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DEDICATED TO
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LET THESE WORDS BE WRITTEN IN GRANITE WHERE ALL MAY SEE—"A GOOD NAME ENDURETH FOREVER."

John H. Battison

ROMANCE OF RADIO AND TELEVISION

1914 TO 1954

By JOHN H. BATTISON

NRI Director of Education

1914 These were the "good old days"—when Radio was referred to as "wireless" most of the time—when only the stout-hearted dared walk into the room of a Radio fan and risk jarring the "cat's-whisker" off the long-sought-for sensitive spot on the galena crystal—when tubes were so microphonic that a heavy footstep anywhere in a house sounded like thunder in the phones—when practically all broadcasts were in code, and many a tense midnight listener mistook static for voices from the moon or Mars. "Bloopers," those unforgettable regenerative receivers developed by De Forest in 1912 and Armstrong in 1914, were just becoming known among experimenters; these sets acted like miniature transmitters during tuning, causing howls in neighboring receivers for blocks around. Loudspeakers existed only in the dreams of inventors; listening was done with headphones, and crushed and aching ears were the reward for perseverence.

The two-element rectifier tube had been invented by Fleming in 1906, and De Forest had added a grid to this tube in 1909. Pickard had perfected the crystal detector in 1907, and it was for many years the most popular of all detectors. Of course, Marconi had in 1901 amazed the world by broadcasting the letter "S" from Poldhu, England, to Saint Johns, Newfoundland. Our own NAA in Arlington, Virginia, went on the air in 1913 with a 100 kw. spark transmitter operating on 6,000 meters. About this same time Nauen, Germany, began broadcasting on 16,900 meters or about 18,000 cycles (just above the audio band), and station FL atop the Eiffel Tower in Paris began broadcasting on 10,000 meters. Many an oldtimer still remembers tuning in these stations with a crystal set having huge tuning coils and an aerial hundreds of feet long. The Titanic had crashed into an iceberg in 1912, with Radio summoning assistance and bringing news of the disaster to a young wireless operator named David Sarnoff (now Chairman of the Board of RCA) who was listening in a New York City skyscraper.

It was in 1914 that Hiram Percy Maxim founded the American Radio Relay League. War broke out in Europe this year, and amateur licenses were suspended in practically all foreign countries. American amateurs listened with suspicion to German Radio stations in this country and found at least one to be sending code reports on allied shipping to German submarines; recordings of the messages, turned over to the Secret Service, resulted in confiscation of this station.

Broadcasting of entertainment—even of grand opera with Caruso singing—was now several years old,—the De Forest Radio Telephone Company had started things off with phonograph records in 1907. Only a handful of experimenters heard these first "canned" programs, and these were more interested in DX (distant) code reception than in the highly distorted and almost unrecognizable music.

Few people even dreamed of the vast entertainment possibilities of Radio during these days. James E. Smith founded the National Radio Institute in this year primarily to train men for careers as wireless operators on land and sea.

1915 Human voices leaped across the Atlantic for the first time in history; a radio-telephone conversation between radio operators at Arlington, Virginia, and the Eiffel

Tower in Paris was also heard by listeners in Honolulu. More and more ships were being equipped with wireless, creating a demand for trained wireless operators. The ability of Radio to save lies at sea in time of disaster was demonstrated forcefully again and again.

1916 America was doing its best to keep out of the great conflict in Europe despite the sinking of the Lusitania by a German submarine in 1915. Wireless was adopted by the New York Police Department as a means of combatting crime. Across the seas, wireless telegraphy was made compulsory this year on all British vessels over 3,000 tons. Naval vessels of all countries were rapidly being equipped with transmitters and receivers.

1917 America entered the World War. All amateur Radio enthusiasts pulled down their antennas and packed away their Radio apparatus in observance of a Government order. Many answered the Navy's call for volunteer wireless operators, and by the end of the war, over 3,500 American Radio Relay League members were in service as operators and Radio technicians. All activity in Radio during the war was concentrated in the various divisions of the Government and among Radio manufacturers who were making equipment for the Government.

1918 Radio played an important part in the activities of the U. S. Signal Corps in France, as well as in maneuvers of the U. S. Navy. Radio principles were applied to submarine-detecting apparatus for the first time. Radio technicians became an established unit of U. S. armed forces, doing all repair work on Radio apparatus. Tube manufacturers were making special hard (high-vacuum) tubes for the Navy, and somehow these tubes got out to the public shortly after the end of the war. Their superior performance doomed the former gaseous or "soft" tubes as amplifiers, although the soft detector was to reign supreme for some years to come.

1919 The war was over! All bans on Radio were removed and amateur Radio was re-established as a hobby. Spark transmitters were being junked in favor of vacuum tube oscillators, and more and more hams gave up C. W. for phone operation. Scores of commercial wireless stations were built in this country; most of them used the famous Alexanderson alternator, which was simply a huge A. C. generator capable of producing A. C. powers up to 300 kw. at frequencies over 100 kc. These alternators fed power directly to the transmitting antenna.

It was during this year also that Dr. Frank Conrad of Westinghouse broadcast phonograph records over a home-made transmitter in his garage in Pittsburgh, getting an avalanche of fan mail and requests for favorite recordings. Westinghouse officials were amazed at this interest in Radio.

From this small beginning in 1920 grew the 50,000 watt broadcasting station of KDKA and KDKA-TV.

1920 Westinghouse built its first transmitter in a little shack atop its nine-story factory in Pittsburgh. This station, eventually assigned the famous call letters KDKA, amazed the world with a broadcast of presidential election returns on November 2, 1920, followed by a report of Harding's election. Some two thousand newspapers began printing KDKA programs regularly; Radio was being acclaimed everywhere as the newest form of entertainment for the home, and receiver sales skyrocketed upward. Navy multi-range receivers left over from the World War were being sold to the public at this time, as also were receivers using honeycomb coils. "C" batteries made their appearance, pleasing the public because they cut down plate current and made "B" batteries last longer. Receiving tubes were hard to get, and cost anywhere from $6 up. Radio experimenters spent about $2,000,000 this year, not for complete sets but rather for parts with which to build their own crystal sets, small vacuum tube receivers, and transmitters. The first Armstrong superheterodyne circuit was announced. Amateurs immediately began experimenting with its circuit.

1921 Station WJZ (now WABC) at Newark went on the air and soon was broadcasting regular bedtime stories. The Dempsey-Carpentier prize fight broadcast made a hit; Radio had a sudden flurry of activity, with hardware, stationery, drug and even millinery stores selling commercial receivers or mechandising the handiwork of a mechanically-minded son or kid brother. Horns with places for attaching headphones were offered at $10 and up; glass and wooden bowls were also widely used to boost the sound output of headphones and permit groups of persons to listen. Attachments for holding phone units against the tone arms of phonographs were being sold this year. Signal strength was measured in terms of "can hear it with phones on the table."

Broadcasting stations were springing up like toadstools; while there were only 5 in December of the previous year, 532 more had gone on the air by September, 1922. More than 20,000 dealers rushed madly into this entrancing new field, and thousands more started manufacturing Radio apparatus. The majority of these received badly burned fingers toward the close of this year, when intense competition knocked the bottom out of prices. In New York, Chicago and elsewhere, cut-price Radio centers started up, offering the stocks of financially embarrassed and bankrupt Radio manufacturers at mere fractions of the original prices.

1922 WGY and WEAF (now WNBC) went on the air, with WEAF making history by offering its facilities to advertisers. Major Armstrong announced his super-regenerative loop receiver, a 3-tube circuit which amplified signals over 100,000 times with "nary a bloop or squeal."

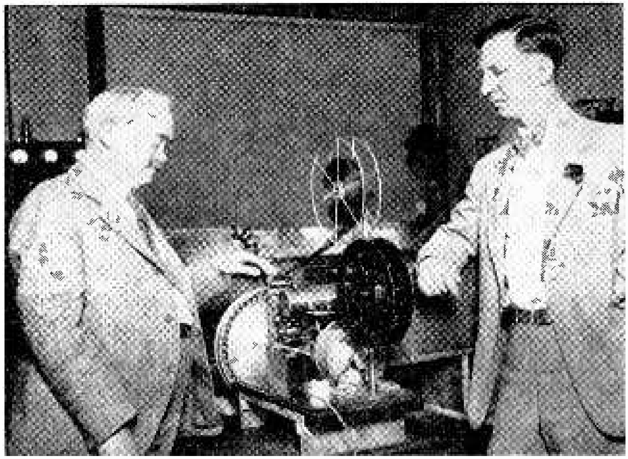
Magnavox came out with a deluxe electrodynamic horn type loudspeaker. The Hartley regenerative receiver circuit was popular with experimenters. Practically every high school student of the time had a crystal receiver and spent hours jiggling the little coil of wire called a "cat's-whisker," to get a signal into the headphones. What a thrill it was in those days to clamp on the headphones, tune the receiver, and scratch the crystal for half an hour to hear a station 25 miles away!

1923 Neutrodynes took the country by storm. These sets didn't squeal, and you could actually get a station twice in succession at the same dial setting—sometimes! President Harding had one of these receivers installed in the White House. Other popular receiver circuits included regeneratives and ultradynes; popular tubes were the 201A's, the 171A's and the UV199 "peanut" tubes. Vacuum tube receivers had replaced crystal sets, except possibly among the high school experimenters. Loudspeakers had come to stay. Set manufacturers prided themselves on the assortment of knobs and gadgets which decorated receiver panels, but already the public was calling for a single-knob control. Women resented the unsightly batteries, and inventors worked day and night to find some means of operating receivers from ordinary light socket power. Radio receivers became obsolete in from three to six months during these days, with even the larger companies selling surplus stocks at half-price and lower to clear the shelves for new models.

1924 President Coolidge's cat, presumably wandering in search of some errant love, was sought for and found by Radio, with newspapers making much of the story. Over 1,400 broadcasting stations were now pumping programs into the American ether; each station took any frequency it pleased in the band between 200 and 550 meters, since licenses did not specify any definite operating frequency. High-power transmitting tubes were not available, and the power radiated by each of these early stations was even less than that consumed by the average one-slice electric toaster. Daily broadcasts of Major League baseball games began this year, making a hit with fans.

The receivers being turned out by manufacturers were becoming more and more complex. By the thousands, an eager public snapped up superheterodynes, reflex sets, T.R.F. receivers and neutrodynes, and immediately there arose a need for skilled men to service these complex creations. Earlier receivers had been so simple that they seldom required servicing, and the real technical equipment in transmitters was being installed and maintained by trained factory experts, many of whom were NRI men. To meet the public demand for repairs on ailing receivers, Radio dealers began hiring men especially for servicing work—and thus a new profession was born. Early servicemen sweated over burned-out A.F. transformers in the famous De Forest Model D-7 self-contained loop receiver which with four tubes and a crystal detector in a reflex arrangement gave seven stages of amplification. In the equally famous RCA "portable" superheterodyne, the honeycomb coils and the extremely fragile type 199 tubes were going bad and creating profitable service calls. Western Electric came out with a magnetic horn loudspeaker, and this was soon supplanted in popularity by magnetic cone loudspeakers, some more than three feet in diameter.

1925 Radio coils reached a peak in unique design; set builders had to choose between standard solenoid coils, pancake coils, spider-web coils wound on forms like the spokes of a wheel, honeycomb coils, toroidal or doughnut-shaped coils, binocular coils, bank-wound coils, random-wound coils and even figure-of-eight coils. Coil forms were often removed after the windings were cemented together with a coating of coil "dope," on the theory that this would reduce losses. The Raytheon cold-cathode gaseous type BH rectifier tube was perfected this year. Over-production of receivers was a chronic complaint in the Radio industry, with hundreds of manufacturers plunging foolhardily into production schedules which inevitably resulted in bargain sales, receiverships and bankruptcies. Radio was now well established and so intriguing was this new entertainment to the public that each new improvement was received with open arms by all who could dig up the necessary money.



J. E. Smith assists the late Dr. C. Francis Jenkins in early Television experiments. This photo was taken about 30 years ago.

1926 The first all-electric sets timidly made their appearance, mostly with T.R.F. circuits and separate power packs. The "tinker" type of serviceman, seeing the array of chokes, filter condensers and voltage dividers in the power pack, silently dropped out of the picture. "B" eliminators became popular, with the type 80 tube sharing honors with the Raytheon BH tube as the rectifier in these units. The famous Browning-Drake receiver circuit revived a dying interest in set-building. The purchaser of a complete new Radio installation still had to choose five separate items in most cases: 1. A Radio receiver in a table model cabinet; 2. A loudspeaker; 3. A set of tubes; 4. An "A," "B," and "C" battery eliminator pack; 5. A suitable table or cabinet.

A U. S. Court decided that the Secretary of Commerce had no power to regulate broadcasting—only the power to issue licenses. This decision made Radio broadcasting even more chaotic than before; new stations merrily started up and increased power in tremendous jumps in order to drown out rival broadcasts. Whistles and heterodyne squeals were heard on almost every program. This year also marked the start of the National Broadcasting Company, the first network of stations.

