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INDUSTRIAL SCIENCE LOOKS AHEAD[1]

By DAVID SARNOFF

PRESIDENT, RADIO CORPORATION OF AMERICA

INDUSTRIAL science at war is shaping a new world. While the battlelines of the United Nations encircle the Fortress Europe and the pincers of Victory tighten on the enemy in the Pacific, civilization advances ever closer to the post-war horizon. With Victory will come the day when the scientific instruments and processes of war will turn abruptly to peace. Machines and tools, as well as industrial and economic thinking, will be converted quickly from the demands of war to the needs of peace. Industry will be called upon to relieve the strains of war with utmost speed by ministering anew to human welfare, health and comfort. Already post-war planners are at work in many fields of industrial endeavor.

But it is not new for American industry to be surveying and planning for the future. That process is always at work here, whether the world is at peace or at war. Only by advanced thinking, research, engineering and continual pioneering, can industrial science put new ideas into action. By doing this, industry serves its workers and the people, and thereby wins the right to survive.

We have but to consider some of the outstanding wartime developments of industrial science to realize their widespread applications in all fields; from automobiles to giant turbines and diesel engines, from cameras to facsimile and television. Endlessly, these advances extend into every realm of our daily lives. Among the promises of better living we are told of new plastics, light metals, synthetic textiles, high-octane gasoline, artificial rubber, luminescent lighting, air-conditioning, dehydration of foodstuffs and many other innovations. We even hear of glass flatirons and plastic lenses. We are promised revolutionary changes in homes, aircraft, communications, ships, railroads, automobiles, highways, clothing and foods. In myriad ways the wartime inventions in electricity,

[1] Address before the Lancaster Branch of the American Association for the Advancement of Science, delivered at Franklin and Marshall College on November 11, 1943.

metallurgy, chemistry and physics will open new gateways for industrial science to enter and enrich our everyday life.

As for the great, modern art of radio, I can promise you that as a service to mankind everywhere, it will keep pace with the march of science and industry.

To-day is the anniversary of a historic event that provides us with a timely opportunity to review the remarkable advances of radio within a quarter century, to reflect upon its vital role in the war, and to look into its future.

Twenty-five years ago this morning, news flashed across the hemispheres that the first World War had ended. In retrospect that day appears as a fleeting moment. History lifted her pen and paused to dot the "i" of an empty Victory that proved to be only the prelude to a global war unprecendented in fury, extent and destruction.

In that autumn of 1918, Germany's pleas for peace had revealed the plight of the German people. Germany was cracking. American radio was entrusted to transmit to a defeated nation President Wilson's Fourteen Points as a basis for the restoration of peace, and for a general armistice on land, on water and in the air. Radio operators stood by for the answer. It came on the midnight air of November 11, when silence in the "ether" over the Atlantic was interrupted by a flash from Europe. At 2:45 A.M. New York time, the news broke. The State Department in Washington announced the Armistice had been signed at midnight, and hostilities would cease at 6 o'clock in the morning—11 A.M., in France.

There was no radio broadcasting to spread the welcome word—"It's over, over there!"

Under the banner headline "Peace," Americans read the news at their breakfast tables. The world was only a reading world at that time. It had not yet learned to listen. News spread slowly in 1918. Although powerful radio alternators relayed these tidings around the world to ships on the Seven Seas, homes were not yet radio equipped. Many days passed before news of the Armistice filtered into remote hamlets and farms. War correspondents were scribes, not eyewitness broadcasters; they had the pen but no microphone. To-day, news travels at the speed of light, in every language, to every corner of the earth.

In those days there were no globe-encircling short waves, no high-power vacuum tubes, no universal receiving sets. The radiophone was just learning to talk. The electron tube had not yet revealed its power and its unlimited possibilities.

The radio of that day gave everything it had to win the war. Research men and engineers rushed new devices into service to maintain contacts with the battle-fleet, with the convoys and the American Expeditionary Force in France. Although ships in the mid-Atlantic could not maintain direct contact with American and European shores, the long waves of powerful land stations swept across the sea and linked America with its Allies. War bulletins moved through the air at the rate of 30 to 40 words a minute. To-day, short waves and high-speed automatic machines handle news at the rate of more than 600 words a minute. In the first World War, American newspapers had to wait for ships to arrive with the historic pictures of Pershing and the A.E.F. in France. Now radiophoto service can deliver pictures of Eisenhower and his forces in Italy and MacArthur and his troops in the South Pacific a few minutes after the camera snaps them.

