CONTENTS

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RCA ENGINEER

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Send all inquiries to Bldg. 2-8, Camden, N. J.

On the first anniversary of the RCA ENGINEER it is a real pleasure to extend my heartiest congratulations and best wishes for the continued success of this interesting and informative technical journal. The staff has done an excellent job in presenting the running story of engineering within the RCA organization. Reportorially you have brought the engineer to the forefront by recognizing his achievements and by introducing him pictorially to all of us. Engineering is the spearhead into the future and the engineer is the man who leads the way.

David Sarnoff

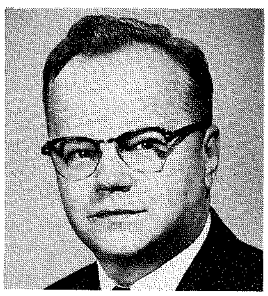
Chairman of the Board
Radio Corporation of America

Thanks to our engineers for the great part they played in RCA's attainment of its most successful business year in 1955. Just as the engineer in the Army opens the way in communications and transportation so the technical engineer clears the way and directs the signposts on the road of electronic progress. By developing new products and services the engineer is a vital factor in our advance, and I am sure that he will meet the challenges that will make it possible for RCA to achieve the goal of a two-billion-dollar business for 1966. As the years go by that story of progress will unfold in the reports published in the RCA ENGINEER which is a splendid publication.

Frank M. Folsom

President
Radio Corporation of America

First Anniversary



On the first anniversary of the RCA ENGINEER, the editorial staff is to be commended on meeting a need that existed for a long time within our organization. As we continue to grow we naturally acquire larger engineering groups. It is very important, however, that the identity of the individual is preserved; it is paramount that each member of our staff be fully aware that he or she is an important element in our business. At the same time every engineer must be kept informed. These two functions of identity and information are being admirably performed by the RCA ENGINEER.

Engineering has an important role in a company such as ours, which creates and produces technical products. Because of the great potentialities of science and continuous technological advances, more and more will be expected from us. Our history proves that, for today our business activity is centered around products and services engineeed within the past ten years.

Our engineering and development programs are expanding rapidly to keep pace with the pattern of our ever-growing business. New engineering facilities and laboratory space are being provided on a scale commensurate with the increased scope and magnitude of our engineering efforts. This indicates the importance of the job ahead of us as engineers. It is essential that we maintain close contact with one another and continue to focus our talents to assure an increasingly high rate of technical progress.

The RCA ENGINEER, with its objectives and the slogan "by and For the RCA Engineer"—recognizes the professional nature of scientific work, the existence of a fraternal interest and the necessity for a free exchange of knowledge among engineers.

E. W. Engstrom

Senior Executive Vice President
Radio Corporation of America

THE ENGINEER AND ENGINEERING MANAGEMENT

by **CLARENCE A. GUNTHER,**
Chief Defense Engineer
Defense Electronic Products

How many times have you thought or said, "Oh, that's a problem for management" . . . as though it were some mystic cloud under which we operate? Management must not be looked upon as an impersonal thing, since it is made up of men with duties to perform just as specific as those of the line engineer. To fully understand the operation of engineering management, one must first visualize the broad objectives and duties of managers. An awareness of these functions by engineers can help them perform their jobs more efficiently and with greater directivity.

It is the purpose of this editorial to point out some of the things expected of engineering managers so that a better picture can be gained of why the engineer's work must conform to an established pattern.

WHAT IS MANAGEMENT?

One definition given by the American Management Association is, "Management is guiding human and physical resources into dynamic organizational units which attain their objective to the satisfaction of those served and with a high degree of morale and sense of attainment on the part of those rendering service." These are rather high-sounding phrases and for our purposes, perhaps, management could be broken down into two general classifications: 1) top company management and, 2) engineering or working management.

First, perhaps, we should think about top management so that we may better understand the goals and objectives of our engineering managers. Top company management must satisfy the owners of the company, the stockholders. They must plan ahead to keep the company strong and make provisions for expansion of company buildings and facilities. Top management also has an overall responsibility to its employees and to the public. They must give priority to programs which will assure that the company can meet and surpass competition.

The most successful company can't continue to exist unless all of these requirements are satisfied by top management, which starts at the Board of Directors and the President. Successful top company management then delegates these decisions and programs to the closest operating level so that they are still in a position to maintain the direction necessary to coordinate a wide range of operations.

ENGINEERING MANAGEMENT—WHAT IT DOES

Basically, it is the task of engineering management to execute the broad plans established by top management in greater detail. Within the scope of the objectives and philosophies established, certain policies are originated to simplify and coordinate the task of engineering management. Keeping these policies in mind, the engineering manager must assume responsibility for plans, budgets, schedules, cost estimating procedures and the coordination between engineering and marketing. Product design must be kept at a high competitive level in order to maintain the position of leader.

In addition to the need for satisfying these requirements, engineering management must satisfy the needs of top management and serve as an organization which coordinates the activities of technical people in carrying out successfully the development of the product. "Accountability" for performance is an extremely important part of this responsibility. Designing for performance and quality, getting the job finished on time, answering the "whys" and "hows," and the careful control of budgets and expenses are requisites.

One of the most important functions of engineering managers is to assume full responsibility for the performance of all the members of a unit. They also have the task of determining the facilities and procedures which optimize the utilization of engineers within the limits of the basic charter under which management must function. In carrying out established objectives, engineering management must make itself available for consultation and guidance at all times.

RETURN ON INVESTMENT

An important factor in the operations of a manager is to assure a good return on investment. Without satisfactory results in this area, a company would be unable to satisfy its stockholders and attract the capital to insure continuity of employment, and continuity of long range projects. As a result, such a company would be unable to make a satisfactory contribution to the public.