In England the British Broadcasting Company was granted a Royal Charter. Its license to broadcast contained only one important restriction, namely, that no money could be accepted from outside interests; in other words, there was to be no commercial sponsorship of Radio programs. Broadcasting in England was to be paid for by the manufacturers of Radio equipment, by the Government, and by license fees collected from owners of receivers.

1927 Television was the big topic of discussion this year. Television receivers were being sold in kit form and as complete sets by Jenkins, Baird, Freed-Eisemann and several others. These sets used elaborate scanning discs and neon crater lamps, with the same scanning discs and photoelectric cells at the transmitters. Mechanical television systems reached the peak of their popularity this year, and even telephone television was tested out (two persons could see as well as talk to each other even though separated by many miles, but the quality of the image was very poor).

A super-abundance of stations forced manufacturers to sacrifice tone quality and fidelity to sharp tuning in order that interfering stations could be tuned out. Sales of Radio receivers reached a new low; the public sat back, waiting, aware that perfected A.C. sets were just around the corner. The Federal Radio Commission was established by the Government to clear up the chaos among transmitters. The first act of this Commission was to revoke all broadcasting licenses; it then assigned channels and powers so that interference between stations was at a minimum, and reduced the number of stations as well. The Columbia Broadcasting System was started. Single dial receivers became a reality, with the Kolster Six as one of the early leaders. The McCullough A.C. tube was announced.

1928 Attempts were made to bridge the Atlantic Ocean using mechanical television, but image quality was still poor and unsatisfactory either for commercial use or for entertainment. RCA put out the famous Radiola 17, an A.C.-operated receiver. Diode detectors began to receive consideration among set designers. Types 226 and 227 tubes with A.C. heaters were released by tube manufacturers and immediately snapped up by set manufacturers. The typical A.C. T.R.F. receiver of this day used type 226 tubes in the R.F. and A.F. voltage amplifier stages, a 227 tube as detector, a 71A tube in the output stage and an 80 in the power pack. A.C. screen grid tubes were announced the latter part of this year, with the 224 leading the list. Next came variable mu tubes and power pentodes.

1929 The Majestic receiver line, with several styles of console cabinets from which to choose, was the hit of the year. Majestic sets, with their characteristic deep bass response, met with instant popularity, and a few are still in use today. An estimated 110,000 people were employed in the Radio industry this year.

The Radio manufacturing industry underwent an inevitable upheaval this year. Important Radio patents had been scattered among many holders; patent rights were being openly violated and infringement suits were common. The Radio Corporation of America, organized shortly after the war in order to keep control of the Alexanderson alternator in this country, secured control of the important Radio patents, and granted licenses for these to other manufacturers, who could then build receivers without fear of litigation.

1930 The T.R.F. circuit still reigned supreme this year, even though many supers were being made. Interest rose in short-wave reception among the listening public; to meet this, manufacturers began putting out short-wave converters which changed an ordinary T.R.F. receiver to a short-wave superheterodyne. Plug-in coils for changing bands were replaced with band-changing switches about this time, but the average Radio set purchaser was content with broadcast band reception and scorned the complicated all-wave receivers. The National Carbon Company this year brought out a 2-volt air cell battery for farm Radios; this battery required no recharging and had a life of about one year as a filament supply. Experimental television broadcasts with mechanical systems were begun by the British Broadcasting Company this year in the 500-1600 kc band.

1931 RCA brought out the Radiola 80, one of the most famous of all Radio receivers; it was a 9-tube A.C. superheterodyne, and did more than anything else to start the super on its sudden climb to the throne as king of receiver circuits. The first midget receiver to attract widespread attention, the Jackson Bell set, came out this year; it heralded the flood of midget receivers which still continues today. This year just about marked the end of the set-building boom which had started back in 1922; receivers built at home from kits gave way to manufactured sets.

1932 Automatic volume control was introduced to make single dial receiver control more nearly possible and make reception more enjoyable by compensating for fading. Manufacturers, seeking ways and means of overcoming the summer slump in the Radio business, began giving considerable attention to auto Radios. The auto sets sold this year required separate "B" batteries or a dynamotor, as well as a separate loudspeaker. Remote tuning controls were provided right from the start, however.

1933 Police Radio installations became an important factor in the war on crime, creating new jobs for Radio operators. Remote control tuning, with cables running from control unit to receiver, was featured by some manufacturers. Another feature of the year was the Philco inclined sounding board.

1934 All-wave receivers which actually brought in foreign short-wave stations were the hit of the year. Among broadcasters the big news was WLW's boost in power to half a million watts under an experimental license. It was this year, too, that Admiral Byrd isolated himself for several months in a cabin 123 miles south of Little America, with Radio as his only means of contact with the rest of the world.

1935 Interest in television was reborn with the announcement of the Zworykin iconoscope and the Farnsworth image dissector tube for cathode ray television. Sensation of the year was the introduction of metal tubes. Radio broadcasting stations alone had a payroll of $21,491,000, and Radio technicians installed 1,100,000 auto Radios. All-wave antennas were developed for the new foreign-station receivers. All-wave signal generators and cathode ray oscilloscopes were brought out by manufacturers, to assist servicemen in repairing the new sets.

1936 Automatic tuning was the big new feature in the receivers announced during the fall of this year; most of the early sets also had automatic frequency control. Approximately 8,000,000 receiving sets were sold this year. Philco made a few cathode ray television receivers for experimental purposes, and other laboratories worked feverishly on cathode ray television development. An estimated 3,000,000 automobiles were equipped with auto Radios at the beginning of this year, and three out of four families in this country had home Radios.

1937 Floods in the Ohio River Valley disrupted communications and made thousands homeless. Radio jumped into service; broadcast stations and amateurs joining together to re-establish communication with isolated communities. Portable and police radios were installed in boats, which were directed by radio in their rescue efforts. Hundreds of lives were saved by the unceasing day and night efforts of radio operators and announcers.

Events of the Presidential Inauguration were broadcast to the world over one of the largest radio hook-up in history, with a number of NRI men at the controls in Washington. Features of the new radios were cathode-ray tuning eyes, slide-rule tuning dials and sleekly veneered cabinets for consoles. A trend toward higher fidelity and more classical music resulted in the formation of the NBC Symphony Orchestra. RCA conducted extensive experiments with cathode ray television.

1938 Push-button tuning was now considered almost essential. High-fidelity receivers made their appearance. Standards for television systems were approved by the Radio Manufacturers' Association, paving the way for the introduction of commercial television. Howard Hughes set a new record in flying around the world; contact with America by radio was maintained for the major portion of the flight, with Hughes broadcasting over a nation-wide hook-up while flying over Germany. Huge water-cooled 250.000-watt transmitter tubes, taller than a man, made news this year, along with midget or finger-size tubes for hearing aids.

1939 Important demonstrations of television at the New York World's Fair and the start of regular high-fidelity television broadcasts in the U. S. served to arouse the public's interest. Several manufacturers made a limited number of high-definition 441-line commercial television receivers. Time tuning and remote wireless controls were the two outstanding features of the year's new radio models. Radio cabinet designers matched accepted classic furniture styles with many console units. Automatic frequency controls were no longer required to correct for errors in push-button tuning systems, for the development of adjustable iron core coils and zero-temperature coefficient condensers made electrical tuning systems satisfactory. Improved mechanical push-button tuning systems were used in many midget sets. High fidelity cabinet arrangements such as the acoustic labyrinth became more prevalent among higher priced receivers. Wind chargers were available for farming communities and built-in loop aerials were brought back as a noise-reducing feature. Considerable interest was shown in facsimile broadcasting, and the frequency modulation system of Major Armstrong was announced. The start of the European war revived the public's interest in short-wave receivers with which to hear foreign broadcasts. It soon became evident that radio was to play an important part in this war as a means of communication between military units.

1940 To keep the public buying standard sets, many appeared with "television jacks" intended for the sound portion of television programs. Frequency modulation began to compete seriously for public interest as a high fidelity, noise-free means of transmission; commercial FM stations were permitted for the first time. Real portable receivers and extra small table models were widely sold. Tubes with 117-volt filaments made their appearance. A radio operated from a gas flame was demonstrated at the World's Fair. (The flame heated a thermocouple which produced sufficient power to operate the radio.) The war brought about a curtailment of amateur activities as communication with foreign countries was forbidden. Defense measures began to be taken, and many manufacturers began to convert to the manufacture of military equipment. The Selective Service Bill was signed and the draft started.

1941 So far the biggest year in radio history; 13,000,000 radio sets and 130,000,000 tubes were made this year. Radio models were frozen by agreement among the radio manufacturers, so as to release engineers for development of military equipment. Television in color was demonstrated and over $8,000,000 spent on television equipment and research. Commercial operation of television stations was permitted, with the acceptance of new standards. Frequency modulation began to spread rapidly with 30 commercial stations on the air. Hundreds of broadcast stations had their frequencies shifted and servicemen enjoyed a boom resetting push buttons. Interest in high-fidelity record-player combinations reached a high level.

Then, in December, came Pearl Harbor and the United States was again at war. All amateur operating activities stopped.

1942 The manufacture of all broadcast receivers was stopped and all receiver manufacturers changed over to defense activities. The manufacturers of war materials called for industrial control equipment and electronic engineers were in great demand. The better trained radio engineers and operators were snapped up in defense jobs or drafted, leaving a shortage of operators for broadcast and commercial stations. The Federal Communications Commission relaxed requirements for operating license classes for operating these stations. The manufacture of radio tubes was limited and many types were dropped altogether. The development of television was halted, but existing television facilities were used in training air raid and civilian defense personnel—the first example of mass education by television. Amateurs were permitted to join in civilian defense, forming communications networks for emergency purposes.

1943 Radio servicemen began to feel the pinch of the parts shortage. The draft was now taking large numbers of radio men, resulting in a business boom for those remaining. Remodeling receivers to get around shortages became fashionable. Electronic equipment of amazing types and quantities was made for the military forces. Equally amazing strides were made in electronic factory control equipment, designed to speed up production and deliver improved materials.

1944 Servicemen obtained some relief from the parts shortage as manufacturers were allowed to make some replacement parts. The emphasis was still on war needs, with no new radio receivers being manufactured. Even so, the United States had about 30,000,000 homes equipped with 57,000,000 radio sets.

1945 With the signing of the Japanese truce in September, 1945, the radio industry turned to the problem of supplying increasing public demands caused by acute deterioration of radio receivers during the lean war years. Production of long-needed a.m. receivers, even in the latter four months of the year after the lifting of War Production Board limitations, was quite slow because we still hadn't the necessary components for high rates of production. Industry was looking forward to frequency modulation and the Federal Communications Commission changed the frequency allocations to 88—108 megacycles. In general, with the war drawing to an end in 1945, it became a year for contemplative talk of what was going to be done to revolutionize public life through the great war-time inventions. Radar was to be a great motivating activity, so much so that it was jokingly said that even vacuum cleaners might be equipped with radar to stop damaging furniture legs.

1946 This was the year of great radio production. Roughly speaking, over fifteen million radio receivers were made and close to ten million of them were table models. About two million were battery receivers, a million and a half portable receivers, and about two million radio phonograph combinations. The demand was high, and since the price was also high, table model sales were in front. At first, any make of receiver was accepted, but as supply caught up with the demand, only the well known brands sold. A start was made on the frequency modulation receivers. Of the grand total of fifteen million only half a million frequency-modulated sets were made during this year. Of particular importance was the emergence of the universal a.c.-d.c. receiver using new miniature tubes lending compactness to the receiver. Selenium rectifiers, a war-time development, gradually came into use as a replacement for the vacuum tube rectifier in the small receiver. CBS petitioned the FCC to adopt its color TV system but was turned down.

In the broadcasting field there was a gradual increase in the number of AM broadcasting transmitters going on the air. FM stations were increasing in number. There were also a few television transmitters on the air and a number of TV construction permits. War-time developments began to appear in the transmitters but the so-called "miracle developments" did not appear in the radio receivers.

1947 During this year the number of radio receivers produced was again close to fifteen million, of which eight hundred thousand were FM receivers. Again the table model receiver was the best seller. Compactness was realized by using miniature tubes and resistors, selenium rectifiers and miniature i-f transformers. The printed circuit used in combination resistor-capacitor units was introduced. Again there was an increase in the number of broadcasting stations. The real value of the war-time research became evident in communications. There were improvements in aircraft radio. Airborne and shipborne radar in commercial navigation came into use and also new electronic circuits in industry. Electronic computers, radio frequency heating, photo-electric controls, and other electronic mechanisms were prominent improvements. Pulse techniques and other unique methods of modulating radio transmission began to appear. There was great progress in the frequency-modulated and television antennas along with the development of slot antennas for vhf and uhf. However, radar did not achieve the position of importance which some had predicted for it.

