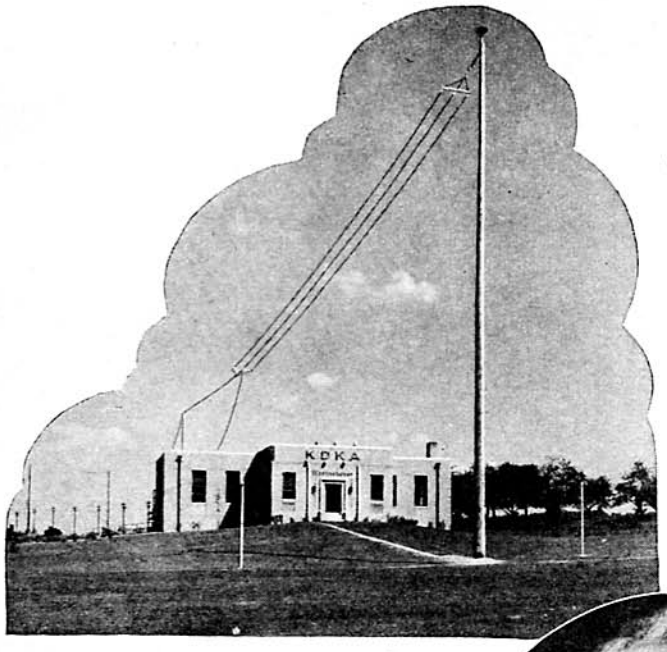
KDKA

Employing two 200-kilowatt, water-cooled tubes, this giant transmitter, erected at Saxonburg, Pa., is an outgrowth of the tiny 100-watt outfit that broadcast the Harding election returns on the night of November 2, 1920



Above is an outside view of the new KDKA transmitters at Saxonburg, Pa. Dr. Frank Conrad—at right—a pioneer broadcaster and assistant chief engineer of the Westinghouse company, who has just been awarded the Edison medal for his contribution to radio broadcasting and short-wave radio transmission

IN the amazing manner of what may some day be known as the "radio decade," our erstwhile pioneer and infant commercial broadcaster, KDKA, has achieved the ripe old age of ten and acquired a 500 horsepower voice. It seems hard to realize that 400,000 watts of power have grown from the feeble, hesitant, 100-watt transmitter that undertook the task of sending news to a few eager listeners on that momentous evening of the Harding presidential election. Since that occasion, November 2, 1920, the station has not missed a single day of broadcasting.

Those gifted with an historic mind or a penchant for first causes may perhaps rejoice that the late war had something to do with the fact that we now listen to Phil Cook, Amos 'n' Andy, or the Philharmonic Symphony. It had—and for the simple reason that the Westinghouse Electric and Manufacturing Company did considerable work in radio during the World War, first for Great Britain and later for the United States. At the end of the conflict, H. P. Davis, vice president, who had been directing war activities of the company, found a large staff of men and considerable equipment on hand. Mr. Davis decided to make use of this personnel and equipment.

Experimental stations 2WE and 2WM were set up, one at the East Pittsburgh plant and the other at the Wilkinsburg home of Dr. Frank Conrad, Asst. Chief Engineer of the Company. Step followed step until it became possible for Dr. Conrad to broadcast entertainment programs from his home each Saturday night. These became so popular with the radio amateurs that one of the Pittsburgh department stores advertised receiving sets that would bring in the Conrad programs.

Seeing this advertisement convinced Mr. Davis that the proper field of radio was unlimited, that it could be a medium of mass communication as well as a means of secret and confidential messages. So plans were made to broadcast regular programs from the Westinghouse plant, instead of from the Conrad home, and to begin this service with the returns of the national election, November 2, 1920.

