BROADCAST NEWS

June 1936

In This Issue

RCA MANUFACTURING COMPANY, INC., CAMDEN, N. J.

RCA Manufacturing Company, Inc.

A Service of Radio Corporation of America

Camden, N. J.

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POWER RADIOTRONS — **BROADCAST TRANSMITTERS**
POLICE TRANSMITTERS — **POLICE RECEIVERS** — **AVIATION RADIO EQUIPMENT**
SPECIAL COMMUNICATION EQUIPMENT

BROADCAST NEWS

REG. U. S. PAT. OFF.

E. T. JONES
Editor

PAUL V. LUTZ
Associate Editor

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RCA MANUFACTURING COMPANY, INC.

CAMDEN, NEW JERSEY, U. S. A.

CRIME CONTROL WITH RADIO

Educational Phase and Increased Speed in Communication of Great Assistance to Law Enforcement Agencies

By DAVID SARNOFF, President, Radio Corporation of America

A mobile crime control unit completely RCA equipped.

NO subject more properly commands the attention of thoughtful men and women, of fathers and mothers everywhere, than the problem of "Youth and Crime Today."

It is tragic enough to think that some boys and girls of today will be criminals tomorrow. But it is appalling to be told, as we have been, that the youth of today is furnishing so large a share of our criminals. The material loss resulting from this juvenile delinquency is bad enough, but its social and spiritual loss is the most tragic indictment of our civilization.

Others more informed than I am on this subject have discussed these questions from the standpoint of their actual experience and expert knowledge. I have been asked to discuss here the part which radio plays in this great problem.

Radio as a Preventive

What is the relationship of radio to crime? Radio is the greatest means of mass communication at our command. It is a distributor of knowledge, of culture and of entertainment. Radio, therefore, can contribute the moral and mental enlightenment which should be the most effective deterrent of crime.

But once the crime has been committed, radio takes its place as the longest arm of the police department, the speediest method of capturing the fleeing criminal.

Speed Necessary in Combatting Crime

In the struggle between law breakers and law enforcers, the contest between escape and capture has always been one of speed. In the past, a start of a few minutes gave the fugitive a decisive advantage. If his horse ran faster than that of his pursuers, he escaped. If it did not, he was caught. When science replaced the horse with the railroad, the few minutes which elapsed before an alarm could be sounded were often irretrievable.

Then came the telegraph. No matter how fast horse or train could give him speed, the criminal might find the police waiting for him at his destination. If he crossed the seas, the cable would prove his Nemesis. Later came the telephone, to give new and decisive advantages to the Law in its contest with Crime.

But the victory was brief. Progress, in presenting a new boon to mankind, unfortunately gave back to the lawbreaker his most effective weapon — speed. The automobile, followed quickly by the airplane, once more gave to the criminal a swift means of escape. It increased the area of search and diminished the chance of detection.

Radio's Part in Crime Control

Presently the same scientific progress created another force in crime control, although at first

With radio, the modern policeman is more than ever the guardian of life and property.

A 100-watt RCA police transmitter which gives excellent coverage.

neither the criminal nor the police were fully aware of its potentialities. That force was radio. Men could talk from point to point without having to depend upon connecting wires. Not only could they talk from point to point without these wires, but a man could talk from one point to thousands of unconnected and different locations simultaneously.

For the first time communication became mobile as well as rapid. Radio flashed the alarm of crime instantaneously over a wide area. It cut off escape by sea as well as by land. It cut off that escape in all directions at once. It turned the criminal's newest helpmate, the automobile, against him. It enabled men to hunt him down with airplanes and speed boats. It flashed his picture and his fingerprints to the police of every city. It raised a barrier against him on every side and as he sought escape, the very air through which his car was speeding was charged with alarms to the nearest law enforcement officers.

So it was the scientist who became the apprehender of the criminal. Through radio broadcasting and through facsimile reproduction, the radio engineer made the criminal's lot more hazardous. No speed which the lawbreaker can command can outdistance radio, which travels with the speed of light.

Large Population Protected

The part which radio plays in the detection and apprehension of the criminal is of recent date, but despite its youth, radio equipped police cars now patrol the principal cities of forty-three states. These cities have an area of 61,000 square miles, and more than 40,000,000 inhabitants. Such police cars are as closely in touch with headquarters as if a wire connected each one of them with their central police station. In New York City alone, 480 cars patrol 83 precincts, some of them scores of miles away from headquarters.

To indicate the speed with which this new force can operate, I am told that in a recent demonstration, which was in no way pre-arranged, three cars patrolling the Rockaway section, far out on Long Island, were ordered by radio to report to the central office. The first telephone response from one of these cars was made in less than one minute after the radio order had been flashed.

Radio Places Criminal on the Spot

This was no unusual circumstance, as the record of the New York Police Department will show. One instance which they describe with pride at Centre Street is the case of a holdup on the twenty-first floor of a Fifth Avenue office building. One of the bandits accidentally discharged his revolver. Frightened by their own alarm, the robbers fled at once. They ran down three flights of stairs and then stepped into an elevator. But when they got to the ground floor, three minutes after the shot had been fired, they found every exit closed by policemen who had raced to the building in radio cars. A tenant in a nearby office, who heard the shot, had 'phoned to the police. Radio did the rest.

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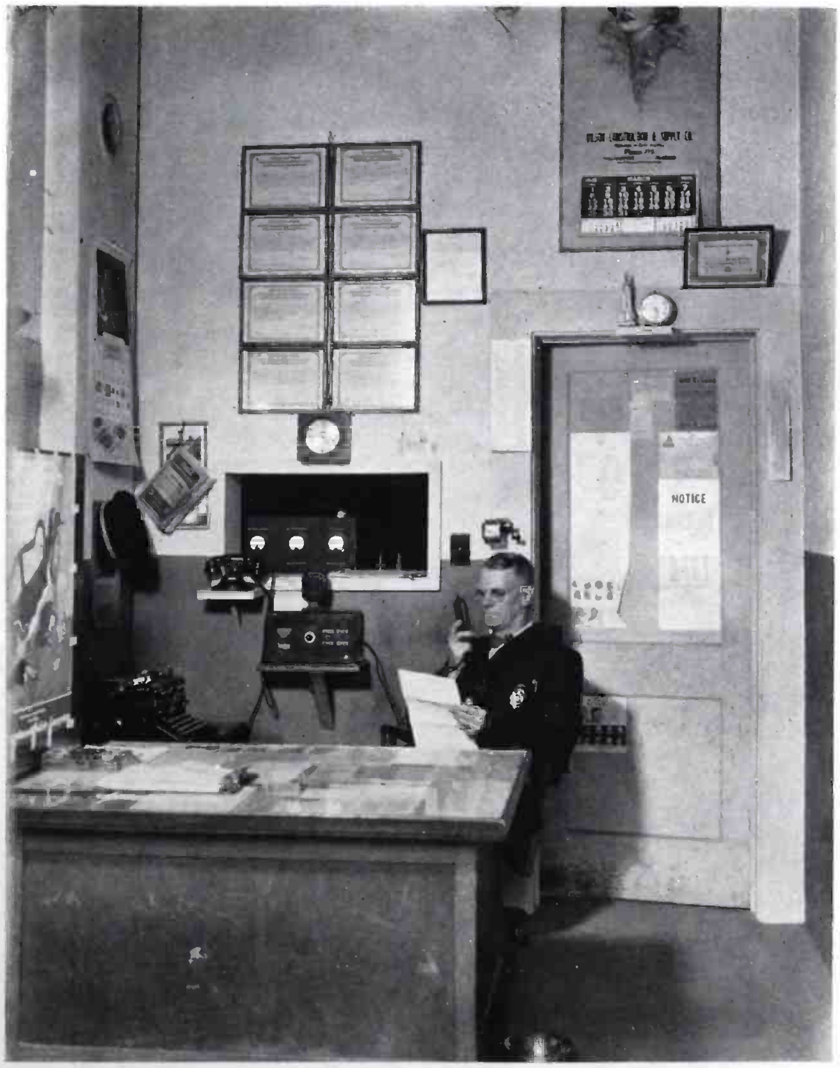

Calling all cars! A metropolitan GHQ in the war on law breakers.

Magnetic microphone for use in the RCA mobile police transmitter ET-5022.

But even that achievement was slow compared with the speed which trapped the extortioner who recently threatened the wife of a well-known advertising man in New York. The criminal used the telephone to make his demands. On one of his calls, the intended victim kept him talking while detectives traced the call to a pay station. When they located it a radio alarm was sent out from headquarters. A minute later, the lady heard the man at the other end of the wire yell, "Don't shoot! I'll come!"

Last year patrolmen in New York's 480 radio cars made 4,941 arrests, almost all at the scene of the crime. These were obviously, as one police officer put it, better and less expensive arrests, because the criminals were caught red-handed, important evidence was preserved before it could be destroyed, and the Police Department saved the cost of investigation and search.

Use of Radio In Kidnapping Cases

Radio has also been used effectively against kidnapping, the most terrible of all crimes. Strangely enough, one of the earliest instances of this use was in the kidnapping of the four-year-old son of Dr. E. F. W. Alexanderson, inventor of the famous Alexanderson alternator, one of the most important developments in the history of radio. When his child was abducted in 1923, Station WGY in Schenectady broadcast a description of the boy for several days and Dr. Alexanderson personally used the microphone and asked the public to help in the search. Four days later, a man who heard the broadcasts in a nearby town was passing what he supposed to be an abandoned shack when he heard a child singing. He investigated and found the Alexanderson boy in the custody of an old woman, who, it was determined later, had no idea that she was taking care of an abducted child.

In the case of the recent kidnapping of the son of a New York broker, a phone call was traced, but this time the criminal managed to escape when he saw the radio car approaching. However, within a few hours the child was released and quickly restored to his parents. Being a smart lad, he was able to give an accurate description of his kidnappers, and this coincided with a description the police had of the extortioner who had telephoned. They tracked him down in a short time, and he then confessed that when he saw the police car he realized that he had no chance to carry out his plans and therefore had set the boy free.

RCA police motorcycle receiver, AR-5025.

Early Use of Radio in Crime Control

What is believed to be the first use of radio to capture a fugitive from justice took place in a shore-to-ship transmission in 1910. The criminal was the famous Dr. H. H. Crippen of England, who had murdered his wife and was caught on the high seas.

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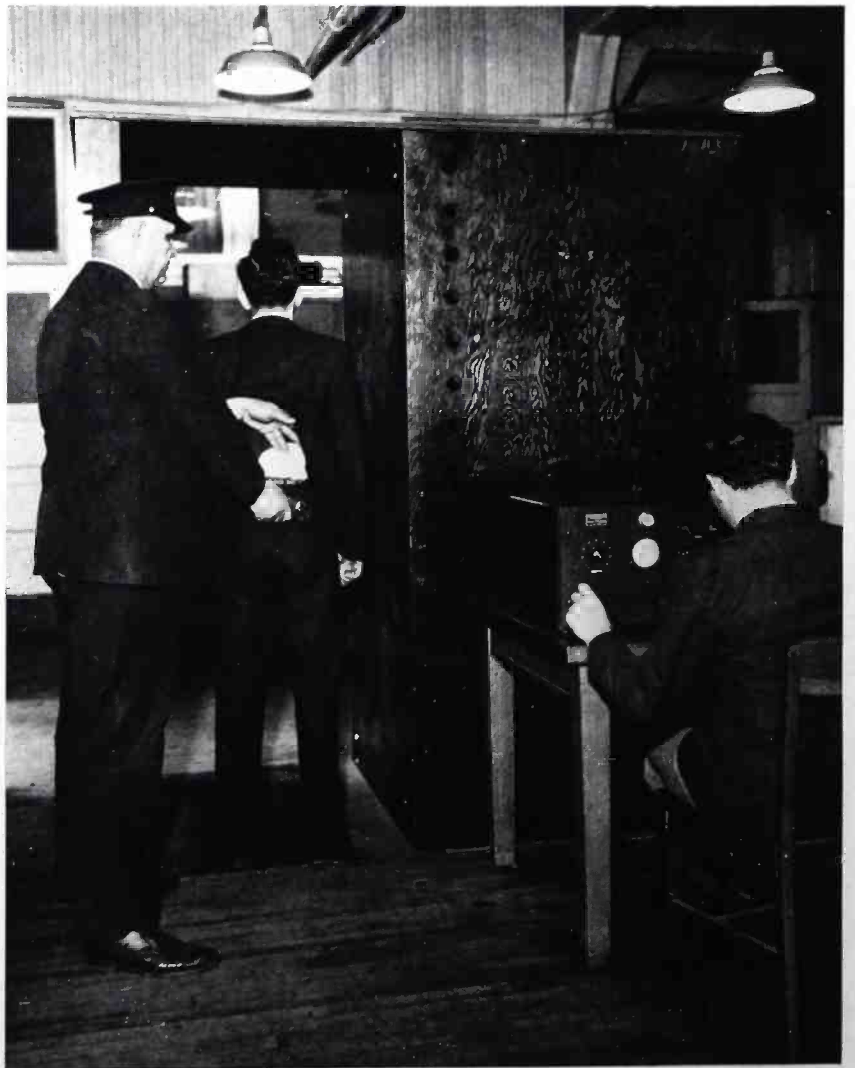


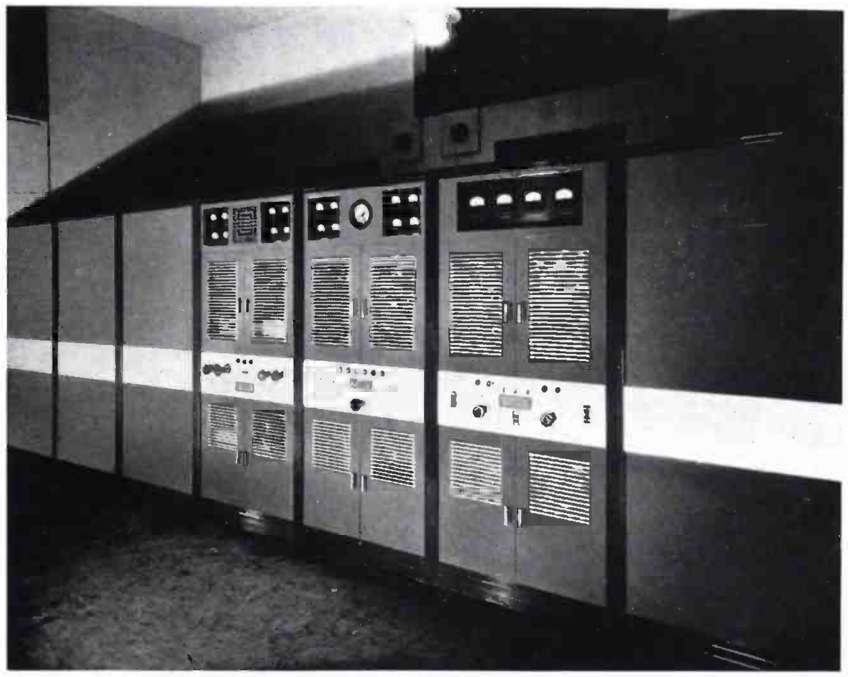
An RCA gun detector or automatic "frisker" which reveals the presence of ferrous metals.

UP GOES POWER AT WFBC

Progressive South Carolina Station Steps Ahead With New RCA 5-C Transmitter

THREE transmitters in three years and still going forward is somewhere near a record. Yet that is the pace set by the fast moving, hard hitting Greenville organization which mans station WFBC. Under the aggressive and progressive leadership of the publishers of the News and Piedmont it has grown from a small fifteen watter listed as WQAV in the early days of radio to one of the South's leading stations.

Center of the textile industry in the South, Greenville is also the hub of a vast and varied manufacturing region. Within the radius of its coverage area lies a huge market ripe for radio development and with its new facilities WFBC is able to give the thorough and extensive coverage required.



The New RCA 5-C, 5 KW transmitter installed at WFBC.

Modern Layout

The transmitter house is thoroughly modern from every angle. It is built of brick, fireproof construction, painted snow white and trimmed in black. It is built in three sections. The center section houses WFBC's new RCA 5-C transmitter.

As the visitor enters the large double doors in front he gets an idea of being in a cathedral-like structure. The ceiling is high with ventilators on either side near the top. This is for the purpose of permitting the heat generated by the powerful transmitter to rise and escape .

Walls are painted light green. The floor is waxed concrete. The transmitter is in the center of the room and the visitor faces the center of its three panels upon entrance. To the left is an immense radiator, a water pump, a large centrifugal pump and a metal duct. This is the transmitter's cooling system. Distilled water is run around the large transmitting tubes and then led into the radiator where it is cooled. It is then pumped through copper pipes back to the tubes. The hot air from the radiator is blown through the duct and out the rear of the building. In winter the duct will be opened and warm air blown into the transmitter room.

The modern transmitter house.

Large Switches

To the right at the rear of the transmitter room are the big magnetic switches which bring in the heavy current required to operate the 5,000 watt transmitter. Enough current to run an electric train is led into this new transmission plant.

At the left of the entrance is a control panel for properly handling the program signal and regulating certain phases of the transmission; The program comes in

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A STUDY OF NOISE CHARACTERISTICS

Several Phases of This Very Important Subject Are Interestingly Discussed

By VERNON D. LANDON

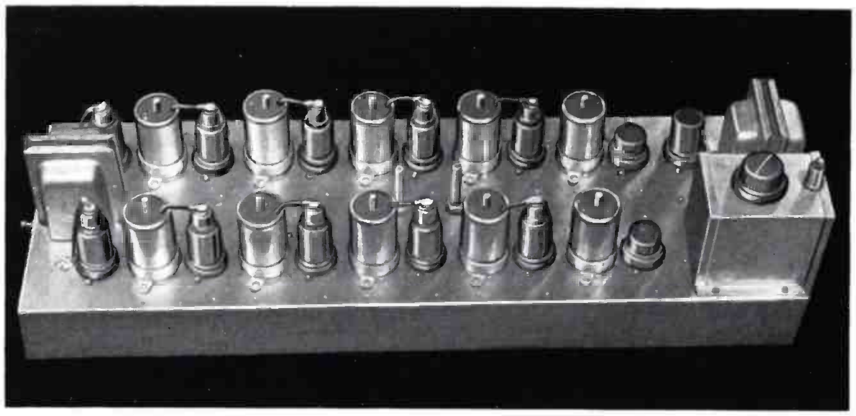


Figure 1.