1948 Production of broadcast receivers continued heavily in the first part of 1948. People were insisting on well-known "name" products and gradually the supply caught up and passed the demand. The chief reason for this was that Television was coming into its own. The RMA standard for television transmissions had previously been accepted, and in 1948 it became clear that its framework resulted in good techniques of transmission and reception. In the larger areas of New York, Washington, Baltimore, Boston, Chicago, etc., Television was the main topic of discussion. The telecasting of Republican and Democratic conventions from Philadelphia made newspaper headlines throughout the nation. People bought television receivers as they became available. The RCA 630 and the Dumont were the basic receiver circuits and were licensed to the other manufacturers. The radio industry took on the production of TV receivers in earnest. The most popular set was the 10-inch receiver. A 12-inch set remained high priced and a 15-inch set was definitely a luxury.

A number of projection receivers also appeared on the market. Television was here. Its acceptance was no longer doubted. The communications field increased in activity and vhf, uhf and micro-wave came into their own for civilian use. Mobile communications services expanded, including taxicabs, railroads and other common carriers. In the phonograph field, the LP phonograph record was introduced, making it possible to accommodate the average symphony or concerto on a single disc, with attendant saving in storage space. In September the FCC realized that Television broadcasting was growing faster than it could be controlled and imposed a "freeze" on new construction and authorization of TV Stations for three months while a new system of allocating channels was worked out.

1949 This was the year when television really arrived! At the beginning of the year industry expected to produce 2,000,000 television receivers; as it turned out, 4,000,000 were produced! The "freeze" of new television station construction imposed by the FCC in 1948 restricted the erection of new television stations to those authorized at the time of the freeze. The question of color television was interjected into the freeze with unforeseen results. The 7-inch television receiver was beginning to fall by the wayside and the 10-inch also was becoming less popular. The 12-inch receiver was now the average with 15 and 16 inch receivers as "luxury" models. A 10-inch television receiver that cost over $300 in 1947 could now be purchased for under $200. The television industry was girding up its loins for a coming color television battle although at that time the ramifications were not known.

RCA introduced a 45 rpm 7-inch record with a rapid action changer. This complicated the phonograph industry by making three speeds—33 rpm, 45 rpm, and 78 rpm, the "standard" record speeds. Three speed record changers began to make their appearance in most of the new Phonograph-Radio-TV receivers.

It was clearly a time of expansion and opportunity for the properly trained Teletrician or Radiotrician. A man who had an understanding of the fundamentals of radio, television and electronics was assured of rapid strides in that growing field.

$68,400,000 were spent on television advertising in 1949—first year in which it was considered worthwhile to keep a record of the expenditures in this infant medium—compared with $628,000,000 for radio.

By the end of 1949 there were 98 television stations and 2021 radio stations.

1950 This was truly a year of change and excitement. The TV freeze imposed in September, 1948, for an expected three months stretched out and was eventually to last almost four years, although at that time, no one knew it. On January 1, 1950 there were 4,000,000 TV sets in use in the U. S. and on December 31, 1950 there were over 10,000,000. The number of stations increased by 9—from 98 to 107. Nearly 15,000,000 radio receivers and 383,000,000 tubes were manufactured. Auto receiver production soared to almost 5,000,000 and there were 90,000,000 radio sets in use in 45,000,000 homes in the United States by the close of the year.

In the summer of 1950 Korea erupted! The stock market fell to some degree and the radio and television market was unsettled. However, it soon re-bounded under the impetus of Government and military radio orders. Shortages began to develop in commercial radio receiving equipment, particularly in the supply of Alnico 5 used for loudspeaker magnets. Even so, the annual advertising bill was over $200,000,000 for television alone and almost $700,000,000 for radio.

In September the FCC announced that the CBS non-compatible color television system had been approved for use by the broadcasting industry. This touched off an immediate chorus of criticism from RCA and many other radio manufacturers who contended that the introduction of non-compatible color television would render obsolete over 10,000,000 television receivers.

A number of companies announced the manufacture of adapters and converters ranging in price from $12.50 to $200, which would make possible the reception of color television in black and white or color on older receivers. But due to the fact that very few color television programs were broadcast the CBS color television system did not catch on.

There was a lot of talk about transistors and many people both within and without the broadcasting industry began to consider them as a complete replacement for the vacuum tube. Of course their scarcity and the fact that the Government was reserving all transistor production for military reseach added to the rumors which were growing about this miraculous invention.

1951 By the beginning of 1951 America was crying out for Television; more and more Television stations were demanded and pressure upon Congress and the FCC to end the Television freeze was very heavy. Only one new Television station was added during 1951 to make a total of 108. However, the end of 1951 saw 3,144 broadcasting stations authorized.

This year 13,000,000 receivers were manufactured and approximately 5,000,000 auto receivers. The total number of auto receivers in use rose to 20,000,000 with 100,000,000 radio sets in use, an average of a little more than two radio sets for every home in the United States! In this year when only one TV station was added, 16,000,000 TV sets were in use. The total number manufactured, 5,500,000 was 2,000,000 less than in 1950. But it still represented a very good output in view of the unsettled world conditions at that time.

Various material conservation methods were making their presence felt, among them the use of self-focus and electrostatic focus picture tubes which eliminated need for expensive (in terms of copper and steel) centering and focusing devices. Although peace was in the air and was being discussed, fighting still went on bitterly in Korea. On the home front most items were in reasonably good supply but some were still rigidly controlled by the Government.

The words "color Television and UHF Television" were on the lips of everyone interested in Radio and Television for in the early part of this year the FCC issued its proposed rule to extend the Television band to the UHF region of 470 meg. to 890. The same 6-meg. band width was proposed so that existing receivers could be used by an additional reputedly simple UHF converter.

As the year ended, Radio and Television stocks were on their way up again, away from the slump at the beginning of the year. The total cost for Television advertising had almost doubled the previous year's figures to total $388,000,000; still less than radio's $712,000,000 but almost 100% greater than the previous year. At the end of 1951, over 300,000 people were employed in electronic manufacturing. This was the last year of comparative quiet before the Television rush of 1952-53 began.

1952 The hopes of the world for peace in Korea were still fluctuating but the Television broadcasting field looked bright with promise. This was the year in which the freeze finally ended. On April 14, the Federal Communications Commission issued the Final Television Allocation Report which made possible grants of new TV stations after July 1 of that year. As soon as the freeze was lifted, the FCC was flooded with applications for new Television stations and in the six months up to December, 1952, fifteen new TV stations, among them some UHF, went on the air.

The number of Television sets manufactured soared to 6½ million and 21,000,000 homes had TV sets, with a total of 22,000,000 Television sets in use in the country—thus proving that already some homes had more than one Television set. In spite of this surge of Television activity, 10,000,000 radio sets were manufactured. At the end of this year about 700,000 people were employed in connection with the Electronic and Television industries. Manufacturers engaged in military and civilian manufacturing were frantically advertising for qualified technicians, engineers and the manpower shortage in the Radio and Television electronic field was a reality.

Color Television came again to the fore and the National Television Systems Committee become very active in field testing and establishing standards for a new national color Television system.

About 110,000 transistors were manufactured in this year, mostly for Government and research. 15-inch, 16-inch, and 17-inch television receivers were the most popular.

In the six short months that UHF Television had been on the air, 75,000 UHF converters were sold for a total of $3,000,000 and the public and servicemen were clamoring for more.

1953 The year 1953 produced almost unbelievable changes in the Television picture. In one short year, the number of Television stations on the air went up from 123 to 326! Of these, 216 are VHF and 110 are UHF. No figures are available as yet for 1953 employment in the giant Radio-Television Electronic industry but it does not take much imagination to see what a demand there is for skilled Radiotricians and Teletricians who can take care of the installation and servicing of all the new UHF and VHF Television receivers, converters, and antenna installations. These figures do not include non-commercial educational stations which also offer employment possibilities. Including FM, AM and TV stations, there are approximately 3000 stations broadcasting today.

The junior experimenters, boys still in their early teens, were not forgotten either, and we at NRI proudly presented in time for Christmas, the Junior Experimenter's Electronic Kit which we prepared especially for younger people as an introductory step toward the wonderful field of Electronics.

In the world, wars and rumors of wars, continued, but at the close of 1953 there was hope for a brighter 1954 in the slackening of nuclear tension between Nations. Radio and Television are destined to play a large part in removing distrust between peoples of different races and nationalities, and the Voice of America has been constantly stepping up its transmissions to bring the story of freedom and love of peace to the other side of the Iron Curtain. Many NRI graduates and students have been assisting in this project, keeping the Radio and Television stations of the Nation operating and running efficiently.

As Television pushes ahead to new frontiers and the FCC's often quoted figure of 2000 or more TV stations, there appears to be unbounded opportunities for qualified technicians, such as NRI turns out.

There is no limit to the vista of opportunities for us. Television is even now reaching to the northernmost quarters of our country and by the time that this is in print, there will probably be two Television stations operating in Alaska. Two days before writing this, magnetic tape recording of black and white and color Television was demonstrated by RCA. Magnetic tape recording of audio signals is as common today as the use of phonograph records. Transistors have come into their own and are being used in miniature receivers. For the future, color, 3D-Television, transistors, Television magnetic recording, and a score of many as yet unannounced developments beckon to the man who has accepted the challenge of electronics and equips himself to be a Radiotrician or Teletrician. Good luck to you all in this year of promise, 1954, our fortieth anniversary year.

SALUTE TO THE NATIONAL RADIO INSTITUTE

"The following broadcast was prepared by staff members of Radio Station WRC, of the National Broadcasting Company, in Washington, D. C. It was heard over that station on November 15, 1953, as one of a series of broadcasts to salute pioneer industries in the Nation's Capital."

A FRIEND of James E. Smith once laughingly remarked to him that the three most familiar faces in American advertising belong to three men named "Smith." Two of the trio are brothers and the third is none other than James Ernest Smith himself. The friend said it as a joke . . . but nevertheless he was probably right!

As far as names go, there's certainly nothing outstanding about "Smith"—or even "James E. Smith." The Washington telephone book lists a hundred and seventeen different "James Smiths," and fourteen of these have "E" for a middle initial. *But* . . . only one of the fourteen has a face that's familiar to millions of people all over the country. And that *one* is the founder and president of the National Radio Institute . . . located right here in Washington at the corner of Sixteenth and "U" Streets, Northwest.

Where, you ask, has this man's face been displayed that he should be seen by millions of people? Just pick up any of the nationally-circulated science and mechanics magazines and thumb through the first few pages. You'll come to a full-page "ad" in eye-catching black-on-yellow, with a man's picture and the caption: "I will train you at home to be a radio-television technician." You've probably seen the face and the advertisement numerous times, because the same picture and layout have been running for literally decades in all the leading technical publications. And, incidentally, he means what he says about teaching you the fundamentals and fine points of radio and television. His school—the National Radio Institute—has enrolled more than half a million men and women since it was founded in 1914. His students have qualified in every technical phase of broadcasting . . . have, in many cases, become tops in their field. In fact, it can safely be said that he has trained more people for radio and television than any other man.

And how did such a fabulous career as his get started? Well, from early boyhood, Jim Smith had been interested in electricity. Men had just begun to open up its secrets . . . were just learning how to harness this great raw energy, while revealing yet unexplored regions in the realm of electrons and protons. It was an exciting new field, and Jim wanted to find out all he could about it. But since his father was a none-too-prosperous New England farmer, a higher education for Jim meant getting out and earning it himself. So, turning from the farm to something more lucrative, he took a job as a locomotive fireman . . . worked at it for more than a year, and finally quit when he'd saved enough money to enter Worcester Polytechnic Institute. On graduating in 1906 with a Bachelor of Science degree in electrical engineering, he joined the Westinghouse Electric and Manufacturing Company of Pittsburgh, to test equipment and do a little teaching.

One of his former classmates at Worcester Tech, meanwhile, had traveled south to Washington and taken a job as instructor at McKinley Tech High School . . . and had it not been for *him,* Jim's life probably would have been entirely different. It seems this fellow became seriously ill while in the middle of the school term; and he asked Jim to come down and teach his classes for the rest of the semester. Jim got an extended leave of absence from his job and headed for Washington and Tech High, where he took over the course in Applied Electricity. For Jim it meant more than just a teaching job, or doing a friend a favor. It was a chance to experiment, to learn, and to teach others what he already knew.

At the time, the wireless had already been invented and demonstrated; and all over the country it was finding practical application among enthusiastic amateurs. As exciting and, at the same time, as inexpensive as a hobby could be, people were finding out that they could send and receive messages in code with little more than a hunk of crystal, a set of earphones, and a thin length of wire called a "cat's whisker." Not the least excited by the developments was the young shop instructor, Jim Smith, who introduced telegraphy as a regular part of the school's course in electricity. Needless to say, the faculty and the Board of Education were quick to appreciate his achievements, and just as quick to offer him a permanent position, which he accepted. For the school system, his acceptance was extremely significant, for in him they had one of the relatively few men in the country with any advanced knowledge of radio. And for Jim it meant a continuation of the two things he liked best: teaching and electronics.

The word "radio" didn't come into general usage until after the World War, when sounds other than dot-dash signals began to be transmitted.

Yet even before the broadcasting of speech and music, people were greatly amazed by the sending and receiving of *any* sound great distances without a visible means of conveyance. Seldom has anything captured the public fancy as did radio during those first years. People practiced and experimented . . . traded information and devoured any literature on the subject that was available. And if anyone knew enough about it to teach the subject in school, that person was indeed popular!