For these reasons, expenses involving capital investment usually secure even more careful attention than those involving current operating expenses. Return on investment, therefore, sets many policies affecting operations planned. Planning of engineering projects is done jointly with Marketing activities to assure both a healthy current financial situation

CLARENCE A. GUNTHER, Chief Defense Engineer for Defense Electronic Products is responsible for Engineering Standards and Services, General Engineering Development, Technical Administration, and Camden Engineering Personnel. He also has functional engineering responsibility for the four operating departments. Mr. Gunther is the possessor of more than 25 years of RCA engineering experience. For a more detailed biography of Mr. Gunther, see RCA ENGINEER, Vol. 1, No. 5 (page 60).

and a technical investment permitting a healthy growth of our business.

THE ENGINEER-MANAGER RELATIONSHIP

Engineering management then is not a mystic cloud, but is made up of people (at each level of organization) to whom specific responsibility has been delegated. It is from these people, whether they are functioning in a staff or line capacity, that the engineer may expect decisions and seek advice, whenever needed.

Certainly the engineer's first responsibility is technical achievement. However, it will repay him to know and understand engineering management so that he may take full advantage of his manager's guidance.

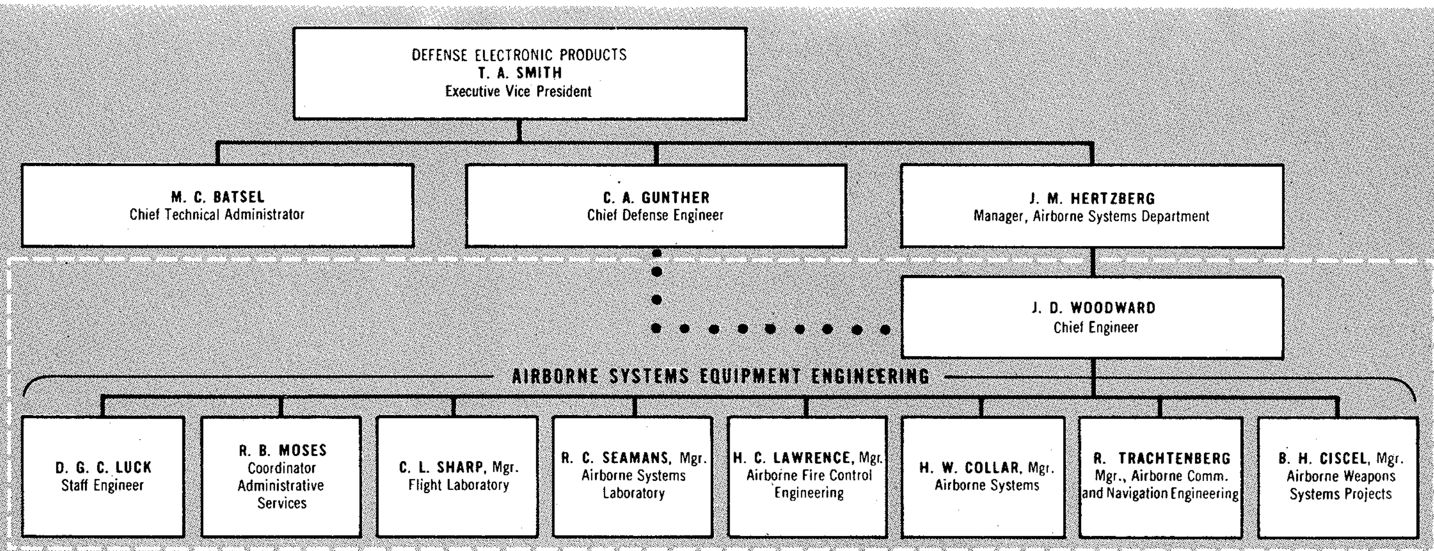
Then too, an understanding of the engineering manager can help the engineer further develop himself as an individual, as a member of the Engineering Profession, and as a part of his company. Engineers have the responsibility of building their efficiency by self-education, utilization of the special skills that other engineers possess, and full utilization of the facilities made available to them.

In these days of complex equipment, the engineer is called upon to offer judgment which his scientific training in orderly thought has made possible in many areas other than those of a strongly technical nature. It is not sufficient that an engineer be only creative or that he fulfill well a specific technical design. It is also necessary that this work be utilized by others in an effective fashion.

CONCLUSION

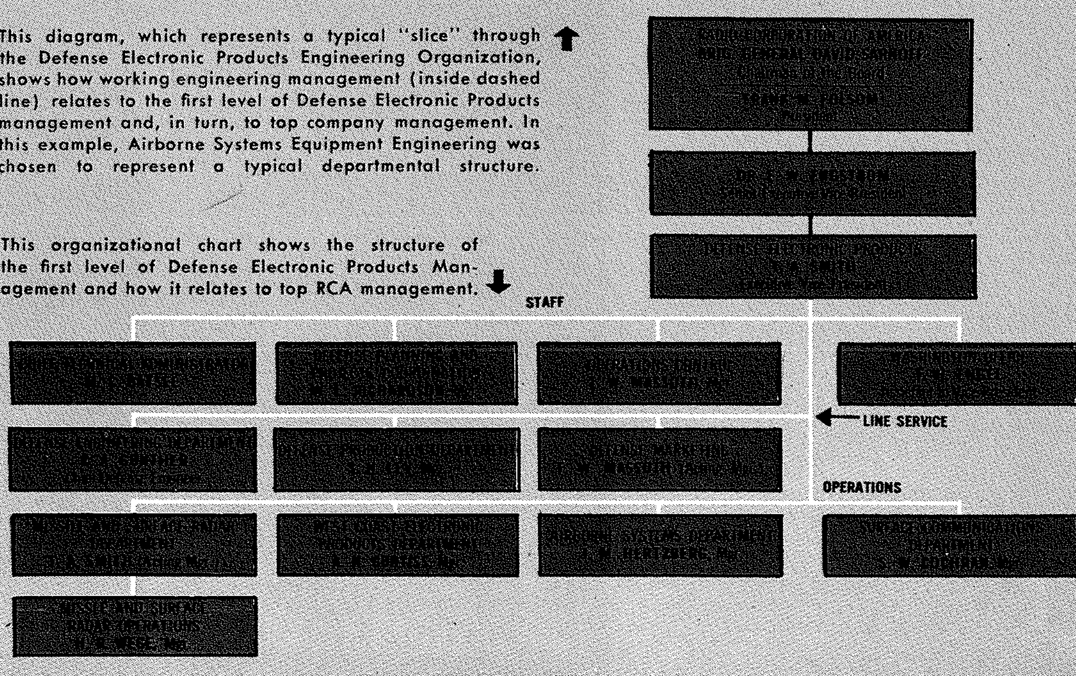
The engineer will, therefore, be called upon to help determine how his technical effort may best be fit into the overall objectives of the company. To accomplish this, he needs to know about and perhaps communicate with essentially every functional activity of the Corporation, particularly engineering management.