To-day, largely because of radio, New York is the communication center of the world. In 1918, it was London. During the first World War the United States found itself at the mercy of foreign communications. America learned the lesson then that radio was the nerve system of war as well as of peace. Immediate steps were taken to safeguard the future, to give the United States supremacy in world-wide communications and to make sure that never again would this Republic be dependent upon the wavelengths, cables or wires operated and controlled by other nations.

As a result of this determination, the direct radiotelegraph circuits of RCA now reach 51 countries in Central and South America, the West Indies, Europe, Asia, Africa and Australasia. Radiophoto circuits operate between New York and London, Stockholm, Berne, Moscow, Cairo and Buenos Aires, while the terminal at San Francisco serves Honolulu and Melbourne.

In this war, radio is everywhere—with soldier, sailor, marine and airman. Modern warfare has put radio instruments into every bomber and fighter plane, into every mechanized unit and into every ship. There were no walkie-talkies or handy-talkies in No-Man's Land, at Verdun or at the Marne. The "cease firing" order signed by Foch was shouted and carried by runners along the trenches. The radio equipment of that day was too massive and too heavy for more than a limited use in airplanes. Now, compact, efficient radio goes aloft with all planes; wavelengths are their lifelines. Coordinating great aerial squadrons, radio guides the bombers and swarms of fighters over the targets and safely back to the airports. The paratrooper leaps from the skies with a miniature radio transmitter—no larger than a cracker-box—strapped to his belt. The artillery, through its radio, knows at all times what the infantry wants, when it wants it and exactly where it wants it.

These historic comparisons dramatize the great advances made by radio in a quarter of a century. Industrial science and private enterprise, free and unfettered, took the war-born electron tubes, the radiotelephone and the short waves and adapted them to peaceful pursuits. Clues to what might be accomplished in peace were, however, in the air during those final months of the first World War. When a subchaser dashed out to sea from a port in Maine, its radio operator moved a portable phonograph near to his radiophone microphone to broadcast a popular wartime tune, "I May be Gone for a Long, Long Time." From the Navy station at New Brunswick, N. J., the "Star Spangled Banner" was broadcast up and down the coast. These were forerunners of the day when radio music from hundreds of stations would encircle the globe.

War had revealed that new instruments could be made available for mass communication. The time was opportune and industrial science was prepared to answer the challenge. Soon after the Armistice, America became aflame with a new national pastime—that of listening-in. The vast industry of broadcasting came into being. Its achievements as a service to America and to all the world during the past quarter of a century are an epoch-making and dramatic story of American ingenuity and enterprise at its best.

In no other nation has radio developed as it has in the United States. Nowhere else are people better informed. To-day this country is served by more than 900 broadcasting stations and four national networks. There are 60,000,000 receiving sets in our land. The owner of every set is free to listen to any wavelength from any country. American radio dials are symbols of freedom.

The scientists who worked out inventions and harnessed the wavelengths to equip America with this unsurpassed radio system realized only vaguely that their achievements might be used in a second World War. Theirs were the tasks of peace. They worked to make a symphony orchestra sound with perfection hundreds and thousands of miles distant from its source, and enable the human voice to ring true on the other side of the globe.

They extended the influence of news, education and religion to all parts of the earth. They made the world an open-air theater in which countless millions of people could enjoy free entertainment.

Thus, scientists made American radio the voice of freedom, so interwoven with our daily lives that we have come to think of radio as an achievement only of the twentieth century. It is, however, a child of the ages. Modern radio came into existence through a long process of evolution. The long corridors of time, through which man has conducted research and experiments, extend far into the past. They lead back to ancient Greece. There, the first electric sparks, called electrum, kindled a new science and unleashed a new force—electricity.

While the men of science were seeking to explain the mystery of these sparks, the philosophers of Greece foresaw that if democratic government were to remain effective, the range of the human voice would have to be greatly extended. Aristotle argued that the best of states might well outgrow geographical boundaries with populations reaching such size that well-ordered and efficient government could not function. He said that a democratic government required that the citizens keep in touch with one another; that their leaders know each other and that they study at first hand their common political problems and the policies necessary to meet them. But Aristotle warned that it would be impossible to accomplish this in the overgrown State, "for who could be the leader of the people in such a State, or who the town-crier, unless he have the voice of a Stentor?" It would seem that Aristotle even forecast the need for television, because he believed that the people needed to see their leaders, as well as hear them at long range.