INTEREST in noise reducing methods is on the increase. This is due to the partial success obtained by the use of limiters with or without wide band amplifiers, and by the use of frequency modulation. As a preliminary to understanding the operation of these systems, the characteristics of noise itself must be studied. A great deal has already been learned about the characteristics of noise. It is the purpose of the present investigation to clear up certain disputed unknown points.

Two very definite objects were sought in the experiments which are described here. First, to determine the crest factor of smooth r-f noise such as tube hiss and its variation with amplifier band width (crest factor is defined as the ratio of the amplitude of the highest peaks to the r-m-s value of the noise); secondly, to determine how the amplitude varies with band width for noise of the impulse type.

PART I

SMOOTH NOISE OR HISS

Review

With smooth noise of the thermal agitation or tube hiss type, the energy is uniformly distributed throughout the radio frequency spectrum. Hence the hiss power output of a radio frequency amplifier is proportional to the frequency band-width (at a given amplification). The r-m-s voltage output is proportional to the square root of the band-width. The variation of peak amplitude with band-width is to be determined.

Apparatus

No method of calculating these peak values is known to the writer; thus the facts had to be found by experiment. To do this, a two channel, high gain, r-f amplifier was built. Photograph of the chassis is shown in Figure 1. Each channel has five stages of amplification, with two tuned circuits per stage. One channel had a band-width of 4.1 and the other a band-width of 61.9 kc. at 90% of the amplitude of the central frequency which was 150 kc. in each case. The shape of the two selectivity curves is the same.

The two channels are placed in operation alternately, by switching the B supply from one to the other. To minimize the chance of regeneration, a cascade resistance capacity filter is used on the B supply. With this circuit the filtering of the first tube is improved by the filter for the second, etc. Each stage was separately shielded by a can over the transformer windings and a separate can over the tube and transformer constituting one stage. A bottom was made to shield plate lead to plate lead feedback, but was found unnecessary. The available gain was about 50 per stage on the sharp amplifier and 25 per stage on the broad. This was more than enough to overload the final r-f amplifier tube with hiss, so that full gain could never be used. For most measurements four stages were found to be sufficient, and the first was disconnected.

No trouble was experienced with regeneration, except when unduly long input and output leads were used, producing overall feedback.

The output of the two channels feeds separate diode detectors which have a common audio amplifier connection. The bias on the diodes may be varied so that peaks have to exceed the bias before anything is heard. The selectivity curves of the two amplifiers are given in Figures 2 and 3.

Both of the channels were relined several times as various changes were made. The bandwidth of each varied slightly from time to time under different condi-

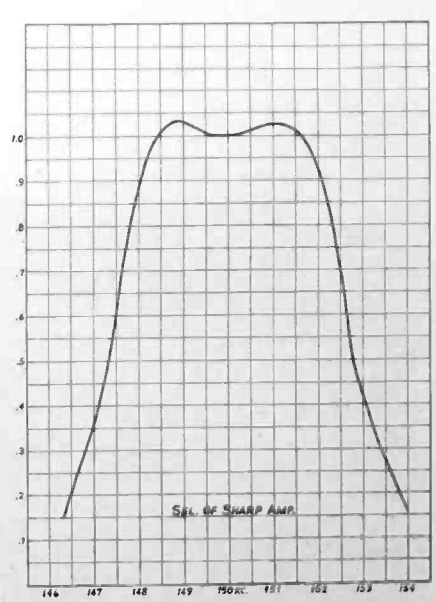


Figure 2.

tions. In each experiment, calculations were based on band-widths as measured during that experiment.

The First Experiment

The amplification of each channel was adjusted so that the highest peaks of hiss were barely audible with 22 volts bias on the diodes. The amplification of each channel was then measured and the ratio of gains compared to the ratio of band-widths, and to the square root of the ratio of band-widths.

The ratio of gains was 4.4, the ratio of band-widths 15.1, and the square root of the band-width ratio 3.89. On a re-check at a lower gain, the square root of the ratio of gains was 3.85. This indicates that the peaks of hiss vary as the square root of the band-width, just as the r-m-s value does, thus indicating a constant crest factor. However, the accuracy is not very great, due to the difficulty of measuring such high gains accurately. Hence it was decided to measure the crest factor directly.

The Second Experiment

A tube voltmeter was connected across the diode circuit and moved from one side to the other when changing channels. This tube voltmeter is of the plate curvature type, with a bucking battery, and is believed to read r-m-s fairly accurately.

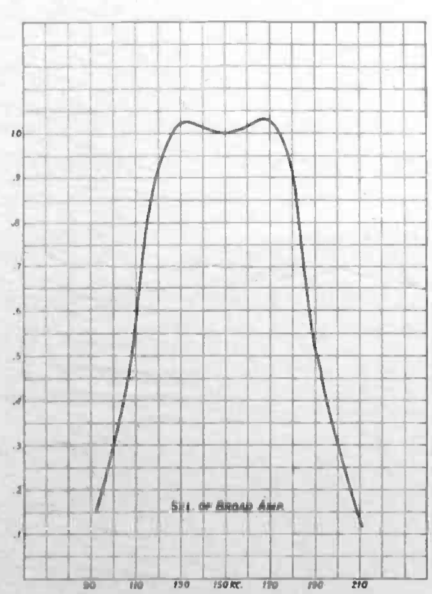


Figure 3.

The gain of each channel was adjusted until the tube voltmeter read 2 volts of hiss. The diode bias was then increased until the noise barely disappeared. The bias required was exactly the same for the two channels, being 7.7 volts for silence, 7.3 volts for a few clicks per second, and 5 volts as the dividing line between a smooth and a rough bias. The current in these diodes starts at —.9 volts, hence this figure must be subtracted from the biases given above to indicate peak values. This gives a crest factor of 6.8 divided by 2 or 3.4.

Conclusion

Thus we are led to the somewhat surprising result that the highest peak voltages in hiss are not more than 3.4 times the r-m-s value, and that this ratio is independent of band-width.

PART II

NOISE DUE TO IMPULSE EXCITATION

Theoretical

With irregular noise the original source is almost always equivalent to Heaviside functions repeated at irregular intervals. The voltage applied to the antenna may consist of pulses of varying shape and duration, but this is usually due to circuits at the source of noise applying a certain amount of frequency discrimination to the original Heaviside function pulses. Usually the circuits in the receiver are considerably sharper than any that may be present in the noise source. Hence the shape of the envelope of the wave train in the output of the amplifier is usually almost independent of the wave form of the exciting voltages, provided the pulses are separated in time sufficiently to avoid overlapping decay trains.

The shape of the envelope of the wave train in the output of an r-f amplifier is then a function of the circuits of the receiver, and is subject to calculation on the basis of Heaviside function excitation. This calculation is best carried out by the use of Heaviside's Operational Calculus.

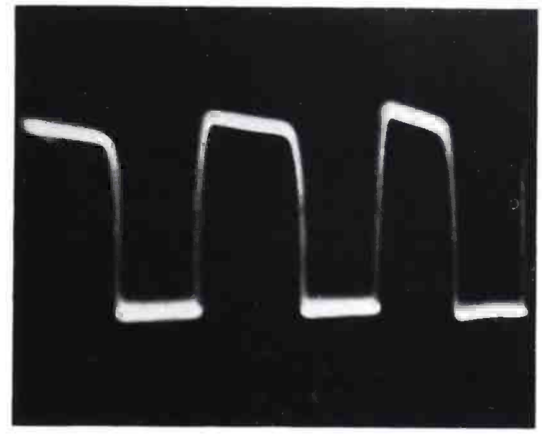


Figure 4.

Mathematical Prediction

Operational methods, which are too involved to be included in a short report, have led to the following equations. The equations are not exact, but the error is negligible if a/ω is negligible compared to unity.

When a single tuned circuit is used per stage, the output of the nth stage divided by the gain is:

$$E_n \doteq \frac{2a}{\omega} \frac{a^{n-1} t^{n-1}}{\lfloor n-1} e^{-at} \sin \omega t$$

$2a/\omega$ is the "power factor" of each circuit.

$$a \text{ is } \frac{R}{2L}$$

ω is the frequency of the wave train times 2π.

If two coupled circuits are used in each stage of the amplifier, the output of the nth stage divided by the gain is:

$$E_n{}^1 \doteq \frac{2a}{\omega} \frac{a}{b} \frac{a^{n-1} t^{n-1}}{\lfloor n-1} e^{-at} \sin$$

bt sin ωt

b is one-half the frequency difference between the two resonant frequencies of each stage multiplied by 2π.

In either equation, the peak value of

$$\frac{a^{n-1} t^{n-1}}{\lfloor n-1} e^{-at}$$

occurs as t equals

$$\frac{n-1}{a}.$$

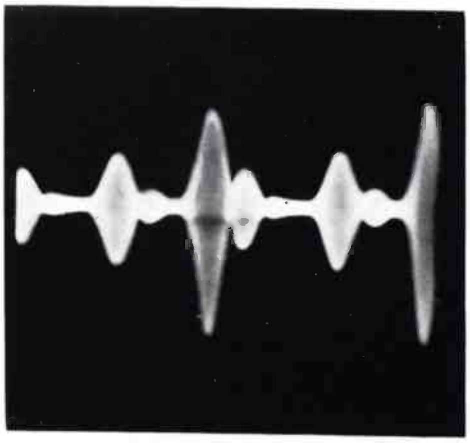


Figure 5.

At this instant

$$\frac{a^{n-1}\,t^{n-1}}{|\underline{n-1}}\,e^{-at} = \frac{(n-1)^{n-1}}{|\underline{n-1}}\,e^{1-n}$$

and does not vary with band-width.

If the selectivity curve of two amplifiers has the same shape, then a/b is the same for the two cases.

Hence the factor a/ω determines the ratio of peak amplitudes in two amplifiers having different band-widths. This factor is proportional to the band-width. Thus the amplitude is proportional to the band-width.

Thus a mathematical analysis leads to the conclusion that the amplitude of a wave train, due to impulse excitation, is proportional to the first power of the band-width and not to the square root of the band-width, as with smooth hiss. The apparent discrepancy made experimental confirmation desirable.

A preliminary experiment was made using the buzzer rectifier of an auto set to generate impulses. This gave results which are fairly consistent with what follows, but the buzzer contact was too irregular to make accurate measurements possible. Hence, a vacuum tube impulse generator was thought desirable.

Additional Apparatus

A square wave generator was made, using a one tube relaxation oscillator and a limiter to cut off the peaks. The frequency could be varied over wide limits by changing the setting of the gang condenser used in the resistance capacity feedback network. The wave shape of the output voltage of this unit is shown in Figure 4, which is a photograph of the wave as shown by the RCA portable oscillograph.

It is evident that the sides of this "square wave" are not sufficiently steep to simulate a Heaviside function to any great degree of accuracy. It is, however, a source of impulses which repeats with much greater regularity than any mechanical device.

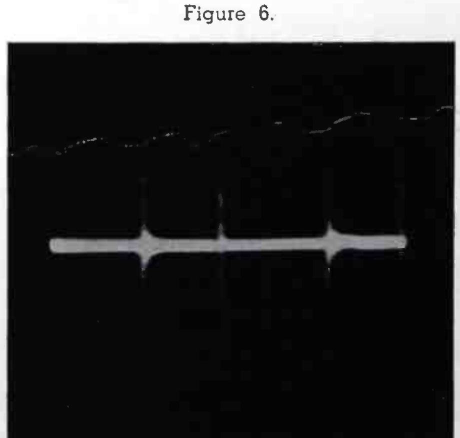
Experimental Procedure

It was found possible to synchronize the oscillograph scanning with the impulses so that the decay train appears to be stationary on the screen. Figure 5 is a photograph of the wave train from the sharp channel. The large diamond shaped figure followed by two "beads" of decreasing size is the wave train due to the up stroke of Figure 4. The similar sequence of lesser amplitude is that caused by the down stroke, which is less effective in exciting the amplifier, due to its lesser slope.

Figure 6 is a photograph of the corresponding wave train from the broad amplifier, with reduced gains. This illustrates the shorter time duration of the wave train from the broad amplifier.

Figure 7 is another photograph of the output of the broad amplifier, but was taken with a higher frequency square wave applied to the input. The individual r-f cycles can be easily discerned.

Figure 6.



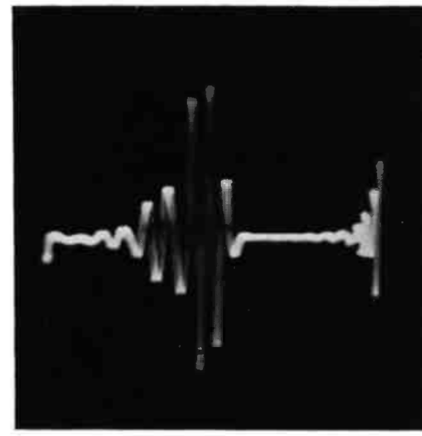


Figure 7.

Returning to the input frequency used in obtaining Figures 5 and 6, the gain required to give a certain amplitude of wave train on the oscillograph was next measured for each channel, and the ratio of gains was calculated. One measurement gave 15.8 and a re-check 16.7; the ratio of band-widths at this time was 16.1.

In view of the experimental difficulties involved, this is considered a good check of the mathematical prediction that the amplitude of the wave train due to an impulse is proportional to the band-width of the amplifier.

Conclusion

The present investigation discloses that random distributed voltages, such as tube and circuit hiss, have peak amplitudes and r-m-s amplitudes proportional to the square root of the frequency band passed. The ratio of r-m-s to highest peaks is 3.4 (crest factor) and is independent of band-width. The experimental observations do not confirm the theory that occasional peaks rise to very much higher values.

For reception of isolated pulses (with decay trains not overlapping), such as ignition disturbance, the r-m-s amplitudes are proportional to the square root of the frequency band passed, and the peak amplitudes are directly proportional to the frequency band passed. This conclusion is verified mathematically and experimentally.

NEW TRANSMITTER PLACED IN SERVICE BY WRAW

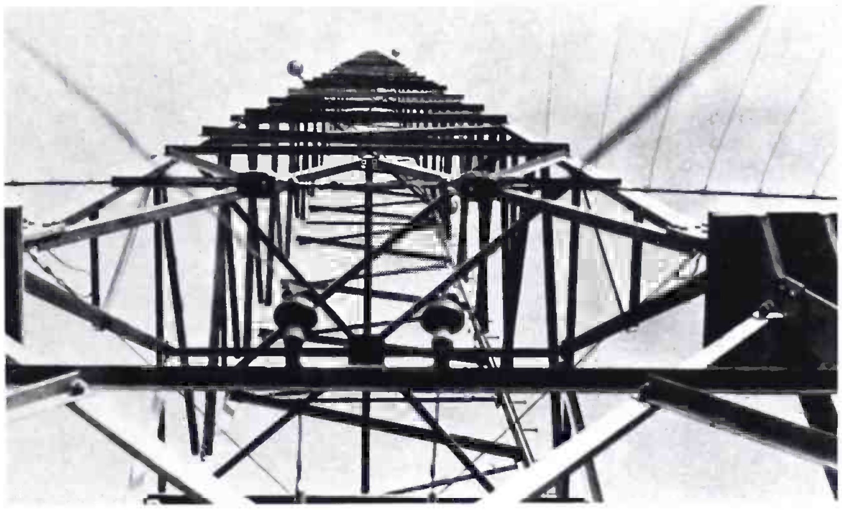
Well Arranged Station in Reading, Pa., Installs 100-E

AMONG the smaller stations of the country, WRAW ranks high. An efficient, well arranged station, it covers the territory surrounding the city of Reading. Located about fifty miles north of Philadelphia it competes very successfully locally with the more powerful stations to the south.

Convenient Arrangement

The transmitter is housed in the Pomeroy Building, 6th and Penn St., which overlooks a large part of the city. The transmitter, speech input equipment and control switches are conveniently arranged in one room enabling the station engineer to face the announcer in the next room. A separate studio is used exclusively for transcription presentations.

The antenna is placed on the roof of the building, resting on reinforced concrete columns. With the substructure the entire weight of the tower is nine and one half tons. It is equipped with a beacon light and is rated by the Department of Commerce as an aviation signal.



A "shot" from below giving a view of the petticoat insulators and the counterpoise.

Note particularly in the cuts shown the counterpoise consisting of sixty-four wires averaging sixty feet in length and also the petticoat insulators which support the R-F line.

Convenient arrangement of the transmitter and speech input equipment at WRAW.

Overall view of the antenna with the substructure

CARE OF WATER COOLED TUBES

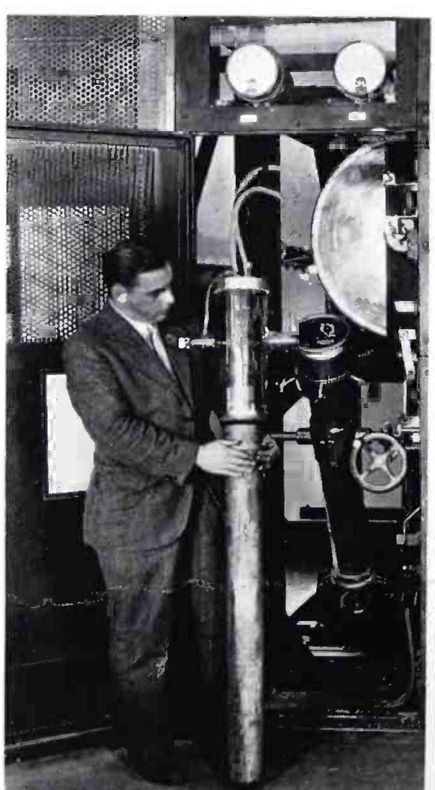
Some Worthwhile Suggestions for Extending Their Useful Life

By BEN ADLER

DURING the relatively few years that power tubes have been in commercial use at broadcasting stations, the requirements placed on them have undergone many changes. Only a few years ago, the aim of the broadcast engineer was to obtain long life from power tubes at any sacrifice. Percentage of modulation was kept down, filaments were run below normal temperature with a resultant increase in distortion, and a general attempt was made to keep tubes in operation until filaments could no longer be lighted or the tubes were absolutely unusable. Under these conditions, the last few hundred hours of life were usually meagre ones, requiring operation at reduced power and increased distortion.

Efficient Operation Paramount

Today the picture is different, even though long life of tubes is still essential. The aim of the broadcast engineer now is to maintain and operate his station at the lowest possible cost commensurate with reliable, high fidelity performance. An attempt is usually made to anticipate tube failures so that poor ones can be removed before they cause trouble which might conceivably occur during an important commercial program. Failure of a twenty dollar tube at a crucial moment might involve a loss of hundreds of dollars and considerable prestige.