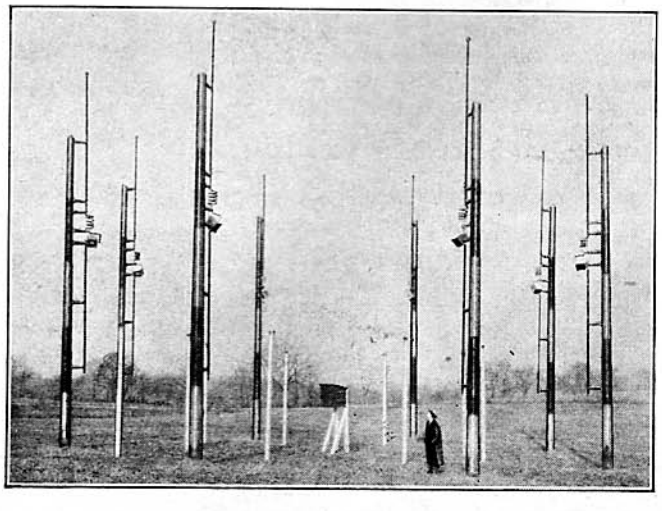
The company's first broadcasting was from a rough "box" affair on the roof of one of the taller buildings of the plant.

Much of the interesting history of the development of broadcast and entertainment technique by station KDKA is now well known. Thousands of radio listeners, of course, remember that the early program material was drawn largely from phonograph records. They also remember that the KDKA Little Symphony Orchestra was an outstanding feature in those early years of broadcasting. Some may not know that in order to accomplish good sound reproduction it was realized that rooms for that purpose would have to be specially designed and that in the case of the first of the summer broadcasts, it was decided to erect a tent which was used for some months as a broadcast studio. Everything went along satisfactorily during the summer and early fall until one night a high wind blew the tent away. And so the first studio of KDKA passed out and into history. The studio was then moved indoors and the tent "pitched" on the top floor of one of the buildings.

Shortly after that the subject of a specially-constructed studio was again revived and designs were prepared. The elements of the present-day studio in which the ceilings, floors and walls are built of materials, sound absorbing in character, are to be found in the early efforts of KDKA.

Church services, sport events, public addresses, concerts, opera, conventions and scores of other broadcasts followed as new pick-up stations were established, and the wave of popularity that greeted radio during 1921 was greater than anything known in the industrial and commercial world.

In brief, within the last decade radio has progressed from



At the right is shown the short-wave antenna system at the Saxonburg site. Through station W8XK programs are regularly sent to listeners in foreign countries