Jim Smith had people coming to him regularly for information . . . and he was glad to help them, when he had the time. Usually they just wanted an answer to this or that problem; but one day four young men asked him if they could take formal instruction from him at night. It took a lot of urging on their part, because along about this time, Jim had become a family man, and had little inclination to spend his evenings away from home. He finally gave in, however, and started teaching radio in one small room of a building at Fourteenth and "U" Streets, Northwest. That was the beginning of the National Radio School. The year was 1914.

J. E. Smith is a Senior member of the Institute of Radio Engineers, a life member of the American Institute of Electrical Engineers (Past Chairman of the Washington, D. C. Section), member of the American Radio Relay League, Radio Club of America, and Adult Education Association of U.S.A. Other affiliations of Mr. Smith are those with the Washington Chamber of Commerce, University Club, Engineering Club of Washington, National Better Business Bureau. He is past President of the Round Table International, and in 1953 was conferred the honor of Knight of Achievement. Mr. Smith is past President of the Washington section of the Worcester Polytechnic Institute Alumni Association. He is a member of the Advisory Board of the Washington Y.M.C.A.

If radio had been developing fast up until then, it really broke wide open when we entered the War in 1917. Our government knew the immense value of radio in modern warfare, and went all out to establish a training program for radio operators and maintenance men. The National Radio School—hardly started by the time we entered the conflict—found itself literally flooded with trainees. The staff had already been increased to six by 1916, and with the sudden influx of students the following year, the number of instructors jumped to twenty. By this time, of course, Jim had given up his job on the Tech faculty in order to devote all his time and energy to running his fast-growing school, and teaching radio to two groups of eight hundred Howard University Students. What made it especially difficult for him at this time was the constantly changing nature of radio: a piece of equipment might be the latest thing one week and obsolete the next. And as if all these things weren't enough to keep him and the staff busy, there was also a rapidly growing list of students learning radio by correspondence. This part of the business had developed when students moving to other cities asked to have their courses continued through the mail. In time, it became the major activity of the school; and then finally classroom instruction was discontinued altogether in favor of the correspondence method. This seemed to be the most practical way of handling the rapidly growing enrollment, since otherwise an enormous institution would have been required to handle the twenty thousand regular members of the student body.

Anyhow, getting back to our story, National Radio School really came of age during the first World War . . . and it's been a first-class insti-

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HOW TO SERVICE THE COMMON AC-DC RADIO RECEIVER

By B. VAN SUTPHIN
NRI Consultant

B. van Sutphin

TODAY, most of the radios that you will service are ac-dc sets. The circuits used in most of these sets are basically the same. This article will help you to understand ac-dc sets and to service them faster.

The composite ac-dc receiver diagram (Fig. 1) and the diagrams of the more common circuit variations form a basic service manual for ac-dc sets. The diagram has been placed in the center of this magazine so that you can easily remove it. After you finish reading the article, you may wish to mount the diagram over your service bench for easy reference.

Tubes Used in Typical AC-DC Circuits

The modern 5-tube ac-dc receiver uses the following tubes or their equivalents: 12BE6 oscillator-mixer; 12BA6 i-f amplifier; 12AT6 second detector-avc-first audio; 50B5 audio output; and 35W4 rectifier. Fig. 2 lists the tubes you are most likely to find in ac-dc sets.

In many cases, a manufacturer specifies a certain tube in the first run of a receiver, but substitutes a different tube later. The manufacturer can, by changing the tube socket and the socket wiring, substitute a 50L6 for a 50B5, a 12SK7 for a 14A7, or a 35W4 for a 35Z5. When such tube substitutions are made by the manufacturer, there is seldom any change in the receiver circuit. The tubes are almost identical; consequently a new tube socket and slight re-wiring allow tubes to be substituted.

This is a very important point, because you will frequently find such substitutions in commercial ac-dc receivers. There is no reason for such a substitution to bother you if you have a tube manual. Simply look at the base diagram of the substitute tube, and determine which pin is connected to which element of the tube. Then check the voltages and compare them with the voltages listed for that particular element of the tube.

Tracing the Filament Circuit

Let's look at Fig. 1, particularly at the filament connection of the various tubes. This basic order of connection is used in almost all ac-dc receivers. The rectifier tube filament connects to the "hot" side of the power line, and the audio output tube is next. Then, the i-f amplifier tube, the oscillator-mixer, and finally the second detector-avc-first audio tube. The second detector-avc-first audio tube filament is usually connected at the B- end of the filament string so that one side of the filament is at B-potential. This helps prevent excessive hum pick-up by the high-gain first audio amplifier stage.

This information enables you to determine where the various tubes should be placed in the receiver even when you receive a set that has had the tubes removed. Locate the socket that has one of its filament pins connected to the hot side of the power line, and install the rectifier tube in that socket. Next, locate the tube socket that has one of its filament pins connected to one of the filament pins of the rectifier tube socket, and install the audio output tube in that socket. Next, the i-f amplifier tube; then the oscillator-mixer tube; and finally the second detector-avc-first audio tube. (Of course, you can start at the B- point for the receiver and trace the circuit in the other direction).

Filament Circuit Defects

The most frequent defect in the filament circuit of an ac-dc receiver is an open tube filament. The simplest way to locate such a defect is by removing each tube from the set and then checking across the filament pins of the tube with an ohmmeter. If any tube filament is open, replace that tube.

There is one further point that must be mentioned in connection with open tube filaments. Notice that the pilot lamp (PL 1) is in parallel with a portion of the rectifier tube filament. Also notice that the rectifier plate connects to the tap of the filament. This means that the B supply current for the entire set must flow through the parallel combination of a portion of the rectifier tube filament and the pilot light. When you find an open rectifier tube filament, you should always check the possibility of a short in the power supply circuit before you install a new tube. This is particularly true when you also find that the pilot light has burned out.

To check the possibility of a short, unplug the receiver, short the two prongs of the power plug, and turn the set's switch on. Then connect one lead of your ohmmeter to the shorted prongs of the power plug, and connect the other ohmmeter lead to the *cathode pin* of the rectifier tube socket. Note the reading and then reverse the ohmmeter leads and again observe the reading. The highest reading is the one to use. Both readings are suggested because electrolytic condensers are involved and you must observe the polarity of your ohmmeter test leads. Only one reading, with the positive ohmmeter probe connected to the rectifier cathode, is required if you know your ohmmeter polarity. A low-resistance reading (10,000 ohms or less) indicates a short. Locate the shorted component and replace it before you install a new rectifier tube. Particularly, check the filter condensers and the audio by-pass condenser connected between the plate and the cathode of the audio output tube, or between the plate of the audio output tube and B-. These condensers frequently short.

Occasionally you will encounter a set that "blinks." That is, the set will start to heat up, and the tube filaments will light; suddenly they will go out. After a minute or so, the filaments will come on again; then go out again. This symptom is the result of a thermal open in a tube filament. Since the tube filaments are in a series, an open at any point will cause all of the filaments to "go out." When the circuit opens, the entire line voltage will appear across the "break" and there will be no voltage drop across the rest of the tube filaments. This makes it easy to find the defective tube. Connect an ac voltmeter, set to measure the line voltage, across each tube filament in turn. Leave the meter connected until the set "blinks." If the tube is good the voltage across the filament will drop to zero. If it increases, the tube should be replaced since it has a thermal open in its filament.

Another common filament defect prevents one or more of the tubes in the set from lighting. The schematic shows that the filament of the second detector-avc-first audio is the only tube filament that connects directly to B-. Now suppose a heater-cathode short existed in the i-f amplifier tube—what would happen? Of course, the heater-cathode short would connect the filament of the i-f amplifier to B—. Consequently, the full line voltage would be applied to the rectifier tube filament, the audio output tube filament, and possibly the i-f amplifier tube filament. The oscillator-mixer tube filament and the second detector-avc-first audio tube filament would receive no voltage. Consequently, they would not light.

When you encounter this unusual condition, it is sometimes difficult to decide just which tubes are receiving filament voltage. The metal tubes used in many ac-dc receivers do not have visible filaments; and although a tube which feels cold would indicate a lack of filament current, you should always use your voltmeter to check the filament voltages. In this way, you can decide exactly which filaments are receiving voltage, and then decide which tube is most likely to have a heater-cathode shhort.

The Five-Tube AC-DC Circuit

As mentioned previously, Fig 1 is a composite circuit. That is, it represents the type of circuit you are most likely to find in commercial receivers. Few sets will be exactly like this diagram, but the general design will be the same. In this discussion, we will consider each part in the receiver, its function, its approximate value, and the effect of failure—either an open or short. The parts will be considered one-by-one starting at the loop antenna and proceeding through the set. The parts are listed in Fig. 3.

The loop antenna picks up the electromagnetic radiation from the air and supplies the resulting rf voltage to the input of the receiver. The loop antenna and the mixer section of the tuning condenser form a tuned circuit that helps pick out the desired signal and exclude undesired signals.

Loop antennas occasionally open, and cause decreased sensitivity and in some cases a tendency for the set to block or to motorboat. Simply check for continuity between the two terminals

Fig. 6. Alignment Table

	1	2	3	4	5
Plate	100	100	60	115	120AC
Screen	100	100	—	100	—
Cathode	—	—	—	6-9	120
Control Grid	*—1	*—1	0	0	—
Osc. Grid	—9	—	—	—	—

*Note: Voltages measured with set tuned to a weak station. These voltages will vary with signal strength.

Fig. 2. Tube List

V1—Osc.-Mixer
12SA7
12BE6
14Q7

V2—I.F. Amp.
12SK7
12BA6
14A7

V3—2nd. Det.—1st. A.F.
12SQ7
12AT6
12AV6
14B6

V4—Audio Output
50L6
35L6
50B5
50C5
50A5
35A5

V5—Rectifier
35Z5
35Y4
35W4

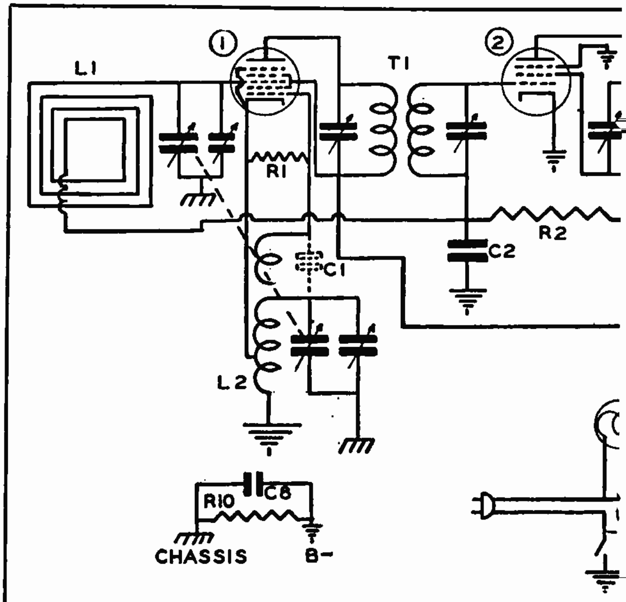


Fig. 1. Basic AC—

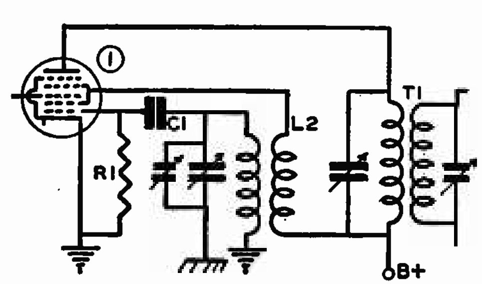


Fig. 4. Oscillator circuit with 2-winding oscillator coil.

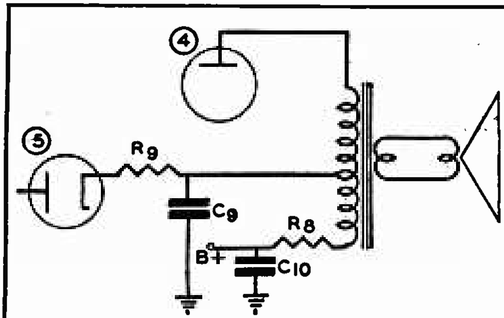
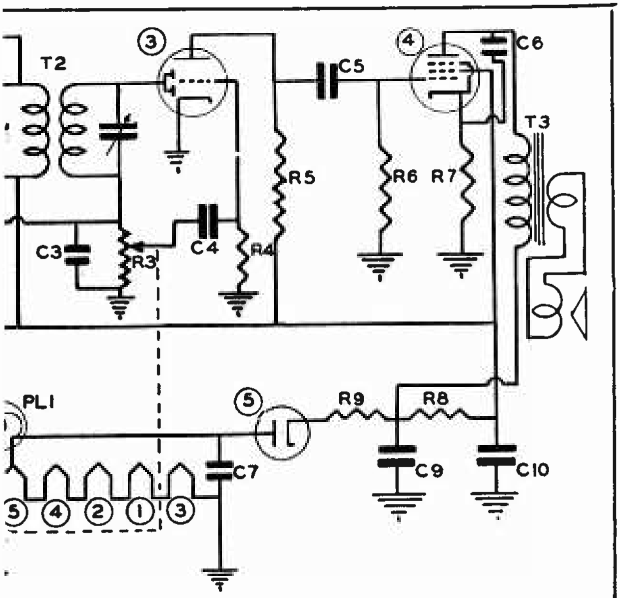


Fig. 7. Tapped output transformer as part of filter network.