However, in conclusion, it is by no means intended that the engineer should perform the other functions. He should simply make use of the specific specialities available to him in these areas so that the desired results may be accomplished with the minimum effort on his part. This will conserve his time for his prime responsibility of attaining the highest level of technical achievement.

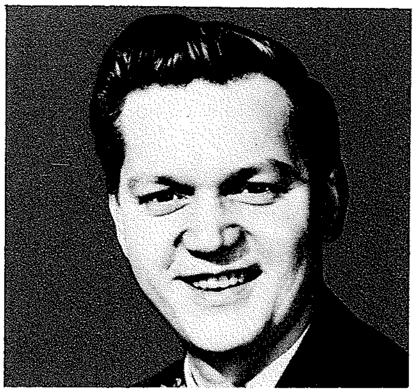


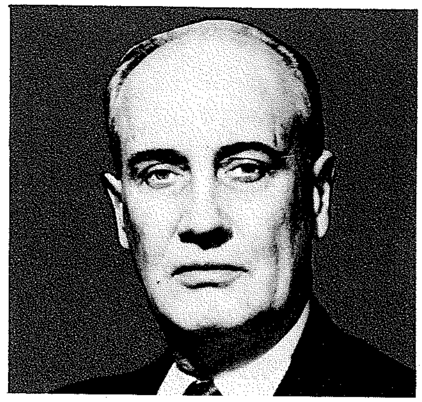
This diagram, which represents a typical "slice" through the Defense Electronic Products Engineering Organization, shows how working engineering management (inside dashed line) relates to the first level of Defense Electronic Products management and, in turn, to top company management. In this example, Airborne Systems Equipment Engineering was chosen to represent a typical departmental structure.

This organizational chart shows the structure of the first level of Defense Electronic Products Management and how it relates to top RCA management.



F. T. KSIAZEK Mr. Ksiazek attended the Case School of Applied Science in Cleveland and graduated from the Illinois Institute of Technology in Chicago with a degree of B.S. in E.E. He was first employed at RCA in 1948 as a Specialized Trainee. He later joined Product Design Engineering on Black and White Television Receivers. His work has included the design of I-F Amplifier Systems and Intercarrier Sound Systems. He has also designed and developed printed circuits for Picture I-F Amplifiers, currently in production. He is a member of Eta Kappa Nu, Rho Epsilon and IRE.





WALTER M. NUSS joined the Victor Talking Machine Company in 1925 and when that company was taken over by RCA in 1929 Mr. Nuss continued in drafting and color design work. For the past 11 years Mr. Nuss has been in Black and White Television Engineering, RCA Victor Television Division.

PRINTED WIRING IN RCA TELEVISION RECEIVERS

By **F. T. KSIAZEK, W. M. NUSS, J. R. ORR AND G. E. THOMPSON**

Black and White Television Engineering
RCA Victor Television Division
Cherry Hill, N. J.

"PRINTED CIRCUITS" is a term denoting a general class of electronic circuits. Basically, they consist of a pattern printed on a phenolic base plate in a configuration designed to perform some electrical function. This pattern may consist of wiring, capacitors, resistors and other components, but the form that has found widest application consists primarily of printed electrical conductors, or "printed wiring."

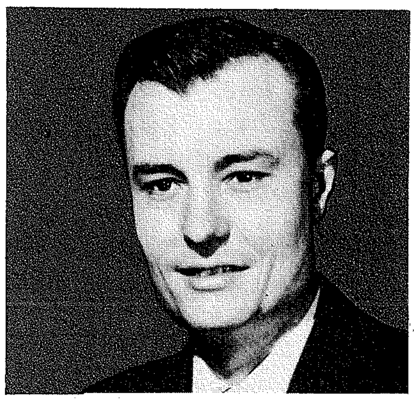
Home television receivers lend themselves quite readily to the "printed wiring" technique. The circuits are complex enough to effect a saving when the components are all soldered at the same time, and yet simple enough for practical boards of convenient size.

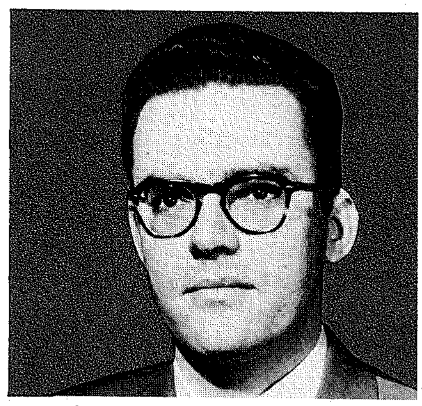
Generally speaking, the chief reason for using printed wiring in commercial television receivers is the reduction in production costs. Savings result from the use of mechanization in the manufacture and assembly of the printed board, and in the automatic insertion of certain components. Dip soldering of the entire board instead of hand soldering the individual joints, plus the single crimping operation, contribute to a major saving in cost.

PRINTED BOARDS IN THE LATEST RCA RECEIVERS

In the RCA Victor television models most recently introduced, the entire circuitry is divided into two groups

J. RICHARD ORR received the B.S. in Electrical Engineering from the University of Pittsburgh in January, 1949 and joined RCA immediately upon graduation. His engineering work has been with Black and White Television Receiver Design, principally in i-f circuits, sound i-f, fm detectors, printed circuits, coils, etc. Mr. Orr is a member of the IRE, Eta Kappa Nu and Sigma Tau.





