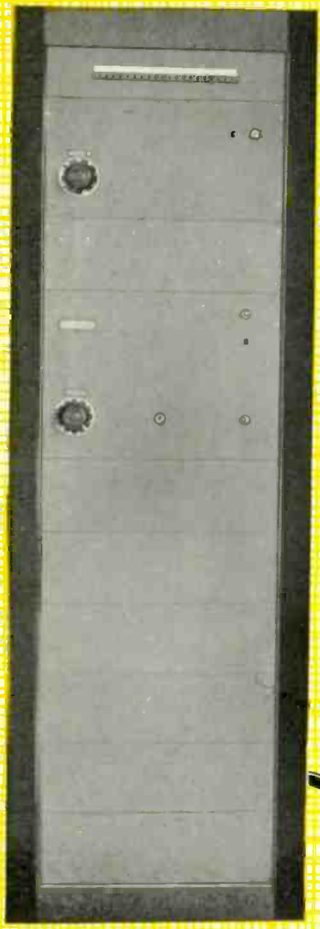
COMMUNICATION & BROADCAST ENGINEERING

JULY 1937



The Gates Studio'er

The Studio'er is a complete high fidelity broadcast speech input system incorporating separate control cabinet, talk back and extreme flexibility. The price is actually lower than less complete console equipments.

(Fully described in Bulletin 82)

Manufactured by

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COMMUNICATION & BROADCAST ENGINEERING

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RAY D. RETTENMEYER
Editor

F. WALEN
Associate Editor

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Broadcast Transmission • Recording • Sound Projection • Television • Facsimile • Aeronautical Radio • Police Radio • Marine Radio • Carrier Transmission • Beam Transmission • Radio Telegraphy • Radio Telephony

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Cover Illustration: An infra-red photograph showing part of RCA's antenna system at Rocky Point, Long Island. Notice that the foliage of the scrub oak appears white, while the foliage of the scrub pine is dark. (See article on page 5.)

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Circulation Manager

Chicago Office—608 S. Dearborn St.—C. O. Stimpson, Mgr.
Telephone: Wabash 1903.

Cleveland Office—10515 Wilbur Ave.—J. C. Munn, Mgr.
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EDITORIAL

ATTENTION, SUBSCRIBERS

EFFECTIVE August 1, 1937, COMMUNICATION AND BROADCAST ENGINEERING will no longer employ subscription salesmen. After that date all subscriptions should be mailed to the publisher. We have adopted this policy in order to protect our subscribers against unauthorized solicitors. Details of this change in policy will be found on page 25.

NAB CONVENTION

THE ATTENDANCE at the Fifteenth Annual Convention of the National Association of Broadcasters, which was held at the Hotel Sherman, Chicago, on June 20, 21, 22, and 23, set an all-time record. The gathering was outstanding as well in the large number of localities represented and the enthusiasm displayed on every hand. For those who were unable to attend, a report of the meeting appears in this issue.

However, on looking back at the convention, we were rather surprised at the small number of broadcast equipment manufacturers represented. There is certainly no lack of interest on the part of the broadcasters, and from all reports the organizations present at this gathering of NAB members were well rewarded for their time and efforts. It seems to us that a good many manufacturers of broadcast equipments are overlooking an excellent opportunity . . . after all, the NAB convention is the biggest gathering of broadcasting executives during the year.

BROADCAST REGULATIONS

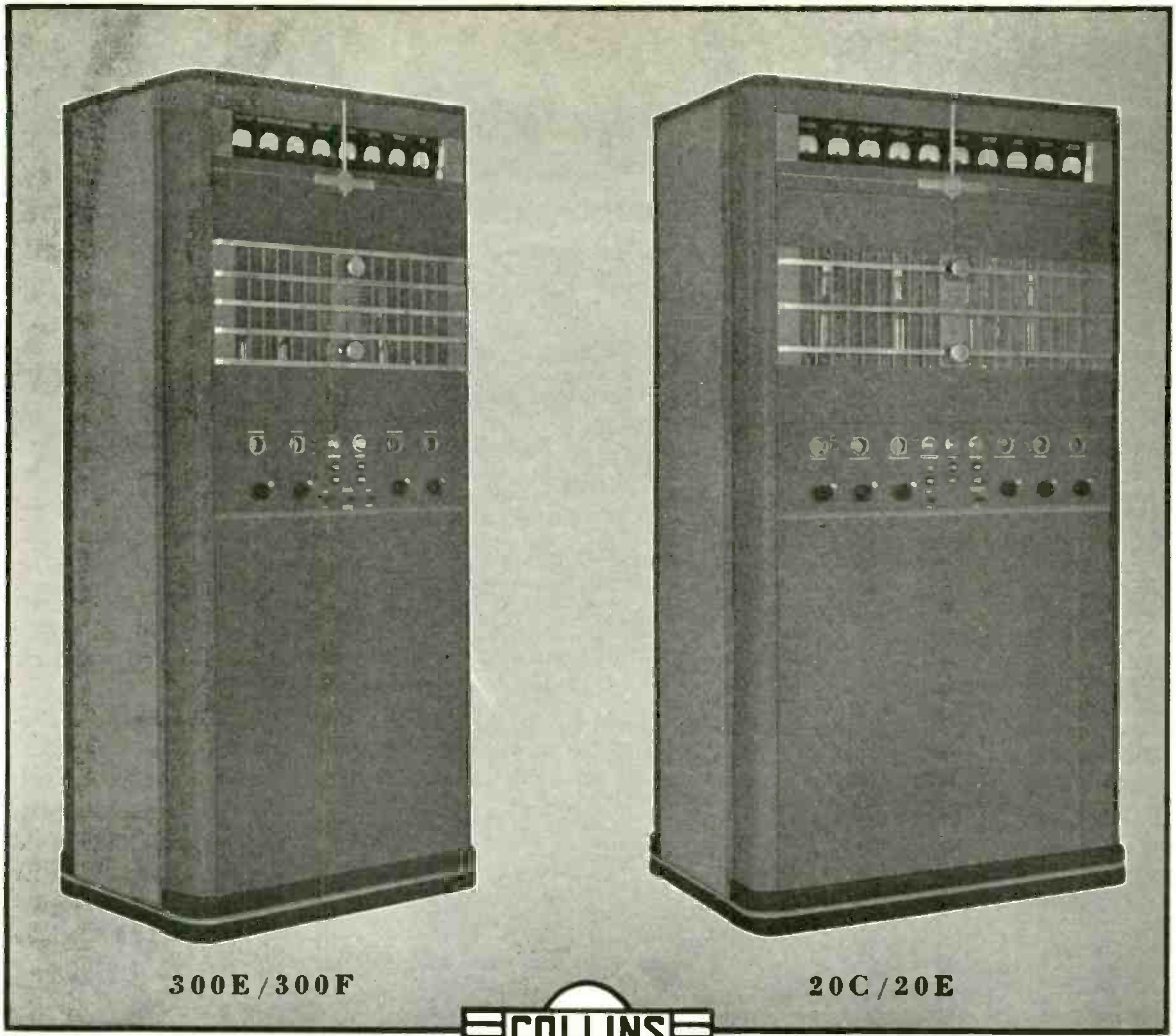
IN ADDRESSING the Fifteenth Annual Convention of the National Association of Broadcasters, Judge Eugene O. Sykes, chairman of the Broadcast Division, Federal Communications Commission, made the following statements which we feel should be of interest to all:

"Last September 15th, the Broadcast Division promulgated regulations governing all classes of broadcast stations except the regular stations with which we are all familiar. It may surprise you to learn that of the 1108 broadcast stations licensed by the Broadcast Division, 408 are other than regular broadcast stations. Of this number, by far the greatest number are relay stations used in transmitting programs from points where wire facilities are not available. On June 15th, the Broadcast Division repealed the rule requiring two-day notice for the operation of relay stations. This requirement had been imposed so that the Commission could authorize operation that would not cause interference on the then very limited number of frequencies, but now more frequencies are available and this provision is not considered necessary. It is believed that the repeal of this rule will be to the advantage of broadcasters in building special-event programs.

"Two other classes of stations governed by these regulations are television and facsimile stations. The new regulations made available three frequencies exclusively for facsimile stations, and carry a provision that such stations may be licensed on any of the several experimental frequencies. The new rules also provide that facsimile broadcasting can be carried on after midnight on regular broadcast stations, under the condition that a program of development of facsimile broadcasting is presented to warrant such operation. The Broadcast Division is very interested to know whether the general public wants a facsimile broadcast service and if such a service can be supplied at this time.

"International broadcast stations, of which there are only a few—twelve in number—occupy a unique position in the broadcast structure in that the signals from these stations are transmitted throughout the world. By selecting proper frequencies and employing directional antennas, it is possible to render service in practically any foreign country. While the government has authorized the operation of this class of stations since 1925, in the last several years there has not been a general expansion either in technical advancements or international program service by the licensees of these stations. In the past two years other countries of the world have developed this service which has resulted in stations in European countries rendering better service in South American countries than is received from the United States stations."

An engineer is a man trained to base intelligent guesses on insufficient data. . . .Bassett Jones



COLLINS

COLLINS 20/300 SERIES BROADCAST TRANSMITTERS FOR POWERS OF 100 TO 1000 WATTS

The owner of a broadcast station is interested in one quality above all others in his transmitting equipment, and that is its ability to stay on the air. Uninterrupted service day after day and year after year means more to him in dollars and cents than any other feature of his technical plant. The Collins Radio Company has considered this fact of utmost importance in building the 20/300 Series Broadcast Transmitters. Over a period of years it has followed their operation in the field and has overlooked no opportunity to build in greater dependability. The record of field service of the 20/300 Series Transmitters is remarkable. The Collins transmitters of this series have a combined field operating time totaling nearly half a million hours and the number of component failures in service have been so few as to be practically nil.

COLLINS RADIO COMPANY

CEDAR RAPIDS IOWA

COMMUNICATION & BROADCAST ENGINEERING

FOR JULY, 1937

A 300-KW GRID-CONTROLLED RECTIFIER

By J. M. WILLEMS
Field Engineer
WESTINGHOUSE ELEC. & MFG. CO.

HIGH D-C VOLTAGE single section power rectifiers are relatively new, and one of the most interesting has been placed in operation at Rocky Point, Long Island, RCA Communications Transmitting Center, for supplying plate voltage from 8000 to 20,000 volts d-c to high-power tubes for transmitting commercial messages to various parts of the world.

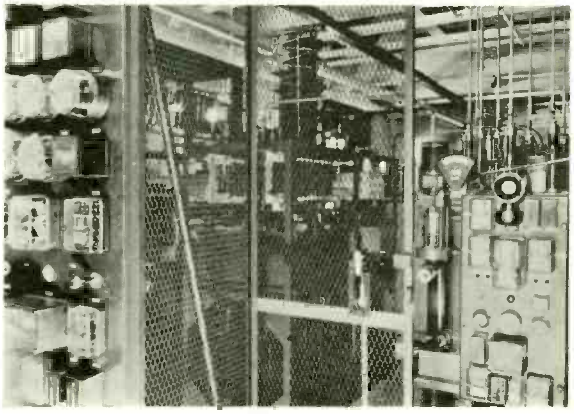
The rectifier section utilizes 12 primary anodes, 12 associated grid-control anodes, 3 excitation and 1 ignition anode. The bottom of the section, insulated from the tank, forms the cathode. On the front is the mercury-vapor pump, interstage reservoir, rotary oil-sealed vacuum pump, hand valve for closing or opening the vacuum pumping connection, McLeod gauge, hot-wire gauge for indication of vacuum pressure and the instrument panel with control relays.

On the rectifier iron frame work other auxiliaries are mounted consisting of phase-shifter equipment, excitation and negative-bias rectox rectifiers with respective transformer units, capacitors, control-grid resistors and transformers, including an assembly of motor-driven pump with radiator and fan.

Power is delivered by an indoor 317-kva water-cooled transformer connected through disconnects and oil switch to a 2300-volt, 3-phase, 60-cycle line. The primary windings constitute two sections, one delta and one star. The voltage on both can be varied through selection of taps operated by motor mechanism. Ten tap positions, each varying the secondary voltage in steps from 6,710 up to 15,620 volts, are indicated by lights on the operator's control panel. The secondary windings are two 6-phase star sections with neutrals connected to an interphase transformer winding. The midpoint of the transformer serves as return or negative power connection. The two groups of 6-phase secondary leads, forming a 12-phase group, are the 12 high-tension leads connected directly to the 12 primary anodes on the rectifier.

ANODE CONTROL

The associated grid-control anodes receive their energy from the secondary of a 15-kva, 2300/230 volt auxiliary transformer through a 20,000-volt insulating transformer with 230/230-volt ratio, an induction-type phase shifter and two low-capacity grid transformers. These two transformers have 12-phase secondary groupings similar to the main power transformer. During rectifier operation both primary and grid anodes are in exact phase relation to secure maximum d-c output voltages. In starting the grid anodes are out of phase with the primary anodes resulting in minimum d-c rectifier voltages.



SHOWING 300-KW, 20,000-VOLT RECTIFIER PANEL AT RIGHT, CONTROL RELAYS AT LEFT, AND INTERMEDIATE RECTIFIERS FOR 200-KW TRANSMITTER IN CENTER BACKGROUND.

THE MAIN TRANSMITTER BUILDING AT ROCKY POINT, LONG ISLAND. NOTICE THE LONG-WAVE AND SHORT-WAVE ANTENNA ARRAYS. (SEE COVER ILLUSTRATION.)

