RESEARCH REPORT

1948

Prepared for use by engineers and executives
of RCA divisions and companies in
planning the development of
products and services

RADIO CORPORATION OF AMERICA
RCA LABORATORIES DIVISION

PRINCETON N.J.

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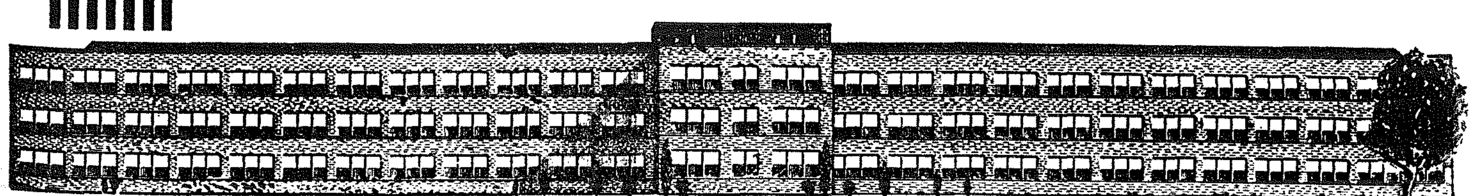
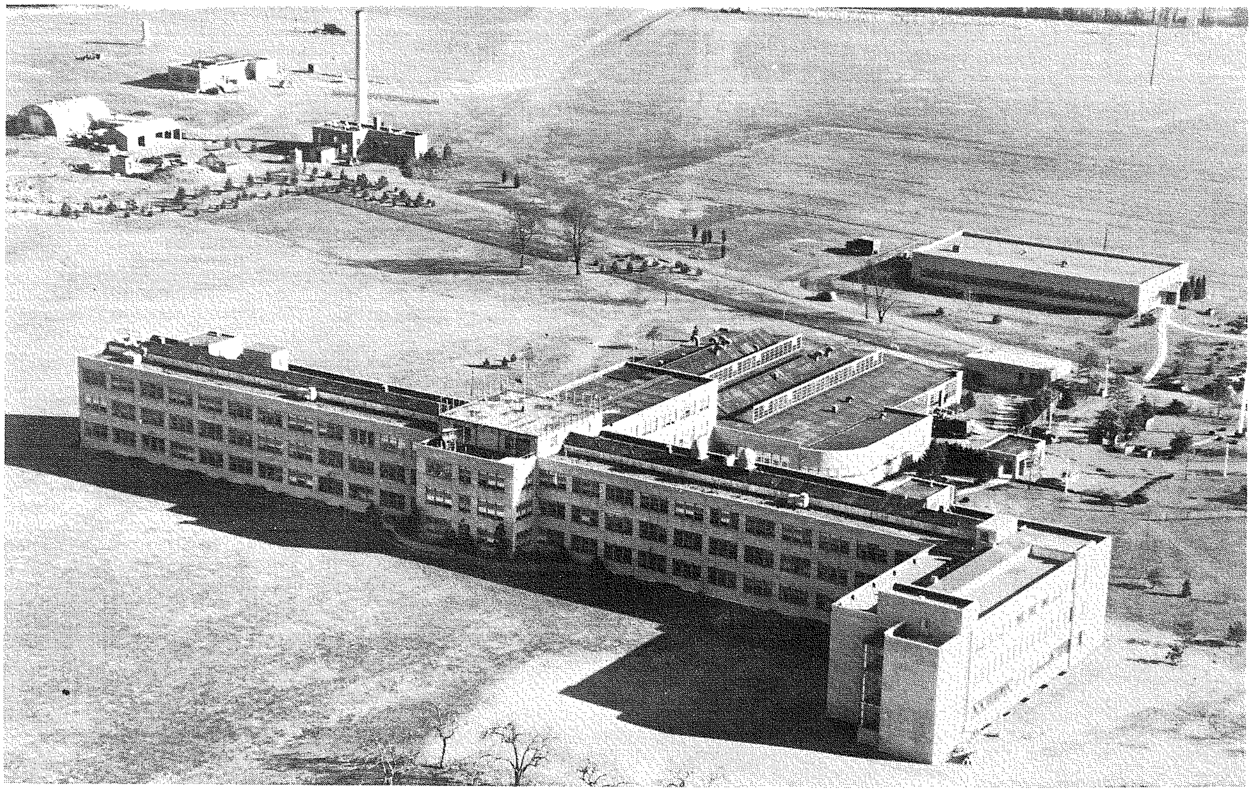




Research Report
1948

Television took its first real commercial steps during 1948. There was a rapid growth of television broadcast stations "on the air" and a remarkable increase in television-receiver manufacture and sales. This rapid expansion resulted in two situations during the second half of the year: the first, a question on the part of the Federal Communications Commission as to whether its rules of allocation were appropriate; and second, a shortage of channels as indicated by a large number of applicants.