Even the larger tubes require extreme care in handling.

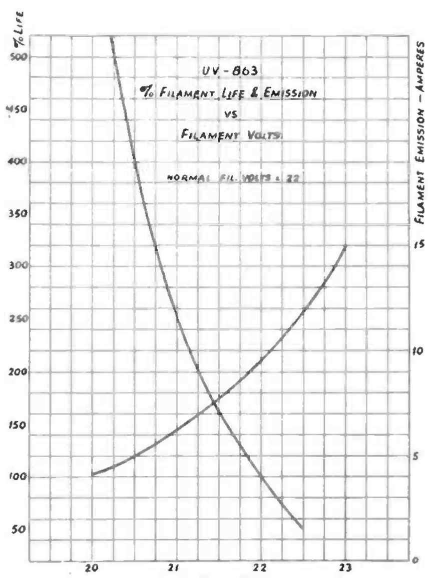


FIGURE 1

Curve showing theoretical improvement in life when operating a tungsten filament at reduced temperatures.

It is apparent that the useful life of power tubes, as applied commercially, has decreased considerably. It is with this thought in mind that an attempt is made here to provide the broadcast engineer with a few hints on the best method for obtaining efficient and satisfactory results from tubes and still meet these extra commercial requirements.

Care of Spare Tubes

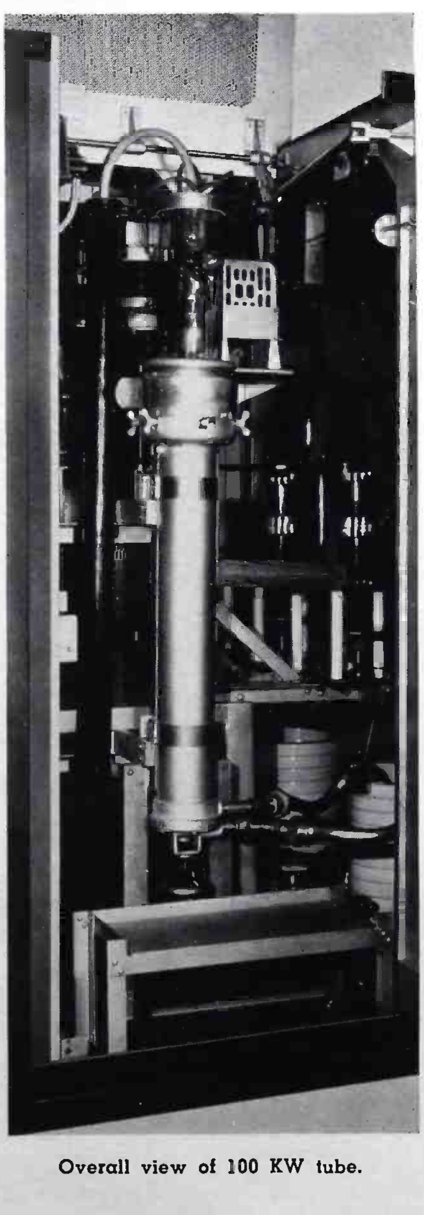
The care of tubes kept on the shelf as spares is important and will be covered first. It is assumed that directions for mechanical handling and storing will be accurately followed. These directions are completely covered in instructions accompanying each tube, and it is recommended that they be carefully studied. Small tubes operating at plate voltages not exceeding 1000 to 2000 volts are not seriously affected by time on the shelf. The larger high voltage types have a tendency to become gassy if allowed to remain idle for any length of time. This gassy condition is not necessarily brought about by air leaking into the tube, but by the liberation of gas from the pores of the elements inside the tube.

A closeup of a 100 KW tube used in the 50 KW transmitter.

Small Amounts of Gas Remain in Tubes

During the process of manufacture, an attempt is made to evacuate the envelope as completely as possible, but a certain amount of air and other gasses remain in the pores of the elements. The elements are heated to incandescence during evacuation to further drive gas out of their pores, but a very small amount remains. After the tube is sealed and conditioned for operation at high plate voltage, the slight amount of gas remaining in the pores of the elements will gradually seep out into the vacuum if the tube is allowed to remain idle for any length of time. The effect of a tube becoming gassy in this way is to limit the plate voltage at which it can be operated. For that reason, a real high voltage tube should not be allowed to remain idle as long as a lower voltage tube.

The gassy condition of a tube manifests itself in excessive plate current under otherwise normal conditions. Also, on peaks of modulation a gassy tube will arc over or "ping." High voltage tubes such as the RCA 862, 863, 848, 207 and 1652 should not be allowed to remain idle for more than two or three months without cleaning up the gas that may have accumulated in them. Simply operating the tubes with filaments heated to normal temperature for one half hour with no plate or grid voltage applied will help keep the tubes cleaned up if done often enough. It is a good idea though, to apply a low plate voltage and excitation, not only to do a better job of cleaning up the gas, but also to determine at regular intervals whether the tube is operable.



Overall view of 100 KW tube.

Method of Cleaning

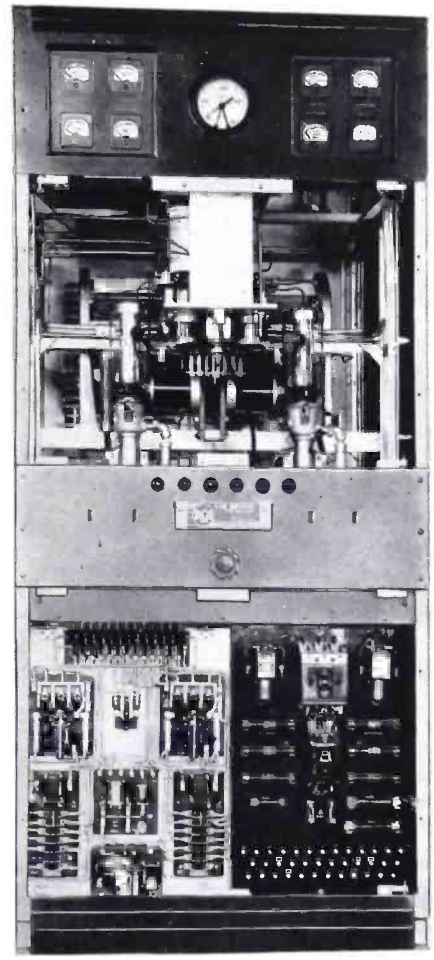
When a tube is found to be gassy, it can usually be cleaned up by first allowing it to operate for a half hour with only the filament on. After that, apply the lowest plate voltage available, increasing it in small steps at intervals of time ranging from ten minutes to a half hour, depending on how bad the tube is. If this is not effective, it is suggested that arrangements be made for returning the tube to the factory where other methods can be tried. It has been found that it is sometimes possible to clean up the gas in a tube by placing it in a circuit as an oscillator operating at a frequency other than that used for regular operation. Of course nothing can be done with a tube that has become a "leaker." A cracked seal or other mechanical defect might cause this. A "leaker" will show symptoms somewhat similar to a gassy tube, but more pronounced. White "smoke" liberated inside the tube is a sure sign of an air leak.

The gassy condition of a tube does not necessarily result from inactivity. It might be brought about by an arc over inside the tube or a sudden overload. The results are usually more severe when brought about in this manner, but the same treatment applies.

"Ping" May Injure Tube

A "ping" or arc-over inside a tube resulting from a slight gassy condition may aggravate the condition or injure the elements inside the tube unless precautions are taken in the circuit design. Where there is a possibility of such a condition, it is recommended that about a 100 ohm resistance be used in series with the condenser output of the plate rectifier. This will tend to limit the peak current on an arc over. Of course the usual plate overload breakers should be incorporated in the design of the transmitter. An automatic reset is valuable, too, not to help protect the tubes but to eliminate interruptions on the air from arc overs.

So much for the care of spare



Tubes in 5-C amplifier.

tubes. Under normal conditions of operation, one of the principle causes of ultimate failure of power tubes result from filament burnouts or loss of filament emission. A discussion of the care of filaments should be broken up into distinct parts; one dealing with tubes having thoriated or coated filaments, and the other with tubes having pure tungsten filaments. This discussion will be confined to the latter, since the larger size tubes available today are pure tungsten filaments. A separate article on thoriated filaments, as used in power tubes, will appear later.

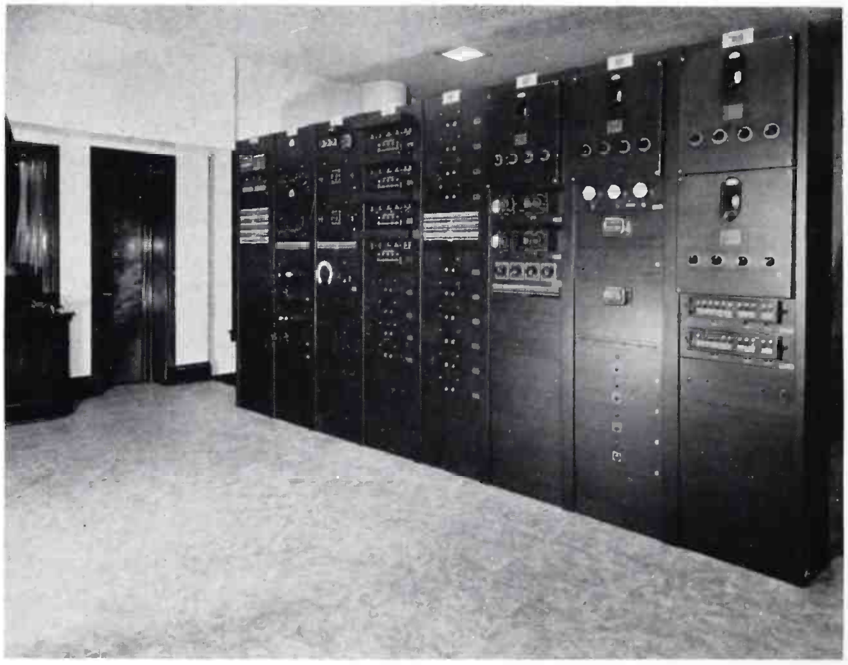
It is well known that a pure tungsten filament requires more power and has to be operated at a higher temperature than a coated filament. The tungsten filament seems to stand more abuse and operates better with high plate voltages and for that reason is almost universally adhered to in large power tubes. Thoriated filaments have other advantages which will be covered later.

(Continued on Page 27)

SOUTHWEST HEARS NEW WKY

Beautiful Studios and Modern Speech Input Equipment Place Oklahoma Station in Front

By EARL C. HULL, Chief Engineer



The modern speech input equipment layout.

RADIO Station WKY, Oklahoma City, Oklahoma, first went on the air in 1920 with 20 watts. It was the first station west of the Mississippi and the third in the United States to broadcast daily programs.

The station was purchased in 1928 by the Oklahoma Publishing Company, and until the recent move, occupied quarters in the Plaza Court building in a suburban residential-business district. The new move brings it downtown to a home conceded to be as thoroughly modern, if not as large, as the best studios in New York, Chicago or elsewhere.

The new studios occupy an entire floor in the recently-completed Skirvin Tower Hotel, and are RCA-equipped throughout.

The new WKY quarters include four regular broadcast studios, one conference - audition room, capable of use as a studio, and a large auditorium studio, still under construction, capable of seating 1,200 persons. This studio is located on a separate floor.

Modern Soundproofing

The latest discoveries in soundproofing have been incorporated in the studio design. "Floating" floors and walls and suspended ceilings reduce vibration to a minimum, and observation windows are of three-pane construction. Doors are of special laminated sound proof construction with squeakless hinges. Another striking feature of the studios is controlled lens lighting, which eliminates either glare or shadows. Each light is flush with the ceiling to avoid acoustical interference.

The WKY control room showing the two RCA operator's consoles and turntable equipment.

Air Conditioning Throughout

All studios and offices are air-conditioned, with an installation which assures automatic control of both temperature and humidity the year around. This is said to be the largest installation of the kind in Oklahoma. To prevent sound-conduction through the air ducts, special acoustical treatment was required. This consists of a lining of a type of seaweed from Nova Scotia.

Constant Check Maintained

High-fidelity transmission is assured by many changes and improvements. For example, all program loops from the studios to the transmitter have been equalized to 8000 cycles, and an RCA audio oscillator incorporated in the control panel permits the equalization of all remote lines to the same degree. Six separate equalizers are incorporated in the line terminal equipment. A constant check is maintained to see that all lines are in condition for high fidelity transmission.

The heart of the set-up is the eight-bay control panel of RCA

(Above) Operator's console with view of Studio A.

(Right) The maze of pipes and ducts which form the air conditioning system.

design. It includes fourteen 41-B pre-amplifiers, four channels of 40-C line amplifiers and two 55 bridging amplifiers. Switching is all electric and interlocked to make it tamper-proof. Mixing is done at the operator's console, which was built by RCA to WKY specifications. The studios include a complete talk-back circuit, which may be used by the operator to talk to any studio, or which permits inter-office communication or conversation between any office or studio.

The monitoring system consists of individually-dialled speakers in all offices, similar to the method in use in the National Broadcasting Company studios in New York. RCA amplifiers are used in all speakers, with the cabinets constructed locally from special WKY designs. Twenty-two channels are available in the monitoring system. RCA velocity microphones are used throughout for program pickup, and inductor microphones for announcers' stations and talk-back circuits. A unique dial system in the operator's control console makes it possible to feed outside networks instantaneously without the use of patch cords, and any program in any studio can be switched to any outgoing line.

Large Audience at Opening

The new studios of WKY were opened to the public on April 13, 1936. Many of the largest advertising agencies of the United States were represented, as well as the National Broadcasting Company, and neighboring radio stations. During the following week, visitors were admitted by ticket only. These tickets were distributed by WKY advertisers. More than 14,000 Oklahoma City and out-of-town people saw the studios during that period, and, following the lifting of ticket restrictions, a steady stream of visitors has continued coming to the studios.

Organ a Notable Feature

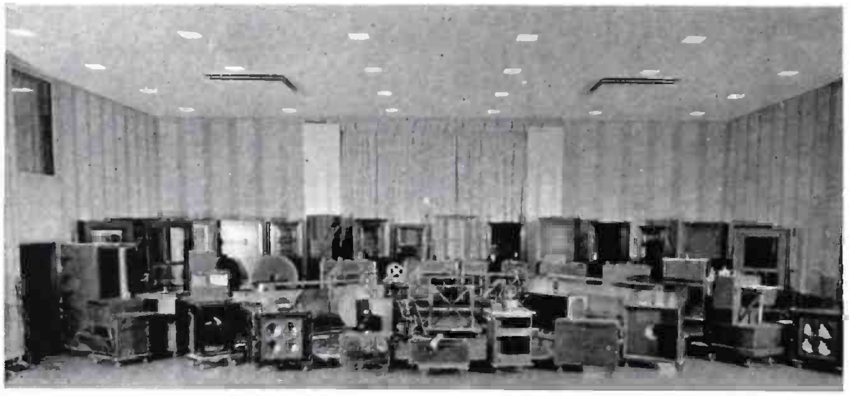
One of the important attractions of the new WKY studios is the large Kilgen Organ, probably the largest ever built exclusively for broadcasting purposes. It has four manuals and 128 stops, and more than 3,000 pipes. The console is on a movable platform.

Radio listeners in the southwestern area served by Station WKY, Oklahoma City, are assured of high-fidelity reception, thanks to complete new studio equipment just installed by this oldest commercial broadcasting station west of the Mississippi. According to many authorities, these new studios represent the most outstanding radio studio in this section of the United States.

Studio A and the Kilgen organ. This is the largest studio on the main floor.

NBC SOUND EFFECTS TECHNIQUE

New Science Shows Remarkable Growth in Six Years



Just about any sound you might wish can be extracted from this collection of gadgets.

THE radio set is tuned in on a tense moment of drama. The listener "sees" the scene — a cheery living room with a blaze crackling in the fireplace, while the wind moans outside and sleet beats against the panes.

There is a creaking sound as the door opens on its hinges. The wind and sleet howl in through the doorway. There are quick steps across the room, harsh words. Then a pistol is fired. The front door slams shut. Outside, a horse rears, prances for a nervous moment, then thunders away into the night, the sound of the hoof-beats growing fainter in the distance.

Ray Kelly not only talks about the weather but really does something about it. Here he's making thunder.

Technique of Sound Effects

Few words have been spoken, yet the listener has been aware of every movement made. This, in brief, is due to the fact that radio sound effects have become a well-defined technique. It was not always thus, and Ray Kelly, head of the National Broadcasting Company Sound Effects Laboratory, is the best person to tell the story.

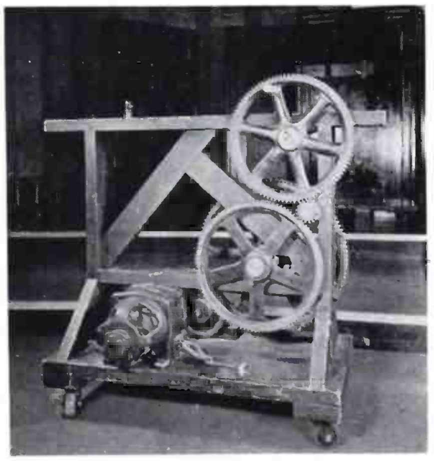
"When I took over the NBC sound effects laboratory six years ago," says Kelly, "my equipment consisted of a set of dishes, some broken, a knife and fork, a handful of toys, one portable door, and one elementary thunder machine. Even as short a time as six years ago, listeners did not demand the veracity of sound which now must be a feature of every program. Sound effects must now be so accurate that the listener will never pause to question their actuality."

Before telling something of the history of sound effects, let's take one glimpse at the method by which the sounds in the scene, described above, were made. The actors in the drama are all clustered around the microphone. Over to the left, with a microphone of his own, is an NBC sound effects man, one of the men in Ray Kelly's department. On his sound table he has an ordinary blank cartridge pistol, a ball of cellophane, two rubber suction cups, and two big black boxes, mounted on rubber wheels. Also on rubber wheels is an ordinary door, in a frame.

How It's Done

By crumpling the cellophane before the microphone the realistic sound of the fire is obtained. The two black boxes are a sleet machine and a wind machine, each run by electric motors. The sound effects man opens the door. The electric motors are speeded up, thus increasing the sound of the wind and sleet. After the harsh words, the pistol is fired and the door slammed. Then the sound effects man picks up the rubber suction cups, one in each hand. By beating these cups on a flat board (cocoanut shells are used when the horse is running

Cabin door, marching soldiers and theatre curtain in sound.