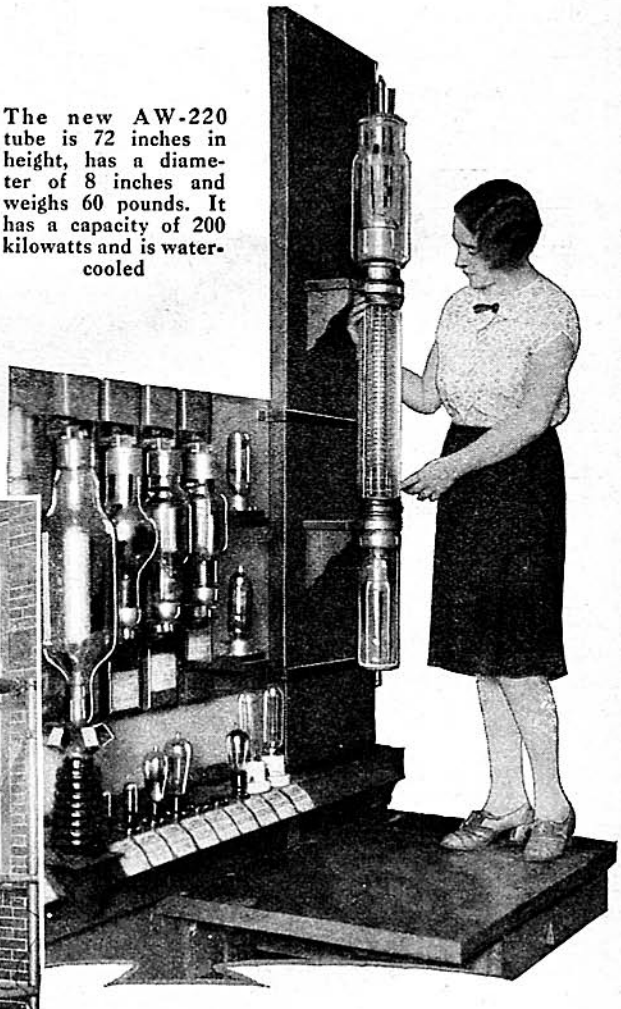
Radio's New 500 Horsepower Voice

By Albert Pfaltz

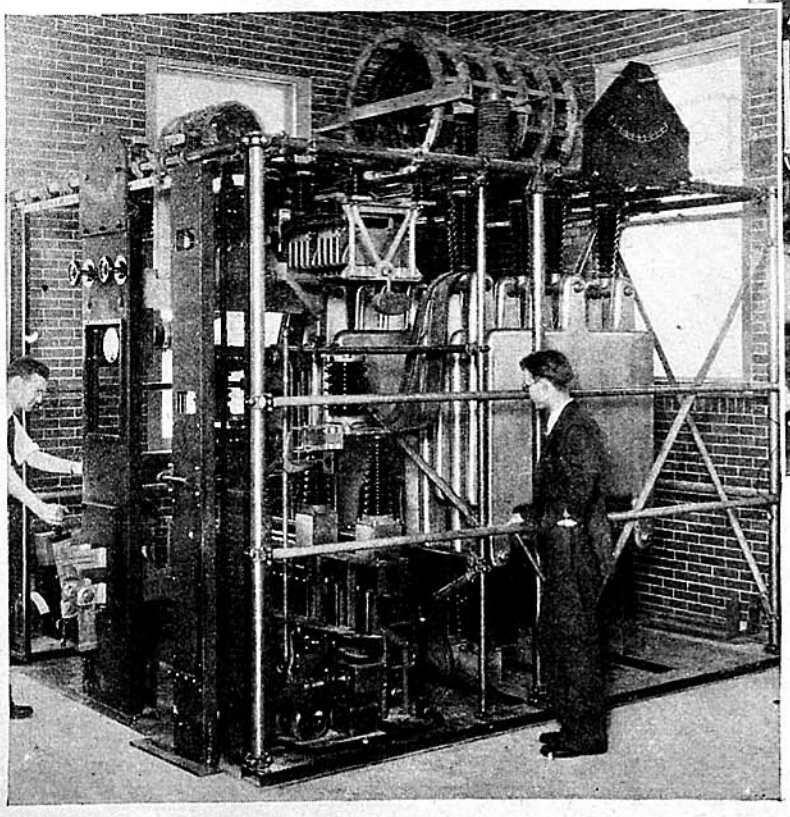
programs of records to recorded programs, from studio niches, wherein a potted palm tree rubbed elbows with a grand piano, to the "cathedral" studio at N. B. C., from entertainment of sorts to some sort of advertising with good entertainment, from strictly local broadcasting to Little America and return. More than this. Television is no longer lurking around the corner. One might almost say it is larking around the corner. The Radio City in New York is soon to become an actuality. The first step will involve the razing of three whole midtown city blocks. Such is progress.

KDKA Builds for Tomorrow

Anticipating the continuing and increasing rapid growth of broadcasting service, KDKA has recently built a new 400,000-watt transmitter at Saxonburg, Pa. The new station has been operating experimentally between 1 a.m. and 6 a.m. For normal operations, however, the power will be held at 50,000-watts as required by the Federal Radio Commission. (*Continued on page* 926)



The new AW-220 tube is 72 inches in height, has a diameter of 8 inches and weighs 60 pounds. It has a capacity of 200 kilowatts and is water-cooled



At the left is the power stage equipment of the Saxonburg transmitter and from this panel energy goes directly to the huge spray type antenna designed by Dr. Frank Conrad. Two of the new tubes are shown set up in their tube trucks. The large plates at the right and the coil at the top handle the enormous radio frequency energy generated at this point. They compose the tank condenser of this transmitter and are made of aluminum

KDKA—Radio's New Voice

One of the most important innovations is the new tube with a capacity of 200 kilowatts. This tube is not merely an enlarged edition of a smaller tube, but is thoroughly engineered as a tube of larger size and of a distinctly novel design. The mere building of a larger tube following the style of the smaller type would not produce the results desired. The quality of output and the life of such a tube would not be up to the desired standard.