Photos courtesy RCA.

This range, providing for a gradual rise in d-c rectifier voltage, is secured by turning the rotor of the phase shifter between two stop arms. Torque is supplied by a small d-c motor, gear-reduction unit and a magnetic clutch. The rotor is held against the stop arm in the "in phase" position by a magnetic brake. Return to the original or maximum delay position is accomplished by release of brake and spring device on the rotor.

The three excitation anodes on the rectifier remain energized during the period of rectifier operation. They provide sufficient current flow for maintaining d-c voltage on the rectifier without load and permit immediate pickup on application of load. Three single-phase low-capacity transformers are used for the purpose, forming in themselves a separate three-phase rectifier.

The firing of the three excitation anodes is initiated by a cathode spot or arc, started through the action of the ignition anode in the center of the rectifier cover plate. A single-phase full-wave rectox rectifier provides the energy. In principle a metal rod is plunged into the cathode mercury pool and retrieved at the instant of contact, drawing an arc. The establishment of this arc is sufficient for pickup of the excitation anodes. With current flowing in the excitation anode circuits, a relay acts to de-energize the primary of the ignition rectox transformer.

VACUUM SYSTEM

In operation the inside non-condensing gases are kept close to 1 micron, which, compared with atmospheric pressure, is 1/760,000th or 0.001 millimeter column of mercury. This high vacuum is maintained at all times by the combined action of a three-stage diffusion-type water-cooled mercury-vapor pump and a rotary oil-sealed vacuum pump. Interposed between the two pumps is an interstage reservoir designed to meet requirements for keeping the two pumping systems in order and to protect against admission of air into the vacuum system in the event of failure.

Vacuum conditions of the section are readily checked and verified through an indicating instrument on the control panel and the McLeod gauge on the rectifier. The indicating instrument is graduated in microns and forms part of the hot-wire vacuum gauge mounted on the rectifier. Composing circuits constitute a Wheatstone bridge affected by temperature variations of a filament in a bulb subjected to gases in the rectifier. In the event of changing gas pressures the resistance of the filament varies, causing a corresponding change in micron indication. Included in the circuit is a contact-making device set to operate an alarm when the micron pressure reaches a value considered unsafe for rectifier operation.

The McLeod gauge is connected with a steel tube to the rectifier section allowing equalization of gas pressures. By a method of compression, the gas in the gauge is trapped and by comparison of respective levels of mercury in glass tubes, the pressure can be read directly in microns on a scale graduated and calibrated in accordance with Boyle's law for perfect gases.

ARC BACKS

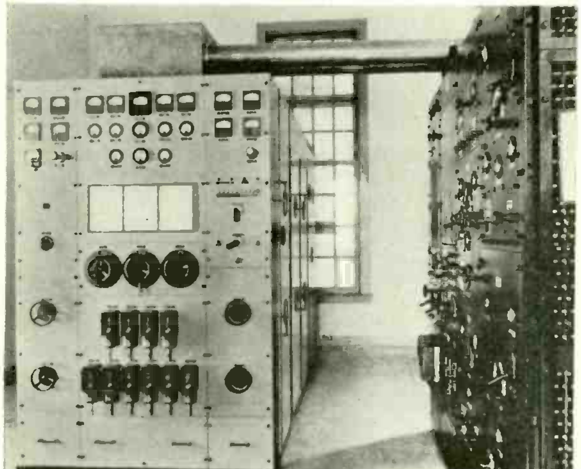
Protection against overloads and arc backs is furnished by respective d-c and a-c devices. They are designed to operate independently under an extremely short time constant. The power output of the rectifier is interrupted for only a short interval of time, or until the fault is removed, and the rectifier is then restored to normal operation.

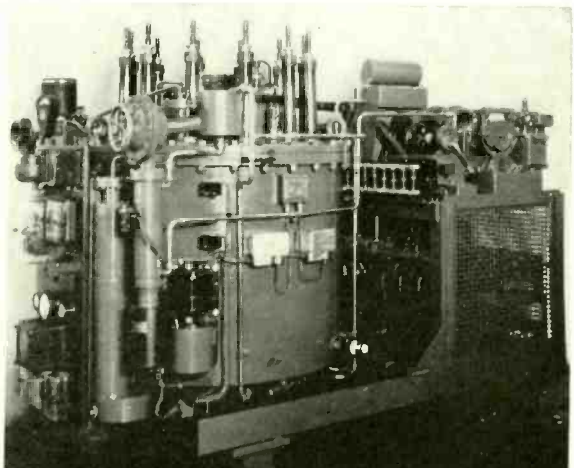
Operating temperature is controlled by thermal devices acting within certain limits. When too low, a condition of rarified vapor densities exist affecting conduction of current and before the rectifier can be started temperatures are raised by a heater system on the rectifier. When the temperatures are within the desired limits, it consists of a cooling system circulating water through the various jackets and annular coolers of the rectifier. The cooling system comprises a motor-driven pump, radiator and fan mounted as one assembly on the iron frame work of the rectifier. The radiator and fan serve as a water to air heat exchanger, dissipating the losses in the rectifier and the mercury-vapor pump.

•

DEPENDABILITY RECORD

EMPHASIZING the extensive use now made in transport aviation of radiotelephone communication between airplanes in flight and the ground stations along the route, the report of James G. Flynn, superintendent of communications for American Airlines, Inc., for the six months period ended April 30, 1937, shows that during the period 150,251 "contacts" or telephone conversations between the pilots and the ground stations of American Airlines, Inc., were completed. During each day of this period an average of 800 messages were delivered by the ground stations to pilots in flight or were received by the ground stations from the airplane pilot. Messages included weather reports, traffic-control orders, wind conditions, routing instructions and the many other reports which contribute to safe operation of aircraft.


THE 200-KW SHORT-WAVE TELEGRAPH TRANSMITTER AT ROCKY POINT.


CLOSE UP OF 300-KW, 20,000-VOLT D-C MERCURY-ARC RECTIFIER.

SNOW STATIC EFFECTS ON AIRCRAFT

Condensed from a report on UAL's study of the problem as it affects radio reception. The original report was presented before meetings of the Institute of Aeronautical Sciences and American Association for the Advancement of Science at Denver, Colorado, June 22.

By H. M. HUCKE
Superintendent
Communications Laboratory
UNITED AIR LINES

TWO TYPES of atmospheric static interference are normally experienced in aircraft reception. The first type consists of short, intermittent crashes which result from lightning flashes. The second type is peculiar to air transportation in that it is normally only experienced on aircraft when they attain speeds exceeding 100 miles per hour. This type of static is classified under the general heading of "snow static," although the identical effects are experienced in ice crystals, rain, hail, snow, and dust storms. Normally, it is only experienced while flying through clouds containing moisture or dust particles and is usually recognized as a combination of noises containing frying sounds, intermittent or regular crackling, and a characteristic musical "crying" during which the noises run up and down the audible musical scale. In thunder storms and line squall conditions, the phenomena of "snow static" has been experienced at ground stations when the wind was of sufficient velocity to blow the water or dust particles past the ground station antennas so rapidly as to simulate the effect of speed in aircraft flight.

Snow static was first recognized as such about the time radio equipment was first installed on commercial air transports in 1929. Its effects were not serious since most flying at that time was done by contact observation of the ground and not by instruments and radio, coupled with the fact that aircraft cruising speeds were relatively slow. As instrument flying came into vogue along about 1933, along with faster planes, the reliance placed upon radio beacon reception increased and the effects of all static were more generally recognized.

In November, 1936, United Air Lines began assembling equipment and personnel to make a thorough study of the subject. This culminated in an expedition for snow static investigation which got under way last February and has been actively pursuing the problem to date.

Work was carried on in a standard 10-passenger, 2-motored, all-metal Boeing transport equipped with work benches, electrometers, oscillograph, recording meters, and special radio sets and antennas. The plane personnel consisted of: A. C. Ball, Special United Test Pilot; R. R. Brunner, Engineer, Bendix Radio Corp.; H. W. DeWeese, Engineer, UAL Communications Lab.; Prof. R. H. George, Purdue University; H. M. Hucke, UAL Communications Engineer-in-Charge; N. E. Klein, Engineer, UAL Communications Lab.; Dr. A. A. Knowlton, Reed College, Portland, Oregon; Howard Morrison, Aviation Section, Bell Telephone Labs.; Dr. Marcus O'Day, Reed College, Portland, Oregon; L. W. Raymond, UAL Division Meteorologist; Prof. E. C. Starr, Oregon State College.

The material which follows represents a resume of our notes to date. While many phases of the investigation are incomplete we feel that the information which has been gathered will be of material assistance.

PILOT BALL AND H. M. HUCKE EXAMINING ANTENNAS ON THE "FLYING LABORATORY."

The problem was attacked simultaneously on three general fronts to determine, first, the meteorological aspects of static formation and its avoidance; second, the static generating effect of the plane and its reduction; third, the value of special antennas in reducing the interference.

METEOROLOGICAL ASPECTS

We can assume that the earth is a huge ball floating in free space. As such it gathers an electric charge which is stored in the atmosphere which surrounds it. The charge near the surface is normally about 35 volts per foot of altitude. This tapers off as the atmosphere becomes thinner with altitude until at 20,000 feet it is about 15 volts per foot. The total voltage between the earth and the outermost reaches of the atmosphere has been estimated at about 1,000,000 volts.

As long as this charged atmosphere remains evenly distributed, a plane may fly through it without suffering from static interference. After taking off it rises slowly enough to allow the charge on it gradually to build up until at 20,000 feet it would be charged to about 300,000 volts with respect to earth. It would be charged at zero volts with respect to the atmosphere immediately surrounding it.

The air surrounding the earth is not normally in equilibrium due to the action of the sun. The sun's rays heat portions of it unequally and cause it to rise. As it rises, the electro-static field becomes distorted, but under average conditions readjusts itself and retains a reasonable equilibrium. The rising air, however, brings up moisture which condenses to fog and forms clouds.

If the fog forms slowly the electrostatic charges on particles retains a reasonable distribution. If it forms rapidly due to turbulent air currents, the water droplets are churned about. Since the electro-static charges remain on the droplets, they are also churned about and the cloud becomes unstable electro-statically. Lightning will occur if sufficient electro-static instability results, thus forming the usual thunderstorm.

When water droplets are carried about by the wind in a cloud they are usually split up into larger and smaller units. Tests indicate that the large droplet is usually positive while the fine spray which is separated from it by the wind is usually charged negatively. There is considerable question as to whether the mechanical action of splitting the droplets produces the difference in electric charge or whether the difference in charge results from the fact that the fine spray usually is carried upward while the heavier droplets are carried downward. If the charge is due to the different mechanical position of the two types of droplets, it would seem that their position with respect to the earth's electro-static field could produce a difference in charge. There is good possibility that differently charged droplets result from the combined action of the several theories rather than by any one single method.

The general theory of thunderstorm formation has been described by Simpson in England and gives a good picture of the situation and may be obtained from any standard text on meteorology.*

*Humphries' "Physics of the Air."

Actually, the cloud is the result of rising air entering a cooler portion of the earth's atmosphere. Considerable turbulence results in the rising portion of the cloud and water particles are often carried upward and fall back into the rising current a number of times. If the churning action goes on for a sufficient length of time the water droplets may be built up into large size hailstones. When their weight becomes great enough so that the rising air can no longer support them, they fall out of the cloud as hail or rain. This churning action produces a turbulent distribution of electric charges on the droplets in the clouds. If we were to fly through such a cloud we should theoretically record a gradual change from positive to negative as the charged areas are passed.

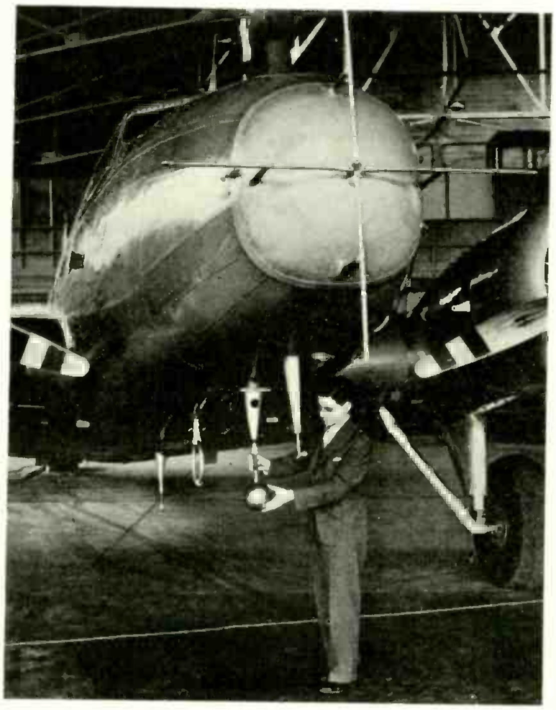
Actually the theoretical Simpson cloud never exists in nature. In the course of our work we flew through and recorded the voltages in about fifty clouds. Some clouds were entered in a number of different directions and at different altitudes. Of interest is the fact that the distribution of charged droplets in a cloud is vastly more random than the theoretical Simpson cloud indicates. Our flights indicate that the interior of a cloud is in constant motion and consequently the charged droplets are undergoing continuous change of position. The flight tests further indicated that if any comparison of antennas is to be of value it must be made by having the antenna on the same plane and switching from one antenna to another in a second or less. Such switching back and forth between two antennas must be repeated many times before comparisons can be trusted. We obtained most useful results in the larger clouds.