GEORGE E. THOMPSON received the B.S. in Electrical Engineering from the Citadel in 1951 and joined RCA in February, 1951 as a Specialized Trainee. He was assigned to Black & White Television Engineering, RCA Victor Television Division in August 1951, where he has been employed until the present.

—(1) The components that are conventionally assembled and, (2) The components that are automatically assembled on five printed boards.

There are four basically different chassis found in the latest receiver line (designated KCS-94, -95, -96 and -97). Each employs printed boards, and since there are only minor differences between each chassis, this article will describe the printed boards in the "KCS-96" only, for the sake of simplicity. (See Fig. 1).

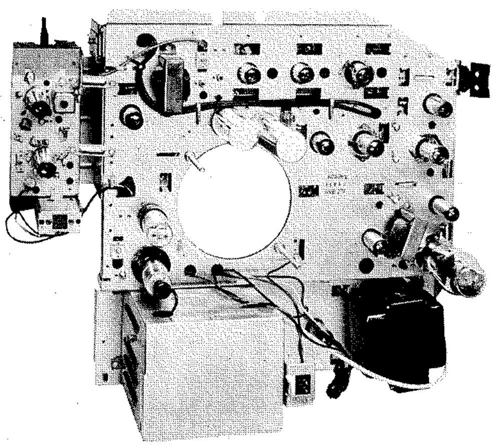
The "KCS-96" is the chassis used in the "Super" series of the RCA Victor Television Receiver line, which is rounded out by the "Special" and "De Luxe" series. The KCS-96 employs five printed wiring boards. Approximately 80% of the entire circuitry is contained in the following groups of circuits which make up the five boards: (1) Picture i-f and Second Detector, (2) Sound i-f and Audio Output, (3) Video, Noise Cancellation and AGC, (4) Sync Separation and Vertical Output, (5) Horizontal Frequency Control and Horizontal Oscillator.

Each of the above mentioned boards has several special requirements, so each will be discussed individually.

PICTURE I-F AND SECOND DETECTOR

Basically, the picture i-f printed board consists of a stagger-tuned amplifier, including three stages of amplification at a center frequency of 43.5 megacycles and a bandwidth of 3.25 megacycles, with a gain of approximately 20,000.

The design of the i-f board involved duplicating the performance of a comparable circuit using conventional coils and conventional wiring. Stray coupling, always troublesome at frequencies of 40-50 mc in conventional circuits, was particularly problematic in printed board design, for this reason: in conventional circuits stray coupling problems are overcome in many cases by relocating a component from one tie-point to another; however, the inherent inflexibility of printed board design prevents this, once the circuit layout is finalized.



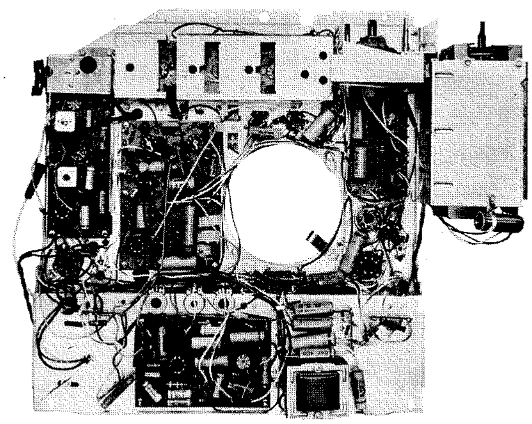


Fig. 1—Top and bottom views of The RCA KCS-96 Television Chassis

Printing of the bifilar coils with narrow lines and close spacing also presented complications which were resolved only after considerable development effort on the part of several groups.

The problems encountered, as well as their solutions, will be discussed in this article, while outlining the development of the printed picture i-f from the initial stages of design to the final stages in production.

When work was first begun on the design, few standards were available, so the field was wide open and the path to rapid design was not clear.

As shown in Fig. 2, all wiring and coils were printed on the boards, while resistors and capacitors were mounted on the reverse side. The square-wave shaped configurations are filament chokes used to isolate the filaments of one i-f stage from the other, thus minimizing coupling through the filaments. Here the requirements are sufficient inductance in the coil, and sufficient current-carrying capacity in the wire (0.3 ampere).

Each stagger-tuned stage consists of a printed coil which tunes with the inter-electrode capacitances of the tubes and the stray capacitances due to the printed wiring configuration. Bifilar coils are used to minimize the charge time constants in the grid circuit, thus increasing the immunity to noise pulses.

Electrical requirements of the printed coil itself demanded that a certain "Q" be maintained to fairly close tolerances and that the coils withstand a 1500V "hi-pot" test applied between the windings. In addition, the coil had to be covered or masked during the dip-soldering operation and later protected from humidity.

Glass cloth with a special adhesive, applied under pressure and heat immediately after the etching operation, was found to satisfy the above requirements. Since the glass cloth and the adhesive remain on the board, the coil itself is protected from solder and an effective humidity barrier is provided, together with an increased voltage breakdown characteristic between the printed circuit conductors.

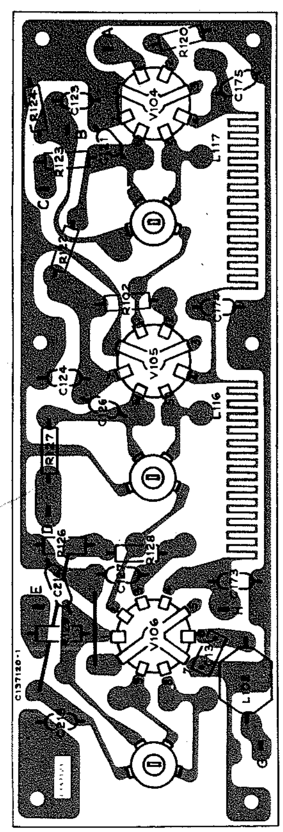


Fig. 2—Picture i-f printed board assembly

Tuning of the coils to make up for variations in tube capacitances was achieved by using an aluminum washer fixed to a threaded screw as shown in Fig. 3. The inductance range obtained in this manner was sufficient to allow tuning of the coil to the correct frequency in each stage. A powdered-iron washer of the same type was considered, but was found to have approximately half the tuning range of the aluminum washer, and hence could not be used.

