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A Proving Laboratory For Radio Receivers

Description of a New Laboratory as a Link Between Sales, Development and Production.

By L. W. REINKEN*

In Newark, New Jersey, the Radio Department of Westinghouse maintains a small but complete radio laboratory, which is unusual from a functional standpoint. It is a link between the factory, the development laboratory and the sales department. It translates the ideas of the sales and publicity departments into engineering terms for the development laboratory, keeps in close touch with development and after development has been completed, maintains an engineering sampling inspection of production.

One of its most important functions is a daily sampling check on quality of factory production. By this check, it is possible to anticipate grief in the field and have possible sources of trouble corrected at the factory.

* Westinghouse Electric and Mfg. Co.

The production sample receivers are chosen at random from the final assembly line at Camden—about eighty miles away—and shipped via daily motor truck to Newark. At the laboratory they pass through the routines shown in Fig. 1. The apparatus used in the following routines is described later in the article.

Production Check

After unpacking, the shook, skids, balsa wood blocks, tubes and separately packed items are inspected for defects, and the shook inspected for improper marking.

The receiver is given a mechanical inspection for poor finish, damaged finish, missing parts, damaged knobs, grille, etc.

An air test is made on the receiver just as it would be made in a dealer's store. The receiver is tested with its own tubes on standard line voltage, and a listening test made for sensitivity, selectivity, fidelity, hum and power output. In addition, the operator looks for such faults as noisy volume controls, binding shafts, backlash—in fact anything that detracts from perfect operation of the receiver.

The phonograph operations are further tested for noisy or scraping turntables, defective automatic starts or stops. A listening test is made on record reproduction, home recording, radio recording, etc.

After the air test has been made and any necessary repairs have been performed, the voltage test with standard tubes follows. All voltages and the plate current of each tube are meas-

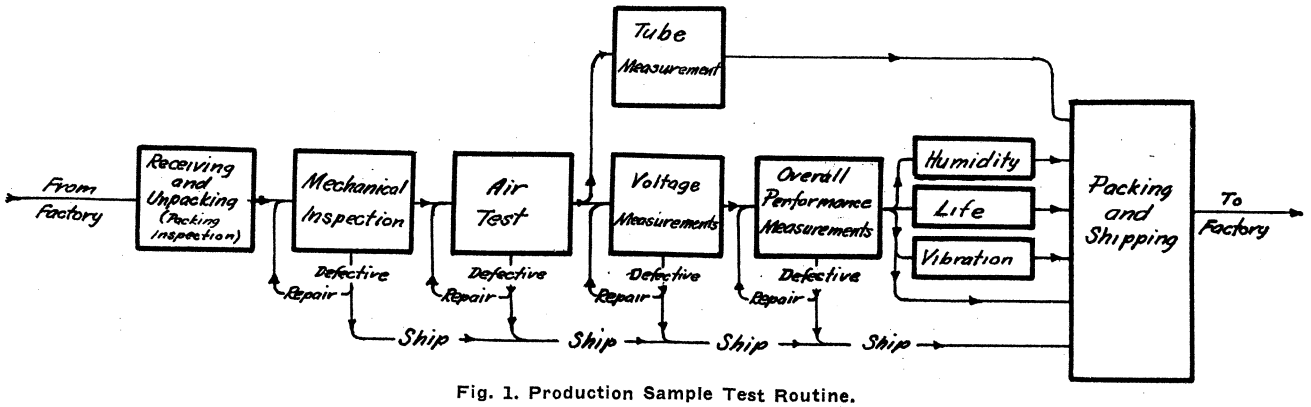

Fig. 1. Production Sample Test Routine.

ured. The voltage at two feeder points in the socket power unit and the hum voltage are also measured.

The tubes are individually tested. The mu, plate impedance, and mutual conductance of each tube is determined at standard voltages. Tubes not meeting factory limits are noted on the test report.

Overall performance measurements are made with standard tubes and standard line voltage in a completely shielded room. Here sensitivity, selectivity and fidelity are measured and compared with factory limits. Causes of out-of-limit characteristics are determined and noted, and if necessary a detailed investigation is made.