Two thousand years later we have seen this come to pass, for science has provided government and its leaders with radio. The entire nation has become an open forum. The leader of the modern state is heard at one time by more people than Aristotle, Socrates and Plato reached in their whole life-time. Electricity has made the microphone the voice of the Stentor; our leaders talk to the people, and at the same instant they are heard around the world.

We of this generation have seen men of evil intent stopped by the very tools of science they perverted ruthlessly to extend their power. We have watched science halt the tyrant and dictator as the stentorian voice of the United Nations cried out in defense of freedom, democracy and justice.

When this war ends, we shall be on the threshold of a new era in radio—an era in which man will see, as well as hear, distant events. The first two decades of this century belonged to wireless telegraphy. The second two decades featured sound broadcasting; the third two decades promise television. It is not too bold to predict that the fourth two decades will introduce international television with pictures in color.

It is even possible that in the two final decades, we may complete the century with power transmission by radio, and its use in the operation of vehicles, automobiles, ships, railroads and airplanes. When completed, the story of these first hundred years of radio will make fascinating reading. Even a Jules Verne could not tell us all that lies ahead in this magic realm of radio-electronics.

The science of radio is no longer confined to communications. Among revolutionary accomplishments —in other lines, we have the electron microscope, one of the most important new scientific tools of the twentieth century. Developed in RCA Laboratories, and based upon television techniques, this instrument has a high wartime priority rating for use in scientific, medical and industrial research. For the first time, it has made it possible for us to see and identify molecules and to photograph the influenza virus. It has revealed, in infinite detail, the true structures of fibers, crystals and pigments. The submicroscopic world is now opened wide for exploration. Bacteria, tissues and minute particles of matter have been brought within range of man's eye, for the electron microscope, many times more powerful than the strongest optical microscope, permits magnifications up to 100,000 diameters. A needle on such a scale of magnification would appear as huge as the Washington Monument; a blood corpuscle as large as the wheel of an automobile and a football field, five times the size of the United States.

Wartime industrial research and engineering have rushed into use still another branch of radio—the art of utilizing high-frequency radio waves for heating. It violates no military secret to report that in this new field of radio-thermics, a laminated airplane propeller can be processed in minutes compared with hours required by ordinary heat and pressure methods. In many cases where uniform heat under accurate control is necessary in industrial processes, radio-thermics offers great promise in efficiency and time saving. The wide scope of its application ranges from case-hardening steel to dehydrating foods, from gluing prefabricated houses to seaming thermoplastic materials by means of a "radio sewing machine." These accomplishments are all based upon the simple fact that micro-waves, in penetrating an object, encounter resistance and create heat.

Further afield from communications, research men are exploring supersonic vibrations, far above the range of the human ear. The use of these ultra-sonics in chemistry may open a field in which high-intensity sound accelerates chemical reactions. Experiments also indicate important possibilities in many other fields, including underwater-communication, emulsification of liquids and precipitation of dust from the air.

We attribute all these lines of progress to the science of electronics. The heart of that science is the radio tube. Millions and millions of radio-electron tubes are on duty around the world. They are being manufactured in the United States at the rate of 400,000 a day. And a very important part of this production is right in your own home town—in the RCA plant at Lancaster. The communities in which they are made are on the front line of production. The great importance of each radio tube that moves off the production lines can only be envisaged by considering the many functions it performs in helping to win the war. The delicate finger of the worker who makes the tubes has a task as vital as the finger of a soldier on the trigger of a rifle.

Likewise, radio-electron tubes are as important in peace as in war. They are the master keys to revolutionary advances in radio. They have registered the sound of footprints in the past; they are the pulse of the present, and the "eye" of television that sees far into the future.

The day may come when every person will have his own little radio station tucked away in his pocket, to hear and to speak with his home or his office as he walks or rides along the street.

We have much to learn about the micro-waves, in which is wrapped up this new world of individualized radio. Tiny electron tubes may make it possible to design radio receivers and transmitters no larger than a fountain pen, a cigarette case, a billfold or a lady's powder-box. Some day people may carry television screens on their wrists, as they now carry watches. For, as the useful spectrum of radio approaches the frontiers of light, the apparatus will become simpler and more compact.