Straight line production by Ray Kelly. A whole factory operates when these gears whirl.

on a hard road) an accurate imitation of the sound of a running horse is obtained.

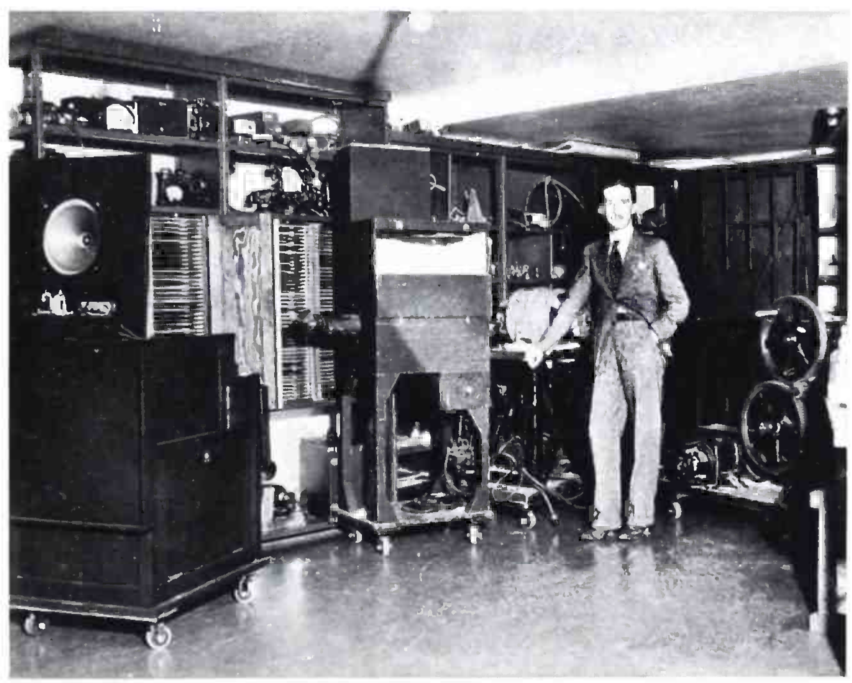
As short a time as six years ago, sound effects were a very minor part of broadcasting. Today, as has been indicated, they are an entire department in a vast corporation. When Ray Kelly started he had one assistant, a college boy who worked part time. Today, in the New York office alone, he has fourteen assistants, all highly trained technicians, all working at high speed to provide sound effects for some 160 programs a week.

Sound Effects Library

The first problem was a sound effects library. He set to work to collect sounds of almost everything that made sounds—all types of motor noises, animal moos, bleats and neighs; bird calls; the sounds made by falling water; sounds in all their infinite variety. He wanted these sounds on his library shelves, ready for use at a moment's notice, and he began to get them.

In many instances, he found that a recording of the actual sounds was best. In some cases, however, and due to the delicacy of the microphone, he found that it was better to create the sounds synthetically in the studio, as in the case of the cellophane "fire" and the rubber suction cup "horse."

The sounds made by firearms caused him a lot of trouble. After much experimenting, he finally was convinced that a pistol shot sounded more like a pistol shot than any imitation of the sound. It was also noticed that the actors in the studio reacted more realistically when a real pistol was used—and Kelly is an artist in his own right. Machine guns baffled him, though, until one of a thousand-odd experiments developed what he was looking for. Now when a gangster on an NBC radio drama cuts loose with his "tommy gun," one of the sound effects men simply waggles a telegraph key, set on top of a long amplifying box. When the sound comes out, almost any gangster who wasn't looking would automatically say, "They've got me, boys."



Neither snow nor rain nor sleet stays the completion of appointed programs.

Special Equipment Required

One big room in the department is filled with weird-looking machines and other contraptions, all evolved after years of trial and error. One side of the room is lined with doors of almost every variety—doors which squeak eerily as they open, doors with knobs which rattle, automobile doors, screen doors, swinging kitchen doors. In the center are the rain, sleet and wind machines. Kelly found, after much experimentation, that rain did not record very well. He made several complicated devices which reproduced the sound — for the microphone—better than the actual sound of the elements. It was much the same with wind and sleet.

Showers or deluges are readily supplied with this specially designed mechanism.

On the other side of the room are the water machines. One of these is simply a paddle wheel in a barrel—the sound of a steamboat chugging 'round the bend. Another is nothing more than an ordinary sink and faucet, through which water is forced by a system of compressed air tanks; Kelly found that only a faucet would make the sound of water dripping from a faucet.

Thunder Machine

One of the NBC sound effects chief's especial pride is his thun-

(Continued on Page 29)

"HAM" OPERATORS PROVE THEIR WORTH IN FLOOD AREAS

Communication Carried on Under Trying Conditions

Equipment at WRAK used in the emergency operations.

DURING the recent floods in the Eastern section of the country the farflung organization of "ham" operators came into its own and proved the value of constant tinkering with coils and circuits. Not alone from one restricted area but from the entire front affected by the deluge "hams" picked up the burden of communication, which for all practical purposes had broken down.

Hartford, Williamsport, Johnstown, Pittsburgh and a host of smaller communities suddenly found themselves utterly dependent upon the amateur operators for any word they were to send or receive from the outside world. But in many cases the messages handled between the stricken and the unharmed sections of the same city were even more important. The emergency calls for police, fire departments, doctors, nurses and supplies were not only handled in large volume but were also handled efficiently.

Portable Station Installed

In Williamsport, WRAK installed a portable amateur station to maintain communication with other amateur stations throughout the city and in addition, temporary portable setups were established in the Red Cross headquarters in the city proper and in South Williamsport. Included in the equipment in the central studios were several ACR-136 RCA receivers which were used continuously for over one hundred fifty hours with good results. This service was the more remarkable since they were located in the direct field of the WRAK antenna and were subjected to continuous interference from motors and competed with a vastly increased number of signals on the amateur band.

All Bands Used

All amateur bands were in use, both CW and phone, to great advantage. Last but not least, hundreds of amateur stations stood by with the filaments of their transmitters lighted, and the switch at hand ready to "Flip," listening and waiting, hour upon hour, ready to "come in" should their services be required.

The first news and requests for assistance from the Red Cross were sent from Johnstown early in the evening of March 17. The messages were intercepted by units of the NCR and in very short order nearly every unit in the area had an amateur radio station on the air. A plan for just such an emergency has been on paper for a number of years, and this plan was put into practical operation. Emergency dispatches moved with precision, and speed that would do credit to any commercial circuit.

The ACR-136 receiver which played an important part in various flood areas.

Stations Moved

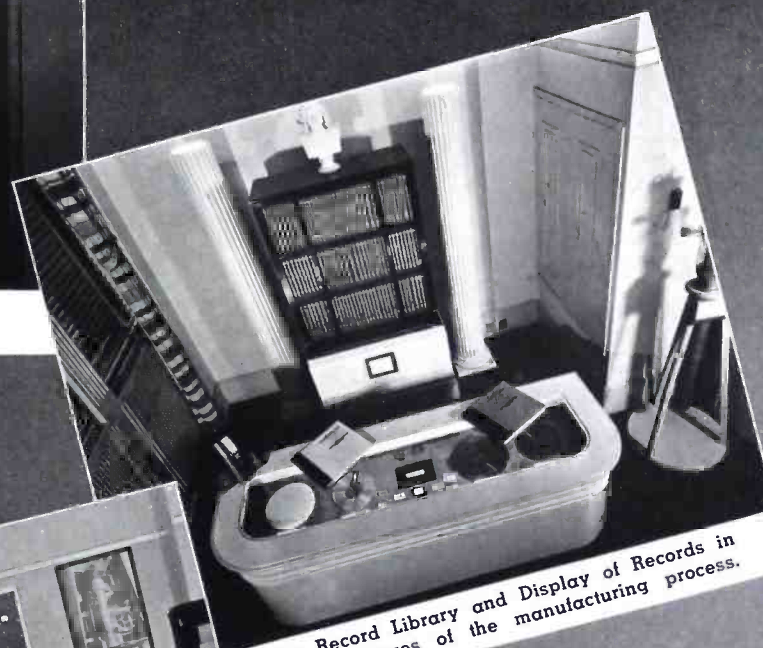
It was not long before Pittsburgh was also under water, and the problem of securing power to operate the radio equipment became a factor. Stations were picked up and moved to points where power was available. Some did not get the chance to move.

(Continued on Page 28)

WRAK, Williamsport, Pa., carries on during the flood.

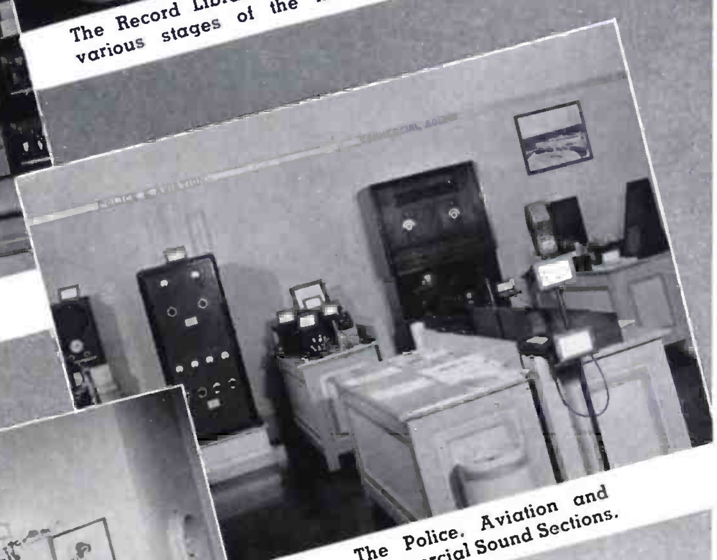
VIEWS OF THE NEW RCA DISPLAY ROOM

Entrance to the Display Room in which all RCA Products are shown.



The Record Library and Display of Records in various stages of the manufacturing process.

A corner showing a 1-D Transmitter and Speech Input Rack.



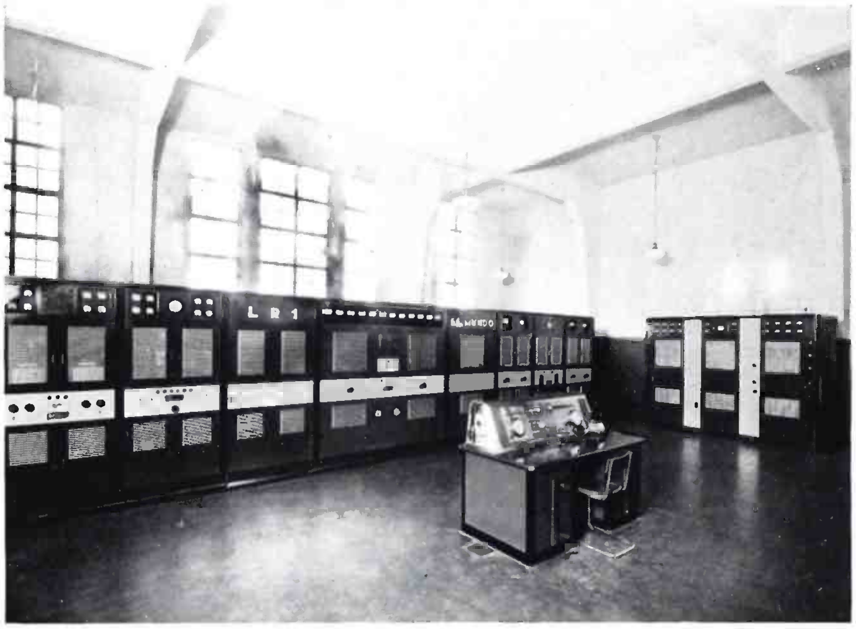
The Police, Aviation and Commercial Sound Sections.

The living room, where receiving sets may be heard in home-like surroundings.

BUENOS AIRES NOW HE

Beautiful Studios, 50 KW Transmitter and Lo

By R. V. B



Great 50 KW transmitter at LR-1 which gives excellent coverage over a large area.

EMPRESA Editorial Haynes, Ltda., publisher of "El Mundo," "El Hogar," and "Mundo Argentina," Argentine newspapers, has just inaugurated its new 50 KW broadcast station LR-1, and, simultaneously, short-wave stations LRU and LRX. All three are supplied with the latest type RCA transmitters and studio equipment and were completely installed by RCA Victor Argentina. LR-1 is the first 50 KW transmitter ever installed anywhere in the world which operates entirely from AC power.

In order to make this tremendous advance possible, RCA engineers developed a new 100 KW Radiotron, Model 898, two of which are used in this transmitter, completely eliminating the previous necessity for direct-current motor generators.

Modern, Spacious Studios

The building, housing the seven studios, control rooms and offices, is of marble and granite, with studios B, C and D, the main control room and four dressing rooms on the first floor. Studio B is two stories high, and seats orchestras up to 40 pieces.

The main control room is the nerve center of all the studios and transmitters. The operator's master console is designed for transmitting two programs simultaneously, and is equipped with all necessary switching controls, volume indicators, jack strips, indicator lights, attenuators, telephones to "the outside," to the transmitters, to the office, and to each individual control room. It also has a monitor speaker, and a cathode ray oscillograph for visual observation of the modulation as well as for testing purposes. There is a 9-AJX cabinet rack equipped with a 40-C amplifier for emergencies and for use as an outside line amplifier when needed; an AA-4194-B monitor amplifier, and a 52-E beat frequency oscillator, which is used for calibrating the telephone circuits and amplifiers.

The second story contains three additional studios, the record library, and a gallery for studio B. The business offices, director's office, and program audition room, are also on this floor.

On the third floor is studio A, capable of seating orchestras up to 150 pieces. Each studio has an individual control room, equipped with an operator's console, speech input rack, Type 9-AJX, including microphone preamplifiers, Type 41-B, program amplifiers, Type 40-C, monitoring amplifier, Type AA-4194-B, and metering and jack panels. Studios B and C also have two transcription turntables. The building is air-conditioned throughout.

One of the magnificent studios.

RD 'ROUND THE WORLD

st Equipment Place LR-1 in Leading Position

IGATOOR

Ideal Transmitter Site

The transmitter is 15 miles north of the city of Buenos Aires along the shore of the Rio de la Plata and is located about two miles away from the city of San Fernando. It is on a good concrete road, provides ample area with good isolation, and the ground is flat and swampy. Preliminary to the selection of this site, RCA Victor Argentina made a field survey using a temporary 1070 KC transmitter operated from a gas-engine-driven generator and the RCA TMV-75-B field intensity meter.

The half-wave Blaw Knox-tower, 530 feet high and weighing 80 tons, can be seen long before arriving at LR-1, and as one approaches, the short-wave antenna towers also become visible, then the transmitter house and chief operator's residence. At night the towers and station house are brilliantly flood-lighted.

The master control desk.

Advanced Technical Features

The entire transmitter is "full automatic" and can be started by a single remote-control key on the operator's console. The frequency of the transmitter is 1070 kilocycles, controlled by the famous RCA quartz crystal unit, and of the last ten frequency measurements made by Transradio Internacional, two showed a variation of only 10 cycles, while the other eight showed zero variation from the assigned frequency. While a variation of as much as 50 cycles or .005 of 1% is allowed, actually, the frequency has been exact.

Upon closing the "start" switch, the cooling system is placed in operation, and signal lights on the console indicate that the various air and water units are functioning. When, after a few seconds, the normal water flow is attained, the filaments are gradually thrown on. At approximately the same time that the larger filaments reach full voltage, the slow heating filaments of the low-power rectifier tubes reach their required temperatures, and plate voltage is automatically applied to them.

When an overload occurs in this transmitter, the plate voltage is instantaneously removed to cut the arc, automatically applied again at one half the voltage a fraction of a second later, raised to ¾ voltage in 5 seconds, and then smoothly raised to full voltage by the automatic regulator. So quickly does all this occur that nothing more than a click is noticeable on the ordinary receiver, and it is probable that the listeners of LR-1 never know when an over-load occurs.

(Continued on Page 30)

A group of notables snapped at the inauguration of LR-1. Left to right: A. T. Consentino, Chief of Radio Communications, Posts and Telegraphs, Post Office Department; R. Hummel and H. Wesley Smith, of Empresa Editorial Haynes Ltda.; Gen. Agustin P. Justo, President of the Argentine Republic; Dr. C. Risso Dominguez, Director General of Posts and Telegraphs.

UNUSUAL STUDIOS FOR WMEX

New Notes in Design and Decoration at Boston Station

ON THURSDAY, March 19th, another large station, WMEX, Boston, moved into its new studios at 70 Brookline Avenue. The rapid growth of this popular eastern outlet made additional space necessary. While following the general layout adopted by the larger stations of the country the WMEX studios reveal a number of new notes in decoration, ideas which give them a decidedly individualistic character.

Ample Space

Embraced in the new setup are three studios, reception room, an elevated control room looking into the studios, executive office, business office, client's audition room, sales office, program office, personnel office and a music library room. Altogether there are forty-five hundred square feet of floor space in the new home.

The modern touch pervades the entire establishment. Floors, furnishings and the distinctive mural decorations all reveal the influence. Musical and radio motifs are used throughout to produce unusual effects.

Among the bizarre murals, the "Radio Robot" is perhaps the most interesting. A microphone indicates the brain, meters the breathing power, and a tube, the body. The effect is startling in its concept of radio as a mechanical superman. The time detail in which the sun dial, hour glass and clock are placed in juxtaposition forms another attractive design.

Radio Details

Free use is made of microphones, tubes and other features of broadcasting for the decorative detail in all the studios.

Studio "B" with mural in the background.

Studio "A" with musical note inlaid directly in linoleum. Wurlitzer Console at the left.

Studio "C" showing the "Radio Robot" Mural.

The studios are treated individually and with recognition of the fact that various acoustic qualities are required. In general the walls are treated for sound with "Absorbex" backed by rockwool.

A new method of solving a difficult problem has been met in covering the organ swell shutters. Hitherto it has been necessary to leave them uncovered or use drapes to bring them into harmony with the other furnishings. Through the use of Venetian blinds WMEX accomplishes the end in an extremely simple and direct manner.

The studios throughout are RCA equipped, including speech input and transcription equipment.