To achieve a "Q" of 80, the line width had to be about 12 mils (0.012"), making the use of photo-etching necessary. With the glass-cloth covering, a spacing between windings of 12 to 15 mils was sufficient to withstand the 1500V hi-pot requirement.

The last i-f stage, one of the stag-

PRINTED WIRING
—continued

gered triple, uses a 6AS8 pentode-diode. Here, it was convenient to use a dual-purpose tube, since all the associated components can be clustered together on the same board, under the same shield, minimizing the radiation of harmonics.

In the initial design, stray coupling due to the layout presented some difficulty and considerable development was required to isolate one stage from another electrically. This required the use of tube shields, some special external ground wires and external shielding across the bottom of the tube sockets. In addition, to guard against radiation and i-f pickup from external sources, such as police broadcast and "doctor's call service," which operate in the 40 megacycle range, a removable cover shields the entire board on one side while the chassis covers the other side (See Fig. 1).

The overall performance of the picture i-f printed board is essentially the same as a conventionally wired and mounted amplifier with respect to gain, bandwidth, selectivity, and ease of alignment.

SOUND I-F AND AUDIO OUTPUT

The starting point for the layout of this board was the input terminal to the sound take-off coil. This point had to be in a position close to the receiver's video amplifier circuit in order to maintain relatively short leads on the coupling capacitor between the video amplifier plate circuit and the sound take-off coil (Fig. 4). The tuning capacitor for the sound take-off circuit was mounted on the printed board outside the transformer can. This eliminated the installing and soldering by hand inside the can, and resulted in a cost saving.

The ratio detector circuit was laid out with the pentode plate conductor (V101-6) and the diode leads (V102-1 & -2) as short and direct as possible (Fig. 5). The ratio-detector transformer was then designed around the layout to the performance requirements, with a balanced 6AL5.

With intercarrier sound it is important to maintain good a-m rejection at 4.5 mc, because in this type receiver a local oscillator adjustment will not move the sound i-f to a better point on the a-m rejection characteristics. Removing sound at the video plate presents an additional cross modulation problem. This meant a tighter control on the a-m rejection properties of the transformer. The problem was alleviated somewhat through the use of printed circuits, by supplying the transformer vendor with a standard coil and an actual printed circuit board in which the transformer was to be used. The vendor then had an exact operating circuit for a reference.

One advantage of printed circuits as used with a ratio detector is the elimination of the unbalanced a-m component in the output due to variations in wiring lead dress.

The transformer shield cans were ⅞″ to a side, with latch type terminals, as shown in Fig. 6. The terminals on the transformer itself were also the latch type, which fit into a standard cutout on the board.

Conductors and terminals were made reasonably wide to eliminate a registry problem when the coil was inserted. Copper was left around both shield can terminals even though both were not connected to ground in order to add rigidity to the can after dip soldering. Ground patterns are used around and between the printed i-f transformers and certain of the conductors to act as electrostatic shields; however, large areas of copper were not used in order to prevent blistering when dip soldered. It was found that copper pads around the tube shield ground point should be as large as possible. When the tube shield was inserted, there were conditions where the ground terminal of the tube socket would break loose from the printed wiring. In general, conductor widths were made as wide as possible, consistent with enough clearances to meet the performance requirements of the circuits. Spacing between conductors requiring certain voltage breakdown specifications is affected by such things as humidity, coatings, etc. For ordinary applications, where temperature and humidity variations are typical of indoor operating conditions with no external coatings, .001″ per 6 volts is considered a safe design. The most severe voltage clearance problem on the sound i-f and audio board was the V103-5 plate lead, which, under condition of having the speaker disconnected and the