The new tube, called the AW-220, is 72 inches in height, has a diameter of eight inches and weighs 60 pounds. Two of the new tubes are incorporated in the transmitter.

In its design engineers found one of their greatest problems to be that of cooling the grid. This difficulty has been solved by I. E. Mourmomtseff, company research engineer, who has produced a water cooled tube of great mechanical strength and sturdiness embodying a double end construction.

A modern water softening system has been installed for use in connection with the cooling system for these gigantic vacuum tubes. There is a practical reason for this installation because these giant tubes are expensive and unless properly protected their useful life period is limited. Therefore, anything that can be done to increase their life constitutes a saving in costly replacements.

According to E. B. Landon, chief operator of the transmitting station, the water must be tested frequently to protect the tubes and the cooling system. Ordinary city water cannot be used because it contains lime and other minerals which form harmful scale in the coils.

At the KDKA station this ultra-soft water is pumped to an outdoor cooling pool before going to the cooling coils and the tubes. Hot water coming from the station circulatory system enters the pool through a fountain-like spray. After cooling in the pool, it is pumped through the same circuit again.

An idea of the capacity of the cooling problem may be obtained from the statement that approximately five tons of cooling water must be passed through the water jacket of the cube each hour it is in operation. This water cools the tube in the same manner as water in an automobile cools the motor. One hour's operation of the tube would heat enough water to supply the domestic requirements of the average home for several weeks.

While of course these AW-200 tubes will only be used to generate high frequency power for radio stations, an appreciation of the power capacity of one of these tubes can perhaps best be gained by a comparison with familiar household devices. For example, a similar amount of power of the kind distributed commercially would operate simultaneously four hundred toasters or flat irons. This would also be the equivalent of power required to light one thousand average homes of five to six rooms or the energy to operate two modern street cars.

(*Continued from page* 873)

The antenna system of the new KDKA radio transmitting station, conceived by Dr. Conrad, is designed to make the local signal strength less than it would be for the conventional type of antenna, and to make the distant signal strength greater than for the conventional antenna. This is desirable from the standpoint of both listener and broadcaster; it makes the signal less objectionably loud to local listeners, and yet gives better reception to distant listeners; and it allows the broadcaster to use the radiated energy to better advantage in reaching distant points, since less energy is absorbed by objects in the local area.

The Antenna System

Sixty-two rigid tests were made to find a location which would be adaptable to favorable broadcasting before Saxonburg was definitely selected. These tests were made to determine the proper altitude with no interference from metal construction, free from trees so as to prevent undue interference and ample area for erection of the necessary structures and antennas.

KDKA's famous symphony orchestra, which is nationally known for its regular broadcasts

The site at the new transmitter occupies 130 acres. The long-wave antenna over which KDKA broadcasts consists of a circular arrangement of poles surrounding about eight acres. The poles are 100 feet above the ground and painted, according to law, yellow and black. Aerial hazard beacons also have been erected to serve as a warning to aviators.

A much smaller space is required for the short-wave transmitter of W8XK. It is through the short-wave station that programs are sent great distances for reception in far away lands.