MILESTONES IN VACUUM TUBE PROGRESS

By JOSEPH D'AGOSTINO

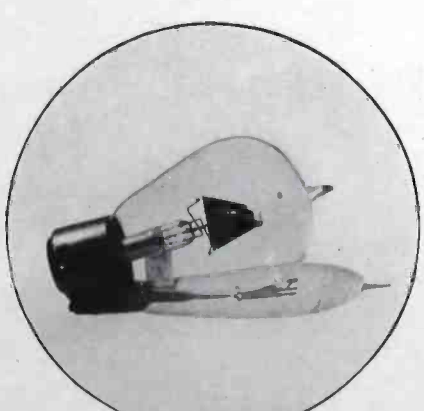
Figure 1. Original Fleming

Editor's Note: Mr. D'Agostino, of the National Broadcasting Company started collecting radio tubes as a hobby as early as 1914, and up to the present time has what is probably the largest electronic tube collection in existence.

TO assign definite dates to "milestones" in the development of the radio tube may place the author in a target position because of numerous legal actions that have pursued the art. The statements that follow are true, however, in the main.

As far back as 1725 DuFay noticed that a conductive path for electricity was formed between a hot sphere and a cold one. Many experimenters worked with this idea and then in 1873, Mr. F. Guthrie found that at red heat an insulated iron ball would retain a charge of negative, but not positive electricity. This discovery brought about the Elster and Geitel experiments with an incandescent lamp having a filament and a plate, in 1880, three or four years before "Edison's Effect," which the latter made no attempt to explain at the time. That Elster and Geitel knew what it was about, is shown by their pointing out the valve effect of this combination in 1889.

Figure 2. A commercially used Fleming valve.



Dr. Fleming, in England, began his experiments in 1883 and not 1896. It was J. J. Thompson's researches on the conductivity of gases, published in 1897, which were responsible for Dr. Fleming's being able to apply what was then common knowledge, to the use of this Elster and Geitel device in radio circuits.

The de Forest Audion

This led finally to the work of Dr. Lee de Forest and his "audion," or three element vacuum tube. This development, incidentally, was the beginning of the present radio industry, which produces millions of radio sets, tens of millions of radio tubes each year, and maintains over six hundred broadcasting stations. It also is the basis of communication stations that link the world, and today electronic tubes are continuing to find hundreds of industrial, musical and entertainment applications. It is further my personal belief that this once innocent appearing "glass bottle of mystery" is destined to change a lot of the fundamental processes such as the very creation of music itself.

The following table concerns, of course, only radio application tubes — the many industrial tube developments are not noted.

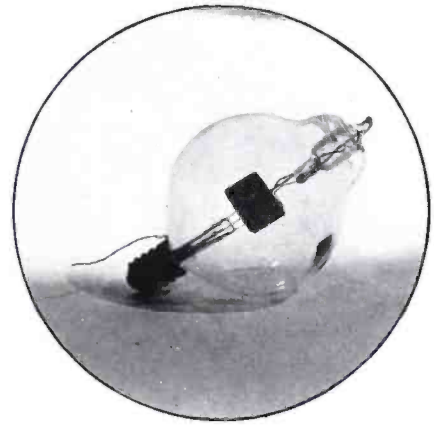
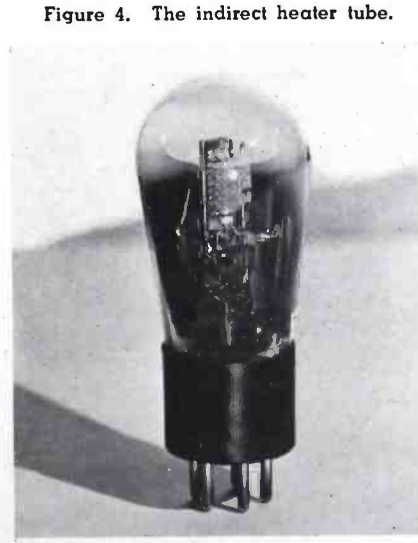


Figure 3. The de Forest Audion.

1. Edison discovered "Edison Effect" .. 1883
2. Fleming experimented with Edison Effect 1896
3. Fleming patented two element rectifier tube 1905
4. Dr. Lee de Forest added third element to Fleming Valve 1907
5. Triodes first used in transcontinental telephony 1914
6. Triodes first function in telephony from Arlington to Honolulu and to Paris 1915
7. First "hard" tubes introduced generally 1920
8. First use of "thoriated" filaments commercially 1923
9. General use of power tubes as complement of standard receivers 1926
10. Development of high current, low voltage filaments 1927
11. Commercial development of shield grid tube 1927

(Continued on Page 29)

Figure 4. The indirect heater tube.



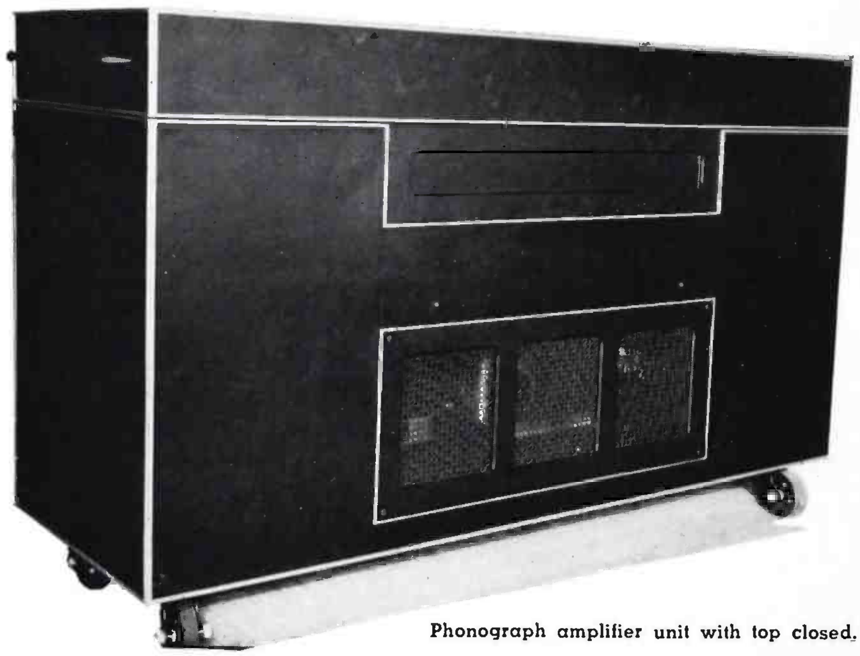
RECORDED SOUND EFFECT EQUIPMENT ALSO MAKES NOTABLE PROGRESS

Many Standard Effects Available on Device Designed by NBC Engineers

By R. H. HEACOCK

ONE of the main differences between a broadcast program of today and that of ten years ago is the naturalness of atmosphere of the presentation. Captain Henry's "Showboat" with its churning paddle wheel and deep whistle, Fred Allen's cheering crowd as it enters Town Hall and the Town Hall News with its falling curtain, "lights out," clicking projector all give the necessary color in the establishment of the idea of listening to these actual occurrences.

The function and technique of recorded sound effects are now an accepted and stabilized part of radio program production. In fact their use has been extended to an increasing number of programs resulting in a demand for an additional amount of equipment with the numerous improvements that NBC's large experience in the field indicated. Therefore, the apparatus described herein was developed from basic specifications prepared by NBC Sound Effects and NBC Audio Facilities Groups cooperating with the engineering staff of RCA Manufacturing Company.



Phonograph amplifier unit with top closed.

In the past sound effects devices have been constructed in an attempt to make these recorded sounds available for use in the regular program. In general the limiting and most disappointing feature of these devices has been the spotting mechanism for placing the needle upon the record at a pre-determined point. Units have been constructed with high gain amplifiers and high fidelity speakers so that it has been possible to control the volume satisfactorily, as well as the response, through the use of convenient mixer networks to properly mix and control the overall output level.

The spotting mechanism itself, however, has generally been a rather complicated and not entirely trustworthy device. Latches which are supposed to be released when and only when an associated electromagnet is energized frequently engage the pickup arm so securely that the electromagnet cannot disengage the latch, and instead of the expected sound, nothing but an empty period of silence, lasting until some quick thinking person steps in to "cover up," follows the moment the sound effect device has been cued in. If the contact face of the latch has been altered to permit easier disengagement, frequently the arm will drop upon the record ahead of the time desired if a slight jolt disturbs the equipment.

Since other spotting mechanisms used in the past have been released entirely independently of the radial position of the turntable with relation to the pickup arm, it is evident that if a record

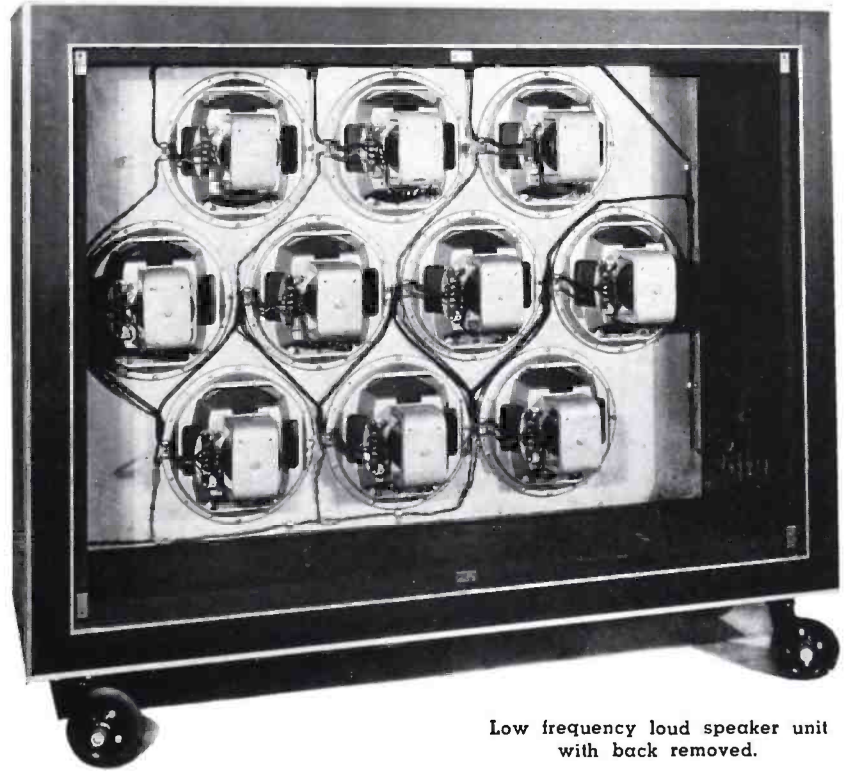
Phonograph amplifier in operating position.

is used where the center hole is eccentric with relation to the recording groove, a variation in the point of contact between needle and the record will be introduced, which is extremely serious and which may amount to several grooves, one way or the other, depending upon the radial position of the record with relation to the pickup arm.

These difficulties which have been outlined above have been carefully considered in the design of the spotting mechanism, and it is felt that each has been overcome.

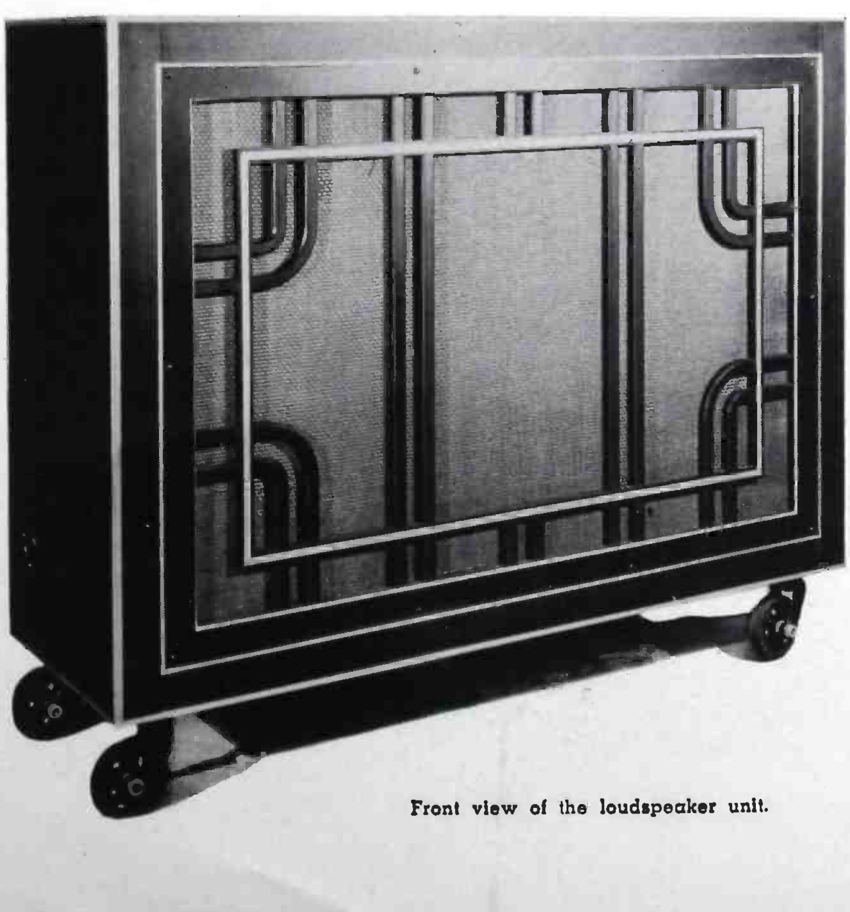
A general description of the complete equipment follows, together with a more detailed account of the design of the "word spotting mechanism."

The complete equipment is contained in three portable cabinets; namely, the phonograph cabinet (MI-4870), the high frequency loudspeaker cabinet (MI-4490) and the low frequency loudspeaker cabinet (MI-4491).



Low frequency loud speaker unit with back removed.

The Phonograph Cabinet—The phonograph cabinet (MI-4870) contains, essentially, three two-speed (33-1/3 r.p.m.-78 r.p.m.) turntables equipped with pre-locating pickup mechanisms, a mixer circuit with its associated attenuators and switching devices, a voltage amplifier (MI-4231) and two power amplifiers (MI-4256), the inputs and the outputs of the two power amplifiers being connected in parallel. The right hand turntable is equipped with a small speed varying lever in order to provide a means for rapidly accelerating or reducing the speed of the record to provide more realistic sound effects. This feature is particularly desirable when reproducing those varieties of sound usually associated with a locomotive, trolley car or motor car picking up speed or coming to a stop.



Front view of the loudspeaker unit.

The Voltage Amplifier — the voltage amplifier (MI-4231) consists of a three-stage resistance-capacitance coupled amplifier utilizing a Radiotron RCA-57 in the first stage, a Radiotron RCA-56 in the second stage, and a Radiotron RCA-56 in the third stage. Filament and plate supply are obtained from the power supply unit of one of the two power amplifiers.

The Power Amplifier — Each power amplifier (MI-4256) consists of a Radiotron RCA-59 driver stage and two Radiotron RCA-2A3's connected in a class "AB" power output stage. The power supply unit utilizes a Radiotron RCA-83 full-wave rectifier tube. Fixed bias of the Radiotrons RCA -2A3 is obtained from a Radiotron RCA-80 full-wave rectifier tube. The maximum usable audio output of the equipment is 40 watts.

Phonograph Receptacles — Receptacles provided on the phonograph cabinet are as follows:

(a) Two external input receptacles, marked "EXT. IN.—1" and "EXT. IN.—2," which permit mix-

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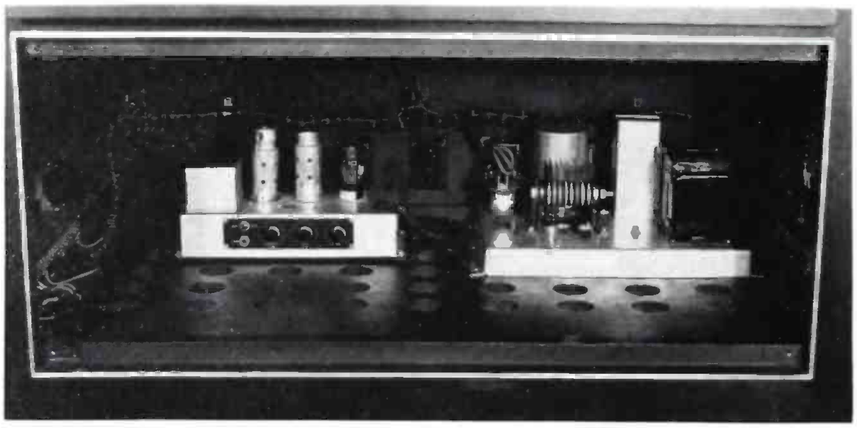


Close-up of the amplifier compartment in the phonograph amplifier unit.

ing of one, two or all the turntables with one or the other of the two external programs. The equipment is designed to work from a source impedance of 250 ohms.

(b) A mixer output receptacle, marked "MIXER OUT." which permits the connection, without amplification, of the output of one, two or all the turntables to an external (250-ohm) line or, if desired, the mixing of the output of one, two or all the turntables with either one of the two external inputs and the connection of the result, without amplification, to an external (250-ohm) line.

(c) Four output receptacles. Two of these receptacles, one of which is marked "EXPON." and the other marked "HIGH FREQ." are for high frequency loudspeaker connections, and the respective output circuits to which they are connected within the cabinet are provided with volume controls for the individual control of each circuit. The other two of the four loudspeaker output receptacles are marked "LOW FREQ. — 1" and "LOW FREQ.— 2" respectively. They are provided for low frequency loudspeaker connections. The amplifier output connections are such that the equipment works into an impedance of 15 ohms.

The High Frequency Loudspeaker Cabinet—The high frequency loudspeaker cabinet (MI-4490) contains four Type UZ-4209, high frequency, double voice coil 10-inch (8-inch cone) loudspeakers (MI-4460). The voice coils are connected in series parallel. The three-contact, polarized, male receptacle for voice coil cable connections is located at one end of the loudspeaker cabinet. The Type UZ-4209 high frequency loudspeakers are equipped with 55-volt fields. The four fields are connected in series parallel and the 110-volt DC, male, input receptacle for field supply is located at the opposite end of the cabinet to the voice coil input receptacle.