Temperature and Humidity Tests

Occasionally a set, after completing all other tests and found normal, is placed in a chamber capable of maintaining approximately 110 degrees Fahrenheit and nearly 100 per cent humidity. Periodical measurements indicate parts susceptible to moisture. After drying the receiver, and restoring to normal, the defective parts are replaced with parts of different design or treatment and the receiver again subjected to humidity. These tests supply data on which are based specific suggestions to the factory for changes in impregating materials, etc.

A normal set is connected to the power supply source and is allowed to run continuously—checking at regular intervals for signs of breakdown or deterioration. A more valuable form of life test for power supply units is a device which turns the set on and off repeatedly, subjecting the condensers to surges and the transformer and chokes to heating and cooling strains.

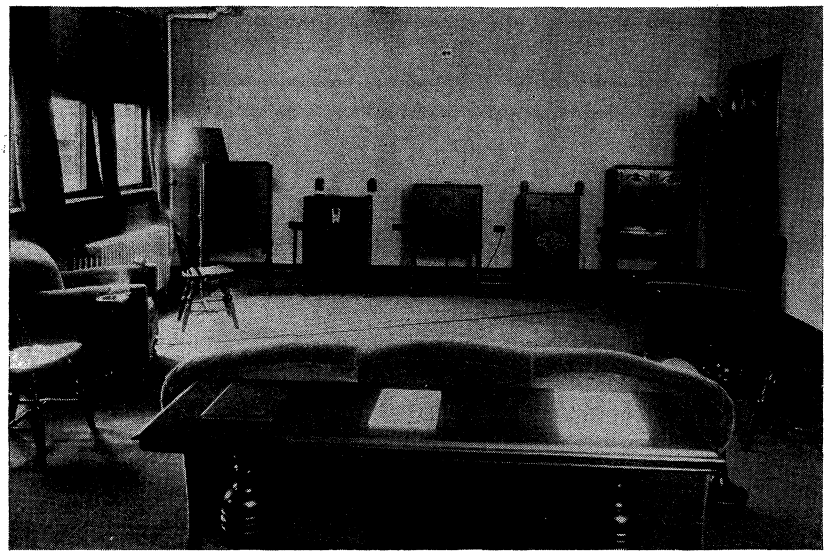

Fig. 2. Living Room Conditions.

Periodically a normal set is placed on a vibrating machine and shaken until something breaks down. Sometimes it takes days of continuous vibration before any change is determined. This test is much more severe than any but the most unusual shipping conditions encountered.

Competitive daily reports and weekly summaries are sent to the New York Office. From these reports is prepared a weekly letter to the factory commenting on production from an unbiased, engineering, standpoint.