From a meteorological standpoint there are roughly two types of clouds in which static will be formed. The first is the simple thundercloud formed by the rising of moisture on a hot summer day. The second is formed by two air masses of different temperatures coming together and forminig an air mass "front." Either type varies widely in the amount of turbulence and lightning does not necessarily result in every case. Even though lightning does not occur, the turbulent mixture of plus and minus charged snow, rain, or ice particles is present.

The warm air type of thundercloud usually reaches its maximum early in the afternoon and begins to subside as the sun goes down. The cloud generally begins to spread out in the evening and the updrafts are less violent. When in this condition it is satisfactory for flying and will give good snow static areas for test purposes. The static usually disappears before midnight.

The "front" type of clouds persist on through the night and will show static areas at practically any time. In winter, the "fronts" cover areas hundreds of miles long and are most troublesome from a radio flying standpoint. Summer thunderstorms may be avoided by flying around them but this is impractical for the winter air mass fronts. In mountainous country air mass movements are usually broken up into secondary turbulent areas over the crests of the mountain ranges. These turbulent areas also usually contain charged moisture particles.

Whenever the line of the air mass front lies at right angles to the line of flight the static area is traversed in a short time. When the front is parallel to the line of flight the plane may be in the static area for several hours. This is the condition which constitutes the greatest hazard to radio navigation. Since the air mass front is usually not perpendicular to the face of the earth but lies in a horizontal plane like a thin slice of cake, it is possible to avoid the static area by changing altitude. This is a problem in which our meteorologists can advise the pilot and thus assist him in remaining in static free areas. Considerable data must be gathered before consistent predictions of static areas can be made.



H. M. HUCKE WITH THE FLYING LABORATORY. NOTE THE ANTENNA INSTALLED ON THE NOSE OF THE PLANE.

STATIC GENERATION ON PLANE

If a plane slowly climbs up through a cloud in which the charged droplets are uniformly distributed and in electro-static equilibrium no snow static disturbance is heard in radio. As it climbs, however, it must rise from an area of one charge to an area of greater charge with respect to the earth. The plane is, in effect, a large metal body which may have on its surface an electro-static charge in the same manner as the earth has a charge. The charge in the atmosphere immediately around the plane must, therefore, gradually increase as it climbs upward and decrease when it glides downward.

With a sharp two-foot steel point projecting from the rear of the plane discharges up to 10 or 15 microamperes have been measured while ascending or descending through charged fog particles. No static was heard in this condition. As long as the charging and discharging of the plane does not exceed a certain rate no static is heard. Since there must be a difference of potentials between the plane and surrounding atmosphere before discharge can take place, it is apparent that the plane must exceed a certain potential before static is heard.

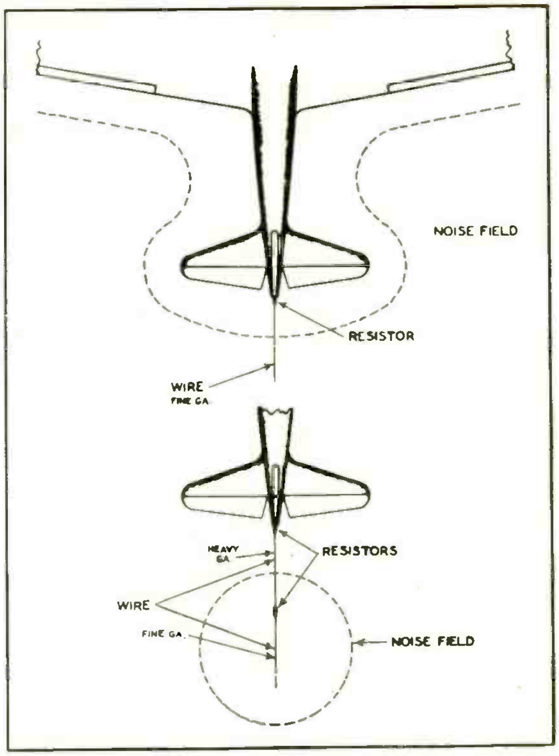
In such a condition the 40-foot short-wave antenna on top of the plane gave no noticeable static in the short-wave receiver until a continuous current flow of 2 microamperes was exceeded. The receiver had a one-half megohm resistor across the antenna input through which this current flowed. The d-c voltage drop across this resistor was therefore one volt but the ripple superimposed on this d-c voltage must have been only a few microvolts if it was of a random nature. Thus the noise in the receiver is caused by the random variation of the discharge flow rather than the total discharge.

Whenever the discharge from the steel point or antenna exceeded a certain rather broad maximum, the characteristic snow static sounds were heard in the radio.

A series of points were installed on the plane to learn the distribution of this discharge. These were arranged on the nose, tail, each wing, behind the exhaust outlet, behind the propeller, and at four points along the plane belly. The points were connected in a number of group arrangements to vacuum-tube electrometers. The electrometers were in turn connected to paper recorders. Recordings were made in a variety of cloud formations over a period of eight weeks.

A grouping of these points suggested by Professor Starr gave the most orderly results. This group consisted of a pointed 2-foot rod in the disturbed air at the tail, a pointed 2-foot rod on the nose projecting into the undisturbed air ahead of the plane and a plate on the nose to record the impacting water particles.

ILLUSTRATING THE FIELD PATTERN OF THE NOISE.



A study of our data on all the points has resulted in the following conclusions: (1) that the plane may be either positive or negative with respect to the surrounding cloud; (2) that at any instant one wing may be in positive cloud particles while the other is in negative; (3) that at any instant the nose of the plane may be in positive particles while the tail is in negative or vice versa.

The maximum cross-flow measured from wing to wing was about 500 microamperes though undoubtedly larger flows are possible. The maximum would constitute a stroke of lightning. There are many records of lightning strikes on all-metal planes which indicate wing to wing flows of several thousand amperes. During our flights we encountered one condition in a thundercloud in which the plane's magnetic compass moved 10 degrees with respect to the gyro-compass for a period of several minutes. This may have been due to a strong magnetic field in the cloud or to a cross flow of current in the plane structure. Ground tests indicated that a wing to wing flow of about 45 d-c amperes was required to produce the same compass deviation. A nose-to-tail current of 125 amperes produced the same effect. This would vary with the position of the plane with respect to the earth's magnetic field.

It is known that a negatively charged point will go into corona about 50 percent more readily than a positively charged point. It is also known that the action of the propeller in cutting up water particles at a top speed of 800 feet per second will produce an electric charge. It is reasonable to believe that the wing of a plane moving at 260 feet per second will break up water particles and produce a charge. The electric charge recordings are, therefore, the summation of at least 6 variables: (1) the plus or minus charges of the water particles in the cloud which are collected by the wing foil; (2) the generation of charge due to the wing sections splitting water particles; (3) the generation of charge due to the propeller splitting water particles; (4) foreign matter in the water particles (Portland, Oregon, tap water split by the rotating propeller gives a positive charge while Cheyenne, Wyoming, tap water gives a negative charge); (5) the rectification action of the test points with different polarity of the plane charge; (6) cross current flows due to the plane short circuiting sections of cloud having different potentials.

From the above it is obvious that the mechanism by which the plane gathers an electro-static charge is quite complex. Rather than spend valuable flight time trying to reach an orderly conclusion from this group of variables, it was believed best to proceed on to possible solution. In any case, it appeared probable that whether the plane became plus or minus it eventually reached a sufficiently high potential for corona discharges to appear on wing tips or any sharp projecting points. As a check on this assumption a cathode oscillograph connected to any of the test points gave typical corona discharge tracings whenever the characteristic sounds were heard in the radio.

The plane was charged up by a small Wimshurst machine while standing on the ground and by bringing a pointed ground wire near its structure, the characteristic snow static sounds could be duplicated. Since this experiment was limited by the installation of the rubber tires, the a-c modulation of the Wimshurst disk and the general variability of such a generator, a more substantial arrangement was desirable. Through the courtesy of the Westinghouse Company and Stanford University, we were able to borrow high-voltage insulators and assemble a 100,000-volt d-c ray power supply. The plane was set up on these insulators in a large metal hangar and charged up to either plus or minus 100,000 volts. With this arrangement engineers could remain inside the all-metal plane with all radio equipment operating and use the test equipment in the same manner as was possible in flight. The tests further substantiated the corona discharge theory. The power was sufficient to make the anti-static loops and regular antennas inoperative in the same general ratio as had been observed on the test flights. The characteristic snow static sounds were present.

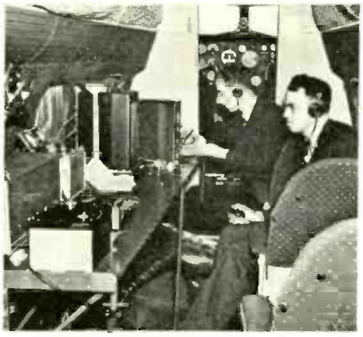
Static noise in the receivers with regular antennas began as low as 30,000 volts, depending upon local humidity and the proximity of the artificial ground plane to the various points on the plane. The "crying" snow static sounds usually began at about 55,000 volts and occurred more readily when the plane was positive with respect to ground. This crying phenomena was readily traced to a corona discharge from some point on the plane. Artificial points were set up for its study and we concluded that the space charge in the ionized air around the point breaks down at an audio-frequency rate. This rate varies with the amount of moisture in the air and the voltage gradient at the point. Under controlled conditions it will produce any audio-frequency note.

At any one time it will be possible for a number of points to produce this musical corona in any order. This, then, is the cause of the characteristic snow static sound.

A study of the plane structure indicates that antenna masts, rivet heads, cotter keys, on aileron hinges and tail wheels, the antennas themselves and any sharp points on the plane are the focal points of the corona discharges and consequently the source of snow static radio interference while in flight.

Unless these discharge points are quieted snow static cannot be eliminated. Covering them with an insulator, reducing their sharpness, or covering them with a well-rounded corona shield will only allow the plane to build up to a still higher potential until some other point starts corona.

A study of the noise indicates that it has a very short wavelength and that its attenuation with distance is rapid. The field pattern caused by a point in the corona at the rear of the airplane is shown in an accompanying diagram. Note how the area of interference production is continuous with the trailing edges of the airplane. When a resistor was added in series with the point the interference was materially reduced by a change in the noise field pattern to a



N. E. KLEIN (LEFT) AND H. W. DE WEESE MAKING TESTS IN THE PLANE.

location in the rear of the airplane and comparatively isolated from it, as illustrated in the lower portion of the diagram. Curves run on resistors indicate that at least 100,000 ohms and in some cases up to 10 megohms are necessary. Moving the point away from the plane takes advantage of the rapid attenuation and gives a better pattern.

This indicated that a trailing discharging point as far as possible behind the plane with suitable suppressor resistors had possibilities for discharging the plane. Up to 1-milliampere discharge at 50 feet could be obtained with 100,000 volts without disturbance in the radio using the regular antenna. A 25-microampere discharge from a point without suppressors two feet from the plane prevented radio reception. Since the mechanical troubles of a trailing wire are not desirable a second version of this idea was tried. Here a series of 17 three-foot, three-thousands inch diameter wires having a 5-megohm resistor in each was attached to suitable points on the wing and tail surfaces. Test flights of these dischargers are still in progress. Results in the air have verified the test made on the ground. The single trailing wire appears superior to the individual short wires though tests are not yet conclusive. The dischargers are still considerably short of a commercial cure and to date will only clear up radio range reception in about 15 percent of the conditions encountered. Apparently the rate of discharge is not yet fast enough when the plane enters areas where the water particles have too high a potential. Although this system is not yet commercially practical, we feel that it is the first step on the road to a final solution.

Our antenna tests indicate that snow-static interference is considerably worse at the rear than at the front of a plane. When the snow-static noise was of average strength, the loop located in the tear drop housing and the loop on the belly were both rotated and indicated that the source of maximum disturbance was toward the rear of the plane. When the static became extreme, rotating the loops indicated static in all directions. Probably corona had started on the wing tips and propellers in conditions of severe static.

In mild snow-static when beacon reception on the "V" antenna was normal, the two rear beacon antennas were so noisy that no beacon reception was possible. The vertical rear antenna had a 25 to 1 better signal pickup due to polarization of the range signals, but the snow-static pickup was about the same on either. Both rear beacon antennas were about the same length and spacing from the fuselage. We concluded that the snow-static interference radiation was not normally polarized.

Although the 40′ top antenna was far superior to the lower "V" antenna from a signal pickup standpoint; in snow-static the "V" antenna would pick up 5000-kc short-wave stations 1000 miles away when they were unreadable on the top antenna.

Although we did not test a trailing wire as an antenna, we did conclude from our study that it should be about the worst form of antenna for reception in snow-static. It would carry as high as 2 milliamperes of discharge current in vigorous "warm front" conditions. The static leak connected across the input of the average receiver is about ½ megohm; with a 2-milliampere peak current the voltage drop across the antenna input circuit of the receiver could be 1000 volts. The noise modulation on this d-c voltage would be less than 1%, or only a few volts of random a-c.