For the first of these the Commission, following engineering conferences and a hearing, issued a "freeze" order effective October 1, 1948, suspending further television channel assignment until the allocation plan could be restudied. Shortly after the issuance of this "freeze" order we suggested that co-channel interference might be reduced by synchronizing the picture carriers of the stations concerned. We proceeded at once to follow up with experimental verification and brought about the synchronization of NBC's channel 4 stations, WNBW in Washington and WNBT in New York. This development is significant in that it increases the interference-free range of a television station and provides a significant advance toward lifting the "freeze" order.

For the second situation, that of the scarcity of channels in terms of the number of applicants, we conducted extensive field tests in Washington to determine the applicability of the Ultra-High Frequencies for television broadcasting. This information was submitted to the Commission and to the industry during hearings held in September and by later publication. These tests pointed the way for utilization of the Ultra-High Frequencies, indicating similarities and differences in comparison to the currently used Very-High-Frequency channels.

We continued during the year an active program on color television. Our color-television work will undoubtedly come to some stage of field test activity during 1949.

We were active in black and white television, conducting research where marked improvements in performance might be realized at the transmitter end and on practical development of components and circuits for receivers.

Just at the year end our new laboratory wing was completed. We began to occupy the new laboratory facilities which provide us with space to do additional work on home-type receivers of particular interest to the RCA Victor Division and to our licensees.

During the second half of the year we made a public demonstration of Ultrafax. The demonstration involved cooperative effort of NBC, Eastman Kodak Company and RCA. One of the things hoped for as a result of the demonstration was that it would point the way for future activity.

In this section of the report for 1947 it was pointed out:

> "A new field of activity appears on our horizon - electronics of solids. We look forward some years in the future to doing in solid materials what we have in the past accomplished in radio tubes. This new science is unfolding, and we plan to have a full part in its development."

During the year the Bell Telephone Laboratories announced the development of the Transistor, a three-element crystal amplifier. Following this announcement we have been very active in learning how to produce the devices and in studying their properties and methods of utilization. We believe that we have made significant advances.

We are continuing a modest program in instrumentation related to nuclear physics. This work is being done under government contract.

Other work done for the military services under contract continues at a stabilized level. We expect during the coming year to increase slightly the total amount of work done under government sponsorship. The new building constructed during 1947 for military research has been very effective in the conduct of this activity.

We established late in the year a program of sponsored advance development in the RCA Victor Division. The work programs undertaken are those which are of interest to our broadcast-receiver licensees.

Following a period of adjustment after the war we have now reached a reasonably stable balance between long-term fundamental research and research applied to RCA's present fields of operation. For the most part the fundamental research is done with RCA funds. However, where the interest in the end results is likely to be limited to the military fields, we are undertaking fundamental work under contract. We are continually learning how to render better service to RCA divisions and companies and to our licensees.

The research staff increased in number by a modest amount during the year. A similar growth is planned for the coming year with emphasis on additional members to do research on home-type receivers and radio tubes.

This report does not include any item on which a military-secrecy classification continues in effect. Excluding such items was decided upon in the interest of making the report of greatest usefulness.

While the material presented here is not classified in a military sense, it is highly confidential in an RCA sense; the report and the material contained in it should be so treated.

The first several sections of the report review matters of general interest in our research program. The following sections are devoted to the research projects classified by groups for convenient reference.

To assist the technical people of RCA who read this report, there are included at the close of each item, in the sections reviewing research projects, references to pertinent documents, technical reports and publications. Also, the names are given of the research people to whom technical questions should be directed if further information is needed. As a general rule, where two or more names are given, the first is that of the supervisor in general charge of the research, while the others are those of men most familiar with the details of the work. The names given are not intended to be a list of those to whom credit is due for the progress reported.

While many members of the technical staff had a part in the preparation of this Research Report for 1948, special credit goes to C. M. Burrill and E. T. Dickey who compiled the material and handled the editorial work.

E. W. Engstrom

E. W. Engstrom

Princeton, New Jersey
February 1, 1949.

The most important practical advance has been the perfection of a method of growing bacteria for examination in the electron microscope. In this technique, the bacteria are grown under near-dry conditions on a collodion membrane which separates them from their nutrients. Their growth can be followed accurately with a light microscope, and when they reach a desired stage, they can be removed and placed in the electron microscope without disturbing their physical relationships in any way. By means of this technique, it is possible to know the life history of each cell examined. Furthermore, since this technique makes it possible to examine different cells at different stages of their life history, an electron-microscopic record can now be made of the changes which occur as the cells grow.

In addition to this accomplishment in the study of bacterial cells, significant progress has been made using similar techniques in the study of the mode of reproduction of the bacterial viruses. The pictures obtained, showing various stages in the destruction of bacterial cells through the action of virus particles, have created a great deal of interest among bacteriologists and biologists. In fact, following the presentation of this research at scientific meetings but before publication of a scientific paper, copies of these pictures have been requested for six bacteriological textbooks which are in the process of revision. In addition, one of the photographs (reproduced here) was selected for an honorable mention award in the Second International Competition, "Photography in Science", sponsored by the Smithsonian Institution and the Scientific Monthly, published by the American Association for the Advancement of Science. The awards in this competition were made on the basis of significance in scientific research and not on photographic or artistic skill.