Fig. 6. Alignment Table

Step	Signal Generator Coupling	Signal Generator Frequency	Receiver Dial Setting	Adjust
1	High side to stator of oscillator tuning condenser. Low side to B—	455kc	Low end of dial	Trimmers of 1st and 2nd i-f transformers
2	To loop of wire placed near loop antenna	1400kc (see note)	1400kc (see note)	Oscillator trimmer
3	Same as in Step 2	1400kc (see note)	1400kc (see note)	Mixer trimmer

Note: To avoid interference in steps 2 and 3, you can use any frequency between 1400kc and 1500kc; just be sure that you set the receiver dial and the signal generator dial to the same frequency.



-DC Schematic.

Fig. 3. Parts List and Values

R1 —22K-ohm, 1/2 watt
R2 —2 megohm, 1/2 watt
R3 —1 megohm potentiometer
R4 —10 megohm, 1/2 watt
R5 —470K-ohm, 1/2 watt
R6 —470K-ohm, 1/2 watt
R7 —150-ohm, 1 watt
R8 —1200-ohm, 2 watt
R9 —33-ohm, 1/2 watt
R10—470K-ohm, 1/2 watt
C1 —50 mmfd mica or ceramic
C2 —.1mfd.
C3 —250 mmfd
C4 —.01 mfd.
C5 —.01 mfd.
C6 —.005 mfd.
C7 —.1 mfd.
C8 —.1 mfd.
C9 —30 mfd./150 V } may be a dual
C10—50 mfd./150 V } condenser
PL1—#47 pilot light

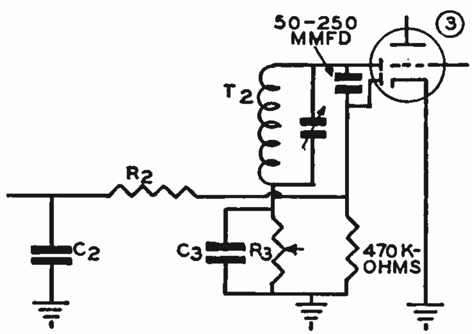


Fig. 8. Separate avc system.

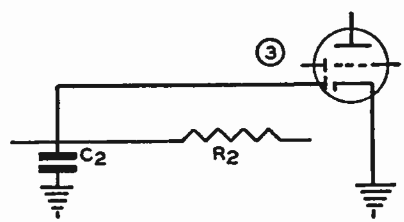


Fig. 9. Gas gate.

of the loop. An open circuit reading indicates an open loop. Incidentally, be sure that you use the correct pair of terminals on the loop. Some receivers have an extra winding for use with an external antenna and these leads are usually brought out to their own terminals. Loop antennas rarely short.

Another possible loop antenna defect is absorption of moisture. (This is particularly true of loops wound on porous cardboard.) This condition will show up as decreased sensitivity and abnormally broad adjustment of the loop trimmer. The simplest way to correct this trouble is to replace the loop. In fact, that is the simplest way to correct any defect in the loop antenna, except an open loop connection or a poor solder joint at one of the terminals.

The dual-section variable condenser tunes both the input circuit of the set and the oscillator circuit. If you need a replacement condenser, purchase a "superhet condenser" designed for use with a 455-KC i-f system. Dust often collects in tuning condensers and prevents proper contact between the rotor and the condenser frame. Cleaning the rotor contacts with carbon-tet and applying a few drops of oil will generally clear up this problem.

Occasionally you will find a tuning condenser with bent plates. The set will generally be noisy at one point on the dial and dead below that point. If you can determine which plate is bent and straighten it, do so. If all of the plates are bent, purchase a new condenser.

L-2 is the oscillator coil. The coil is subject to opens, shorts, and possible absorption of moisture. If the coil opens, the oscillator will stop and the set will be dead. If the section of the coil that is between the cathode of the oscillator-mixer tube and B— opens, the oscillator will stop and a higher than normal voltage will appear between the cathode of the tube and B—. If the other section of the oscillator coil opens, you will have no real indication except lack of oscillation. Of course, a quick ohmmeter test would disclose that the coil is open.

Particularly notice the open circuit winding shown immediately above coil L-2. This winding provides capacity coupling between the grid of the oscillator tube and the oscillator tank coil. Though no connection exists between these two coils, there is capacity—sufficient capacity to provide the necessary feed-back. In some cases, this special winding is not used. Instead, a 50-mmf. or a 100-mmf. condenser is connected between the grid of the oscillator tube and the ungrounded side of the oscillator coil. The effect is the same.

There is no real way to check the capacity winding except by temporarily connecting a condenser between the ungrounded side of the oscillator coil and the grid of the oscillator tube. However, the winding rarely fails, and consequently a testing procedure is not particularly necessary.

The oscillator circuit shown in Fig. 4 is used in some ac-dc sets. Notice that the oscillator coil has two separate windings. If a tapped oscillator coil like the one shown in Fig. 1 is not available for replacement purposes, rewire the circuit so that it is like the one shown in Fig. 4.

In both oscillator circuits R1 is the grid resistor for the oscillator stage; the bias for the stage is developed across this part. This resistor is usually 22K-ohms for the mixer tubes listed in Fig. 2. If this resistor shorts, the oscillator will stop; if the resistor opens, the oscillator will stop. The resistor will sometimes increase in value and prevent the oscillator from operating at one end of the dial.

T-1, the first i-f transformer, couples the output of the oscillator-mixer to the grid of the i-f amplifier. If the primary of the transformer opens, there will be no plate voltage on the oscillator-mixer tube. Of course, the set will be dead. If the secondary of the i-f transformer opens, a higher-than-normal negative voltage will appear at the grid of the i-f amplifier tube. Sometimes you will find that connecting a meter between the grid of the i-f amplifier tube and ground will cause the set to start playing. This usually indicates that the secondary of the i-f transformer is open. An ohmmeter test will verify this. (This is a relatively rare complaint, and one that you are not likely to encounter.) Of course, the i-f transformer can absorb moisture. When this happens, both the selectivity and the sensitivity of the receiver will decrease. Replacement is the only practical solution for i-f transformer defects. Use a standard replacement 455-kc i-f transformer. The above considerations also apply to the second i-f transformer, T-2.

R-3 is the volume control and, at the same time, the load resistor for the second detector stage. The control is generally a 1-megohm unit, but values between 250K-ohm and 2-megohms are sometimes used. If the control opens, the set may oscillate at certain settings of the volume control, and operate normally at certain other settings, but the set is more likely to be dead. To check the control, connect one of your ohmmeter leads to the B— terminal of the volume control, and the other to the hot terminal. Read total resistance of the control on your meter. Next, move one ohmmeter probe to the center terminal of the control. Then vary the control over its range. The resistance should vary smoothly without any abrupt changes. If an open circuit reading is obtained at some particular setting of the volume control, the control is open and should be replaced. It is highly unlikely that the volume control will ever short; the internal construction makes that virtually impossible.

Another common volume control defect is noisiness. Many servicemen use carbon tet to clean volume controls. However, you will be able to do a much better job if you will mix ten drops of machine oil with one or two fluid ounces of "carbon tet." Shake the mixture so that the oil will dissolve in the carbon tet. This mixture does a much better job than carbon tet alone. Also, commercial preparations for cleaning volume controls are available.

Three voltages appear across resistor R-3: The dc voltage developed by the detector action, the rf signal voltage, and the audio signal voltage obtained from the modulated rf carrier. The dc voltage is desirable for avc purposes, and the audio voltage is, of course, desirable to operate the first audio amplifier tube in the receiver. The rf signal is not desirable and must be by-passed for good detector action. Condenser C-3 is the rf by-pass. Generally, this condenser is connected directly across the two outside terminals of the volume control. This condenser is usually a 250-mmf. mica condenser or a small ceramic condenser. If the condenser opens, the receiver may oscillate. To check the condenser, temporarily substitute a new one.

Resistor R-2 and condenser C-2 are the filter network for the avc system. Resistor R-2 is generally a 1-meg. or 2-meg. unit and condenser C-2 is generally between .02-mfd. and .1-mfd.

If condenser C-2 opens, the avc voltage will vary at an audio rate. At the same time, rf energy probably will be fed from the grid circuit of the oscillator mixer tube to the grid circuit of the i-f amplifier. This feedback will probably cause oscillation. If condenser C-2 shorts, no avc voltage will be applied to either tube, and the set will more than likely distort on strong signals.

If resistor R-2 opens—as it frequently does—the receiver may have any one of a number of symptoms. The set may be dead, it may overload on strong signals, or it may oscillate. If resistor R-2 is completely open, the grid circuit of the i-f amplifier tube and the grid circuit of the oscillator-mixer tube will be "floating." Consequently, the grids will slowly assume a negative charge that will be sufficient to cut off all plate current. Therefore, the set will be dead. If the resistor has increased in value so much that the avc voltage across resistor R-3 is not transferred to the grid circuit of the two tubes, the set will overload on strong signals and produce distortion. If the resistor increases in value so much that insufficient avc voltage is supplied to the two tubes, the i-f amplifier stage may oscillate. Check the resistor with an ohmmeter; check the condenser by temporary substitution.

C-4 transfers the audio signal from the volume control to the grid of the first audio amplifier tube. It is generally a .01 mfd. unit. If this condenser shorts, the dc voltage across resistor R-3 will be applied to the grid of the first audio amplifier tube. The set will probably distort on weak signals and be dead on strong signals. If the condenser opens, the set will be dead.

R-4 is the bias resistor for the first audio amplifier tube. It is usually a 10 megohm unit, but higher values—up to 20 megohms—are sometimes used. If this resistor increases in value, the bias voltage on the first audio amplifier tube will also increase. If the bias increases too much, the tube will be cut off and the set will be dead. If it increases only slightly, the sound will probably be distorted. If the resistor is shorted, the set will be dead.

Resistor R-5 is the plate resistor for the first audio amplifier stage. It is generally a 470K-ohm unit. If this resistor decreases in value, the plate voltage applied to the first audio amplifier will increase, and the gain will decrease. If the resistor increases in value, the plate voltage applied to the first audio amplifier tube will decrease, and the set will indicate one of two troubles: either the sound will be distorted, or the set will be quite weak.

C-5 is the coupling condenser between the plate of the first audio amplifier tube and the grid of the audio output tube. It is generally a .01 mfd. unit. If this condenser shorts, the positive voltage at the plate of the first audio amplifier tube will be applied to the grid of the audio output tube; distortion will result. If the positive voltage at the audio output tube grid is sufficient to overcome the bias, excessive current will flow through both the audio output tube and the resistor in series with the cathode. The cathode resistor will probably be damaged, and the tube may become gassy. If condenser C-5 opens, the set will be dead.

R-6, generally a 470K-ohm unit, is the grid resistor for the output stage. If resistor R-6 shorts, the set will be dead as the grid of the audio output tube will be shorted to ground. This is highly unlikely. If the resistor increases in value, you will probably notice a decrease in the sound output, and, at the same time, some distortion.

R-7 is the cathode resistor for the audio output tube; the value is usually 150 ohms. If the resistor increases in value, the bias applied to the audio output tube will also increase, and the set will probably distort. Of course, if resistor R-7 increases enough, the negative voltage will reduce the plate current to the point where the set will be dead. More about R-7 in a moment.

C-6 is the audio by-pass that keeps the undesired high-level high-frequency audio components out of the plate circuit of the audio output tube. It is generally a .005 mfd. unit. If the C-6 opens, the volume will probably increase slightly and the set may oscillate. In addition, you will notice a distinct change in tone. (Many servicemen refer to this condenser as a "tone control condenser." The term, though incorrect, gives you a rough idea of its effect.) If C-6 shorts, the plate voltage for the audio output tube will be applied across resistor R-7. Consequently, resistor R-7 will be severely damaged. In fact, the resistor will probably burn in two. The primary of T-3 may also be damaged or open.

T-3 is the audio output transformer for the receiver. The load required by most of the tubes used in the output circuits of ac-dc sets is between 2000 and 4000 ohms. Therefore, the output transformer should match a 2000-4000 ohm plate circuit to a 4-8 ohm voice coil. If the primary of this transformer shorts, the set will be dead but plate voltage will still be available for the audio output tube. In fact, the plate voltage will be slightly higher than normal. If the primary opens, no plate voltage will be available for the audio output tube, and with screen voltage applied but no plate voltage, the screen, if visible, will be red hot. The tube will probably be damaged. If the secondary of the audio transformer opens, the set will be dead. This is highly unlikely.