During the tests we reeled out 150′ of steel No. 14 B & S stranded aircraft cable. It had no resistance sup-

(*Continued on page 28*)

NOTES ON THE NAB CONVENTION

THE FIFTEENTH Annual Convention of the National Association of Broadcasters was held on June 20, 21, 22 and 23 at the Sherman Hotel in Chicago, Illinois. As predicted in our June editorial, this was the largest and most successful gathering in the history of the organization. There were 568 registrations at this meeting compared to 549 last year.

The convention opened with an address of welcome to the members by Mayor Edward J. Kelly of Chicago, while President Charles Myers and General Manager James W. Baldwin began the business session with discussions of the progress of the association and its work during the past year. Baldwin explained the new NAB electrical transcriptions library which the association has developed to combat ASCAP and other musical licensing pools. Eighty sixteen-inch records constituting twenty hours of music are offered to NAB members and will be available for reproduction on the air without further releases as "public domain music."

The principal speaker at the opening session was Judge E. O. Sykes, chairman of the FCC's Broadcast Division, who assured the broadcasters that "no drastic reallocation of broadcast facilities is contemplated by the Federal Communications Commission. . . ." Speaking on "The Duty and Responsibility of the Broadcaster," Judge Sykes pointed specifically to the reallocation hearings of last October and the engineering recommendations now pending before his division. He also stressed the importance of public service in broadcasting and told the broadcasters that they must perform the best job possible for the public. According to the Judge, "the best answer to those who are not satisfied with our American system of broadcasting is to render such a wonderful public service that these critics may, in the course of time, be silenced. You must be just and fair to everyone in your community and your editorial policy should be one to bring about closer cooperation and not to stir up strife thereon. You should build up and not tear down."

JOHN ELMER. WCBM. NEW PRESIDENT. NAB.

SALES MANAGERS

The selling tactics of transcription companies and advertising agencies that sell local merchants radio programs unfit for their businesses and markets were condemned in a resolution passed by the Sales Managers' Division of the NAB. Lew Avery, stations WGR-WKBW, Buffalo, who was named chairman of the division by unanimous acclamation of the 150 radio sales executives in attendance, announced that the division would increase its activity during the coming year in behalf of more rigid interpretation of local rates to eliminate loose practices in the industry. The discussion, concerned largely with local sales problems, centered on comparison of local and national rates and the wide diversity which has made loose sales practices prevalent during the past few years. Another important action of the sales executives' session was the resolution in favor of a standard contract form. The legal mystery of spot contracts has long caused spot buyers to dread placing radio business. Whether this NAB action will lead to adoption of the standard contract by stations is doubtful. The sales executives went on record, however, in favor of a standard form containing the basic clauses of the recognized 4A form.

C. W. MYERS. KOIN. FORMER PRESIDENT. NAB.

OFFICERS AND DIRECTORS

The following constitute the officers of the NAB for the current year: President, John Elmer, WCBM, Baltimore, Maryland; First Vice-President, John J. Gillin, Jr., WOW, Omaha, Nebraska; Second Vice-President, William J. Scripps, WWJ, Detroit, Michigan; Treasurer, Harold Hough, WBAP, Fort Worth, Texas; Managing Director, James W. Baldwin, Washington, D. C.

The following are the directors of the NAB: Edward A. Allen, WLVA, Lynchburg, Virginia; Ralph R. Brunton, KJBS, San Francisco, California; Harry C. Butcher,* WJSV, Washington, D. C.; Arthur B. Church, KMBC, Kansas City, Missouri; Edwin W. Craig, WSM, Nashville, Tennessee; Gene T. Dyer,* WGES, Chicago, Illinois; Herbert Hollister,* KANS, Wichita, Kansas; J. O. Maland, WHO, Des Moines, Iowa; C. W. Myers,* KOIN, Portland, Oregon; Eugene P. O'Fallon, KFEL, Denver, Colorado; John F. Patt, WGAR, Cleveland, Ohio; Frank M. Russell,* WRC-WMAL, Washington, D. C.; Theodore C. Streibert,* WOR, New York, N. Y.; T. W. Symons, Jr., KFPY, Spokane, Washington; L. B. Wilson, WCKY, Cincinnati, Ohio.

ENGINEERING REPORT

Recommendations of the engineering committee included the suggestion that a modern antenna will often more than double the station's effective power. Station owners were also warned against overmodulation as a cause of

(*Continued on page* 16)

*Elected this year.

PERFORMANCE OF A DIRECT

By FRANK W. STELLWAGEN

THE GENERAL THEORY and the performance of individual component parts in direct lateral recording systems have been discussed in publications during the past year. To the author's knowledge there has not been any detailed data published on a complete recording-playback system showing the overall performance, as well as the performance of the component parts in the system. It should be of general interest, therefore, to show the overall performance of a recent installation of a double turntable studio recorder mechanism and a recording-playback control bay.

Fig. 1 illustrates the double turntable studio recorder and the control bay to be described. The recorder turntables and mechanisms are located on either side of the control bay. Each turntable has a cutter head and a pickup terminated at the patch cord panel of the control bay. The control bay consists of a group of rack and panel units which may be interconnected with patch cords as shown in Fig. 2. Two identical power amplifiers with separate power supplies are mounted on the rack. Ordinarily the No. 1 amplifier is used in the recording channel and the No. 2 amplifier in the playback channel. Both amplifiers have their input and output terminated at the patch panel. The No. 2 amplifier may serve as a standby unit for the recording channel or as a second recording channel. An equalizer panel can be patched into the recording channel. The equalizer panel has two controls, a base control at 60 cycles and a high control at 5500 cycles.

A recording input selector switch permits instantaneous switching between any two of the five incoming lines. Extra jacks are available on the patch panel for additional lines. The amplifier output may be switched to cutter No. 1 or cutter No. 2 by means of the

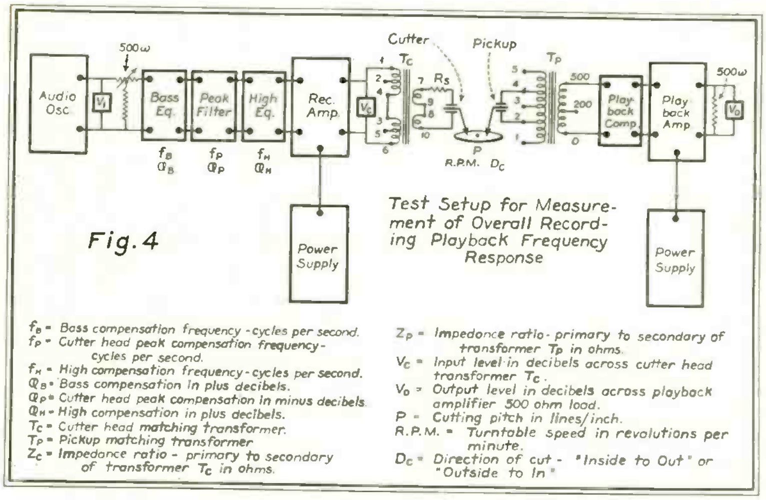


Fig. 4. Test Setup for Measurement of Overall Recording Playback Frequency Response

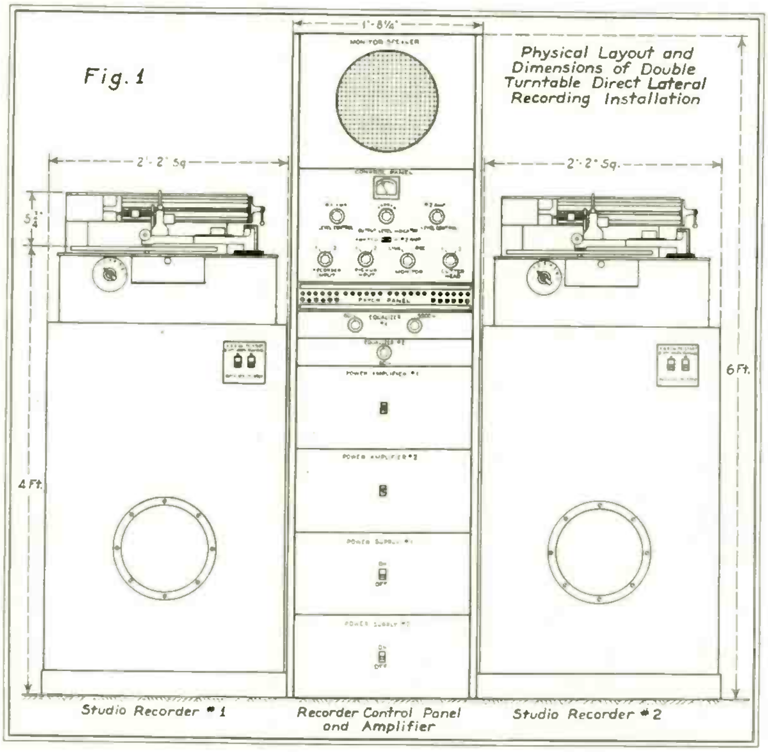


Fig. 1. Physical Layout and Dimensions of Double Turntable Direct Lateral Recording Installation

Studio Recorder #1 — Recorder Control Panel and Amplifier — Studio Recorder #2

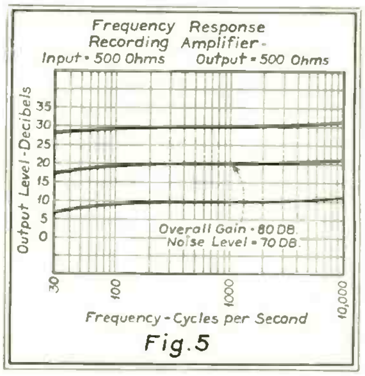


Fig. 5. Frequency Response Recording Amplifier

LATERAL RECORDING SYSTEM

FAIRCHILD AERIAL CAMERA CO.

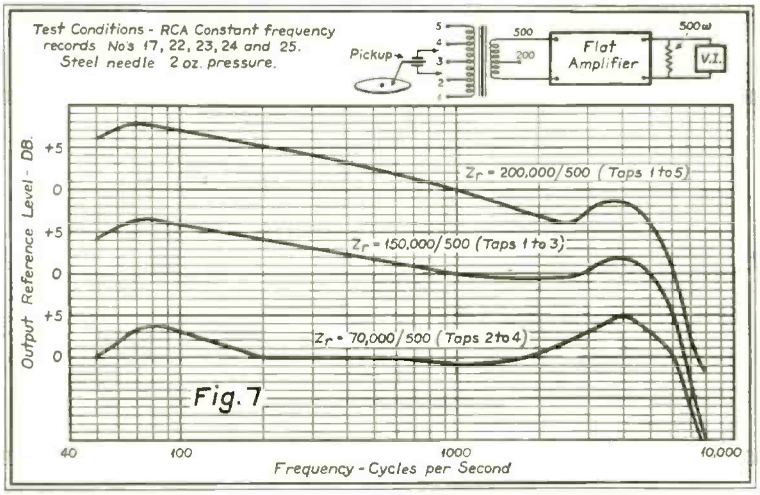


Fig. 7

cutter selector switch. The recording level is controlled by the input-level pad connected in the recording amplifier input and mounted on the control panel. The power-level indicator is switched across the recording amplifier output for monitoring the recording level.

The playback channel includes the No. 2 power amplifier and its respective input pad. A pickup input selector switch provides for instantaneous switching of pickup No. 1 or pickup No. 2 into the input of the playback channel. A playback compensation unit may be patched into the input circuit. The playback amplifier output may be patched into either of the two outgoing lines or to the monitor speaker.

The pickup may be placed in the sound track of a recording, a few inches behind the cutter head, reproducing the program immediately after recording.

The monitor line-playback switch is provided to compare the reproduced record with the incoming line. This practice provides an instantaneous check on the performance of the recording equipment while recording, and permits manual adjustment of the bass and high compensation for the best sounding records.

The studio recorder mechanisms and turntables are precision built units for direct lateral recording of sound on aluminum discs, plasticized thermosetting phenolic resin discs, cellulose nitrate or "acetate" discs, or gelatin composition discs. It may also be used for lateral recording on wax when suitable modifications are made in the height of the recording turntable. The specifications on the recording machine are as follows:

(1) Motor-synchronous, 0.10 hp, 115-volt, 60-cycle, condenser start and condenser run; balanced statically and dynamically; designed for low vibration

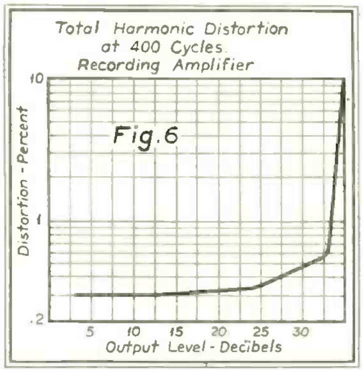


Fig. 6

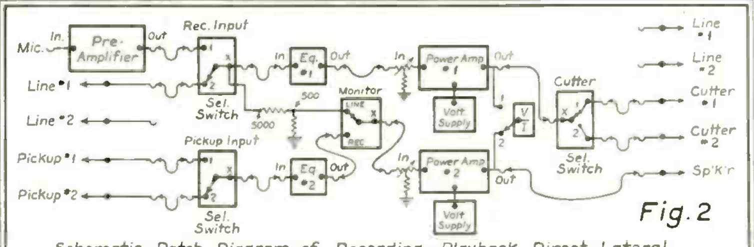


Fig. 2

Schematic Patch Diagram of Recording - Playback Direct Lateral Recording Installation

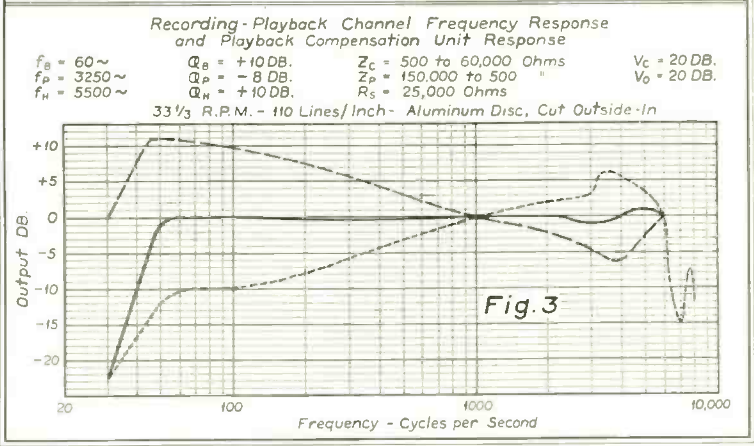


Fig. 3

level and minimum synchronizing torque angle. It is mounted on a rigid base assembly which rests on the floor independent of the general mechanism.