References: *"New Preparation Techniques for the Electron Microscopy of Bacteria", J. Hillier, R. F. Baker and G. Knaysi, JOURNAL OF BACTERIOLOGY, pp. 569-576, November, 1948.*

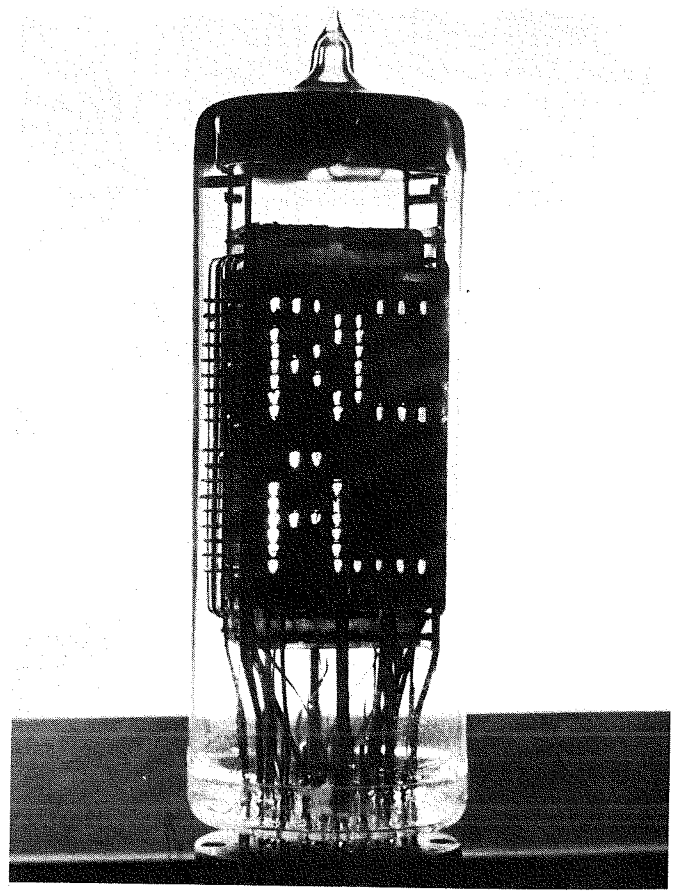
"Internal Structure and Nuclear Apparatus in Cells of E. Coli as Shown by Improved Electron Microscopic Techniques", J. Hillier, S. Mudd and A. G. Smith, JOURNAL OF BACTERIOLOGY, March 1949.

For further information refer to:

J. Hillier

9-2 The Selectron

The selectron is a new type of electrostatic storage tube for the registration of on-off signals. The development of this tube was undertaken to meet the need for such a storage or memory device in high-speed, electronic computing machines of the digital type, such as the computer under development at the Institute for Advanced Study, under the direction of Professor John von Neumann. Early samples of the selectron were designed to register 4096 signals. However, in a subsequent re-evaluation of the mathematical requirements for such a tube for the Institute for Advanced Study computer, it was found that a tube capable of registering a considerably smaller number of signals would be acceptable.



The latest model of the selectron tube; the illuminated elements are remembering "on", the dark elements "off". Half of the elements are on the opposite side of the tube and cannot be seen.

This, together with considerations of the need for absolute reliability under practical operating conditions and the desire to facilitate the contemplated small-scale construction program, made it appear desirable to reduce the number of storing elements per tube from the original value to 256.

Our main effort during the past year was directed to the solution of the many mechanical problems connected with the construction of the tube. Methods of fabricating all the parts and techniques of assembly have now been developed, so that a series of several hundred tubes can be made in our laboratory at reasonable cost in time and money. Such a program is planned to supply the Institute for Advanced Study with sufficient tubes for the pilot model of their electronic computer. This will use a complement of 40 of the small selectrons to provide a memory for 256 numbers of up to 13 digits in the decimal system of notation, equivalent to 40 digits in the binary or scale-of-two system actually employed by the computer. Several tubes have already been completed and are being life-tested in special equipment which we have built for the purpose.

For further information refer to:

J. A. Rajchman

10. Materials, Components and Techniques

10-1 Crystal Amplifiers

For many years, the vacuum tube has been the backbone of radio and other communications. Nevertheless, it has been appreciated that it might be supplemented, in many cases even supplanted, by other devices for rectification and amplification. The crystal detector was developed during World War II to such a degree that it became superior to the tube for microwave mixers and for certain types of detectors. Copper-oxide, copper-sulphide, and selenium rectifiers have also achieved success in competing with two-element vacuum tubes. However, the vacuum tube has retained supremacy in the amplifier field..

It was realized that in such non-vacuum devices as the crystal or copper-oxide unit the control of current by means of a third electrode could lead to several advantages over vacuum tubes as amplifiers: no heater or filament power would be required, a decrease in size might be achieved, very low-voltage, high-current units could be made (for example, to operate directly from an automobile storage battery), and there might even be cost advantages. Work along these lines was started by RCA about 1934, when it was found that the theory of electrical conduction in solids was

CROSS SECTION OF EXPERIMENTAL POINT-CONTACT GERMANIUM AMPLIFIER