The speaker changes the voltage variations into sound variations. A PM speaker with a 4-8 ohm voice coil is generally used in ac-dc sets. If the voice coil opens, the set will be dead; if the voice coil shorts, the set will also be dead. The resistance of the voice coil is usually between 4 ohms and 8 ohms. You can therefore check the voice coil with the lowest range of your ohmmeter. It is seldom practical to repair a defective speaker. Replacement is always the best solution.

Other defects occur in speakers. The voice coil will sometimes open intermittently. When this happens, the sound output of the speaker will disappear, and then suddenly return with a loud crash. Usually, the sound will come back when loud bass notes are being transmitted, and immediately disappear again. Speaker cones sometimes warp and cause the voice coil to drag on the pole piece of the speaker. When this happens, the receiver will distort. If the dragging is slight, the distortion will occur only at low volume.

R8 is the filter resistor of the receiver. It is usually between 1000 and 2000 ohms. If the resistor shorts, the set will hum; if it opens, the set will be dead. In either case, you can check the resistor with an ohmmeter.

If you find the filter resistor badly burned, be sure to check the output filter condenser and the plate by-pass condenser for the audio output stage before you install a new resistor. If either of these condensers is shorted, the new filter resistor will overheat.

C9 and C10 are the filter condensers. C9 is usually 30 mfd. and C10 is generally 50 mfd. (They are usually combined in a dual-section condenser.) If either of them opens, the set will hum. If either of them shorts, excessive current will flow through the rectifier and the tube will probably be damaged. A 30 mfd./150 volt input filter condenser and a 50 mfd./150 volt output filter condenser are satisfactory for replacement purposes. (Use the 30-mfd. condenser as an input filter and the 50-mfd. condenser as an output filter. Connecting the condensers in this manner gives a very low hum level.)

R9 is the current limiting resistor used to prevent excessive current flow though the rectifier tube and the pilot light while the input filter condenser is charging. The resistor is usually 22-ohms or 33-ohms. If the resistor opens, the set will be dead; if it shorts, turning the set off and back on immediately may burn out the pilot light.

The current limiting resistor can be connected between the cathode of the rectifier tube and the input filter condenser, or it can be connected between the pilot light and the plate of the rectifier. In either position, the resistor limits the current flow when the set is turned on.

C7, generally between .01 mfd. and .1 mfd. is the noise by-pass condenser for the set. The only purpose of this condenser is to prevent noise pulses in the power line from entering the receiver. If this condenser shorts, the house fuse may blow. Notice that the condenser is connected almost directly across the ac line. In other cases, if this condenser shorts it will burn out the pilot light and a portion of the rectifier tube filament. The condenser may be connected from the plate of the rectifier tube to B—, from the cathode of the rectifier to B—, or directly across the power line. The purpose of the condenser is the same in each case.

C8 couples the B— lead of the receiver to the chassis itself. It is generally a .1 mfd. unit. Notice that one side of the oscillator coil is connected to B—, but one side of the oscillator tuning condenser is connected to the receiver chassis. Condenser C8 completes the circuit so that the oscillator coil and the tuning condenser are in parallel. If C8 opens, the set will probably be dead, or the receiver will tune the wrong range. (Notice that if condenser C8 opens the oscillator frequency will increase.) The simplest way to check the condenser is by temporary substitution. If condenser C8 shorts, the B-line of the set (one side of the power line) will be connected directly to the receiver chassis. In that case, the set will be dangerous.

Resistor R10 is connected across condenser C8 to prevent C8 from assuming a charge equal to the line voltage. Notice that if resistor R10 opens, condenser C8 can assume a charge equal to the line voltage. Therefore, 110 volts can exist between B— and the receiver chassis. However, this will not produce any particular effect on the receiver performance, but the set would be dangerous.

Representative voltage readings are given at the upper left (Fig. 5) of the diagram. These readings are approximately what you should expect in an ac-dc receiver, with a half-wave rectifier circuit, that is operating properly.

Alignment information is given at the upper right of the diagram (Fig. 6). Before you align the receiver, you must connect an output meter to the set. If you are using a volt-ohmmillammeter, use the OUTPUT jack of the instrument and the COMMON jack. Connect the COMMON lead to B— in the set and connect the OUTPUT lead to the plate of the audio ouput tube. Set the test instrument to an ac range that will read voltages up to 100 volts. If your test instrument does not have an OUTPUT jack, connect a .01 mfd. 600 volt condenser in series with one of the test leads. Then connect one of the test leads to the B— point for the set and connect the other one to the plate of the output tube. Set the instrument to an ac range that will read voltages up to 100 volts. (Most vacuum tube voltmeters have a d.c blocking condenser built in, but it is well to use the .01 mfd. unit just in case.)

In Step 1 of the alignment procedure, be sure that you connect the high side of the signal generator output to *the stator of the oscillator section of the tuning condenser,* and set the receiver dial to the low end of the range. These two precautions will prevent the receiver oscillator from beating with the output of the signal generator and giving you misleading results. If a tunable beat or squeal is heard short the oscillator section of the tuning condenser gang and connect the signal generator output to the mixer grid (grid #1) of the oscillator-mixer tube. This stops the oscillator and any squeals now heard are due to oscillation in the i-f amplifier.

In Steps 2 and 3 of the alignment procedure, connect the output of the signal generator to a 2 or 3 turn loop of wire (4 or 5 inches in diameter) placed near the loop antenna. This will provide sufficient coupling for alignment purposes, and prevent the signal generator from detuning the receiver circuits.

Circuit Variations

As mentioned previously, commercial receivers will seldom be exactly like the one shown in Fig. 1. There will be circuit variations. For the most part, these will be substitutions of different part values, etc. That type of circuit variation should not give you any trouble. There are, however, some variations that require further discussion and explanation.

In Fig. 1, condenser C6 is connected between the plate and the cathode of the output tube. The cathode is not by-passed. Therefore, a portion of output signal appears across the cathode resistor. If you replace this condenser, be sure to connect it as it was originally, and be sure to use the correct valve. In some receivers, C6 is simply a plate bypass used to keep the high-level high frequency audio signals out of the plate circuit. In these sets, the condenser is connected across the output transformer primary or between the tube plate and ground.

Some receivers use a triple-section filter condenser including a high capacity-low voltage section as cathode by-pass for the audio output stage. Use of a cathode by-pass condenser increases the audio output. In commercial receivers that do not use the condenser, you can often increase the audio output of the set by connecting a 20-mfd./25-volt condenser across the cathode resistor. (Use of a cathode bypass will increase the low frequency response by removing degeneration at the lower frequencies.)

Some manufacturers use printed circuits in their receivers. The printed circuit usually replaces resistor R5, condenser C5, and resistor R6. When you encounter a printed circuit in an AC-DC receiver, trace the leads and try to determine just what the printed circuit replaces. Not all of them are coupling networks between the first audio amplifier stage and the output stage. If you cannot obtain a duplicate printed circuit for use in a certain receiver, you can always use individual components of the proper value.

Some receivers use a tapped output transformer as part of the filter network. Let's look at Fig. 7 for a moment. Notice that electrons from the plate of the audio output tube flow *down* through the primary of transformer T3 to the tap and back to the rectifier. Also notice that electrons from the remainder of the receiver would flow *up* through the primary of transformer T3 to the tap. Therefore, the hum currents buck each other. In addition, the lower portion of the transformer primary acts as a filter choke in the B supply circuit. If a tapped output transformer is not available for replacement, change the circuit to the one shown in the basic AC-DC schematic. (Fig. 1)

Some manufacturers use a choke in the power supply instead of the 1200-ohm filter resistor. As these sets generally use lower values of filter capacity, it is best to purchase a small ac-dc choke for replacement purposes. If you cannot obtain a replacement choke and it is therefore necessary to use a 1200-ohm filter resistor, be sure to increase the capacity of the filter condensers so that you have the normal 50-30 mfd. network.

A permeability tuning system is used in a few ac-dc sets. In this system, the inductance of the coils is varied while the circuit capacity remains constant. Special alignment procedures are often necessary for circuits using this tuning system; you should, therefore, try to obtain the correct service information for the set.

Manufacturers have found uses for the extra diode plate in the duo-diode triode tube generally used as a second detector, avc, first audio. One of the popular circuits is the separate avc system as shown in Fig. 8. Notice that the rf signal is transferred to the extra diode plate through the small mica condenser (between 50-mmfd. and 250-mmfd.) and is rectified by the diode circuit. This rectification produces a dc voltage drop across the 470K-ohm resistor. This voltage—after filtering—is used as avc voltage.

When a tube is gassy, the grid of the tube becomes positive. If the grid of the tube is connected to the avc line, the avc line will also become positive and the positive voltage will be fed to all other grids connected to the avc. Therefore, a gassy tube can cause all the other tubes on the avc line to draw excessive current.

To prevent the above sequence of events, some manufacturers use the extra diode as a "gas gate." (Fig. 9) When the extra diode plate is connected as shown in Fig. 9, the avc line cannot become positive because a positive voltage on the avc line makes the diode plate of the "gas gate" positive and thereby allows the tube to conduct. When the tube conducts, the avc line is shorted to B— through the diode plate-cathode path in the tube. When the avc line is negative, the "gas gate" has no effect on the circuit operation.

Approximately 9 volts dc is developed across the oscillator grid resistor, R1. In some receivers, this voltage is used for bias in other circuits. A 15-megohm resistor between the grid of the oscillator and the avc line will feed a certain initial bias to the avc line. This bias prevents excessive current flow through the oscillator-mixer tube and the i-f amplifier tube when no signal is applied to the input circuit of the set.

Also, the voltage across R1 is sometimes used as bias for the audio output stage. In that case, the "cold" end of resistor R6 (in Fig. 1) is disconnected from B— and then connected to the oscillator grid with a 270K-ohm resistor. The ac circuit is completed to B— through a .1-mfd. condenser connected between the "cold" end of resistor R6, and B—.

In some circuits, protective bias for the i-f amplifier stage is obtained by using a small value—generally less than 200 ohms—cathode resistor. The cathode bias developed prevents excessive current through the i-f amplifier tube under no signal conditions.

Some manufacturers increase the sensitivity of their sets by using an rf amplifier stage. In that case, an audio output tube with a 35-volt filament is used, and another 12-volt tube for use as an rf stage is added to the filament string. (The tube is usually the same type used in the i-f amplifier circuit.) An rf amplifier stage in an AC-DC set is likely to be a very simple circuit. In fact, an extra tube and an extra tuned circuit is generally the limit. These circuits are so simple that they are not likely to give any trouble.

Some manufacturers use slug-tuned i-f transformers. Again, the change is so slight that it is not likely to give you any trouble. When a replacement transformer is needed, however, use a slug-tuned transformer. Generally, those units have a much higher Q than the more common i-f transformers, and therefore give better selectivity.

Some ac-dc sets use a selenium rectifier instead of a tube rectifier. When such a substitution is made, the selenium simply replaces the diode rectifier tube, and a filament resistor is added to drop the voltage to the correct value for the various tube filaments.

Certain other receivers use voltage doublers in the power supply. It is impossible to say just how the voltage doubler is likely to be connected, as it may be a half-wave unit, or a full-wave unit. For that reason, you should try to obtain the service information for the receiver whenever you encounter a set with a voltage doubler.

The circuit variations discussed are not all of the possible variations. However, the other circuit variations that you encounter in service work are likely to be so slight that they give you no difficulty whatsoever.

The Story of the National Radio Institute

Fred Edwards

By FREDERICK F. EDWARDS

NRI Correspondent

THIS story, like that of Radio and Television itself, is no mere meaningless list of names and dates. Rather it is a record of pioneering and achievement that may well stir pride in the heart of every student, graduate, or member of the Institute staff.

Here is a tale of men with faith in Radio and and in themselves; a drama of obstacles met and overcome, of promises made and (more important) kept, of hard work, of loyalty, and above all, the transformation of the ambition of thousands, through Institute training, from dreams into reality.

Today the Institute is so strong and thoroughly organized, the Radio-TV industry is so large and has enriched our lives in so many ways, that few think of their humble beginnings and early struggles.

The first twenty-five years of Radio ending in 1914 saw Marconi's successful transmission and reception of wireless messages.

By the turn of the century, transoceanic wireless was in sight. Dr. J. Ambrose Fleming invented the diode vacuum tube in 1906, the year in which Mr. J. E. Smith, the founder of NRI, graduated with the degree B.S.E.E. from Worcester Polytechnic Institute.

Shortly after this, Dr. Lee de Forest invented the "audion" and experimented with sound broadcasting in New York City. By this time Mr. Smith, the ambitious young electrical engineer, was working for Westinghouse in East Pittsburgh, a position he gave up to become an instructor in electricity and other subjects in the Washington, D. C. school system.

In 1914 the first World War was let loose on an unsuspecting world. Thus the stage was set for the founding of the National Radio Institute.

Mr. Smith had become deeply interested in various phases of wireless and had thrown himself with customary enthusiasm into the task of mastering the newest and most fascinating branch of electrical science. Such enthusiasm became contagious. Mr. Smith was besieged with requests for information on wireless problems, and in response to the demand, finally organized a class of four students in a small room in the old United States Savings Bank Building at 14th and U Streets, Northwest, Washington, D. C. The National Radio School, as it was known at first, had come into being.