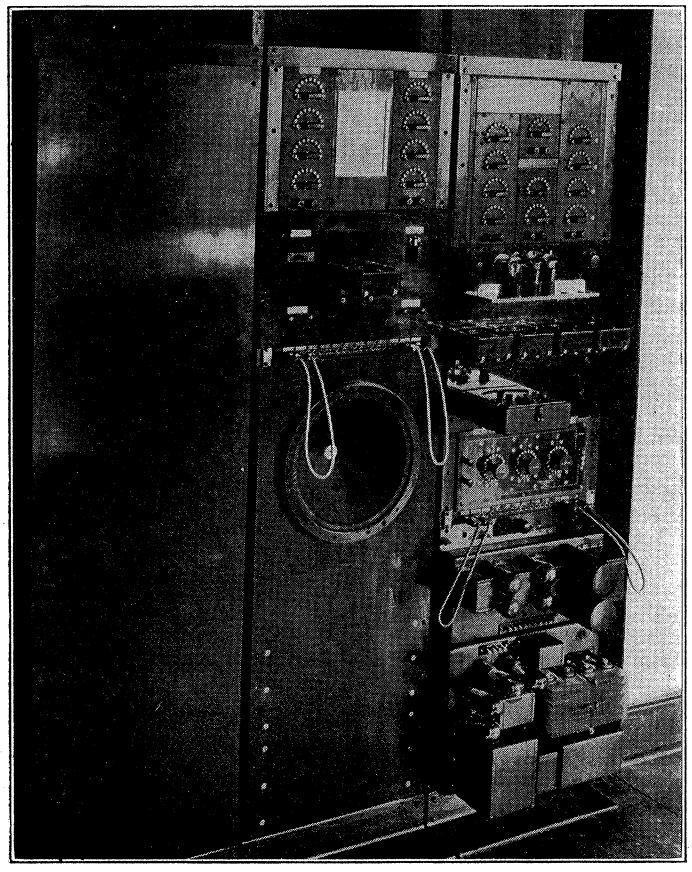

Fig. 3. Transmission Rack.

Development

In addition to the production check briefly outlined above, the Proving Laboratory performs several other functions.

It maintains a keen interest in competitive receivers in general—and particularly in the relative performance of competitive receivers and of Westinghouse receivers under home conditions. Listening tests are conducted in a listening room furnished to reproduce the acoustics of a living room, and equipped with relays to permit rapid comparison of receivers.

These listening tests are supplemented by field engineers' reports on tests made by distributors and dealers, and by overall performance measurements of competitive receivers.

All of the men in the laboratory have had experience in radio development laboratories, and some have had additional experience in radio factories. This experience, coupled with close contact with the field, and with the merchandising section, permits the laboratory to specify accurately the performance requirements for new models under development.

Development samples are submitted to the Proving Laboratory for criticism. They are put through their paces —compared with present competitive merchandise, and checked against the performance requirements originally set up. Criticisms are obtained from members of the sales department, and the combined engineering and sales comments are sent to the development laboratory.

Other Functions

The laboratory contacts with distributors through field engineers. Service bulletins, service problems, special installations and distributor demon

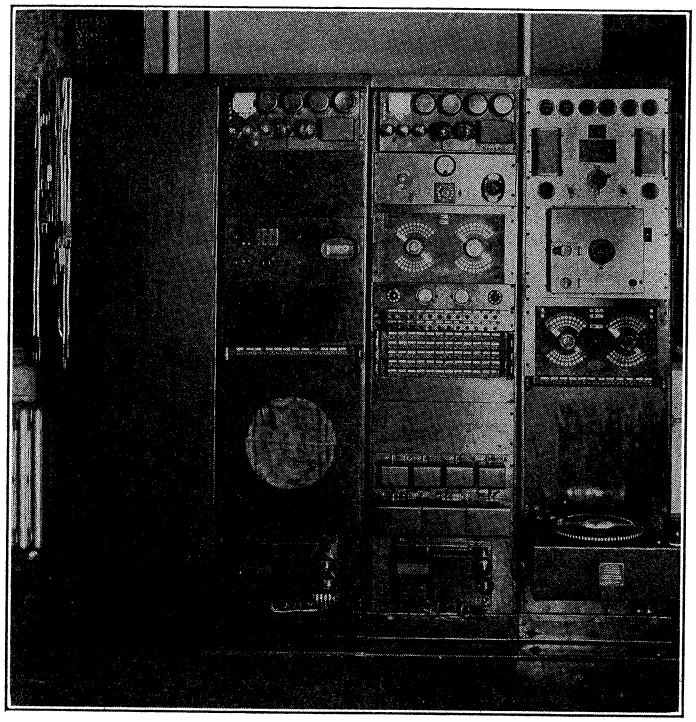

Fig. 4. Bridge Rack.

strations are some of the field jobs with which the laboratory is concerned. This is the field engineers' province, of course, but the laboratory finds intimate contact with the field to be of importance in formulating ideas to be incorporated in receivers.

Rack Apparatus

Most of the larger units in the laboratory are mounted on standard steel racks 72 inches high and 19 inches wide. The units associated with each set of racks terminate on a central jack panel. Patch cords enable any desired set-up to be obtained on the rack. With the aid of circuits running to other parts of the laboratory it is possible to set up combinations of apparatus located at separated positions.