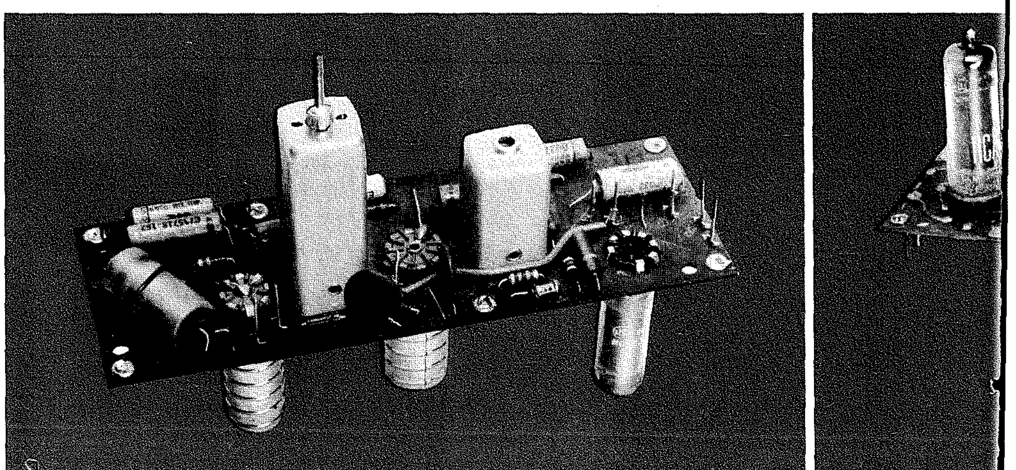


Fig. 4—The sound i-f printed board—top (left) and bottom

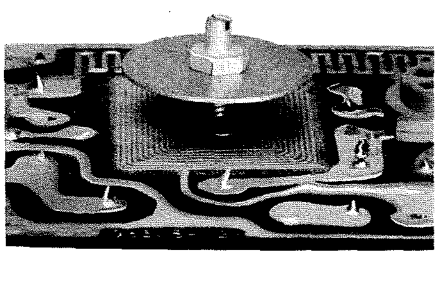
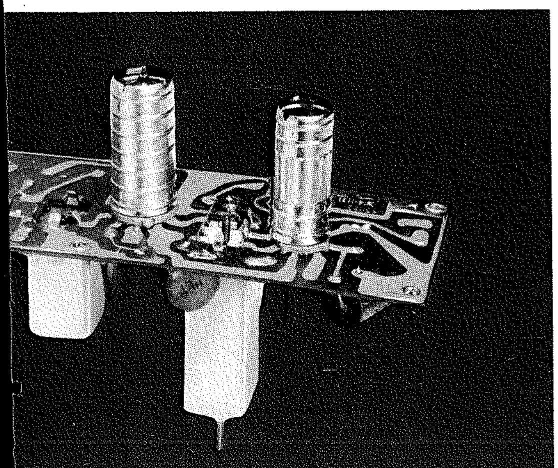


Fig. 3—Detail of the i-f coil tuning washer on the picture i-f printed board

volume control set to maximum, could develop better than 1000V peak-to-peak. Following the above voltage breakdown specifications gave no trouble as far as leakage resistance was concerned in this board. The leakage resistance specification is as follows (Refer to Fig. 5) "with R110 disconnected from terminal R, the leakage resistance from terminal R to the ground plane shall be not less than 200 megohms after 20 hours at 95% relative humidity, 40°C and ½ hour drying time."

The current-carrying capacity of a certain conductor width is limited by the amount of heat generated in that conductor during operation. On the board being discussed, the width of the filament conductor from V101-5 to V102-3 had to be increased over the original layout to stay within the maximum allowable temperature rise.



The problem of direct 4.5 mc pickup on the audio amplifier grid (V101-9) which is a-m detected in the grid circuit was solved by additional shielding of this circuit from other parts of the receiver. Unwanted a-m also appeared on this grid due to direct coupling from the pentode section of V101-6 to the triode section of V101-9. V101-6 is the first sound i-f amplifier, and unwanted a-m occasionally appears in this stage on strong signals in the form of a 60-cycle "sync buzz." Since the screen grid is not bypassed for audio, sync buzz will develop across the screen dropping resistor, R103. Normally, this presents no problem in that the ratio detector is insensitive to a-m, and the buzz is eliminated, but since the audio amplifier is in the same tube envelope, direct coupling takes place. This was solved by reducing the value of R103 from 1000 ohms to 100 ohms. With only one-tenth of the sync buzz developed, the amount coupled to the audio amplifier is reduced to a point of inaudibility. 4.5 mc harmonic radiation was somewhat of a problem with this board and a shield over C108 with a ground contact from this shield to T102 shield can was necessary. Mounting the board to the chassis presented some problems that were not readily apparent when this task was first undertaken. The mounting points provide grounds to chassis, and many points are connected together on the board to provide several grounding paths. Under certain conditions, however, it was found that an intermittent or poor connection would present an excessively long grounding path, which would cause (1) feedback: if r-f were being returned to ground, the long ground path would act as an antenna and radiate; or (2) the long ground path in some instances would add circuit inductance and change linearity and sensitivity in the ratio detector. This problem was corrected by soldering the grounding points on the board to lances on the chassis, instead of using self-tapping screws.

Some of the requirements of this board are as follows: with 10 μv of both sound and picture signal at the antenna terminals, the receiver should have noise-free sound and should develop enough audio at the ratio detector output to drive the audio output stage at least into 10% distortion. The ratio detector should provide this output with adequate bandwidth, (in this case 100 kc dynamic bandwidth would be sufficient) an f-m to a-m ratio at 400 cycles of at least 30/1, adequate downward amplitude modulation capability, and frequency stability well within the linear portion of the ratio detector output characteristics. The sound take-off circuit should provide adequate gain and good selectivity for interference rejection purposes and at the same time have enough bandwidth so as not to introduce excessive downward amplitude modulation.

VIDEO, VERTICAL AND HORIZONTAL BOARDS

In laying out the video, vertical and synchroguide boards for the KCS-96 chassis, size and performance of the printed boards were the most important considerations. These printed boards may be summarized as follows:

Board	Tubes	Function	No. Components
Video (Fig. 7)	6AW8	1st video amplifier & noise cancellation	
	6U8 6AQ5	1st sync amplifier & AGC video output	47
Vertical (Fig. 8)	6CG7	sync output & vertical oscillator	28
	6AG5	vertical output	
Horizontal (Fig. 9)	6CG7	frequency control & horizontal oscillator	22

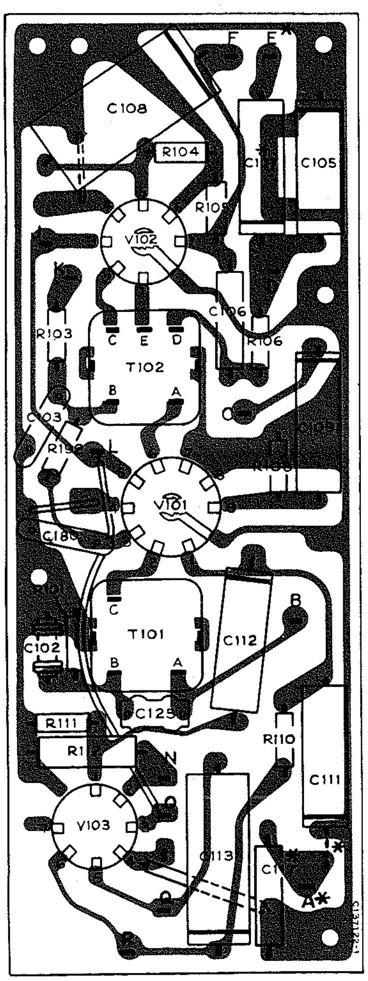


Fig. 5—Sound i-f assembly layout

In considering board size, each board had to be made as small as possible so that the cost of the board material would not be excessive for the number of components mounted on it. The method of determining this was to compare the cost of the conventionally wired section of the receiver to the printed section of the receiver. The saving realized by the use of printed boards was due to the fixture and machine insertion of components and the dip soldering of the boards which soldered all components on a board at one time. Thus, most of the hand operations of putting components in the chassis and hand soldering were eliminated.