Additional students sought admission and the young school filled an increasing need by giving practical training in this new field.

From time to time students who were compelled to leave the city for one reason or another expressed desire to continue their studies. The first effort to teach Radio through the mail was undertaken. In the face of critics and skeptics, the National Radio School proceeded to develop a successful home study method of training parallel with its classroom training, thus establishing definitely our position as the pioneer home study Radio school. In our files we have a set of lessons graded by Mr. Smith for a student in Livermore Falls, Maine, and bearing dates as early as February 14, 1916.

The heavy demands made upon Mr. Smith for instruction left him little time for the school's business affairs, and Mr. E. L. Degener became associated with the school in charge of advertising and organization. Mr. Degener today is General Manager and Treasurer of NRI.

Thus in the first two years the present management had taken charge, and the policies that have guided us through more than a third of a century were taking form. A year later, in 1917, the United States entered the World War and the demand for wireless operators filled the classrooms to overflowing. Facilities were expanded, a staff of twenty instructors was engaged and over 150 local students were in training. Radio technicians were made part of the regular military forces. In the Spring of 1918 the U. S. Government gave Mr. Smith entire charge of training 800 students at Howard University for Radio work in the U. S. Army.

Steadily increasing demands for instruction in wireless telegraphy and the growing interest in wireless telephony or "Radio" as it began to be known, expanded both the home study and resident classes. The former required all available facilities at the original 14th and U Street address, so classes were moved to 1345 Pennsylvania Avenue, Northwest, a convenient central location on historic Pennsylvania Avenue. About this time also the Service Radio School located nearby was taken over and absorbed by the Institute.


E. L. Degener, General Manager.
36 Years of Service with NRI

These were "the good old days." The National Radio School had become the National Radio Schools. We operated a Radio station with call letters 3YN between the downtown and uptown locations for the instruction of local students. Mr. Smith personally graded lesson papers besides handling consultation and classes. On more than one occasion, Mr. Smith carried the mail across the busy avenue to the Post Office to set the standard of personal, prompt service that inspires our staff to this day.

In 1920 Westinghouse KDKA began broadcasting An irresistible wave of popular interest in broadcasting swept the country. This was the day of the crystal receiver and the head set. An interesting sidelight is the story of the Harding vs. Cox election returns. Washington's two largest newspapers have offices on Pennsylvania Avenue and flashed election returns on screens for the information of election crowds. Their returns received by ordinary telegraph service were often behind the returns received by station 3YN as broadcast from KDKA and other early stations, and we were thrilled when "National Radio" scooped the Nation's Capital.

The same year and month, November, 1920, the National Radio School was incorporated under the laws of the District of Columbia as the National Radio Institute.

The need for trained Radio service men brought to light the need for a name for men who were properly trained. The term "Radiotrician" was coined and used by us as early as 1922. Registration for the term was secured in the U. S. Patent Office in November, 1928, and has since been secured in Canada, England and elsewhere for the exclusive benefit of NRI Graduates.

In 1938, the term "Teletrician" was registered with the U. S. Patent Office for the exclusive use of NRI Graduates. These names have been carefully protected ever since. Unless a man has taken the NRI Course, he cannot properly call himself a Radiotrician or a Teletrician.

Radio grew complex and technical. The Institute adapted its training and methods to keep in step with the new situation. The resident schools were gradually closed out. In 1923 the Institute was established at 1223 Connecticut Avenue, Northwest, near the famous old British Embassy Building, since torn down, and the entire effort of the Institute was thrown into home study training.

First one floor was occupied, then two. The Institute continued steadily in growth, and in October, 1927, our present large building, then two stories high, located at 16th and U Streets, Northwest, was purchased and the second floor occupied. The next year it was necessary to take over the first floor also, and in 1930 the third floor was added to provide urgently needed additional space.

By 1946 we had outgrown our building. We purchased another three story building, two blocks from our main building. This we call the Annex. The new addition was completely renovated, air conditioned, made spick and span, and a number of our departments moved into it.

Closely paralleling the physical growth of the Institute and responsible for it, has been the growth of the Course and of the instruction staff. It is a matter of pride to the Institute that some of the earliest members of our organization are still with us. They have grown up with the Radio-TV industry and with the school. As we have grown, new blood and new ability have been added, also, to meet the continual demand for the latest practical and experimental knowledge in the field and to maintain our position of leadership in Radio-TV home study.

The constant development of Radio with its new discoveries and new applications, the requirements of home study students for more convenient lessons and more readily understood instruction and the success of the Quiz Book between 1918 and 1924, pointed the way to the writing of all our own lesson books. First came a series of fourteen, later increased to eighteen, on wireless telegraphy, and then a course of eight books on Radio telephony, a total of twenty-six books by 1920.

Rapid strides in broadcast station and transmitter development as well as in broadcast receivers forced complete rewriting of the Course and extensive additions so that by 1926 there were forty books in the Course, and by 1928, fifty. In spite of every effort to maintain the Course at a high level of accuracy and completeness, the continuous strides of Radio, during the twenties led to a complete revision of our Courses and still more textbooks. Every textbook was completely rewritten from cover to cover and many new books were added on various branches of servicing, broadcast station operation, commercial and ship station operation, aircraft installations, television, sound pictures, public address systems, and many others.

J. Morrison Smith, son of J. E. Smith, assistant to the General Manager, and Secretary of NRI.

This policy has been faithfully pursued; every year some books are revised, others replaced with entirely new ones. Every book must pass critical inspection for its technical accuracy and equally critical examination for its simplicity and readability.

The earliest experience with home study emphasized strongly to the practical mind of Mr. Smith the importance of combining practical work with the study of theory. The first equipment furnished was for teaching the sending and reception of wireless telegraph signals. Mr. Smith later developed, patented, and undertook the manufacture of a special machine known as the Natrometer for automatic sending of code signals. This was eventually replaced with the even more efficient Nacometer.

With the rise of set servicing came the need for practical experience in handling Radio receiving and servicing equipment, a need which was met by development of practical home experimental equipment. In the past twenty years several distinct series of these outfits have, one after the other, been developed to meet increasingly complex training requirements.

Now that our story has brought us down to date with modern and highly specialized training, modern equipment, a modern training plan, and an efficient staff, let's sketch in some of the significant developments that took place in intermediate years.

Back in 1926 at the beginning of the batteryless receiver era, the Radio compass was coming into general use, the Piezo crystal had been developed, beam transmission had been devloped to a practical commercial stage, and successful Radio telephone experiments were conducted between New York and London.

In the same year both the National Broadcasting Company and the National Home Study Council were organized. The Council is an association of private home study schools and was incorporated in the District of Columbia, October 29, 1926, with Mr. Smith as one of the original incorporators and the National Radio Institute as a charter member.

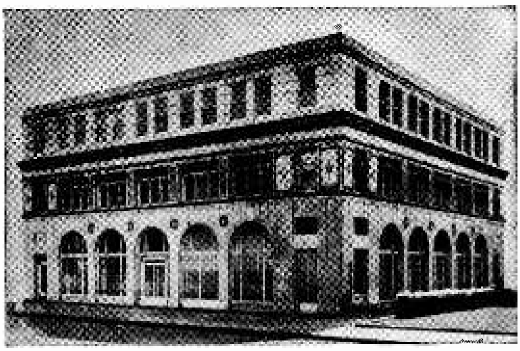
The purpose of the Council from the very beginning has been to elevate the standards of home study training. Mr. Smith has been a member of the board of trustees of the Council and was long a member of its educational committee, besides having served as Treasurer and in other capacities. At the present time our Mr. Degener is a trustee of the Council. Other members of the Institute staff have participated actively in Council meetings and as Committee Members to the end that all home study students may receive better training, better service, and a square deal all the time.

From the earliest days of the Institute, Mr. Smith, and other members of the staff had taken up important problems pertaining to the Course and Radio with recognized leaders in their fields. Mr. Smith wished to be able to do this on a more formal basis and give students and graduates the benefit of the most authoritative opinions available on Radio questions. To this end the

National Radio Institute Advisory Board was created in 1929.

Invitations were extended to and accepted by men carefully selected for their variety and breadth of experience, as well as their outstanding records as Radio Engineers. The six original members of the Board represent some of the great names in Radio: Dr. Lee de Forest, Mr. Edgar H. Felix, Mr. Paul A. Greene, Mr. George Lewis, Prof. C. M. Jansky, Jr., and Major-General George O. Squier. We have always felt it an honor to be recognized in this manner and to pass along to our students the advice and recommendations of such leaders in Radio.

Dr. A. N. Goldsmith was added to our Advisory Board in May, 1934, to take the place of Major-General Squier who had died shortly before. With the rapidly growing importance of Television, Mr. Philo T. Farnsworth was invited to serve on our Board and accepted in August, 1935, followed in 1938 by the late Mr. Harry Diamond. When Mr. Diamond passed away, Dr. Cledo Brunetti, Chief of Engineering, Electronics Section, National Bureau of Standards, was added to our Advisors.



This is our main building at 16th and U Sts., N. W., in Washington. Visitors are always welcome.

In connection with the celebration of our Fifteenth Anniversary in 1929, the NRI Alumni Association was formed, the first officers elected, and a unanimous pledge taken to work for the interests of the Institute. This was the first alumni association of graduates of any home study school, an association which has flourished continuously since, and which every NRI graduate is eligible to join. Since then local Chapters have been organized in a number of cities. Among these, Baltimore, Philadelphia, New York, Pittsburgh, Milwaukee, New Orleans, Detroit and Chicago Chapters are the strongest and most active. Baltimore Chapter was the first organized.

The first President of our Alumni Association, elected in 1929, was, during the war, Assistant Director, Broadcasting, Office of Censorship for the United States Government. One of the first Vice-Presidents, Mr. Hoyt Moore, who was present in Washington in 1929 when the Alumni Association was organized, rose to a State Senator in Indiana. Many of our Alumni members have risen to high places in the business world.

Our story is getting long yet we have had barely space to mention subjects about which we would like to write whole pages. We'd like to tell you how with every development of Radio and Television and every change in the industry we have strived to include the change in the Course. We'd like to tell you how we have increased the amount of information in the Course and the effectiveness of the training year after year with little increase in cost to the student.

We'd like to take you behind the scenes here at NRI and show you what a competent, aggressive, conscientious staff has been built up to serve students, show the equipment and methods developed to serve quickly, intelligently, and helpfully. We'd like to bring you into some of our staff meetings here where you could hear us thrash out our student problems and our own, so that the actions we take and the advice we give represent not the hasty thought of one individual but the considered judgment of all those competent to contribute. While Mr. Smith no longer grades the lessons, nevertheless, his ideal of personal service is our daily inspiration.

We'd like to show you our three separate laboratories. These are for research and development, one for Radio receivers, one for Communications equipment and one for Television.

We'd like to show you some of our student records. You'd see records of students and graduates in almost every branch of Radio and Television and in almost every foreign country and colony, besides every state in the Union and every province in Canada. You'd see the records of students assigned to us for vocational training by the Rehabilitation Boards of thirty-five of our forty-eight states, the Territory of Hawaii, and Canada. You'd see records of thousands of war veterans who enrolled with us through the GI Bill of Rights. You'd see records of men who have risen high in government and industry, yet nevertheless acknowledge gratefully the debt they owe the National Radio Institute, and above all you'd see records of that steadily growing body of graduates who, through this training, have won independence and advancement for themselves in Radio-TV.

In 1945, Mr. J. E. Smith, brought his son, J. Morrison Smith, into the Institute and took him under his wing. Young Mr. Smith is a graduate of Worcester Polytechnic Institute, as is his father. For eight years before coming with NRI, J. Morrison Smith worked as an Industrial Engineer with United States Steel and Dupont. When J. E. Smith felt his son had received enough "hard knocks" in the outside business world to prepare him for an executive position at NRI, Morrison joined us. Now thirty-eight years of age, he is assistant to Mr. E. L. Degener, the General Manager and he is Secretary of the National Radio Institute, a position he is filling in the genuine J. E. Smith tradition.

Morrison Smith is active in Radio-TV educational organizations. He is a Director of the Y.M.C.A. of Washington, D. C., and a trustee of Junior Police and Citizens Corps. He is a member of the Institute of Radio Engineers. He is Treasurer of the National Home Study Council, an office formerly held by J. E. Smith, as mentioned in a previous paragraph.

Here at NRI we are thinking and planning for the future Radio-Television world as we expect it to be. Great as has been Radio's growth in the past — we forsee even greater growth ahead, sparked by the phenomenal development of Television. More Radio men and BETTER TRAINED Radio men will be needed than ever before. NRI training must be up to date, and you may rest assured we are keeping it that way. It must be PRACTICAL. We are often making changes, slipping them quietly into the Course for the benefit of our students.

This is our annex located two blocks from our main building. We own and occupy every inch of our 17,500 square feet of floor space.

The work of revision, re-writing, and adding new material goes on constantly at NRI. Every year some lessons are revised and others replaced. Recently seventeen new lessons on television were included in the training.