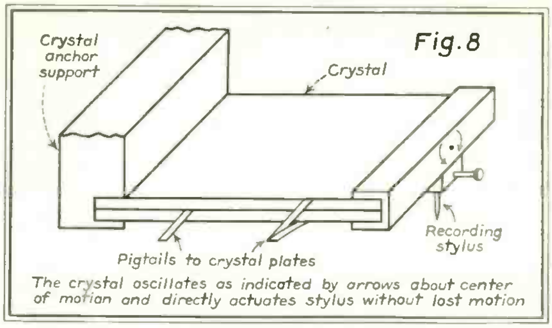
(2) Speed—33⅓ rpm or 78 rpm. The 33⅓ drive is direct through a worm and gear reduction. The change to 78 rpm is made by the movement of a lever on the motor drive base which engages an adhesion drive. Speed regulation 0.25% with vibration level 50-db below recording level on any part of recording mechanism or turntable.

(3) Turntable—16-inch diameter, 25 pounds, seasoned casting dynamically balanced and covered with linoleum. A 50-pound flywheel is connected with a flexible coupling between the gear drive and the turntable.

(4) Overhead feedscrew—driven by an endless belt from the turntable. A stepped pulley provides for a pitch of 100, 110, and 120 lines per inch. Position of feedscrew can be varied by a cam lever for making pre-starting grooves. A scale graduated in tenths of an inch and a pointer show the length of the recording at any time. Entire overhead feedscrew assembly can be adjusted up or down to accommodate different thicknesses of recording materials.

Fig. 3 shows the overall frequency response of a complete recording and playback channel as set up in Fig. 4. The frequency run was made on aluminum at 33⅓ rpm cutting from the outside to the inside of a 16-inch record. A 1000-cycle note was recorded first at plus 20 db across the cutter head transformer and simultaneously played

A PIEZO CRYSTAL RECORDING DEVICE. ONE END OF THE CRYSTAL IS HELD IN THE SUPPORT WHILE THE CUTTING STYLUS IS FASTENED ON THE FREE END.



The crystal oscillates as indicated by arrows about center of motion and directly actuates stylus without lost motion

back at a plus 20 db reference level at the playback amplifier output. The highest frequency, 8000 cycles, was recorded for twenty seconds, then a five-second silent period, then the next lowest frequency was recorded, followed by a five-second silent period, and so on. The dotted curve includes the losses in the recording amplifier, playback amplifier, and the pickup. The necessary playback compensation to obtain a flat response from 60 to 6000 cycles is shown by the dashed curve. The overall response, resulting from the addition of the two mentioned curves, is given by the solid line.

The playback compensation unit is usually a filter connected between the pickup and the playback amplifier. Another method which gives excellent bass compensation is the use of a bass bridging amplifier across the output of the playback amplifier. The playback amplifier drives a dynamic speaker over a range of 100 to 7000 cycles. The bridging amplifier drives a bass speaker mounted in a 15,000 cu. in. air column, acoustically lined. The bass amplifier operates over a range of 25 to 1000 cycles with a control to raise the 60-cycle level 15 db above the 1000-cycle reference level. The minus 6 db at 3750 cycles can be obtained with a filter control at the input of the playback amplifier.

The performance curves of the recording amplifier and the playback amplifier are shown on Figs. 5 and 6. When recording, the output level V_c across the cutter head matching transformer is monitored at 20 db. Momentary peaks may exceed this level by ten decibels and it is desirable that the amplifiers handle these momentary peaks without appreciable increase of distortion. Therefore the total harmonic distortion at 400 cycles is under 0.5% at any output level up to plus 30 decibels. The noise level is minus 70 db below the 20-db recording level, which is quiet for an 80-db gain amplifier.

The frequency-response curves are shown for three operating levels, at 20 db, and at 10 db either side of the 20-db recording level. This data is assurance that the amplifiers have no serious saturation or oscillation effects to influence the performance over the range of levels encountered while recording.

The performance of the pickup used for the test is shown on Fig. 7. The inexpensive and easily available RCA constant-frequency records were used for measuring the pickup response. The labels on these records indicate the relative levels of each band of frequencies so that suitable corrections were made in plotting the response curves.

Note that the dotted curve in Fig. 3 includes the pickup losses. Allowance for the pickup variation in response indicates that the cutter head response extends above 8000 cycles. Inspection of the reflected light patterns on the surface of a frequency run on a recording verifies this conclusion. With this frequency range and total harmonic distortion at 400 cycles of 3% for the entire recording-playback system, the recordings are indistinguishable to the ear from the original studio pickup.

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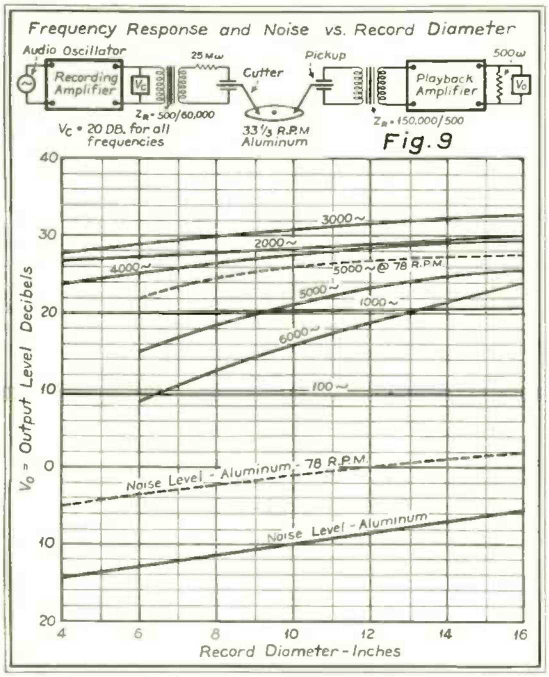


A USEFUL METHOD OF PRESENTING RECORDING-PLAYBACK RESPONSE.

PORTABLE HIGH-SPEED LEVEL RECORDER

By A. W. NIEMANN

SOUND APPARATUS COMPANY

A PORTABLE high-speed power-level recorder, which was recently introduced into the field of acoustic and electric measurements, has many new features. It is designed to make a continuous record of the variation in intensity of any electrical signal and especially for recording great and rapid changes of intensity.

It is in the field of sound measurements that the greatest demands are made on such an instrument, both as to the speed of operation and as to the wide range of intensities which the machine is required to measure. The need for an instrument for measuring reverberation time of rooms and for making measurements of the sound-absorption properties of acoustic materials is largely responsible for the development of level recorders of this type.

If the intensity of the weakest sound which the ear can hear be called unity, the loudest sound which the ear can tolerate without injury is about 10^{14}. Due to this great range of intensities, it is desirable to use a logarithmic scale in such measurements. This recorder uses a db scale for electrical measurements and a phone scale for acoustical measurements. At a frequency of 1000 cycles these scales are the same. The phone-potentiometer used in sound measurements is equalized to have the same frequency characteristic as the ear. More about the phone-potentiometer will be found in the discussion below on sound measurement.

The recorder consists of an input potentiometer, amplifier, rectifier and a motor-driven disc which, coupled to the input potentiometer by means of a magnetic clutch, can vary the potentiometer setting to hold the rectified output of the amplifier constant. Finally a recording stylus is carried on the moving point of the potentiometer which is in contact with a strip of wax paper on which the record is made. This is more clearly shown schematically in Fig. 1. The input potentiometer P is interposed between the input terminals and the amplifier, the signal from the potentiometer reaching the amplifier through the flexible lead L and the contact point K. On the output

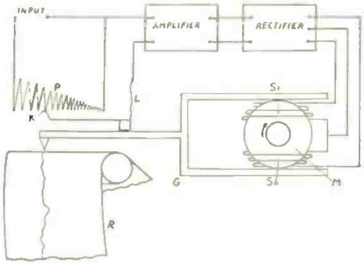
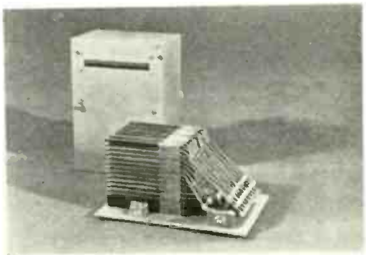


FIG. 1. A SCHEMATIC OF THE LEVEL RECORDER.

of the amplifier is a balanced rectifier from which d-c flows through the coils S1 and S2 which are wound on the two sides of the magnetic disc M. The two prongs of a magnetic fork G slides on the edges of the disc. This fork carries the potentiometer contact K and a scribing point which is always in contact with the waxed paper R.

When there is no input signal across the terminal, a voltage from a 60-cycle source through a copper-oxide rectifier causes a large direct current to flow in S2, while the current in coil S1 is nearly zero. This attracts the prongs of the fork to the side of the disc where S2 is located, and the increased friction causes the disc to carry the potentiometer contact to the end of the scale where the attenuation of the potentiometer is zero. If the a-c voltage is applied to the input terminals, the amplified output in the rectifier causes the current through S2 to decrease, that through S1 to increase. If this input signal were increased to about 0.001 volt, the current through S1 would become equal to that through S2, and both prongs of the fork would be attracted equally to the disc and have the same friction on the disc. Any further increase in input voltage will cause the current through S1 to exceed that through S2 and the friction of the prong of the fork will cause the potentiometer contact K to move to the right, thus reducing the voltage on the amplifier and restoring the balance of current through S1 and S2. The distance which the potentiometer contact moves to restore the balance is recorded on the wax paper by a scriber point, and thus the measurement is made of the amount of change in input signal. In like manner, any change in input voltage results in an unbalance of currents through the coils, and automatic motion of the potentiometer contact to restore the balance, thus recording the amount of change. To say that the recorder has a sensitivity of 0.001 volt means that the application of 0.001 volt on the input terminal will balance the currents so that any further increase will move the pointer from the zero of the scale.

FIG. 2. A POTENTIOMETER WITH COVER REMOVED.



The range of intensity which can be measured is determined by the potentiometer used. These potentiometers are interchangeable and are available in three ranges: 0-25 db, 0-50 db, and 0-75 db. Fig. 2 shows one of the potentiometers with the cover removed. It consists of a non-inductively wound resistance divided into 100 steps. Hence the three ranges mentioned are measured in ¼ db, ½ db, ¾ db steps respectively. If the 75-db range is used, voltage from 0.004 to 22.48 volts can be measured. The variation in sensitivity is less than 0.4 db between 30 and 15,000 cycles.

The speed of operation depends upon the circuit constants and the peripheral velocity of the driving disc. The electrical circuit is so designed that only the disc velocity limits the speed to any great extent. The motor speed is 180 rpm, and the diameter of the disc is 4 cm. Hence, the speed of the rim is 37.8 cm/sec. With a scale 5 cm long the writing point will traverse the entire scale in 0.132 second. If a potentiometer having 75 db range is being used, the recording speed of the instrument will be 560 db/sec.

When equipped with the phone-potentiometer and associated with a high-quality microphone the level recorder is converted into a recording sound meter. The phone is a unit for measuring the loudness of a sound. The sensation which the human ear receives from a sound wave does not depend entirely on the energy of the sound wave, but upon the frequency as well. This is due to the fact that the physical and nervous structures composing the ear do not respond equally to all frequencies. This characteristic of the ear is in common with mechanical devices for detecting sound, such as the microphone. The ear differs from the microphone, however, in that its frequency characteristic changes greatly as the intensity of the sound changes, while a good microphone is designed to give the same frequency response over a wide range of intensities. Thus it is evident that if we wish to measure the loudness of a sound with a microphone and an associated electrical circuit, it is necessary to introduce the proper frequency characteristic in the electrical circuit. Fig. 3 shows the frequency curves of the phone-potentiometer for intensities 10 phones apart. It will be noticed that these curves are almost identical with Kingsbury's curves of equal loudness. These curves, then, give the energy variation of single-frequency sounds when the frequency is varied and the loudness held constant. They show, for loud sounds, very small changes in energy level with frequency, but for sounds of lower intensity the change in energy for constant loudness is quite large.