The functioning of this antenna is based on the fact that local reception is due to radiation horizontally outward from the antenna that is, the ground wave; whereas distant reception depends considerably on radiation initially at an angle of elevation, due to the wave front descending as it moves outward from the antenna, and to reflections from the Heaviside layer. The descent of the wave front as it travels outward is due to the fact that the waves travel slower at the surfaces of the earth than in the upper atmosphere; and the reflections from the Heaviside layer are caused by the ionized condition of the layer which makes it conducting, i.e., like a short-circuit on the end of a transmission line, except that the lines of force are not guided by wires, and hence follow the ordinary law of equal angle of incidence and reflection. There is really no line of demarcation between the ground wave and the upward radiation, conveniently called the sky wave. The part of the wave which reaches the receiving antenna by moving out horizontally from the antenna or by the descent of the wave front, is what is usually meant by the ground wave, and the part which reaches the receiving antenna by reflection downward from the ionized layer, the sky wave. Since the ground wave is attenuated with comparative rapidity, the distant signals are carried largely by the sky wave, and if the ratio of horizontal radiation to sky-wave radiation can be decreased, the desired ratio of local or distant signal strength should be attained.

This decreased ratio of ground to sky-wave radiation is obtained in the new KDKA antenna by using an arrangement and spacing of vertical antennas fed with currents in time phase, such that interference between waves from the various antennas reduces the horizontal field strength in comparison to the field strength at an angle of elevation. The interference of the arrangement of vertical antennas will make the horizontal radiation much less than for a single antenna with the same total current; and will make radiation at an upward angle decreasingly less as the angle is increased, so that at high angles the radiation is only slightly less than for a single pole. This great decrease in horizontal radiation will decrease the radiation resistance of the antenna system, and so will cause the current to increase until the total power radiated is the same. This will make the upward radiation greater, and the horizontal radiation less than for a single antenna with the same power radiation.

In its physical arrangement the new KDKA antenna differs considerably from usual transmitting antennas. The usual antenna has 2 or more fabricated steel towers several hundred feet high, with a concentrated flat top suspended between them, and a single vertical down lead usually near the center. To cut down absorption losses, the steel towers are usually detuned and kept as far as possible from the flat top and down lead, and are sometimes insulated from the ground or even broken into insulated sec-

(*Continued on page* 933)

Radio's New Voice

(*Continued from page* 926)

tions. In contrast to this the new KDKA antenna has eight wood poles about 100 feet high, spaced on a circuit more than 700 feet in diameter and having a vertical down lead at each of the poles, the cage top being suspended between adjacent poles to form a complete circle around the poles. The proper time phase of the currents in the eight vertical leads is obtained by running the transmission line to the center of the system and running individual feeder lines to each pole.

Since the factors governing radio transmission are so many and variable that satisfactory formulas, applicable winter and summer, have not been developed even for the simplest antenna, it cannot be expected that reception will be exactly as calculated. It is possible that in certain localities absorption and minor reflections will entirely over-balance the effect produced by the antenna design. Also while transmission by means of the sky-wave works well at night, it is usually not satisfactory in the daytime. Therefore, for daytime transmission it would be preferable to get the opposite of the effect described above, and to broadcast to a more limited area by means of the ground wave. The opposite effect, suppression of sky-wave and reinforcement of ground wave, can be produced by making currents in opposite poles at 180° out of phase, so that adjacent poles are 45° out of phase. The difference in phase can be obtained by making the feeder lines of different lengths or by artificial lines. Thus, when conditions are not favorable for transmission by reflections of the sky-wave, it is possible to change over by simply changing the feeder line connections, to an antenna arrangement suitable for ground-wave transmission.

The Service Bench

(*Continued from page* 910)

tion. As a matter of fact, this is a good way of boosting the sensitivity in some of the more sluggish receivers. The general circuit adaptation is shown in Figure 4. Don't forget that the grid lead goes to the cap on the tube, and the screen bias potential to the grid connection on the socket.

These circuits and directions are general rather than specific, and will occasionally be modified to fit special instances. When such changes are necessary, they will be apparent to the serviceman who knows his business.

It is recommended that the charges for these alterations be the list prices of the new parts, with no charge for labor or installation. The fact that the necessary changes will be made free, the customer merely buying the new parts at their advertised market value, may be used as a good sales argument in soliciting this sort of work.