The transmission rack, designed primarily for audio frequency studies, is the largest in the laboratory. At the present time it contains push-pull 250 amplifiers, a heterodyne oscillator, variable attenuators, volume indicator, loudspeaker, low-pass filters, a phonograph turntable of the centralized radio type and a cathode ray tube. The rack is equipped with two rows of pilot lamps associated with the power supplies of the various units and with battery chargers at a remote point. Above the pilot lamps are voltmeters and multi-switches for reading the voltage of the battery feeders. Space is provided for a complete centralized radio installation, consisting of a superheterodyne receiver for broadcast frequencies, a short wave adapter, amplifiers, power supply and clock control.

One of the unique pieces of apparatus on this rack is the cathode ray. The tube is the Western Electric 224-B, mounted parallel to the rack panel. It is viewed by means of an aluminum mirror mounted at a 45 degree angle, and is completely controlled by the switches and knobs on the panel. The controls cover filament supply, plate supply, focusing, spot-centering, viewing horizontal ordinate only, viewing vertical ordinate only, and viewing both ordinates simultaneously. This piece of apparatus will later be supplemented by a sweep-circuit device, which will make it possible to view the output of any piece of apparatus as an actual sine wave. This will be of use in studying amplifier overloading.

At the present time the transmission rack is capable of measuring gains, frequency characteristics, overload characteristics and losses. In addition, radio or phonograph programs, or heterodyne oscillator supply are available for testing amplifiers or loudspeakers.

To facilitate loudspeaker study a stroboscope is being designed to permit obtaining a "slow-motion picture" view of loudspeaker parts while vibrating. In addition a padded room and condenser transmitter and volume indicator are available for sound pressure measurements.

The three-rack bay (bridge rack), shown in Fig. 4, contains the following apparatus:

A miller bridge for measuring tubes.

A ratio-of-transformation bridge for transformer study.

Amplifiers and loudspeaker for use with the bridge in securing an audible null balance.

This rack will measure the mu and plate impedance of all receiver tubes, including 224's. Circuits from the transmission rack appear on this rack for patching together the units of the separate racks.

The bridge rack also has a blank panel anticipating future apparatus. One of the advantages of rack mounted apparatus is flexibility of expansion, as well as flexibility of operation.

A single rack, not shown in the accompanying photographs, is used in the voltage test routine in production sample check. This rack is equipped with a step-up transformer, and voltage regulator for maintaining receiver supply voltage constant. Mounted meters measure the supply voltage, current, and wattage. A commercial test kit has been modified for rapid measurement of all the voltage in the receiver.

Also mounted on this rack is an a-c. driven vacuum tube voltmeter for measuring hum voltage at the output of the receiver under test.

Performance Measurements

The shielded room in which performance measurements are made has an inner and an outer shield of copper screening, insulated from each other, and grounded at a common point. The signal generator and attenuator are mounted outside the room and are controlled by bakelite shafts passing through the two copper walls. The room is equipped with a modulating

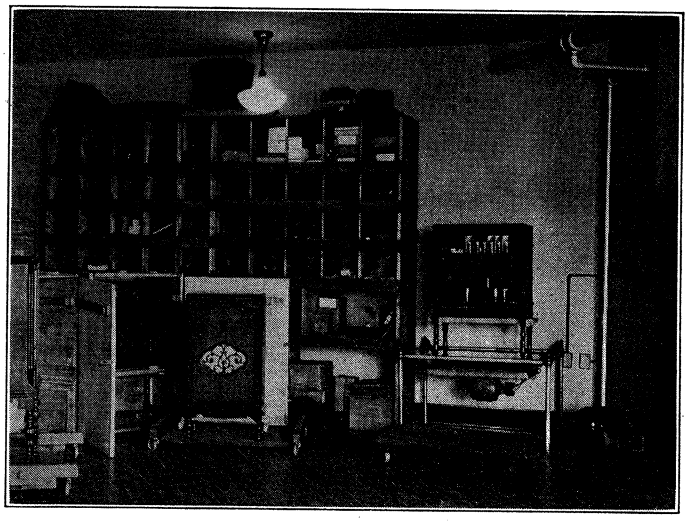

Fig. 5. Stock bins. To the right, the vibrator.

oscillator, output meter and monitoring loudspeaker. A voltage regulator is employed to maintain constant supply voltage for the receiver and measuring devices.