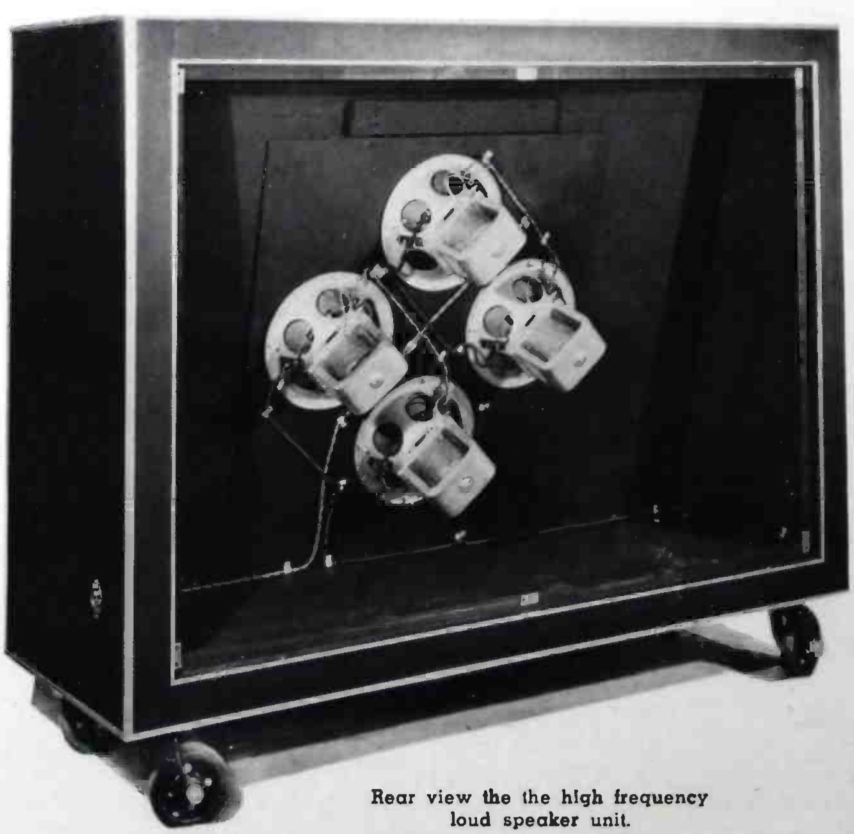
The Low Frequency Loudspeaker Cabinet—The low frequency loudspeaker cabinet (MI-4491) contains ten 12-inch (10-inch cone) loudspeakers (MI-1433). These speakers have been specially designed to materially increase response below 100 cycles without interfering with response at high frequencies. The voice coils are connected in parallel. The three-contact, polarized, male receptacle for voice coil connections is located at one end of the loudspeaker cabinet. The low frequency loudspeaker fields are satisfactory for use on 110-volt field supply. The ten loudspeaker fields are connected in parallel. The 110-volt DC, male, input receptacle for field supply is located at the opposite end of the cabinet to the voice input receptacle. The loudspeaker field power consumption is 100 watts.

Equipment Controls—All equipment controls are installed in the phonograph cabinet. A control panel, accessible by means of a drop door in the front of the cabinet, contains all of these controls with the exception of the three turntable starting switches, which are installed on the turntable motor board (each switch being adjacent to the turntable that it controls).

The controls mounted on the control panel are as follows:

(a) The amplifier power switch, marked "AMP. POWER." This switch actuates a relay, which in turn applies power to the amplifier.

(b) Three pickup switches,



Rear view the the high frequency loud speaker unit.

marked "PICKUP CUTOFFS." Each of these switches is used to open or to close the individual pickup circuit in which it is installed.

(c) Three tone arm release push-buttons, marked "TONE ARM RELEASES." Each push-button, in conjunction with a cam switch on its respective turntable, opens the release magnet circuit of that turntable tone arm and permits the tone arm to engage the record.

(d) Three pickup mixer pads, marked "LEFT," "CENTER" and "RIGHT," indicating the respective turntable circuit that each controls.

(e) The external line mixing pad, marked "EXT. LINE."

(f) Two external line switches, marked "EXT. LINE CUT-OFFS." By means of these switches, one or the other of the two external lines may be fed via the "EXT. LINE" mixing pad, into the input circuit of the equipment.

(g) The master gain pad, marked "MASTER," which functions as an overall volume control for the equipment.

(h) The low frequency tone control, marked "LOW."

(i) The high frequency tone control, marked "HIGH."

(j) The two high frequency speaker individual volume controls, one marked "HIGH FREQ." and the other marked "EXPONENTIAL."

(k) The "MIXER OUT.—AMP. OUT." switch, which permits the input circuit including all mixers up to and including the "MASTER" gain control to be switched to the external line via the "MIXER OUT." receptacle, or to the phonograph amplifier and the equipment loudspeakers.

(l) Two Neon "OUTPUT" indicators, one marked "MAXIMUM" and the other marked "OVERLOAD" are located directly above the loudspeaker volume controls. The "MAXIMUM" neon lamp is connected in a network in the grid circuit of the output stage (Radiotron RCA-2A3 stage) so as to glow when the output reaches a little over 20 watts. The "OVERLOAD" neon lamp is connected in a network in the driver stage (Radiotron RCA-59 stage) of the power amplifier so as to glow when the output reaches 40 watts, and to limit the output to approximately 48 watts. The amplifiers should be worked with the "OVERLOAD" lamp lighted momentarily indicating peaks only. Otherwise considerable distortion will be introduced.

The Tone Arm Pre-Locating Mechanism—The tone arm pre-locating mechanism, which is located in the phonograph cabinet, is a device that will, with extreme accuracy, place the pickup on a predetermined spot on a record, so that the sounds recorded on this predetermined spot on the record may be reproduced and mixed with the regular broadcast program. The mixing process may be accomplished acoustically or it may be accomplished electrically. Acoustical mixing involves the use of the loudspeakers of the sound effects equipment and the acoustical pick-up of the resultant sound effects by means of the studio microphone. Electrical mixing discards the speakers and involves the use of the "MIXER OUT." receptacle to feed the output of the turntables into an external line.

The pre-locating tone arm consists essentially of an upright tone arm support in which is mounted the swivel arm member of the tone arm. A tilting member, at the outer end of which is affixed the turntable pickup, is mounted in a horizontal swivel in the divided portion of the swivel arm. The tilting portion of the tone arm is held up, by means of an electro-magnet, in such a manner that as the tone arm is swung laterally the pickup may be poised, at any point in its swing, over the record. An adjustable counter weight is provided on the tilting arm to regulate the pressure at the needle point. It is believed that 2 ounces of pressure will give the most satisfactory results.

Release Push-Button

A release push-button is connected in parallel with another switch located on the motor board. When the release push-button is depressed, and the latter switch opened by means of a fixed cam on the under side of the turntable, the magnetic circuit is opened, thus permitting the tilting arm to fall and the pickup needle to engage the record. Since the cam switch always opens the circuit of the electro-magnet at the same radial point on the turntable, regardless of the time within that revolution that the release push-button is depressed, the pickup needle always engages the record at a fixed radial angle from the switch opening cam.

Record Centered

A white spot on the edge of the sound effects record is indexed with relation to engraved figures on the turntable rim. The record is centered and excess clearance eliminated by means of a tapered centering pin.

The speed of fall of the pickup is determined by the adjustment of a small dashpot attached to the rear of the tilting arm. In order accurately to locate the radial position of the arm with relation to the record, there is located on the top of the vertical pivoted portion of the tone arm and rigidly attached thereto, a gear which is engaged by a pawl. This pawl is supported by a pawl plate located immediately above the gear so that a notch in the plate will expose one and only one tooth of the gear at a time. Each exposed tooth is of a different color, permitting the indexing of the tone arm for radial position.

Adjustment Provided

An adjustment is provided on the upright support of the tone arm so that when the pickup is at rest (i.e., not playing a record) it will rotate slowly toward the right in such a manner that the heel of the pawl will engage the spindle of a micrometer head. This micrometer head is equipped with a dial gauge, giving an outer dial and an inner dial reading. It is to be noted that one revolution of the indicator of the outer dial is equivalent to the movement of the indicator from one number to the next on the inner dial. Care must be exercised to see that the pawl is properly engaged with the correct tooth on the tone arm gear.

(Continued on Next Page)

Record Indexed

The colored teeth on this gear provide the main sectors of indexing, with the accurate setting in any one sector shown on the dial gauge. Thus, both the color of the tooth and the reading of the dial gauge determine the radial position of the arm with relation to the record. Consequently, with the white dot on the record placed opposite one of the numbers on the turntable rim, the proper setting with relation to the gear color and dial gauge reading will insure the placement of the needle accurately upon a predetermined spot on the record.

It is to be noted that as the white dot on the record edge is moved clockwise or counter-clockwise, syllables or notes may be subtracted or added to the original point of contact of the needle on the record.

No Mechanical Failures

Since both motions of the tone arm mechanism are dependent for operation on gravity alone, and no latches or catches are present, there will be no sticking or jamming of the mechanism.

From the foregoing description of the device, it is evident that the precision with which the mechanism operates makes possible the indexing in a card file so that any specific sound may be listed by means of the record number and three separate readings; namely,

1. The color of the gear tooth exposed by the notch in the pawl plate.
2. The inner dial and the outer dial readings of the micrometer dial gauge.
3. The location of the white dot on the record with respect to the engraved numbers on the turntable rim.

In this way, the usual "hunting" for the desired sound is eliminated and such sounds made as fully available as the various volumes in a properly indexed library. It is to be noted that these readings apply only to the turntable upon which they were taken. If the record is set up for operation, according to these readings, on either of the other turntables, there will be some discrepancy in the point at which the needle will engage the record.

Advantages

It is felt that this device has the following advantage:

1. Simplicity. It is to be noted that there are no locking catches or mechanical latches used in either the up and down motion of the pickup arm or in the rotative motion of the arm. Gravity alone controls both of these motions. Consequently, there is no possibility of sticking or jamming and it is not necessary to make any very accurate adjustments on either of these motions.

2. Once the needle is engaged by the record groove, the arm is as free to move in any direction as a manually operated arm. There are no springs or other constant loads which tend to force the needle in any direction.

3. Since the pawl heel is in engagement with the micrometer head until the needle is actually pulled away by the record groove, there is no possibility of inaccurate lateral wavering of the pickup arm after release.

4. Since the tapered centering pin accurately centers the record by removing all "slop" between the record and the pin and since the rotative position of the record with relation to the turntable is fixed, it is possible to replace the record on the turntable and bring the needle down on the exact word or sound which may be desired by presetting the device.

5. Even though recorded grooves may be eccentric with relation to the center hole, the device will still function perfectly satisfactorily.

6. Since the beginning of fall of the pickup arm is indexed from the record itself, it is possible to accurately spot a fixed sound very much more readily than with a device which does not index form the rotative position of the turntable.

7. Each of the mechanical parts with the single exception of the cammed turntable switch is rigidly located on the single pickup arm unit. This makes it possible to move this arm and use it in combination with any turntable with satisfactory results without the accurate locating of parts with relation to each other on each new set up.

Since the release button may be located remotely, this device lends itself to stage operation. The mechanism could be located in the wings and the stage director could personally release the pickup to provide a realistic scream or other desired sound, which could be properly cued with relation to the rest of the performance. The device is also useful in sound dubbing from already recorded sources on either wax or film. It is satisfactory for use on automatic announce systems or for any other purpose where certain definite sounds must be reproduced from already recorded sources.

Extremely Flexible

The overall equipment is extremely flexible in view of the fact that the single fully equipped arm may be set up on any motor board for use with any turntable as long as the turntable has been equipped with proper release cam. Since all the mechanical parts, with the exception of the motor board switch located under the turntable, are rigidly attached to the single pick-up arm unit, it may readily be assembled to the motor board without extreme accuracy in its location being necessary. The equipment which has been described is obviously quite elaborate and necessarily expensive.

The same release mechanism could be used in combination with the existing turntable units, amplifiers, and speakers so that the overall cost of the setup could be readily controlled, depending upon specific requirements of each installation.

Specific acknowledgment is due to the following engineers for their whole-hearted cooperation and help on this equipment:

Ray Kelly and C. A. Rackey, NBC, A. N. Curtiss, C. W. Slaybaugh, M. W. Scheldorf, J. D. Seabert, R. L. Gibson and J. A. Rancorn of the RCA Manufacturing Company.

CARE OF WATER COOLED TUBES

(Continued from Page 11)

Operating Temperatures

The life of a pure tungsten filament will depend mainly on one thing—the temperature at which it is operated. If operated at a sufficiently low temperature, a tungsten filament will last indefinitely. But this temperature would probably be too low to produce sufficient emission to get any use out of a tube. It is necessary therefore to maintain the filament at some temperature that actually allows the filament to boil off or decrease in size with time. The rate of evaporation of the filament will be determined by the amount of emission required.

Operating at Reduced Filament Voltage

In order to clarify this point, the curves of Figure 1 should be referred to. Theoretical data for the RCA 863 water-cooled tube have been plotted to show how much the filament life of this tube can be increased by operating at a reduced filament voltage, which reduces the filament temperature and of course limits the amount of available emission. It can be seen from these curves that about 9.5 amperes of emission is available when the filament is operated at 22 volts. Should the tube be used in a circuit that requires only half that amount of emission, it becomes possible to operate the filament at a reduced temperature with about 20.5 volts to heat it.

Sufficient Emission Necessary

Of course it would be unwise to operate that low unless it could be definitely ascertained that sufficient emission is available to prevent the introduction of distortion on peaks of modulation. The emission requirements can easily be calculated but it is a good idea to include in the routine maintenance tests a means of determining whether sufficient emission is available. One sure way of making available an adequate amount of emission is to keep the filiament temperature up to normal at all times. It is more economical, however, to operate at a reduced value and take the small amount of trouble necessary to check performance at regular intervals.

Test Necessary

An oscillograph or modulation meter should be employed for the test. With filament voltage of the tube or tubes in the final stage of the transmitter set at normal, modulate the transmitter with a sine wave audio input to 100% as determined by the cathode ray oscillograph or modulation meter. The transmitter should be adjusted so that positive and negative peaks of modulation are equal. The filament voltage should then be reduced in small steps until the positive peaks just begin to fall. The filament voltage at this point is too low to provide the proper emission and should be increased slightly and set for operation. If the necessary equipment is available, harmonic distortion should be measured also.

The test assures the station engineer that he is providing enough emission to take care of the peaks of modulation and still obtaining the best possible filament life from his water cooled tubes. It also serves as a means for predicting filament failure, since it will be found that a higher filament voltage will be required to give the proper emission as the tube gets older.

Accurate Calibration Required

The importance of keeping the filament voltmeter accurately calibrated cannot be stressed too strongly. It can be seen from the curves of Figure 1 that operating at only one-half volt above normal of 22 volts will cut the normal filament life of the tube in half.

It is important to mention here that this procedure cannot be applied to tubes having thoriated or coated filaments. Operating them at reduced temperature will damage the filament and shorten the life.

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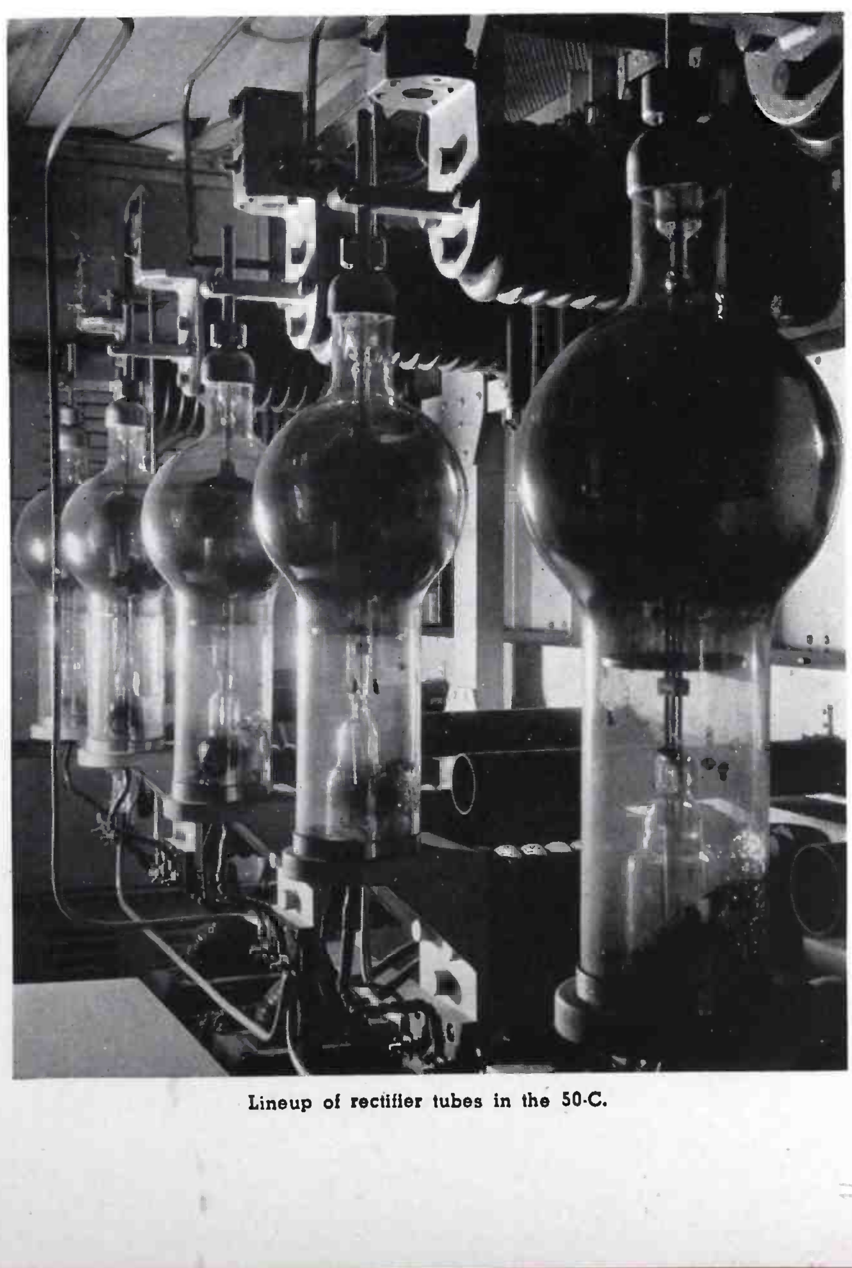


Lineup of rectifier tubes in the 50-C.

"HAM" OPERATORS PROVE THEIR WORTH

(Continued from Page 16)

Several operators left their stations to destruction by the water in their efforts to keep on the air until the last. Stations had to be placed where they were able to deliver and accept traffic, as well as have power available. At no time were interruptions longer than an hour.