In general, the more components on a particular board, the greater the saving over conventional wiring. If the printed pattern becomes very complicated, however, the board cost goes up as the board size increases. The necessity for increased board size is due to the spacing between printed wires rather than the area necessary for components. From the viewpoint of chassis space, it was also desirable to make the boards as small as possible. But, while making these boards as small as possible, it is desirable that the size reduction not be detrimental to performance by introducing the possibility of insufficient leakage paths between adjacent printed wires, coupling between critical components, or coupling between adjacent patterns. In other words, it is desirable that the performance of the printed boards would be as good as, if not better than, their conventionally-wired counterparts.

The layout of the video board is a good example of the above considerations. At the first attempt in laying out this board, a 6AN8 was used instead of a 6AW8. This selection, however, necessitated incorporating the first video amplifier and the noise cancellation functions into separate tubes. The many interconnections between tubes which resulted made the board size large, and affected performance due to increased distributed capacitance and coupling. The use of the 6AW8 made it possible to have the first video and noise cancellation functions in the same tube envelope, and these problems did not occur.

At times, it is impossible to leave enough spacing between printed wires to obtain the desired leakage resistance; this is especially so when the printed wires connect to adjacent pin connections as on a tube socket. To overcome this condition, slots were cut in the board where necessary to increase the leakage paths. A good example of this problem was

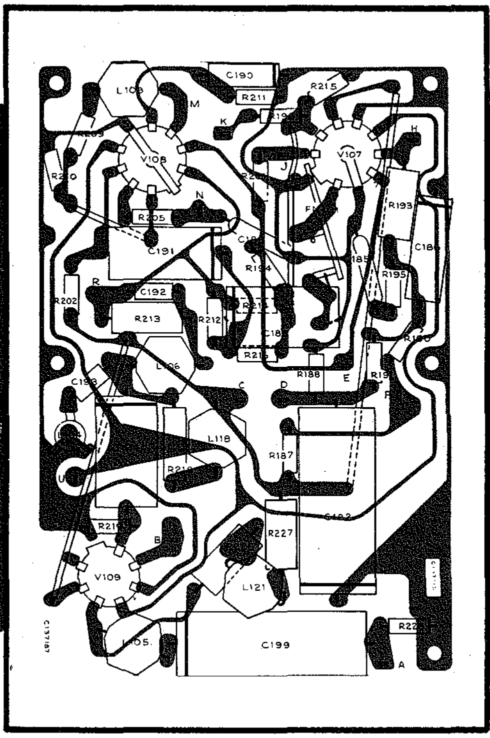
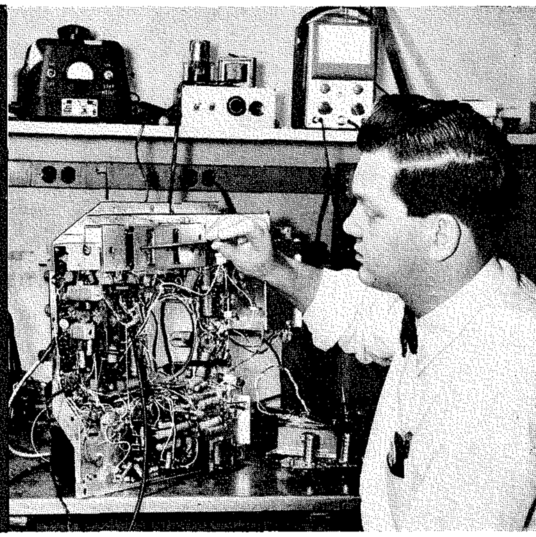