To-day science is leading us out of a world in which radio has been blind. To-morrow we shall have radio sight. By this I do not mean that we shall look only at pictures in motion that travel through the air. Radio-vision will have many uses. It will serve wherever sight is needed. For instance, it will be used to prevent collisions on highways and railroads, on sea lanes and on the airways of the world. Radio will be the new eye of transportation and commerce. Applications of radio optics are unlimited. With radio ear and eye to guide them, the great stratoliners will be super-human in their instincts of hearing and seeing as they speed through space with passengers and freight. Radio, which made the world a whispering gallery, will turn it into a world of mirrors.

Radio's great responsibilities do not stop there. A formidable task lies ahead for communications in the restoration of peace, in the reconstruction of the world and in the re-establishment of international trade.

If American industrial science is to play its destined role in the reconstruction period, government should not unduly restrict private enterprise or enter into competition with industry. On the other hand, it is of no avail for industry merely to point to the dangers of governmental restraints. Industry must give evidence of leadership by presenting practical alternatives.

The day of pioneering in America has not ended. But trail blazing now calls for joint effort by government, labor and industry. Their authority, experience and vision must fuse harmoniously to achieve success. The same spirit of give-and-take must prevail in industrial statesmanship as in national and international statesmanship. There must be but one goal—the welfare of the people and the nation.

Industrial statesmanship can accomplish more than political statesmanship in solving the post-war problems of employment, mass production, prosperity and the continued uplift of the American standard of living. Industry can be the great motive power, in the solution of these problems. The future of every American home and family depends upon it. Therefore, it is imperative that after victory is achieved on the battlefields, American industry devote the same all-out efforts to the peace that it devoted to the war. There can be no let-down. The problems of peace will be of great magnitude. After the devastation of war, mankind will be called upon to win the peace and to make that peace secure with happiness for all people. If industrial statesmanship fails in this great opportunity, then the approach to the post-war problems necessarily will be political instead of economic.

America's cultivation of science has proved the nation's salvation in modern warfare, and it must not be otherwise in peace, for pioneering and research create wealth and employment.

In considering opportunities for employment after the war we must lift our sights to the skies. Man, long confined in his activities to the surface of the earth and beneath the ground, now finds that the air is a new dimension, offering new adventures and pioneering by a new generation. The air is a universal chemical and physical laboratory in which essential elements for life on earth are created. Nature herself makes unlimited use of celestial space for transmission of light and heat from the sun. Only in recent years has man learned to use the air. Only now is he beginning to discover its tremendous potentialities. Literally out of thin air, chemists are creating new products, physicists are building new services, while man is talking on unseen waves and flying on invisible beams.

On the surface of the earth, ships and railroads, automobiles and industrial machines have created millions of jobs. Underground, coal, oil and minerals provide employment for other millions. Above the earth, aviation and radio, electronics and television can open the way for new opportunities in reemployment of war workers, and for the millions of men and women who will return from service.

It is estimated that 10,000,000 jobs which did not exist in 1940 must be found to solve the post-war problem of employment. One great hope in helping to meet this unprecedented challenge will be found in the fertile and unexplored frontiers of space. Science, offering new incentives, is beckoning capital to venture into the open skies.

We are challenged to look upward to our future.

Horace Greeley, if here to-day, might say, "Go up, young man, go up and grow up in space." There, lies the unfathomed West of this century, with no last frontier; there, lies a vast wilderness rich in resources, opportunities and adventure. The Forty-Niners of the present decade will be prospectors in research. They will travel through the air to stake their claims to fame, fortune and freedom.

To assure the full attainment of these results, private industry and the government must play their parts with the utmost honesty of purpose, encouraging individual and collective initiative. The national growth of the United States and its contributions through research and invention, are historic proof that traditional American cooperation between industry and government promotes the best public interest.

The role of government in its relationship to labor and industry should be that of an umpire. A wise government does not seek to favor either management or labor. It must be impartial, not partisan.

When the war ends, and we enter the immediate period of transition, the Government in fairness to both labor and industry must readjust its rigid wartime controls. The emergency regulations necessary in wartime, but not necessary in peacetime, should be reduced as speedily as practicable. Elimination of wartime restrictions will enable manufacturers to produce and supply the goods needed by the nation, to maintain employment and to adapt new developments in industrial science for the benefit of all people.

America must be practical. Science and industry must have American independence if they are to succeed in the gigantic task of reconversion, reemployment and world rehabilitation.