In New England, Ensign Rogers undertook the rebuilding of a standard RCA ATR-219 5-meter transceiver for 7.5-9.5 meters for Commissioner of Public Safety Paul Kirk, in charge of the Massachusetts State Police, for use in flying over the Springfield area.

It was found impossible to load the grid and plate circuits to the lower frequency by capacity alone. After many tests and larger unity coupling inductance was built, the plate capacity increased to 50 mmf and the coupling changed to an inductive link to feed the doublet antenna designed by Mr. Rogers. Using E01 cable for convenience the antenna was mounted fore and aft, from a small brace on the upper wing of the Stearman biplane to the rudder post. There was a "Y" of about 9" in the center to approximately match the doublet from the E01.

Continuous communication was reported by Commissioner Kirk from the moment the ship left the airport for the flooded area. Rescue work was directed from the air. Troopers below could report direct to their Chief and Northampton and Framingham contacted as desired. In fact contact was maintained with Northampton all the way to Boston.

Perhaps the most important lesson learned from the catastrophe was the fact that the amateur chains functioned with smoothness and precision throughout the entire period.

Control Room at WLVA looking into Studio "B"

Studio "A" at WLVA, Lynchburg, Va.

CARE OF WATER COOLED TUBES

(Continued from Page 27)

Another possible source of failure of water cooled tubes is at the seals. These are the places where grid and filament leads are brought out of the tube and where the anode is connected to the glass. Outside of actual mechanical breakage, failures usually occur at these places because of overheating.

Every precaution should be taken to eliminate the possibility of excessive heat being developed at these vulnerable points. Connections to filaments should be kept clean and tight to prevent a high resistance contact. Water systems should be kept clean and in proper order to prevent steam from forming on the tube anode. Radio frequency grid current ratings should not be exceeded. Water flow and temperature interlocks should be provided to prevent operation without proper cooling facilities. A failure from this source should rarely occur if these precautions are taken.

It is felt that radio station engineers not already following the procedures outlined here can greatly benefit by adopting them. Results should include greater reliability and consequently an improved operating record, and a considerable reduction in operating expense.

NBC SOUND EFFECTS TECHNIQUE

(Continued from Page 15)

der machine. In the beginning of radio, thunder was produced either by tapping a bass drum or by bending a thin slab of black sheet-iron, suspended on four uprights. To those in the studio the sheet-iron sounded like a June thunderstorm in full swing. But Kelly's acute ear, listening in at the loudspeaker, caught the faint ring of metal. The average listener might not have noticed, but he knew that the radio audience was becoming more critical. He wanted perfection, so he set to work.

Solution by Accident

The "work" consisted of hundreds of experiments, none of which quite satisfied him. He soon got to the point where he was saying "By thunder!" quite frequently—and he wasn't referring to a machine. Then, at his home one day, Kelly was taking down the summer screens. His screw-driver slipped. To the ordinary ear the sound of the screwdriver sliding across the screen mesh would have been an ordinary ra-a-a-ssp. He listened closer and he heard a low, rumbling undertone. He got busy.

When next a script called for thunder, Kelly trundled his screen into the studio. When the thunder cue came, he rapped on the mounted window screen with a tympani hammer. To those in the studio, there was no sound. The director looked startled. But the control room men had heard—long, rumbling peals that made them automatically look up for the black clouds in a sky which they could not see.

He explained his thunder machine by pointing out that the lowest sound made by the tympani hammer on the screen was picked up by an electric needle similar to that used on phonographs. The sound was electrically amplified before it went into the microphone. Now he has perfected his "thunder screen" so he can use it as the booming of cannon or the rolling of surf. The cannon boom is produced by a sharp tap. The surf is simply some lead shot rolling across the screen.

The chimes of Big Ben in London caused plenty of trouble, too. He had recordings of the actual sound. He used studio chimes with exactly the same pitch as Big Ben's boom. Neither was just right. The sensitive NBC microphones got overtones and echoes. Kelly solved that by using his electrical pick-up once again, and by sounding a chime that was just a trifle off-key. On the loudspeaker, the sound was indistinguishable from the boom of Big Ben itself—and Kelly tried it out on native Londoners.

Rain That Isn't Wet

As for rain—well, Kelly admits that what you hear over your radio is not rain. To be explicit, what you hear is bird seed. Plain bird seed and Ray Kelly's genius with sound is what makes rain on the radio. The sound itself comes from a machine which looks like something you might see in a Jules Verne laboratory. In a turret at the top is the hopper containing the seed. Kelly turns on the electric current and the seeds begin to pour out in a regulated stream. First they fall on a turning disk, with a lever which pushes off a regulated quantity, making the difference between a drizzle and cloudburst. The seed first hit a suspended ping-pong ball. Then they fall on a sheet of cellophane, in turn dropping onto a tissue-paper bag, each different object being in its own separate compartment. It may sound odd, but put them all together (and add Ray Kelly) and any radio listener will admit that you've got rainy weather. And when Kelly turns on his variegated wind and thunder machines—well, that means a night outside that isn't fit for man or beast.

Kelly believes now that his sound effects laboratory is the best in the world. He is confident that he can reproduce almost any known sound, and on very short notice. But he and his assistants are not resting on their laurels. They are constantly at work, improving their library. And they are looking ahead: they are working with an eye to the day when television will become a day-by-day reality.

MILESTONES IN TUBE PROGRESS

(Continued from Page 21)

Figure 5. The shield grid tube.

12. Commercial use of A. C. filaments and indirect heaters in receivers..1927
13. Hot cathode mercury vapor rectifiers 1928
14. Multi purpose tubes 1933
15. Micro-wave tubes 1934
16. Metal tubes 1935
17. The Electron Multiplier 1935

In conclusion it might not be amiss to indicate that the above dates are not the date of origin but rather the date of general announcement.

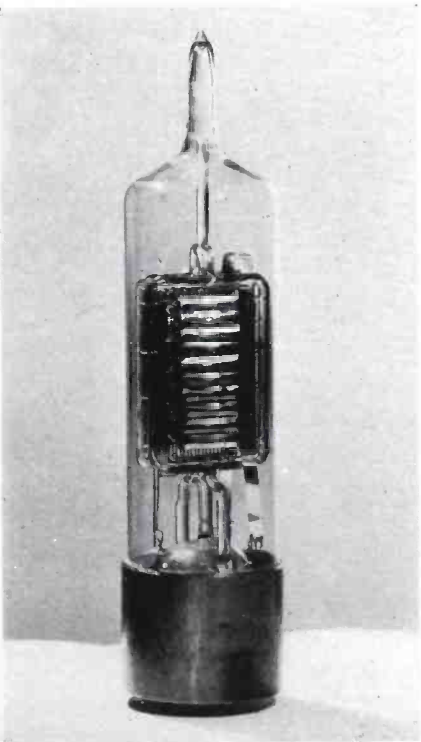


Figure 6. Tube used in first Trans-Atlantic broadcast—1915.

UP GOES POWER AT WFBC

(Continued from Page 5)

over special underground wires installed by the Southern Bell Telephone Company.

Living Quarters

A doorway to the right leads into the living quarters where modernistic furniture, hardwood floors, windows with Venetian blinds and all the touches that make up a home meet the eye. The living quarters consist of living room, bed room, kitchen, dining room and bath.

Water is obtained from a 200-foot well and is forced into the plumbing by an electric pump.

New Tower Antenna Aid to Aviation

WFBC's new 376-foot tower is the tallest self supporting steel radiator in the entire South.

If a low flying airplane should hit the tower the chances are it would bend away in the line of least resistance, allow the fuselage and heavy motor to pass, cut off a wing and right itself without serious damage to the tower, but result in destruction for the airplane.

To guard against such a catastrophe the tower is painted in alternate colors of white and orange to make it more easily visible by day and lighted with red electric lights to make it visible by night. Its presence two and a half air miles almost due south of the city of Greenville has already been marked on aviation maps published by the U. S. Department of Commerce, bureau of air navigation.

In time this tower will become an asset of great importance to air navigation. There are radio compasses on airplanes now. If an aviator wants to come to Greenville he sets his compass on 1300 kilocycles and picks up the program which WFBC will be sending out 18 hours each day. The closer he gets to Greenville the stronger that signal will become. When it reaches the point of highest intensity the aviator will know that he is flying over WFBC's transmitter. He'll also know that he's only six and a quarter air miles from Greenville's Municipal Airport. He'll know that when his altimeter shows say 1,000 feet above the ground he can set his ship on an easy glide in an easterly direction, cruise six and a quarter miles and drop down on a tar and gravel runway made for safely landing airplanes. That's going to be a real service to some one on a foggy, mean night.

WFBC will continue to broadcast from its studios on the second floor of the Imperial Hotel.

LR-1

(Continued from Page 19)

The attainment of low audio distortion in equipments of this size has been difficult in the past because of the number of amplifier stages through which the audio or the modulated radio frequency has to pass, each stage introducing some inevitable distortion. In order to overcome this, RCA engineers have introduced a Class "A" radio-frequency amplifier to excite the two 100 KW RCA-898's. This results in a total harmonic distortion of only 6% at 100% modulation, and an audio response flat within plus or minus 1 db. from 30 to 10,000 cycles.

One of the interesting innovations in the 50 KW power amplifier is the tank condenser, enclosed in an air tight cylinder and operated at 150 pounds pressure. This is done to keep the power amplifier down to a reasonable size and at the same time permit easy servicing.

While LR-1 aims to cover only Argentina and Uruguay with the 50 KW transmitter, reports have already been received from England, Europe, Africa, Australia, New Zealand, the United States and Canada.

The beautiful new building in Buenos Aires which houses LR-1.

CRIME CONTROL WITH RADIO

(Continued from Page 4)

Another instance came two years later when a young man for whom a warrant had been issued at Harrisburg, Pa., was found to have sailed on the S. S. Graf Waldersee from Philadelphia. As the ship was only an hour or so on her way down the Delaware, a tug was chartered and overtook the liner. But when they had caught up with their quarry, the police found that in their haste they had put to sea without the necessary authority to arrest the man. A wireless was sent to Philadelphia and in a few minutes the formal authority was received in reply, and the fugitive was taken off the ship. Today, the use of radio for such arrests is a common occurrence.

Many other radio devices aid the work of the police. By means of facsimile transmission, rogues' gallery pictures and fingerprints can be flashed instantly across the continent or across the sea.

A villain in the famous play, "Within the Law," boasted that he was the first gunman in history to use a Maxim silencer. Similarly, a certain Filipino swindler, arrested in 1929, can boast that he was the first criminal captured by a radio photograph. After fleeing from New York to Honolulu, the sleepy Filipino was aroused from his berth aboard ship at five o'clock in the morning, and identified by means of a facsimile radio photograph, taken from an original in the files of the New York Police Department and projected by radio 2600 miles across the Pacific Ocean.

Today, if a criminal is known to have escaped by ship, a warning and description can be put into the hands of the master of every ship, whether it is an hour or a week out of port. Recently, the police of Poland flashed by radio, a photograph of a suspected forger. As he walked the gangplank in New York, he was quickly identified and arrested.

Science Closes in on the Criminal

Among other radio aids now at the command of the police are such devices as the photoelectric cell, activated by a beam of invisible, or infra-red light, thus forming a surprise "crime alarm" which an intruder on the protected premises cannot circumvent. Then there is the so-called "gun detector," now in use in an increasing number of prisons, to prevent the smuggling of weapons or tools by convicts from workshops to their cells.

No one knows what further protection to life and property the ingenuity of radio engineers will offer society in the future. Perhaps the next step will be to equip each patrolman with a small, short-range radio transmitter by which he can instantly send an alarm or call the nearest station for help. Again it may be the adaptation of one or more of the functions of television to record evidence during the actual commission of a crime. When the time comes that facsimile receivers are in universal use, it will be possible to flash the picture of a fugitive to millions of homes simultaneously and thus put an army of citizens in every part of the country on his trail.

Radio as an Educational Force

So much for what we might call the scientific achievements of radio in the field of crime. As a father speaking to other fathers — and mothers — I would rather speak of the achievements of radio in the prevention of crime. Who can doubt that the growth of knowledge and appreciation of fine music in the minds of millions of school children each year will result eventually in a higher cultural average and a lower percentage of crime? Who will question the statement that many young people who are being brought up under unfavorable social conditions will be influenced to a healthier attitude toward life by listening to an inspiring sermon or an enlightening discussion of some fundamental problem of life? On the other hand, such outstanding dramas of criminology, as those portrayed for the past five years by Warden Lawes of Sing Sing, to mention only one instance, have brought home to many young people the sordid and unprofitable side of criminal life.

If radio can help to improve the thinking processes of young men and women, and if the efforts of educators and sociologists become increasingly more effective, there will be a definite and constructive change in the attitude of young people toward wrong-doing.

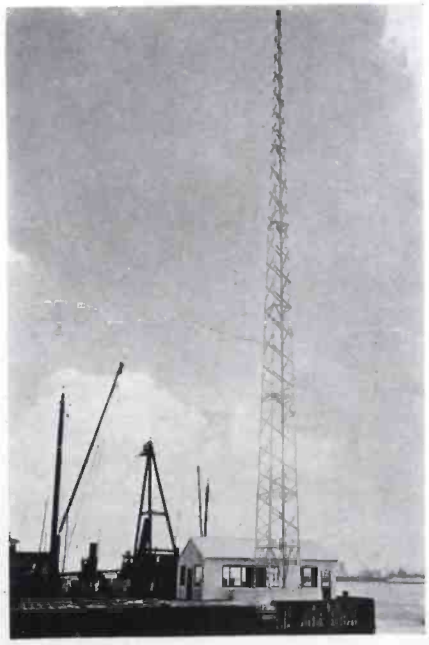
Radio offers to education an auditorium many times greater than the combined capacity of all schools and colleges in the country. At present, the educational world still faces the task of perfecting a method of popular education which will take full advantage of the possibilities inherent in broadcasting. An even greater opportunity for education by radio will come when television adds sight to sound.

NOVEL LOCATION FOR WHOM

WHOM, whose new 250 watt RCA transmitter gives excellent coverage over New York, Brooklyn, and Northern New Jersey, has one of the most unusual sites in the country.

Both transmitter house and antenna shown below are constructed on a pier in the North River.

Members of the staff probably have adopted as a theme song, "River Stay 'Way from My Door."



A REVIEW OF BROADCAST ENGINEERING

Articles in Leading Publications, January-March, 1936

Reviewed by
J. P. TAYLOR

ADVANCED DEVELOPMENT

The Secondary Emission Multiplier — A NEW ELECTRONIC DEVICE, by V. K. Zworykin, G. A. Morton and L. Malter, IRE Proc., Mar. 1936, Pg. 351.

One of the most interesting and widely commented-on of recent papers. Describes the construction, theory and performance of secondary emission multipliers. The improvement in signal-to-noise ratio—as contrasted to conventional amplifiers—is discussed and the advantages of these multipliers for photoelectric applications pointed out. Of interest to broadcast engineers because of application to television development.

Frequency Modulation on Ultra Short Waves, Part I, by D. Pollack, Radio News, Feb. 1936, Pg. 458.

Frequency Modulation on Ultra Short Waves, Part II, by D. Pollack, Radio News, Mar. 1936, Pg. 524.

Another, fairly extensive, resume of Prof. Armstrong's phase-frequency modulating system. (Prof. Armstrong's original paper appears in the May IRE Proc.).

The Electron Telescope, by Dr. Zworykin and Dr. Morton, Electronics, Jan. 1936, Pg. 10.

Resume of the paper, delivered before the AAAS by Dr. Zworykin and Dr. Morton, describing their new development, the electron telescope, which makes infra-red light visible directly.

Electron Diffraction Analysis, by L. H. Germer, Bell Labs Record, Mar. 1936, Pg. 210.

Extremely interesting description of the electron diffraction camera, which is used studying thin surfaces, etc.—as contrasted to X-ray diffraction used in studying thick specimens.

ALLOCATION

Davis Clause Repeal to Strengthen Stations, by Sol Taishoff, Broadcasting, Mar. 1, 1936, Pg. 18.

Non-technical discussion of the likely effects of the expected repeal of the so-called Davis Amendment.

ANTENNAS

The Broadcast Antenna, by A. B. Chamberlain and W. B. Lodge, IRE Proc., Jan. 1936, Pg. 11.

Important analysis of the results obtained to date with tower antennas. Data obtained from actual measurements is emphasized.

Some Comments on Broadcast Antennas, by R. N. Harmon, IRE Proc., Jan. 1936, Pg. 36.

Theoretical development of the results to be expected from vertical antennas of constant phase and current.

A Critical Study of the Characteristics of Broadcast Antennas as Affected by Antenna Current Distribution, by G. H. Brown, IRE Proc., Jan. 1936, Pg. 48.

Mathematical analysis of broadcast antennas with various current distributions (including the "decreased velocity" type) in which the expected field intensities are determined and the relative suppression of fading considered.

R-F Transition Loses, by H. A. Wheeler, Electronics, Jan. 1936, Pg. 26.

Chart (and instructions) for determination by a graphical method of radio frequency losses due to impedance mis-matching.

R-F Impedance-Matching Networks, by R. P. Glover, Electronics, Jan. 1936, Pg. 29.

Chart (and instructions) for the design of Pi-section networks for matching transmitters to antennas, etc.

Top-Loading on Small Portable-Mobile Antennas, by J. L. Long, Jr., Comm. & Broadcast Eng., Jan. 1936, Pg. 17.

Short description of top-loaded antenna of the mobile pickup transmitter used by WHAM.

APEX

Enter the "Apex" Broadcasting Station, Broadcasting, Feb. 1, 1936, Pg. 51.

Non-technical description of the status and prospects of ultra-high frequency broadcasting. A list of licensees to date is included.

A High-Fidelity U. H. F. Transmitter, by J. W. Smith, Radio, Feb. 1936, Pg. 25.

Description of a telephone transmitter developed for applications in the ultra-high-frequency band. Reprinted from Bell Labs Record.

New 41-MC W8XH, by R. J. Kingsley, Electronics, Jan. 1936, Pg. 19.

Brief note on the new transmitter and antenna installation at W8XH (Buffalo), pioneer ultra-high-frequency broadcast station.

FIELD INTENSITY

Some Engineering and Economic Aspects of Radio Broadcast Coverage, by G. D. Gillett and M. Eager, IRE Proc., Feb. 1936, Pg. 190.