Common practice in measuring sounds is either to ignore the variation of the loudness of sounds with frequency or else to choose one of the equal-loudness curves and use it for the frequency-weighting network regardless of the intensity of the sound to be measured. This practice is due to the fact that heretofore no instrument was available which automatically adjusted its frequency-weighting network so that the proper characteristic is used with every sound intensity. This frequency weighting is accomplished by the phone-potentiometer, a photograph of which is shown in Fig. 4. This potentiometer contains reactive networks which give an overall response simulating very closely the response of the ear, as shown by the curves of the figure. Thus the potentiometer serves the double purpose of adjusting the gain for measuring changes of input to the amplifier—i.e., changes in loudness of the sound—and also changing the frequency characteristic to the proper shape for the new intensity.

The rapid recording feature of the instrument is of great importance in

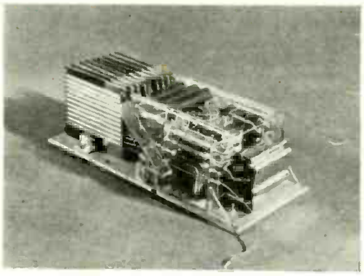


FIG. 4. THE PHONE-POTENTIOMETER.

accurate sound measurements. There is a limit to the speed with which ordinary indicating meters can be made to follow the sound variations, and also a range of speeds which the eye can cover in reading such meters. The recording feature serves to minimize the error due to inability of meters to follow the variations, and eliminates errors in reading since it makes a permanent record which can be studied at

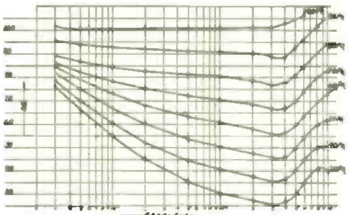
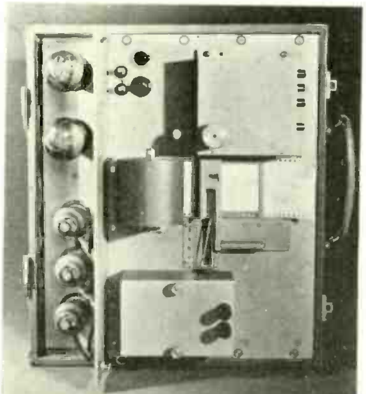


FIG. 3. THE FREQUENCY CURVES OF PHONE-POTENTIOMETER.

leisure with all the care that the particular survey being carried out may require.

The recorder is built as a single unit in a portable case 8½" x 12" x 15" with a detachable cover, and is operated from 110-volt 60-cycle a-c. Fig. 5 shows the plan view of the instrument with the cover removed, and the metal shield removed from the amplifier and rectifier tubes in the back. At the left

FIG. 5. TOP VIEW OF THE RECORDER WITH COVER REMOVED.



is seen an input potentiometer with its input terminals, and at the right of the potentiometer is shown a scale and the arm carrying the scriber which places curves representing the intensity changes on wax-coated paper. A roll of this paper is seen in the center of the picture with sprocket drive for moving the paper continuously. This paper is driven by a synchronous motor and its speed is controlled by a set of gears housed in a box, shown at the right, near the front of the picture. The motor also drives the potentiometer point through a medium of a magnetic clutch. The magnetic clutch is controlled by a balanced rectifier in such a manner that the unbalance in either direction causes a corresponding change in the potentiometer setting. The paper drive has three speeds which may be selected by pushing one of the buttons shown at the right. The fourth button at the left disengages the paper drive and stops the paper. The three speeds are 50 mm/sec, 10 mm/sec, and 1 mm/sec, respectively. The knurled wheel shown at the left side of this housing, near the back, is for starting the synchronous motor.

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NAB CONVENTION

(*Continued from page* 11)

distortion and adjacent-channel interference. Referring to the lack of short-wave relay equipment which last winter hampered radio work in the great floods, the engineering committee recommended that station owners prepare themselves with proper equipment for future emergencies. Most important among the resolutions passed by the resolutions committee was one opposing passage of the Celler Bill now pending in Congress which would authorize the construction, maintenance and operation of a government broadcasting station. Still another feature of the engineering committee report was a proposal for extending both limits of the broadcast band, to be submitted at the Pan American Broadcasting Conference in Havana next November. Committee members also urged NAB to send delegates to the International Radio Conference in Cairo next year.

A sharp criticism of radio station owners for their disregard of program quality in their striving for sales volume was voiced by Arthur Pryor, Jr., radio executive of Batten, Barton, Durstine and Osborn advertising agency, at the closing session. According to Pryor, "the most important task of station owners is to develop better program directors who have the ability to improve the type of programs being presented."

TELEVISION STUDIO CONSIDERATIONS

PART IV

By W. C. EDDY, Lieut. U.S.N. Ret.

HAVING COVERED some of the details that enter into the production problems of a television studio, it might be well to consider now the program itself and see how it will differ from radio. All of us, from technicians to executives, are haunted by the memories of the quick demise of silent pictures upon the introduction of sound. If the addition of the audio track to pictures can revolutionize such an industry over night, we can draw our own conclusions as to the effect that television might have on the broadcasting game. We all know that sound on film brought out new production problems, new studio technique as well as a radically different type of continuity. We can expect the same of television and it therefore behooves us to draw this lesson from history and spend the ensuing months in consideration and preparation of our facilities for handling this precocious infant of the sciences.

What are the logical fields for television program work? I believe that we should first give recognition to the instantaneous properties of the video channel and place newscasts or current events first on the list of program possibilities. Here we have a field that cannot be covered by the press and can only be covered in part by radio. It is a logical field for full development by the video engineers. It has its problems at the present time which must be solved before we can claim such subject matter as specifically television's. We cannot bring the news into the studio except in the form of news-reel stock, so methods and equipment must be devised to go out after the subject matter. In the parallel case of radio's newscasts this required nothing more extensive than a twisted pair and a remote-control setup, the telephone lines being fully capable of handling the frequencies employed. This, of course, is not the case in television. Here our lines and amplifiers must pass the full band of video frequencies, which for usable picture reproduction will be in the order of three megacycles. This requirement alone is a problem in itself, but luckily the past year has seen considerable development work in amplifiers and coaxial lines that can be used under certain conditions. This still leaves the problem of the portable pick-up to be solved by the engineering staffs before the possibilities of this rich field can be tapped by the program departments. Power supplies, antenna systems, flexible low-loss coaxials and field cameras must all be developed if we hope to bring this service to the public.

LIEUTENANT EDDY WORKING ON A MINIATURE TELEVISION SET WHICH HE DESIGNED AND BUILT.

We might swing a bit to the left, if need be, and revert to the intermediate film systems used abroad, but here again we find a complexity of problems both financial and technical standing in the way of immediate usage. In other words, the most natural field for television development, field pickup, is closed to us until the engineering staffs develop the necessary apparatus.

Television will, in all probability, be introduced with our program material staged in the studio or recorded on film. In the early days of commercial television, the public will no doubt accept such entertainment, but it is logical to believe that as direct-pickup technique is improved, the trend will be towards more extensive use of this service and less of the film stock.

Such a policy will hinge on the effectiveness of our studio work. If we can furnish material commensurate with the entertainment standards of the public we have a *raison d'etre* for television, but if we fall short we can soon expect television broadcasting revert to transmitted home movies.

What about radio program material? Can it be rebuilt for television or must the video arts devise new programs for its consumption alone? For many reasons I believe the latter case to be true. Radio appealed to the ear alone, the most easily compensated part of our nervous system, whereas television must appeal to both eye and ear alike. Such material as lends itself to aural gymnastics does not necessarily make good visual entertainment and in some cases cannot be seen if the illusions are to be continued. This is particularly true in the case of sound effects. Recently a discussion of this point was brought up by a member of the program staff on one of the larger radio stations.

"If we can't turn to the sound effects to create our settings," he asked, "can we hope to produce anything but the most simple continuity?"

This was a logical query, for today the radio drama employs sound effects in the continuity as well as in the stage settings themselves. The answer to it lies in film libraries prepared in much the same detail as our sound effects transcriptions. In the place of a portion of a record faded in and out we will use a sufficient footage of the prepared sound film to create the illusion desired, mixing this with the direct pickup material at the control board.

Leaving sound film for the moment let us look at some of the problems that confront us in direct-pickup programs. In radio it is possible to listen to a singer do several choruses of the same song without wearying of the melody, principally because we do not utilize all of our attention and all of our major senses in the process of listening. In television it will be different. Within a few seconds we have seen everything that is to be seen and type material becomes repetitious; it offers no new eye material to compensate for the increased effort that is required of our nervous system. We must therefore take this into consideration in program development and either cut the numbers to short resumes of today's radio material or else work into the successive moments of the script sufficient action to compensate the eye. In all probability the trend will extend in both directions. To those of us who have been experimenting in television program work during the past few years it looks as if the fifteen minute spots without relaxation are doomed with the advent of the visual tract. If we ask the audience to give us their full attention over this quarter-hour period we must in all events keep an everchanging cycle of eye entertainment before them.

The layman likes to picture television as a new and wonderful medium that will bring him a daily series of glorified feature pictures to satisfy his every whim for entertainment. Aside from the financial considerations involved, this goal is well beyond the scope of television in its present or projected stage. This radio picture demands too much attention by the audience to permit less that the shortest and most interesting subject matter holding them at the receiver. Observation of a typical television audience will generally prove this point. During the early moments of the program, the novelty of the picture and interest in the subject portrayed will hold their complete attention but as the continuity drifts on this close attention changes to relaxed indifference to anything but the story. This is as it should be. To really enjoy television one should not have to strain any more than we should be required to wear earphones to pick up our favorite radio program today. If television is to be a commercial success we must be sure that the audience does not leave us after the first few minutes and we must therefore demand their relaxed attention by destroying the illusion of the diminutive television screen and substituting the broader horizons of the story material portrayed. We can accomplish this by furnishing entertainment that will in itself hold their interest and not presume on their willingness to sit through long extended dull continuities. The typical television audience will follow a two or three-minute newsreel with avid interest and at the black out will still be in the mood for more, but a ten-minute reel of standard vintage finds them groping for the exits. It is easy to explain this reaction. The newsreel is fast-moving, interesting and composed of curtailed sequences, while the one-reeler allows the audience to stay abreast of the plot if not considerably ahead of it. I have drawn this version purely for the sake of argument. This of course will not hold true of all newsreels, all one-reelers and all audiences, but I believe it can be taken as a fair example of average audience reaction. Our televised material must conform with the functions of the newsreel that make it interesting program material. It must be short, packed with punch lines and must at all times lead the audience. In the light of this it is easy to see where some of our radio programs of today will fall short. Our serial stories of the air generally comprise fifteen minutes of dialogue built up about a single situation which at times becomes immediately apparent after the opening plug. Such a continuity would hold no more interest over television than the fidelity charts. In its place, however, we could remodel the story into a three to five-minute program, building up to several situations rather than one, and by addition of a fast-moving script could present an interesting feature.

For the sake of argument again, let us look at the standard commercial variety show on the air today. The advertising plug can no doubt be presented in its present form with a possible curtailment of spoken lines and the addition of equivalent action. The typical orchestra that forms the background is not good television material. In the first place it is extremely hard to photograph and even when placed on the screen becomes little more than a static picture of a group of musicians. It lacks the individual personality of a central figure. The band leader himself could be used for a shot or two but even his gyrations are none too interesting. This part of the program then must resolve itself into a series of random shots that cover in succession the whole band, the leader, various solo instruments and preferably a central singer or dancer. Conceding the fact that he can, in all probability, get away with two or three choruses of such material, we are confronted with the name star himself. Here we have a real problem. If he is a singer, we are apt to be accused of being repetitious, if we have just finished with a vocalist; if he is a comedian, he cannot spend his two or three minutes before the lens working up to a punch line unless his associated business is particularly good, and if perchance, he possesses no outstanding television selling point, we can expect the dear old audience to tune him out. We will all sit through dull plays and movies because it entails effort on our part to get up and work our way to the aisle, but with television in the

(*Continued on page* 23)

THE LOW-POWER TRANSMITTERS

PART II

By JOHN P. TAYLOR

IN THE FIRST part of this article (COMMUNICATION AND BROADCAST ENGINEERING, June, 1937) several of the standard transmitters available for use in low-power broadcast stations were illustrated, and the design and constructional features briefly outlined. In the second part, which follows, additional designs will be similarly considered. Since limitations of space make it impossible to describe all the features of each model, some reference to the preceding discussion is necessary, and it is suggested that for a comprehensive review of this field the discussion should be considered as a whole rather than by sections.

THE 310A/310B TRANSMITTER

The 310A/310B transmitter is a deluxe model, especially designed for high-fidelity transmission, and including a number of new and unique features. It is intended for use as a 100-watt transmitter (in which case it is specified as the Type 310A), as a 250-watt unit, or 100/250-watt transmitter (in which case it is specified as the Type 310B). While it has been designed particularly to fulfill the requirements of the low-power field, it is also suitable for use as the exciter unit in higher powered transmitters. In order to provide for this additional application, it is designed to match in appearance and construction the units which make up the larger transmitters of this line.