Mr. Smith's practical mind early saw the necessity of combining practical experience with theory in correspondence training. The first equipment furnished was for teaching code. Later, Mr. Smith developed, patented and undertook the manufacture of a machine known as the Natrometer that sent code signals automatically.

As home receivers increased in numbers and complexity, Radio servicing became more and more important. "Radiotrician" was no meaningless title. NRI graduates got practical experience while earning it, and were trained to do servicing work. Mr. Smith and the NRI staff developed the first home study kits to give experience with Radio circuits and in servicing techniques. Like lessons, kits have to be re-designed to include new circuit developments.

Besides training in Radio and Television Servicing, a course in Radio and Television Communications was introduced in 1949. Here the practical training includes building a working model of a broadcast transmitter. Practical training in Television, with kits to construct Television receiver circuits was brought out in 1951.

Hundreds of boys in their early teens write NRI each year about Radio and Television training. Our courses are too extensive for these young boys, yet we have long felt that we should offer them some way of developing their interest in the subject. In December, 1953, we presented the Junior Experimentor's Electronic Kit, abbreviated "JEEK." Through these experiments, boys can get practical experience and enjoy the fascinating subject of Electronics until they are old enough to enroll for our regular courses.

In 1952 John H. Battison joined NRI as Director of Education. Mr. Battison was formerly a member of the faculty, New York University, TV Dept., he was editor of Tele-Tech Magazine. As Assistant Chief Allocations Engineer of ABC he helped design and construct five TV and five FM Stations. He has been active as a Radio and Television Consultant—last year he was appointed Television Engineering Consultant to American University where he is also a professor. He has written a number of articles and textbooks on Television. As a member of National Television Systems Committee (NTSC) he has served on panels and helped lay the foundations for UHF-TV and the new NTSC color TV system.

Yes, the most important part of the story of the Institute is not the record of past events, not the story of what we have done, but the story of what we are doing today; that, and the day by day achievement of NRI students and graduates.

As we launch strongly into our fortieth year, with all its promises, we renew to every present and future student our pledge to train him thoroughly for today's needs and tomorrow's opportunities.

NRI ALUMNI ASSOCIATION

In the reception room at National Radio Institute is a simply-bound book—black with red corners—which today is one of the most prized possessions of the Institute. You may have seen this book yourself—your own name may be inscribed in it—for this priceless book is the register in which all visitors to NRI are invited to inscribe their names.

Opening to the first page of this interesting volume, we find that the first seventy-five names are all dated November 23, 1929; these are all graduates who came to the institute on that day to participate in the celebration of the Fifteenth Anniversary of National Radio Institute. To commemorate the event and to join together fraternally and constructively the far-scattered Alumni of the National Radio Institute, this group of men on that day declared a convention and founded the now well-known NRI Alumni Association. Thirty-four states from Maine to California, from Florida to Minnesota, were represented in the first roster of members, along with four Canadian provinces and several countries outside of North America. Typical NRI graduates were these seventy-five Alumni, each respected in his community, each well on his way toward a successful career in Radio.

That was twenty-five years ago. So, as NRI this year celebrates its Fortieth Anniversary, we of the Alumni Association simultaneously celebrate our Twenty-fifth Anniversary.

Our record for the past twenty-five years is one of which every member—every NRI student and graduate—can well be proud. We were the first Alumni Association ever to be organized among graduates of a home study school; today, with more than fourteen thousand members from every state of the Union, from every Canadian province, and from a number of foreign countries.

The Charter Members of NRI Alumni Association, photographed in 1929, when our Alumni Association was formed. On this occasion our Charter Members were addressed by the late Charles Curtis, then Vice President of the United States, who is also shown in the photograph, first row, fifth from the right.

we have one of the strongest Associations of this kind in the world. Our members have profited from their contacts with fellow Alumni through Chapter meetings and through our official publication NATIONAL RADIO-TV NEWS, and we in turn have been an inspiration to the Institute in its dissemination of Radio and Television knowledge.

The picture at the left was taken at the time the NRI Alumni Association was formed in 1929. In this group, first row fifth from the right, is Charles Curtis, then Vice President of the United States, who congratulated our members upon their fraternal spirit and their foresight in binding together for the common good of servicemen and technicians everywhere.

That convention in 1929 was brought to a close with a banquet at the Arlington Hotel in Washington. As part of the ceremony, a handsome loving cup was presented to the National Radio Institute through its President, Mr. J. E. Smith. The actual presentation was made to Mr. Smith by the then newly elected Vice President of the Alumni Association, Mr. Hoyt Moore, of Indianapolis, who later became a State Senator in Indiana.

On the face of the cup is engraved the following legend: "Fifteenth Anniversary of the National Radio Institute. Presented to J. E. Smith, President, by the NRI Alumni, November 23, 1929." On the opposite side is engraved the name and state of residence of each charter member of the Alumni Association.

Mr. Smith—Honorary President of the NRI Alumni Association—and all of the members of our Executive Staff extend greetings to the members of the Alumni Association on this occasion of their Twenty-fifth Anniversary and congratulate the seventy-five original members, for their devotion in carrying out an ideal which was founded upon the solid principle that in unity there is strength.

This loving cup was presented to NRI in 1929 by the Charter Members of the NRI Alumni Association. It is handsomely engraved, including the name and state of residence of each Charter Member.

Chapter Chatter

New York Chapter re-elected its entire slate of officers, as follows:

Chairman, Bert Wappler
Vice-Chairman, Thomas Hull, Jr.
Secretary and Treasurer, Louis J. Kunert
Ass't Secretary and Treasurer, Frank Zimmer

Some fine reports from Secretary Kunert listing speakers, subjects and some fifty-five to sixty members present at each meeting. In this issue, because of space limitations, these details are omitted.

New York chapter meets on the first and third Thursday of each month at St. Marks Community Center, 12 St. Marks Place, between Second and Third Avenues in New York City.

Philadelphia Chapter also retained a number of last year's officers. Election results are as follows:

Chairman, Fred Seganti
Vice-Chairman, John Pirrung
Secretary, Jules Cohen
Financial Secretary, Al Schwartz
Treasurer, Charles J. Fehn
Librarian, Joseph Lynch
Sgt.-at-Arms, Ray Stout

Meetings are held on the second and fourth Monday of the month at the Knights of Columbus Hall, Tulip and Tyson St. in Philadelphia. Students and graduates in the area are always welcome.

Pittsburgh Chapter reports the following officers for 1954:

Chairman, Francis P. Skolnik
Vice-Chairman, Tom D. Schnader
Treasurer, H. A. Tate
Secretary, Ken J. Shipley
Executive Committee, Pete Tomasina, William Lundy and John Bardon.

Meetings are held on the first Thursday in each month, 8 P.M., at 134 Market Place. Ken. J. Shipley, 1009 St. Martin St., is secretary.

Baltimore Chapter in 1954 will be served by the following officers:

Chairman, R. F. Thompson
Vice-Chairman, J. Dalivka
Secretary, Joseph Nardi
Treasurer, Elmer E. Shue
Librarian, Wilbur L. Kidd.
Sgt.-at-Arms, John J. Hooper
Auditors, H. J. Rathbun and Thomas H. Clark

Baltimore Chapter meets regularly at 745 West Baltimore Street, in Baltimore on the second Tuesday of each month.

New Orleans Chapter reports the following officers for 1954:

Chairman, Louis E. Grossman
Vice-Chairman, V. J. Cornelius
Secretary, A. H. Buckley, Sr.
Treasurer, O. Jumonville, Jr.
Executive Committee, Ronald R. Reed, P. Boudreaux and Emile Laumann
Financial Committee, L. Edgecombe and M. F. Fogarty.

NRI students and graduates in the New Orleans area who are interested in attending meetings please contact Chairman Louis E. Grossman, 2229 Napoleon Ave., in New Orleans.

Detroit Chapter has elected officers, as follows:

Chairman, John Kehoe
Vice-Chairman, Tom Paterson
Secretary, Robert M. Kinney
Treasurer, F. Earl Oliver
Financial Committee, Ken Kacel and Prince Bray.
Program Committee, John Stanish, Len Gudenau, Frank Schrober and Leonard Reinowski
Librarian, Asa Belton
Sgt.-at-Arms, Charlie Mills

The address of Secretary Robert M. Kinney is 16565 Cruce Street, Detroit.

Milwaukee Chapter reports officers elected, as follows:

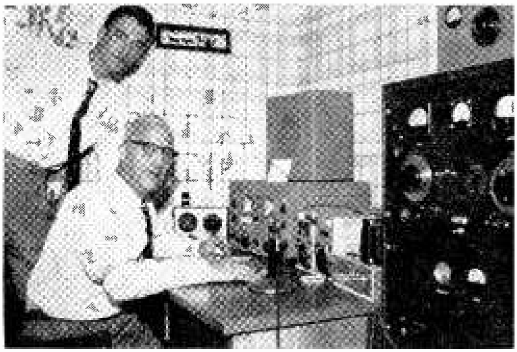
Chairman, S. J. Petrich
Vice-Chairman, Elwin Sowle
Secretary, Robert Krauss
Treasurer, E. Bettincourt
Financial Committee, Erwin E. Kapheim and L. Schroeder
Entertainment Committee, Harvey L. Otto, Robert E. Hanson and John M. Klis, Jr.

The address of Secretary Robert Krauss is 2422 N. 32nd Street, Milwaukee. If interested in attending meetings please contact the secretary.

Chicago Chapter continues to meet at 8 P.M. on the second Wednesday of each month in the American Furniture Mart, 666 Lake Shore Drive. (West entrance.) Students and graduates in Chicago are cordially invited to meet with us.

Some photographs and interesting information regarding chapter activities have been received and are appreciated by the editor. Use of some of this material will be made in forthcoming issues when more space will be available.

Father and Son Enjoy "Ham Shack" Together



Dear Mr. Smith:

"We finally got around to getting a picture of our "Ham" shack. Am enclosing a copy. We are using an 80 meter, and a 40 meter Bendix Command Surplus transmitter for V.F.O., feeding into large transmitter shown on the right of the photo, and are putting out about 100 watts, or so, on c.w. The unit on top of the large transmitter is our antenna coupler. The receiver is a Hammarlund HQ-129-X. We are beginning to get out a bit now, having made contacts as far as Florida, and San Diego, so hope to really get around the country once the cold weather really closes in here.

"Except for the two little Bendix X-mitters, which I got, I might say that my son Bob (VE5RH) worked, and earned his own money to purchase the large transmitter and the receiver himself. He also made the large desk that you see in the picture. It is made of solid birch. He did this last term at school. He hopes to go into Electrical Engineering, especially the electronic end of it.

"Our antenna is an end fed Zepp, with open feed line, and is just about 50′ high. The main wire is 67′ long and is a #12 copper-clad steel-core wire. Lead-in is flameseal #14 copper wire, which is well guyed and supported, so we have a good substantial set up that should withstand our winter gales.

"We find the 40 meter band is best for us at present, and are gradually fixing up our equipment for 20, and 10 meters, as Bob can go 10 meter phone now."

Yours sincerely,

F. R. Hills, VE5FH
2239 Toronto St.
Regina, Sask., Canada

Salute To NRI

(Continued from page 13)

tution ever since. The name was changed to National Radio *Institute* in 1920 . . . the year it became incorporated under the laws of the District of Columbia. Now, the initials "NRI" are just about as well known as the full name. And the name itself has been carried all over the world by the men who have graduated and gone on into different phases of the industry. Of the more than half million persons who have enrolled in NRI during the past forty years, many have become top figures in their field. Others have won recognition in other ways . . . such as the radio crew of the cruiser "Helena," sunk by the Japanese in World War Two. Seven of the eight radio operators on board were former NRI students. And then there are those who never do anything exceptional with their training—just enjoy it as a hobby.

As for the school itself, it seems to be a great place in which to work. Fourteen per cent of all employees have been there over twenty years . . . and several have been with the company almost since its inception. Lab instructor George Rohrich can look back over thirty-nine years. General Manager E. L. Degener has been associated with NRI for thirty-six years. And, in fact, all the company's officers are oldtimers . . . except John H. Battison, Director of Education, and Secretary, J. Morrison Smith, son of the founder, who is still too young to match longevity with men like Gordon Birrel, Director of Personnel; Charles Alexander, Comptroller; Stuart Armstrong, Director of Advertising; David H. Smith, Purchasing Officer; Albert F. Doig, Supervisor of Mailing and Printing; and Louis L. Menne, Executive Secretary of the NRI Alumni Association. Which brings up another "first" for NRI: first — and only — correspondence school with an active alumni association . . . an association boasting fourteen thousand members.

Oh, there are lots of things of which NRI and its founder can be proud; but to sum it all up in general terms, most of their pride stems from the fact that they've played an important part in the development of a vital industry. And for their multiple contributions to the broadcast industry over a period of nearly forty years, WRC is offering this tribute today to the officers and employees of the National Radio Institute, and especially to its founder and President, James E. Smith . . . a leader in the field of electronics . . . a very personable and wonderful gentleman.

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