Never again can the United States be isolated and secure within its own shores. In the fact that no spot on the globe is farther than 60 hours flying time from any local airport is seen the truth that nations must live together as good neighbors. Shriveled by radio and aviation, the new world is a single neighborhood. That is not a theoretical concept. It is a fact.

To-day man can travel by train from Chicago to New York in 17 hours; he can fly in 5 hours. He saves 12 hours, but it is of no avail if he does not use that time constructively. If people achieve more leisure, what are they to do with the newly found hours of freedom? This is one of the paramount problems that faces the post-war world. Recreation and entertainment are vital to a happy life. But to be content man must also work. Mere idleness does not produce happiness or progress. Life is measured by time; it is too fleeting and precious to waste.

Entertainment can be as refreshing as sleep. To gain new ideas and to think clearly, the brain also must have diversion. In leisure some of the greatest dreams of all time have been born and have grown into revolutionary ideas and inventions. The complete conception of the telegraph flashed into the mind of Morse while on an ocean voyage. The idea of wireless flashed into Marconi's mind while vacationing in the Alps. Great ideas in science, art and literature seldom come directly to the work-bench; they are released at unsuspecting moments when the subconscious mind has opportunity to come into its own.

In broadcasting we have an outstanding example of an art that is measured by time and linked with opportunity. The listener may use the hours to good advantage, or he may waste them. It is the use to which he puts his radio set and his freedom in selection of programs that reveals the inherent value of broadcasting. The program is the essence. If it brings laughter, if it stimulates thinking or rests the tired mind or keeps the listener informed and in touch with his fellowmen, then radio is an antidote for idleness and loneliness.

Science is a mighty ally of freedom—its advance has brought much release from drudgery and from want. However, we must progress still further. For better machines are not all that is needed to make a better life. We shall have a better world only to the extent that our social thinking and our social progress keep pace with the advance of physical science.

We are approaching the days in this struggle when the basic challenge of the post-war years will become sharper and clearer. It is a challenge that will ring out to people in all walks of life; to brains and initiative, to cooperation of government and industry, to labor and management, to religion and education. The answer will be found in the minds and hearts of men and women intent upon preserving civilization, and a world at peace.

In this month of Thanksgiving, let us be thankful that America and her Allies have the strength and determination to hold high the eternal torch of freedom. May the victory be a victory of lasting peace, so that out of the bombed and shell-torn earth will come a happier to-morrow for *all* mankind.

OBITUARY

HENRY G. BARBOUR

On September 23 American pharmacology lost one of its outstanding representatives in the death of Professor Henry G. Barbour at New Haven. This loss was accentuated by the death of Mrs. Barbour only one week earlier. Both had long been residents of Connecticut and well-known members of the Yale community.

Henry Gray Barbour was born in Hartford, Connecticut, on March 28, 1886, the son of the Reverend John H. Barbour, a professor of theology, and Annie Gray Barbour. He traced his descent from several colonial governors of Connecticut and Massachusetts. He attended the Hartford Public High School and received his A.B. from Trinity College in 1906. In 1910 he received his medical degree from Johns Hopkins University. On September 15, 1906, he married Lilla M. Chittenden, of New Haven, the daughter of Professor Russell H. Chittenden, renowned for his studies of nutrition. Three children survive him, Henry C., Dorothy (Mrs. John D. Hersey) and Russell C.

From 1910–1911 Dr. Barbour was a fellow in pathology at Johns Hopkins University. In 1911 he did research abroad in Freiburg, Germany. In 1912 he studied in Vienna with Hans Horst Meyer, and later in London. In 1912 he received his appointment of assistant professor in pharmacology and toxicology at Yale University, where he remained until 1921. Leaving New Haven in 1921 he served as professor of pharmacology at McGill University in Montreal for two years. From there he went to the University of Louisville in 1923, where he served until 1931 as professor of physiology and pharmacology. His old associations with New Haven led him back in 1931 to Yale as associate professor of pharmacology and toxicology at the Yale University School of Medicine, and in 1940 he became research associate with professorial rank in pharmacology.

During the first World War he conducted experiments on poison gas as consultant for the U. S. Government in connection with the U. S. Bureau of Mines. He was for many years a member of the revision committee of the U. S. Pharmacopoeia and the consulting editor of "Anesthesiology." He was consulting pharmacologist also to various industrial concerns for short periods on specific problems.

Professor Barbour was interested in the physiology of heat regulation with particular reference to metabolism and water exchange and its application to clima-