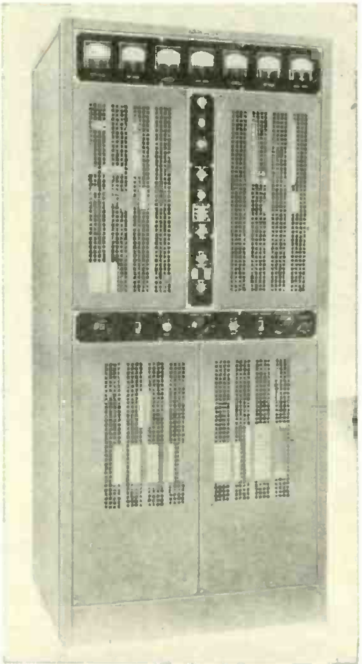
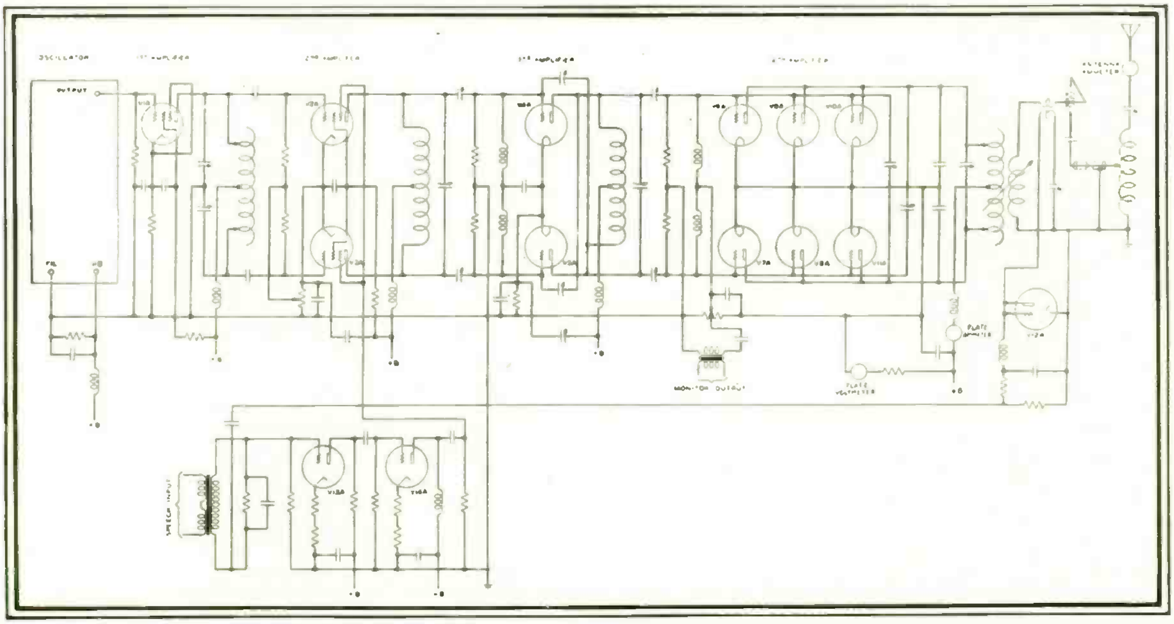


FIG. 1. FRONT VIEW OF THE 310A/310B TRANSMITTER FOR 100-WATT, 250-WATT, AND 100/250-WATT BROADCAST STATIONS.

A front view of this transmitter is shown in Fig. 1. As will be noted, the general style of the unit is along the lines of the locker-type cabinets popularized in recent years. Close inspection, however, reveals that rather marked changes in construction have been introduced and result in several features which are unique. Meters and controls are grouped and centralized as in previous models, and the general appearance of the front of the cabinet is very similar. The four front panels, though, instead of comprising hinged doors, are simply held in place by corner screws. This has been made possible by a general rearrangement of the interior construction. All of the tubes are mounted at the back of the transmitter and access to these is provided by a single easily-opened rear door. This arrangement of tubes allows all of the other circuit components to be located

FIG. 2. SIMPLIFIED SCHEMATIC DIAGRAM OF THE 310A/310B TRANSMITTER. THE OUTPUT STAGES USES FOUR 242-C'S FOR 100-WATT OPERATION, OR SIX 242-C'S FOR 250-WATT OR 100/250-WATT OPERATION.



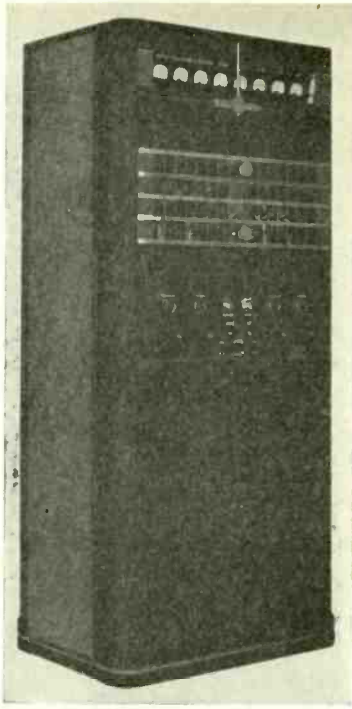


FIG. 3. FRONT VIEW OF THE 300E/300F TRANSMITTER FOR 100-WATT, 250-WATT, AND 100/250-WATT BROADCAST STATIONS.

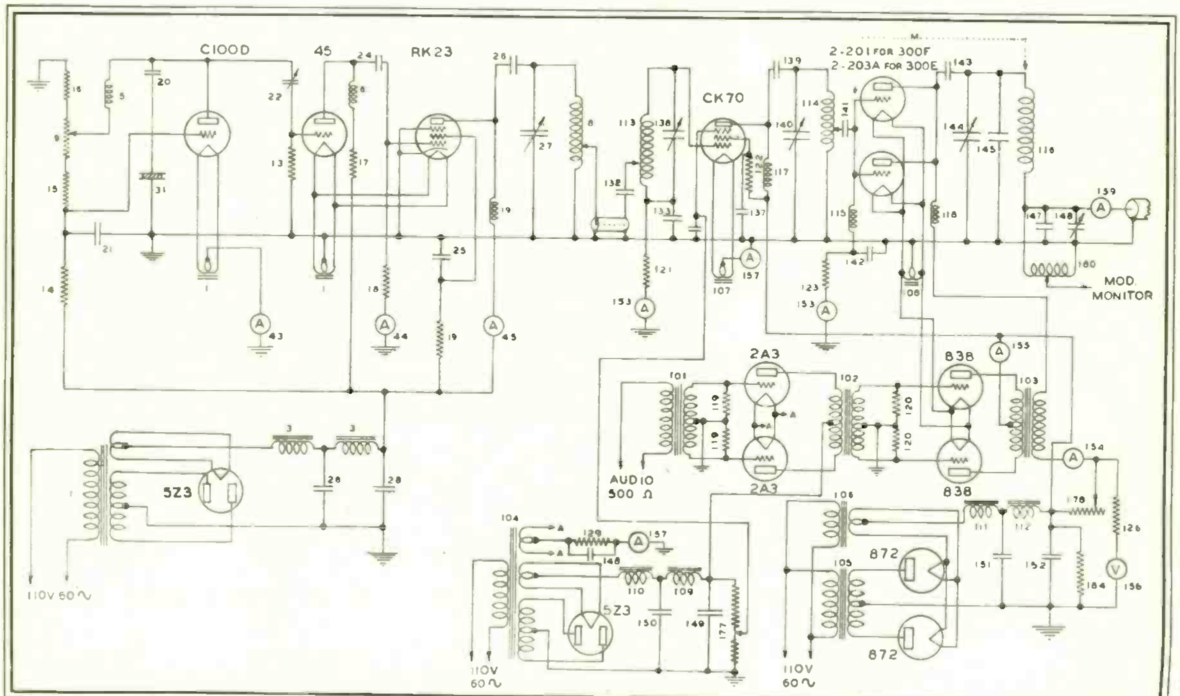
toward the front of the transmitter. Since these latter will seldom require attention, front doors are not required. An important result of this type of construction—aside from desirable simplification—is to facilitate shielding of the low-power r-f components as is required by regulation.

The schematic diagram of this transmitter as arranged for 250-watt, or 100/250-watt, operation (that is, as the 310B) is shown in Fig. 2. The oscillator, which is a separate easily-removed unit, uses a 247-A tube with a low-temperature-coefficient crystal. Such crystals have a frequency variation with temperature of only a few parts per degree Centigrade. It is interesting to note that these not only improve frequency stability, but also make possible use of simpler and more dependable temperature-regulating devices. The former circuits employing mercury thermostats and thyratron relays—which gave accurate temperature control, but were often a source of recurring trouble—are no longer necessary. Instead, a small glass-enclosed thermostat of the bimetallic type suffices, and no relays are required. As a result, oscillator units of the plug-in type become highly practical as well as convenient. The oscillator in the 310A/310B transmitter is followed by a 318-A as a buffer amplifier, driving a pair of 318-A's constituting what is referred to as the "modulating amplifier." This is a balanced stage into which the audio voltage—supplied by a two-stage audio amplifier—is introduced. The use of special suppressor-grid tubes allows the combination of radio-frequency and audio-frequency voltages (grid modulation) to take place in the tubes rather than in the external circuit as heretofore, thereby improving linearity. This modulating amplifier is followed by two linear stages, the first employing a pair of 242-C's and the second six 242-C's. An interesting feature of these latter is the use of variable condensers for interstage coupling, providing accurate impedance matching between stages.

Several methods of changing from 100-watt to 250-watt operation have been noted in the transmitters previously described. That used in the 310A/310B transmitter forms an interesting comparison. In some respects it is the most simple of the various schemes used. As has been noted, the final stage utilizes six 242-C's for 250-watt operation. In order to change to 100-watt operation it is merely necessary to remove two of these tubes and readjust the bias voltage. For 100/250-watt operation all six tubes are used, the change in power being accomplished by changing the bias voltage. This may be done by means of a switch on the front panel—without need of interrupting the program.

Low distortion and noise level are achieved by the use of negative feedback—this being the only one of the low-power transmitters in which this is provided (although approximately equal distortion and noise levels are guaranteed for all of the other models). Other features include full provisions for monitoring, a built-in dummy antenna,

FIG. 4. SIMPLIFIED SCHEMATIC DIAGRAM OF THE 300E/300F TRANSMITTER. THE OUTPUT STAGE USES TWO 203A'S FOR 100-WATT OPERATION, OR TWO 201'S FOR 250-WATT OR 100/250-WATT OPERATION.



output coupling system designed to match a concentric line, and availability of antenna coupling units for either series (base-insulated), or shunt (base-grounded) excited antennas.

THE 300E/300F TRANSMITTER

The 300E/300F transmitter is the most recent addition to the low-power broadcast field—the announcement having nearly coincided with the preparation of the material here presented. Like all of the newer low-power transmitters, it is intended for operation either at 100, 250, or 100/250 watts—being designated as the Type 300E in the former instance, and as the Type 300F in the latter. In construction, appearance and styling this unit is definitely in the deluxe class. Meters, controls and indicating lamps are conveniently and symmetrically grouped, while tubes are accessible through front doors. The unit is not intended for use as an exciter with higher powered transmitters—the policy of the manufacturer being rather to offer a plan for installing new equipment when the power is increased.

A front view of the 300E/300F transmitter is shown in Fig. 3. The design and construction represent, in general, an advance over previous models in which the changes embodied are more those of detail and improvement than of radical alteration. A proven design has been altered only in such part as would improve mechanical detail and add to the attractiveness of the appearance. The latter feature is particularly evident, a new note of modernity having been achieved by use of a rounded and streamlined cabinet of unusual attractiveness.

It is interesting to note that while the general arrangement of this transmitter is in some respects similar to those previously described, this result has been arrived at by a more original line of design than would at first be supposed. Thus, although tubes are reached through the front doors as in other models, this end has been achieved by an entirely different method. This involves a construction in which the tubes are grouped on a single horizontal sub-panel, with r-f components and controls just below, and output coupling circuit just above. Power and control circuits are, of course, located in the lower part of the transmitter. This arrangement provides both manufacturing and application advantages which will be obvious. It also avoids necessity of large access doors. Another unique constructional feature of this transmitter is the placing of a large part of the wiring in enclosed channels at the side of the transmitter. This feature, together with the type of construction employed, makes it possible to achieve a very pleasing appearance within as well as without.

The schematic diagram of the 300E/300F transmitter is shown in Fig. 4. The oscillator and associated circuits of this transmitter are rather unusual. A C100D tube is used, with a low-temperature-coefficient crystal, in a negative resistance circuit. Both the oscillator and the first buffer—a '45—are untuned, the circuit being designed to provide freedom from effects of voltage variations and circuit changes upon frequency. These two stages, together with the second buffer stage—an RK23 in a tuned circuit—are mounted in a separate frequency control unit which is complete in itself. This unit, designated the 40-D frequency control unit, is a rack-type unit intended to be mounted with the frequency and modulation monitors in a standard rack—thus centralizing all of the control units at any convenient point as may be desired. The output of the 40-D is carried to the transmitter proper by concentric line.

The intermediate-amplifier stage—which is the first r-f stage in the transmitter proper—utilizes a CK70 in a conventional circuit. This drives the final stage, which for 250-watt, or 100/250-watt operation consists of a pair of

(*Continued on page 23*)

VETERAN WIRELESS OPERATORS ASSOCIATION NEWS

W. J. McGonigle, President, RCA Building, 30 Rockefeller Plaza, New York, N. Y.

CARL O. PETERSEN

ON BEHALF of the Officers. Directors and Members of our Association we extend heartiest congratulations and best wishes for continued success in accomplishing future outstanding achievements comparable to the past remarkable deeds of exploration by a true adventurer-explorer, our Veteran Member, Lieut. Carl O. Petersen, U. S. N. R.