The present overall measuring equipment will eventually be replaced by overall measuring equipment calibrated to read directly in kilocycles, microvolts, modulation frequency, percentages modulation and milliwatts output. This apparatus will probably be rack mounted to conform with the other units in the laboratory.

At the right of the stock bins, in Fig. 5, is shown the vibrator. This consists of a spring suspended platform, vibrated by means of a motor and eccentric flywheel mounted beneath the platform. (The two units to the right of this instrument constitute a 25-cycle and d-c. motor-generator, and have no connection with the vibrator).

In Fig. 6 are shown the humidity chamber, storage batteries and chargers, The humidity chamber is large enough to accommodate the largest receiver in the Westinghouse line. It is equipped with a motor driven centrifugal sprayer, heating resistors, and thermometers for indicating temperature and humidity in the chamber.

In addition to the above major units, the laboratory maintains the usual stock of meters, decade boxes, resistors, standards, batteries, tubes, tools, etc. Among the portable instruments are an audio oscillator and amplifier, a Wheatstone Bridge, a megger, a capacity bridge, a receiver test kit, a radio frequency oscillator and a wave meter.

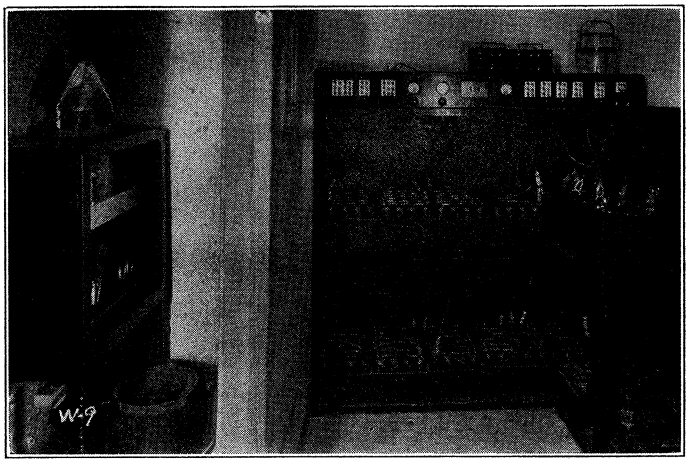

Fig. 6. Humidity chamber and battery charging equipment.

Power Supply

The fundamental power supply for the laboratory is 110 volts a-c. Power supply for d-c. and 25-cycle receivers is obtained from the motor-generators previously referred to. Outlets for 60-cycle, 25-cycle and d-c. supply, appear at numerous places in the laboratory and listening room.

Necessary voltages for the transmission racks are obtained from the battery banks. Two plate supply banks are provided, one of 300 volts for the cathode ray and one of 180 volts tapped at 130. Filament supply is also obtained from two banks, 6 volts for the cathode ray and 24 volts tapped at 12 and 6.

Mercury vapor rectifiers are used for charging the plate batteries, and Rectox chargers for the filament batteries. Pilot lamps associated with the charging circuits appear on the transmission rack. The voltage of any battery tap may be read at the transmission rack by switching voltmeters mounted for that purpose. These meters, in combination with the charger pilot lamps, minimize the possibility of allowing batteries to run down. Fuses for all battery voltages, and a-c. supply, appear on the transmission rack. This facilitates safe repair of rack apparatus.

Machine Shop

The laboratory maintains a small machine shop, equipped with a lathe, drill press, brake, shear, grinder, filing machine and of course, tool makers' instruments and woodworking tools.

The machine shop, in addition to maintenance, builds new apparatus designed by the laboratory. This method of obtaining apparatus has been found economical as well as technically satisfactory. Assembly or modification of purchased instruments into such devices as the cathode ray previously referred to, make it possible to secure useful apparatus not commercially available.

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4. A brief summary of the paper, embodying the major conclusions, is desirable.

5. The Club reserves the right of decision on the publication of any paper which may be read before the Club.

* For 1930 the Chairman of the Papers Committee is Mr. F. X. Rettenmeyer, 463 West Street, New York City.

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