplane, is still to be developed. But it is safe to predict that, in the future, airplanes will be piloted by radio echo through mountain ranges, in clouds, and darkness, and come to a safe landing without seeing the ground.

The instances of unfinished trends could be multiplied. Frequency modulation has already been well established, but it has still far to go. We can foresee chains of relay stations on mountain tops, so that the whole country can be connected up in a system of frequency-modulated broadcasting. Such relay chains may be combined with television, which will come into its own when it can acquire a large enough audience. Television in color will then follow, when circumstances permit.

The growth of television is likely to have indirect effects in other fields, because it contains so many new ideas which will be useful for other purposes. The relay chains will lead to the utilization of sharp radio beams and still shorter waves. Here is a basis for radio trails which will cross the continent like highways, so that the aviator can fly above the clouds and see his way in three dimensions by radio vision, as unmistakably as if he were looking at rows of street lights on a clear night. Ships will see each other in a fog, and their radio lights will be as indispensable as the red and green lights are now for navigating on a clear night.—*From an address delivered on January 26, 1943, during the General Electric SCIENCE FORUM program.*

BRAIN WAVES MADE AUDIBLE?

Dr. R. Fuerth of the University of Edinburgh, in an article in *Nature*, suggests that brain waves, usually recorded on paper ribbons, by a system analogous to radio apparatus, could be converted into sounds, possibly even musical in nature, and thus made audible.

An instrument which he is using at the present time, which he calls the "encephalophone" (from the Greek, "recorder of head sounds"), does such, and in a "satisfactory" manner.

For example the *alpha* waves associated with epilepsy (which pulsate about 12 per second), and the faster *beta* emanations, (which appear as trills or wavering notes) have been converted into sound waves.

Other waves, slower in beat, produce other characteristic tones.

If such a device were made commercially it is believed its advantages would lie in its relative inexpensiveness and its compactness.

RADIO AIDS SNOW REMOVAL

During the recent heavy snowfalls in New York City, the gigantic task of removing the snow was aided by the use of radio.

Since each foreman has in his coupe a radio tuned to the same wavelength as that in use at the airport, orders could be given which expedited the removal operations with a minimum of lost time.

This explains, why, for the first time in years, the snow was removed from New York City's streets, in record time.