We quote from the local Naval Bulletin: "DISTINGUISHED FLYING CROSS" "On Wednesday, June 9, at 11:00 AM, Rear Admiral Harris Laning, USN, Commandant, Third Naval District, presented the Distinguished Flying Cross and its accompanying Citation to Lieut. (jg) Carl O. Petersen, C-V(S), USNR, Unit Commander of Unit 3, Section 6. The Cross was awarded to Lieutenant Petersen by the President of the United States.

"For extraordinary achievement while participating in aerial flights as Photographer and Radio Operator with the Byrd Second Antarctic Expedition. On January 3, 1934, Petersen participated in a flight over entirely unknown Antarctic waters in the vicinity of Meridian 116 W. During the return trip, stormy and thick weather was encountered in an area strewn with hundreds of high icebergs and the situation became hazardous and critical. Petersen showed great coolness and courage on this occasion and eventually, with inadequate apparatus in rough weather, was able to obtain radio bearings which enabled the Commanding Officer to navigate the plane accurately back to the base ship. His conscientious, loyal, indefatigable performance of duty and unusual ability contributed greatly to the success of the expedition."

It is our understanding that the Distinguished Flying Cross is the highest honor awarded by the United States Navy. We can think of no one more deserving of receiving this supreme honor than our own Carl.

Lieut. Petersen received the following telegrams from his fellow members in the Explorers Club:

The noted Polar Explorer, President of the Explorers Club, Dr. Vilhjalmur Stefansson wired: "My Dear Lieutenant Petersen: Your fellow members of the Explorers Club will want me to express in their behalf warmest congratulations upon your receiving the Distinguished Flying Cross of the United States Navy stop We feel you deserve it and are all proud of you."

Colonel H. R. Forbes, another noted explorer and member of the Explorers Club telegrammed: "As an officer—a member—and a friend I beg to salute you—Sir—and to say this deserved praise and recognition fills us all with very deep esteem for a brave and honorable and capable officer."

The Secretary of the Explorers Club, Joseph Robinson, wired: "By direction of the President and Board of Directors of the Explorers Club I have the honor to congratulate you in their behalf and in the behalf of the members of the Club upon receiving from the United States Navy the Distinguished Flying Cross which your courage, achievements and skill as an aviator so well deserve. To these felicitations may I add my own in warmest terms."

Carl replied to the Explorers Club as follows: "Dear Mr. Robinson, Secretary Explorers Club:—It was with great pleasure that I received your telegram congratulating me with the Distinguished Flying Cross. Please extend my sincere and heartiest appreciation to the President, the Board of Directors and all members of the Explorers Club for their thoughtfulness.

"It was the greatest day of my life when I received the United States Navy's highest award for my work with the Byrd Antarctic Expedition. I want you all to know that if it had not been for Admiral Byrd who made it possible for me to go with him on his two Antarctic Expeditions, due to my previous experience in the Arctic and Antarctic, I would not have received The Distinguished Flying Cross, The Congressional Medal of Honor or any other honors that I have received. To him I pay my deepest respect and appreciation."

Carl has been further honored recently by his appointment as Commanding Officer of the Naval Reserve Communication Unit in Nassau County and election as an Honorary member of the Cape Breton Flying Club of Nova Scotia.

Incidentally, Carl received the Testimonial Scroll of our Association in recognition of his outstanding radio work in the Antarctic during the First Byrd Expedition, which was awarded him while he was still at the South Pole. He was informed of the Award via New York Times Radio.

Again, Carl, we say, Bravo!

SUMMER

YES, it's hot! Particularly this evening. And for the same reason there will be no meetings in New York during July and August. However, we'll be seeing you at Bonat's on the first Monday in September, no that's Labor Day, therefore it'll be the second Monday in September. What say, will you be there?

MIAMI

THE NEXT MEETING of the Miami Chapter will be held at 8 PM on July 27th, 1937, at Vic's "Modern Bar" in Little River. Steer an Easterly course from "Little River Radio Company" on 79th Street and look for a steady white light astern of the Western Union office. Next month we'll have details of last meeting of Miami Chapter in this page.

SAN FRANCISCO

GILSON V. WILLETS, Secretary of our San Francisco Chapter, suggests that those interested in our activities in that area should phone him at Overland 7361—address, 1434 26th Avenue, San Francisco, Calif. GVW is a Charter Member of our Association and has high aspirations for the West Coast unit of our Association. Give him a hand!

"HELP THY NEIGHBOR"

HAL STYLES, one of radio's oldest operators, who used to pound a key for the Marconi Company, Independent Wireless and Tropical Radio Telegraph Compauy, and, together with his brother Tom, operated "SY" in Yonkers, New York, in the days of the "Helix" and "Spark Coils," is now busily engaged in Los Angeles, broadcasting one of the West Coast's most noted programs, "Help Thy Neighbor" over KHJ, Los Angeles, and the ten stations of the Don Lee Network. Hal gets jobs for unemployed people, by having them appear in his "radio office" and present their qualifications. Prospective employers listening in, are asked to telephone to the stations during the broadcast, *if*, they have a job to offer. The program has placed over eleven hundred (1100) people at gainful employment in only twenty weeks. Former bank presidents, judges, attorneys, doctors, engineers, and radio technicians are on file with "Help Thy Neighbor," as well as men and women, skilled and unskilled, in all lines.

This is a far cry from the days when Hal had NOTHING to worry about when going to sea, but after all his travels as a radio operator gave him a "slant on human nature" that might never have been achieved otherwise—all of which helps him to understand the problems of persons, victims of our recent depression. Then, too, Hal is engaged in his first love—Radio—which lends inspiration to his endeavors.

Ed Wheeler, local radio editor, devoted an entire column to Hal's program and said in part: "It's an interesting program—as a radio program—this 'Help Thy Neighbor.' As a service, it is far more valuable to a great many people than any other current radio opportunity feature. Major Bowes aids entertainment, individuals or groups, as in a lesser degree, do many other audition features. But, 'Help Thy Neighbor' in the course of a few weeks has given opportunity to literally hundreds of needy persons whom no other known contact agency could have brought into direct and instant communication with employers.

"Incidentally, it is rumored that KFWB—among other interested agencies—is making a strong bid to acquire the feature at the expiration of its current series."

Hal is one of our earliest members and is also a Fellow in the Radio Club of America and a Member of the Institute of Radio Engineers.

Congratulations HS, and best wishes for a full measure of future success in your commendable and praiseworthy endeavor "Helping Thy Neighbor."

LOW - POWER TRANSMITTER

(*Continued from page* 21)

201's in a single-ended circuit. The latter is a rather unusual feature, as is the use of inductive neutralization. Such a circuit has certain advantages in the way of simplicity of construction and adjustment—particularly where a concentric line is used, as is now almost universal practice. Since there is no need for balancing circuits, and since no neutralizing condensers are required, the arrangement of the several parts of the output stage is less critical than in push-pull designs—a feature which facilitates the grouping of tubes, and makes possible the unique construction employed in this transmitter. For 100-watt operation the only circuit change required is the substitution of a pair of 203-A's in the final stage. As in the previously noted designs, provision is made for instantaneous changeover when used in stations licensed for 100/250-watt operation.

High-level modulation is employed, an input audio stage utilizing a pair of 203's in push-pull Class A driving a pair of 838's as Class B modulators. The use of this stable and easily adjusted modulating circuit, together with the unique design of the output stage, make the 300E/300F transmitter unusually easy to adjust—thereby greatly reducing the time necessary, and the troubles met with during installation.

•

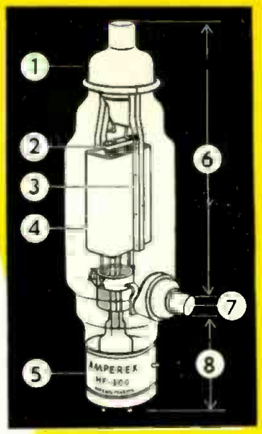
TELEVISION STUDIO

(*Continued from page* 18)

home this effort is reduced to a mere twist of the tuning knob. But let us get back to our program again. Concede the fact, if you wish, that our name star has sufficient material to carry the entertainment for three or four minutes; what can we put on next? We might turn to the orchestra again, this time using them as a background for a clever dancing act, or possibly we might run in a specialty act in front of a traveler while the stage was being set for the next sequence. The logical thing to do at this time is to change our pace, always up, and introduce some footage of film or a staged production in order that we can later return to the name orchestra for a few more minutes of air time. Again, we might feature the star comedian and his accomplices, the closing plug and grand finale, but this whole production would only fill a fifteen-minute spot. It would be ideal from the standpoint of brevity and nonrepetition but would be both costly and complicated to stage. I firmly believe that before television is many months old in the home, the program technique of this new art will be as different from radio as radio is from the stage.

INDEX OF ADVERTISERS

For high power at ultra high frequencies
AMPEREX TUBES



At 60 megocycles 500 watts plate power output can be obtained from the Amperex HF-300. This tube, together with the HF-200 and HF-100, were developed by Amperex a number of years ago primarily for physiotherapy apparatus in which tubes capable of handling abnormally high currents at ultra high frequencies and at reasonably low voltage were required and none at the time available.

So universal was the recognition of the merits and efficiency of these tubes that now more than 70% of all diathermy ultra short wave generators are equipped with Amperex tubes and thousands more are in operation in almost every country in the world in broadcast, communication, amateur and industrial apparatus where they have replaced more costly or less efficient tubes.

Some of the design features which are responsible for the remarkable efficiency of these tubes at ultra high frequencies are as follows:

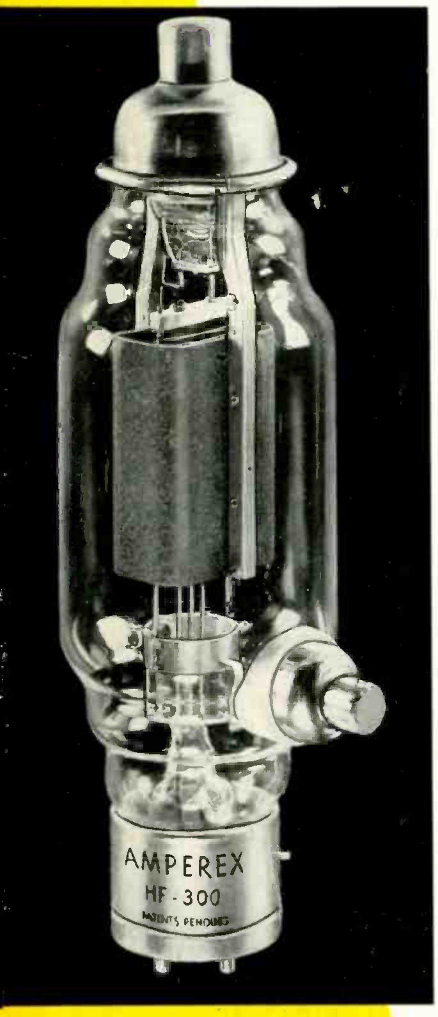
A high mu in combination with a high transconductance reducing requirements for grid excitation and grid power loss to a minimum.

Long insulation paths between electrodes, permitting the safe application of high voltages and reducing dialectric losses.

Extremely low interelectrode capacitances reduce the magnitude of circulating R.F. currents and permit more efficient circuit design.

1. Large heat radiating area at plate terminal
2. One insulating spacer between grid and filament only
3. Large area plate leads
4. Anode of graphite. The perfect heat radiating material
5. Standard 50 watt base
6. Long insulation path, grid to plate
7. Large heat radiating area at grid terminal
8. Long insulation path, grid to filament

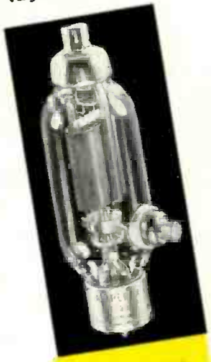
Transit time power losses are reduced to a minimum in the AMPEREX high Gm planar filament structure without sacrificing the decided advantage of extremely low interelectrode capacitance.



F 300

Filament voltage	11-12 volts
Filament current	4 amperes
INTERELECTRODE CAPACITANCES	
Grid to plate	6.5 mmf.
Grid to filament	6.0 mmf.
Plate to filament	1.4 mmf.
Mutual conductance at 150 ma.	5600 micromhos
Amplification constant	23
Plate dissipation	200 watts
Plate power output	500 watts

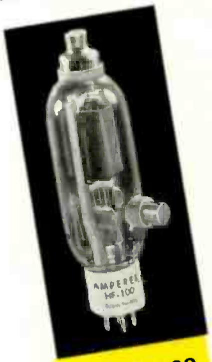
$35



HF 200

Filament voltage	10-11 volts
Filament current	3.4 amperes
INTERELECTRODE CAPACITANCES	
Grid to plate	5.8 mmf.
Grid to filament	5.2 mmf.
Plate to filament	1.2 mmf.
Mutual conductance at 150 ma.	5000 micromhos
Amplification constant	18
Plate dissipation	150 watts
Plate power output	350 watts

$24.50



HF 100

Filament voltage	10-10.5 volts
Filament current	2 amperes
INTERELECTRODE CAPACITANCES	
Grid to plate	4.5 mmf.
Grid to filament	3.5 mmf.
Plate to filament	1.4 mmf.
Mutual conductance at 150 ma.	4200 micromhos
Amplification constant	23
Plate dissipation	75 watts
Plate power output	170 watts

$12.50

Write for detailed engineering information

AMPEREX ELECTRONIC PRODUCTS, Inc.

79 WASHINGTON STREET — BROOKLYN, NEW YORK