Quantitative study of the major factors determining broadcast coverage, considered with particular respect to the economic aspects. A number of tables of service range under various conditions are given for the range of 200 to 2000 kilocycles.

A Study of Ground-Wave Radio Transmission, by R. C. Higgy and E. D. Shipley, IRE Proc., Mar. 1936, Pg. 483.

A comparison of ground wave field intensities, observed in Ohio, with the values predicted by the Sommerfeld theory.

FREQUENCY CONTROL

Notes on Piezoelectric Quartz Crystals, by I. Koga, IRE Proc., Mar. 1936, Pg. 510.

A consideration of the characteristics of quartz plates cut at various angles, with particular attention to temperature co-efficient.

MEASUREMENT

Measurements of Noise on Program Circuits, by R. S. Tucker, Bell Labs Record, Mar. 1936, Pg. 233.

Brief description of the weighted filter used by the Bell Companies in measuring noise level on program circuits. Curves of weighting against frequency are shown.

A Low-Level Wattmeter, by L. Albert and H. P. Beckendorf, Electronics, Mar. 1936, Pg. 28.

An interesting note on the possibilities of the electrostatic wattmeter for measurements at the low levels encountered in communication applications.

A New Precision Wavemeter, The General Radio Exp., Mar. 1936, Pg. 1.

Short description of the Type 724-A (absorption-type) Wavemeter which replaces the Type 224, long a standby for use in antenna measurement, harmonic determination and other broadcast engineering applications.

A Direct-Reading Condenser for Substitution Measurements, The General Radio Exp., Mar. 1936, Pg. 30.

Description of a new precision condenser which reads directly negative increments of capacitance. Useful in substitution measurements.

MICROPHONES

The High-Impedance Velocity Microphone, by J. J. Cummings, Comm. & Broadcast Eng., Jan. 1936, Pg. 14.

Short article on the high-impedance type of ribbon microphone. Disadvantages are not mentioned.

MODULATION

Sidebands and Modulation, by G. Forrest, Radio, Mar. 1936, Pg. 62.

A short note (with good explanatory diagrams) on the several methods-controlled carrier, suppressed carrier, etc.—of radiotelephone transmission.

On Measuring Modulation at the Receiver, QST, Mar. 1936, Pg. 47.

A note on a simple method of connecting a cathode-ray oscillograph in order to monitor modulation at a remote receiver.

Modulation Movies, by J. L. Reinartz, Radio Feb. 1936, Pg. 15.

Observations of modulation with a cathode-ray tube explained in simple language.

OPERATION

With Radio on the Strato Flight, by S. Kaufman, Radio News, Feb. 1936, Pg. 455.

Non-technical description of the rebroadcasting arrangements for the strato flight of the Explorer II, including pictures of the 8-watt gondola transmitter that was heard from coast to coast.

POLICE

Michigan Expands State Police-Radio System, by K. Saunders, Comm. & Broadcast Eng., Mar. 1936, Pg. 13.

Non-technical article on the planned expansion of the Michigan State Police Radio System—particularly interesting because of the outstanding success to date.

An Unusual Mobile Antenna Mounting, by H. Selvidge, Radio, Feb. 1936, Pg. 64.

Construction details of the trick antenna used on the Cruft Laboratories mobile unit. Good idea for police mobile units.

POWER SUPPLIES

Design and Application of Power Transformers, by I. A. Mitchell, Comm. & Broadcast Eng., Mar. 1936, Pg. 13.

Valuable pointers on factors to be considered in selecting power transformers to guarantee broadcast dependability.

SPEECH INPUT

Class B and AB Audio Amplifiers, by G. Koehler, Electronics, Feb. 1936, Pg. 14.

Particularly good discussion of amplifier design, including approximate method of determining load resistance and power output.

Advanced Design of Class AB Amplifiers, by M. Apstein, Radio Engineering, Jan. 1936, Pg. 12.

Discussion of some of the problems met in the design of Class AB amplifiers, together with suggested solutions.

Balanced Amplifiers, Part I, by A. Preisman, Comm & Broadcast Eng., Feb. 1936, Pg. 12.

Balanced Amplifiers, Part II, by A. Preisman, Comm. & Broadcast Eng., Mar. 1936, Pg. 9.

A very complete consideration of push-pull audio amplifiers, with mathematical development and examples of graphical and experimental design methods.

Mixer Circuits, by L. W. Barnett, Comm. & Broadcast Eng., Jan. 1936, Pg. 7.

Extensive discussion of mixer circuits in general, with numerous detailed illustrations of typical circuits.

Output Transformer Response, by F. E. Terman and R. E. Ingebretsen, Electronics, Jan. 1936, Pg. 30.

Method for the determination of the frequency characteristic of a transformer when the leakage inductance, turn-ratio and resistance are known.

Loud Speaker Design, by F. Massa, Electronics, Feb., 1936, Pg. 20.

An authoritative development of the fundamental principles which determine the design and performance of loud speakers with finite and infinite baffles.

Considerations in Speech-Amplifier design, by R. O. Lund, and W. C. Howe, QST, Jan. 1936, Pg. 15.

Some practical considerations involved in the design and construction of high-gain speech amplifiers.

SYNCHRONIZATION

Present Practice in the Synchronous Operation of Broadcast Station as Exemplified by WBBM and KFAB, by L. M. Young, IRE Proc., Mar. 1936, Pg. 433.

Brief review of broadcast synchronization, experiments to date, with a description of the system presently in use at WBBM-KFAB.

TELEVISION

The Eiffel Tower Television Installation, by A. W. Cruse, Comm. & Broadcast Eng., Mar. 1936, Pg. 18.

Non-technical description of this Nipkow-disc installation. Simplified diagrams and photographs are included.

Scophony Television, Electronics, Mar. 1936, Pg. 30.

Details of a high-definition system, using the "split-focus" optical arrangement and the double-image Kerr cell. Diagrams and photographs.

The Electron Art, Electronics, Feb. 1936, Pg. 46.

Brief description of the television receivers recently made available by the Lorenz A-G and Telefunken Companies.

An Experimental Television Receiver Using a Cathode-Ray Tube, by M. Von Ardenne, IRE Proc., Mar. 1936, Pg. 409.

An extended description of the television receivers developed for the German television broadcasts. Diagrams and reproductions of the 180-line pictures received.

TRANSCRIPTION EQUIPMENT

"High-Fidelity" Transcription Equipment, by J. P. Taylor, Comm. & Broadcast Eng., Mar. 1936, Pg. 5.

A detailed description (with illustrations) of the RCA Type 70-A High-Quality Transcription Equipment.

High-Fidelity Instantaneous Recording, by G. J. Saliba, Comm. & Broadcast Eng., Jan. 1936, Pg. 11.

Description of an equipment for instantaneous recording on coated discs.

TRANSMITTER DESIGN

Graphical Harmonic Analysis, by J. A. Hutcheson, Jan. 1936, Pg. 16.

Description of a general, and very useful, graphical method of determining the amplitude of harmonics, including higher-orders, in the output of amplifiers and modulators.

Broadcast Transmitter Features, by J. P. Taylor, Electronics, Jan. 1936, Pg. 20.

General discussion of the trend in constructional design of broadcast transmitters. Good illustrations.

Alnico—A New Magnet Material, Radio Engineering, Feb. 1936, Pg. 20.

A short note on a new magnetic alloy which is capable of lifting sixty times its own weight.

Types of Distortion in Phone Transmitters, by D. J. Tucker, QST, Feb. 1936, Pg. 53.

Distortion effects discussed in simple terms, and illustrated with oscillographic diagrams.

Optimum Operating Conditions for Class B Radio-Frequency Amplifiers, by W. L. Everitt, IRE Proc., Feb. 1936, Pg. 305.

Theoretical analysis of efficiency and output of triodes as Class B amplifiers, with formulas for determining load impedances for maximum output.

Discussion on "Parasites and Instability in Radio Transmitters," by G. W. Fyler, IRE Proc., Feb. 1936, Pg. 328.

Further discussion of Mr. Fyler's interesting and valuable paper which appeared in the Sept. 1935 IRE Proc.

An Analysis of Distortion in Class B Audio Amplifiers, by T. McLean, IRE Proc., Mar. 1936, Pg. 487.

Some notes on harmonic generation in Class B audio amplifiers, with particular relation to the effect of driver regulation and other factors.

Plastics, by H. Chase, Mar. 1936, Pg. 10.

General discussion of properties of various plastic materials used in radio and electronic apparatus.

R-F Power Measurements, by G. F. Lampkin, Electronics, Feb. 1936, Pg. 30.

Discussion of methods of measuring the power output of radio transmitters.

The Class C Amplifier, by J. N. A. Hawkins, Radio, Feb. 1936, Pg. 58.

Discussion of the factors which determine the optimum output and efficiency of Class C amplifiers.

TUBES

New High-Frequency Tube, Comm. & Broadcast Eng., Feb. 1936, Pg. 9.

Characteristics and outline of the RCA-834, a three electrode tube for ultra-high-frequency applications.

The 307-A Power Pentode, by E. A. Veazie, Bell Labs Record, Jan. 1936, Pg. 150.

Description and characteristics of the WE Type 307-A power pentode.

A New Type of Gas-Filled Amplifier Tube, by J. D. LeVan and P. T. Weeks, IRE Proc., Feb. 1936, Pg. 180.

Description of the general features of a new type of gas-filled amplifier tube, with characteristics of some typical designs.

Deflection Control Tubes, by A. Hazeltine, Electronics, Mar. 1936, Pg. 14.

A resume of Prof. Hazeltine's IRE paper (Emporium Section) in which he made the proposal of applying electronic beams to general-purpose tubes.

Advances in Metal-Glass Seals, Radio Engineering, Mar. 1936, Pg. 14.

Short note on this interesting subject. Includes several illustrations.

Power Tube Manufacturing Problems, by L. L. McMaster, Jr., Radio Engineering, Mar. 1936, Pg. 11.

Brief discussion of some of the problems arising in the manufacture of power tubes.

Hydrogen Furnaces for Tube Parts, Radio Engineering, Mar. 1936, Pg. 6.

Interesting discussion, with illustrations, of the use of hydrogen furnaces in the manufacture of tube parts.

Time-Delay Circuits, by C. Felstead, Electronics, Mar. 1936, Pg. 38.

Some circuits for introducing a time-delay in the application of high voltage to the plates of mercury vapor rectifier tubes.

The "Plate Circuit Theorem," by W. Richter, Electronics, Mar. 1936, Pg. 19.

A new proof of this theorem in which the development is unusually simple and clear.

Tests to Insure Tube Quality, by H. F. Dart, Electronics, Feb. 1936, Pg. 32.

An authoritative discussion of the intangible factors which determine the uniformity and life of power tubes, and the tests necessary to insure power tube quality.

WIRED RADIO

Wired Radio, by M. Cummings, Radio News, Jan. 1936, Pg. 394.

A short non-technical note on the growing use of wired radio in restaurants, Hotels and night clubs.

MISCELLANEOUS

And now Science Meters the Radio Audience, by Prof. R. F. Elder, Broadcasting, Mar. 1, 1936, Pg. 7.

A non-technical resume of the use of the audimeter in radio surveys.

Art-Metal Finish, by P. E. Millington and R. Zaun, QST, Mar. 1936, Pg. 30.

Short description of a relatively easy method for the application and treatment of crackle enamel.

NEW RCA PRODUCTS

NEW RCA MODULATION MONITOR 66-B

This new RCA Modulation Monitor meets every requirement of the FCC—as to response, accuracy and stability. Added range, useful in taking amplitude characteristics; High impedance r-f Input Circuit, easily excited; Flasher as well as meter operates on either positive or negative peak of modulation; Low power excitation.

(Above)

RCA JUNIOR VELOCITY MICROPHONE
Type 74-A

This new RCA Junior Velocity Microphone—based on advanced principles of velocity actuation—offers great sensitivity, highly favorable directional characteristics and great naturalness of tone. Overall performance compares most favorably with the standard RCA ribbon-type velocity microphone, recognized as the leader in the broadcasting field.

(Above)

BEAT FREQUENCY OSCILLATOR
Type TMV-134

The RCA Beat Frequency Oscillator is ideal for any application requiring a source of A-C of frequencies ranging from 30 to 15,000 cycles per second. Small, light in weight, and highly accurate, this unit incorporates design features found in only the highest priced laboratory oscillators.

The use of four RCA Acorn type tubes greatly reduces space requirements and permits a more efficient component part arrangement. A neon lamp gives a quick means of checking the dial readings against the line frequency.

COLLAPSIBLE MICROPHONE STAND
59-A

This stand is made of aluminum tubing and strips. The sockets are also of aluminum with the exception of the pivot socket which is brass. The finish is dull statuary bronze. This type of construction makes the stand light and flexible. Length collapsed, 32½"; Extended, 60".

(Right)

RCA VICTOR MAGIC VOICE RADIO
Model 9-K-2 with the Magic Brain, Magic Eye and RCA Metal Tubes

A 9-tube, 5-band Superheterodyne, with the revolutionary new Magic Voice which eliminates "boom" from low notes and allows only the desired "controlled" notes to radiate into the room. Cabinet: A beautiful, precisely constructed console, veneered principally in heart walnut and center-matched butt walnut, with figured stripe Oriental wood veneer decorations. Height 41", width 27¼", depth 14½".

Notes About Our Contributors

BEN ADLER. Mr. Adler graduated from the Polytechnic Institute in Brooklyn. He joined the Phillips Petroleum Co. where he was engaged in geophysical research locating oil wells by means of portable sound equipment. In 1927 he entered the research department of the Radio Corporation of America at Van Cortlandt Park. In 1929 he became manager of the Southern District where he remained until his recent transfer to power tube sales at Camden.

R. V. BESHGATOOR. Mr. Beshgatoor, manager of RCA Victor, Argentina, was formerly with the radio division of General Electric Co. Following this he came to RCA where he was connected with the engineering department and later sales. In 1932 he took over the branch in Argentina.

JOSEPH D'AGOSTINO. Mr. D'Agostino first joined NBC in 1925, with the WJZ Studios, then located at 33 W. 42nd Street. Later he spent several years with the construction of WJZ, first high power broadcast station. He is now Technical Assistant, NBC.

RALPH H. HEACOCK. Mr. Heacock received his A. B. in C. E. from Swarthmore College in 1918. He became Ensign in the U. S. N. R. F. on submarine detachment. Later he was an Aeronautical Engineer, Naval Aircraft Factory, 1919-1922. Following his war experience he became Assistant Superintendent of Inspection, Victor Talking Machine Company, 1922-1929, Phonograph Section, Receiver Division, 1930-1932, Photophone Product Design since 1932.

EARL C. HULL. Mr. Hull, who contributes the interesting story about WKY, is chief engineer of the station.

VERNON D. LANDON. V. D. Landon attended Detroit Junior College In charge of radio frequency laboratories Westinghouse Electric 1923-1929. Assistant Chief Engineer R. F. L., Boonton, N. J. 1929-1931. Assistant chief Engineer Majestic-Grigsby Grunow, Chicago 1931-1933. Entered RCA Victor in 1933 in Receiver Section. A member of the Advanced Development Group, Receiver Division.

DAVID SARNOFF. Mr. Sarnoff, President of the Radio Corporation of America, entered the employ of the Marconi Wireless Company, in 1906, as office boy. Advancing rapidly, he became Commercial Manager and remained in this position until the absorption of the Marconi Company by the Radio Corporation of America in 1919. In 1922 he became Vice President and General Manager of RCA, and in 1930, President. Mr. Sarnoff has received decorations from many foreign governments for his work in advancing radio development.

JOHN P. TAYLOR. Mr. Taylor of the Transmitter Sales Department was graduated from Harvard. He was connected with the General Electric Company before becoming associated with the RCA Manufacturing Company. A writer of note on technical subjects himself, Mr. Taylor is particularly well qualified to conduct the column which will be a feature of Broadcast News in the future.

Frequency Measuring Service

The exacting requirements of the Federal Communications Commission covering frequency variation of any radio transmitter make imperative a close supervision of the frequency of its emitted energy.

Present day transmitters are stable and reliable when skillfully operated and maintained. However, occasional frequency drifts may occur and it becomes important to correct these before they assume a wide variation. Local checking equipment is of considerable value to this end but cannot be relied upon unless occasionally calibrated against standards of unquestioned accuracy. To meet this need the laboratories of the R. C. A. Communications, Inc., offer an unexcelled measuring service.

The equipment of these laboratories comprises a number of receivers specially constructed to enable comparison of the radio frequency of the signal to be measured, with accurately known frequencies developed in the laboratories. These latter are derived from either of two elaborate 100 kc. quartz crystal standard oscillators, which are operated under constant temperature, air pressure and humidity to ensure extreme constancy. The standard oscillators drive electric clocks through two 10 to 1 frequency subdividers and these clocks are checked daily to within a few hundredths of a second against standard time signals of the U. S. Naval Observatory transmitted by the government radio stations at Annapolis, Md., and Arlington, Va.

Check measurements are made regularly on the standard frequency transmissions of U. S. Bureau of Standards Station WWV, operating on 5000 kc., which are certified by the Bureau as accurate within 1 cycle (in 5,000,000). Measurements on these transmissions show an average deviation of less than 2 cycles from 5,000,000, an accuracy approximately 100 times greater than that required by broadcasting transmitters themselves.

Periodic measurement by an independent, impartial source have a distinct value, because they supply extremely accurate frequency checks and also set up a performance record which often proved of great advantage. There is no better means available for calibrating a nation's local checking equipment than the service offered by R. C. A. Communications, Inc.

Many broadcasting, police and commercial stations throughout the United States rely with confidence upon this RCA service and call on it in emergencies for measurements to aid in adjusting their crystal controls and calibrating their monitors.

For Routine Service Apply at the Nearer Office

Commercial Department
New York, N. Y.
66 Broad Street.
Phone: HAnover 2-1811.

San Francisco, Calif.
28 Geary Street.
Phone: Garfield 4200.

For Special Service Apply at the Nearer Laboratory
(Open Day and Night)

Riverhead, N. Y.
Phone: Riverhead 2290.
W. U. Telegraph only: R. C. A. Com., Inc.
Riverhead, New York.

Point Reyes, Calif.
Phone: Inverness 9-W.
W. U. Telegraph only: R. C. A. Com., Inc.
Point Reyes Station, Marin Co., Calif.

An Invitation . . .

You are cordially invited to visit our display rooms, suite 505-A, Stevens Hotel, Chicago, during the N.A.B. Convention, July 6, 7 and 8.