Fig. 7—Video amplifier and first sync amplifier assembly layout

F. T. Ksiazek making tests on the picture i-f of the KCS-96 chassis



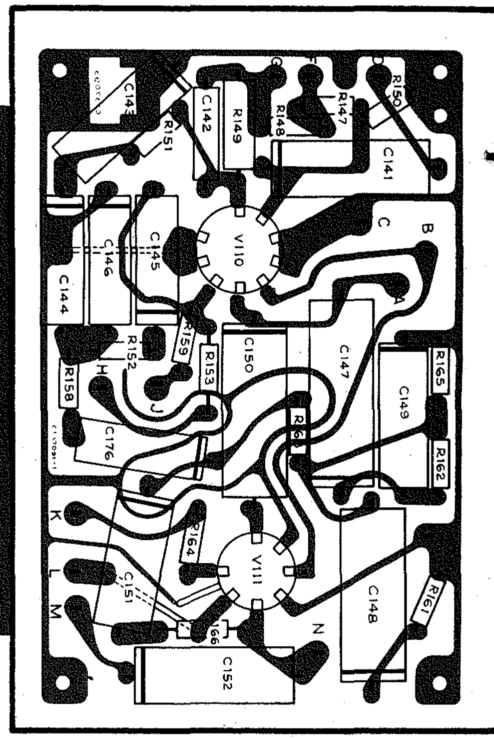


Fig. 8—Vertical oscillator—amplifier and sync output assembly layout

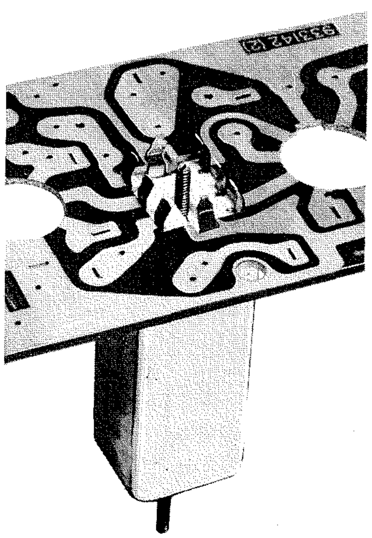
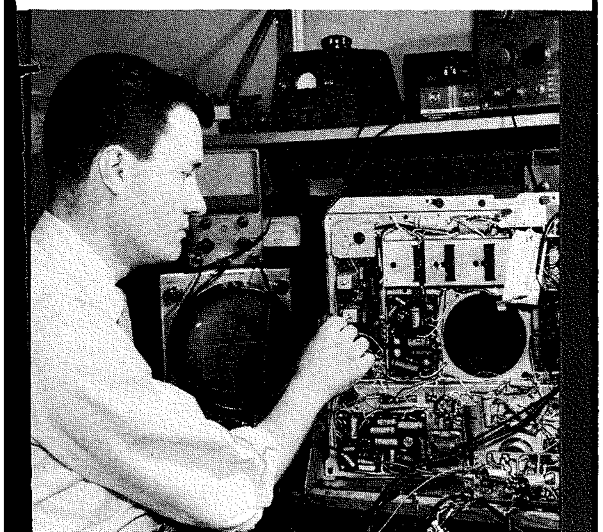


Fig. 6—Detail of the ratio detector transformer and board cutout

the synchroguide board where a slot is used between the printed wires to pins 1 and 2 of the control section of the 6CG7. Without a slot the leakage resistance after 50 hours in 95% relative humidity, 40°C, and ½ hour drying time, would be of the order of 200 megohms which would be good enough for most applications. In this case, however, it produced a frequency deviation of 0.8% which was considered too large. A



J. R. Orr in a test cage making measurements on sound i-f

frequency deviation of 0.2% max. change was desired which meant that the leakage resistance couldn't drop below 800 megohms after the humidity treatment.

Sometimes it was impractical to use slots to keep the leakage resistance high since an extra long slot would weaken the board. For these conditions, jumpers were used on the opposite side of the boards. An example of this is the jumper from pins 8-9 of V110 (Fig. 8) to ground on the vertical board. When running the pattern up to these pins, the frequency change of the vertical oscillator with change in leakage resistance was more than desired; therefore the jumper was used. Jumpers were also used to bridge printed wires where it was impossible to get across and where the use of jumpers produced a saving in board size.

By the use of a layout that gave short direct connections, by the use of slots, and by the use of jumpers it was possible to layout the video, vertical and synchroguide boards such that their board size and cost were reasonable and their performance was good.

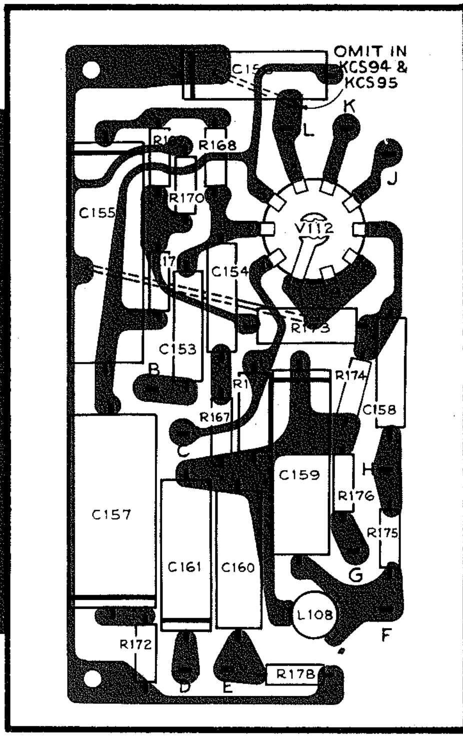


Fig. 9—Horizontal oscillator assembly layout

ACKNOWLEDGEMENTS

Due credit must be given to the factory personnel at Indianapolis for their cooperation and assistance, and to the many others in Camden and Cherry Hill who contributed in knowledge, experience and encouragement. Thus far over one million of each of the above mentioned boards have been used in RCA television receivers with marked success.

Walter Nuss (left) and George Thompson are checking a production video board against the original photo-master

CHART 1

Methods and Standards used in Printed Wiring for RCA Television Receivers

Base Material—XXXP laminated paper-base phenolic, .064″ ± .008″

Copper Laminate—.00135″ thick on one side

"Printing" Process—Photo-etching and silk screening

Component Mounting—Holes punched where needed to save space, rather than fixed grid

Component Assembly—(1) Automatic insertion on conveyors built by United Shoe Machinery Company and the Admiral Corporation; (2) Manual insertion in fixtures with automatic crimping

Component Types—Molded tube sockets; resistors and capacitors with axial and radial leads

Component Lead Diameters—(1) #20—.032″; (2) #18—.040″; (3) #16—.051″

Component Hole Diameters—
(1) .040″ + .005 / − .000 for #20 or #22;
(2) .048″ + .005 / − .000 for #18
(3) .060″ + .005 / − .000 for #16

Conductor Width—Minimum of 1/32″ except for printed coils; minimum of 1/16″ around periphery, soldering pad for leads—minimum of 5/32″ by 1/8″

Conductor Spacing—Minimum 1/16″ between ribbons for voltages up to 375 v. DC; above 375V a factor of .001″ per 6 V is used

Board Mounting — Soldered to mounting lances

Board-to-Board Connections — Leads wire-tapped to terminals (Bell Telephone Method)

Fig. 1—Author Ann Hathaway and Cliff Morris, Mgr. Industrial Tube Design, setting up computer tube for visual examination on laboratory comparator.

DESIGN OF ELECTRON TUBES FOR COMPUTER SERVICE

by
ANN HATHAWAY
Receiving Tube Engineering
Tube Division, Harrison, N. J.

APPROXIMATELY six years ago, RCA introduced a special line of electron tubes designed, manufactured, and tested to meet the specific tube requirements of high-speed computers. Although early computers employed tubes designed for use in home-entertainment receiving instruments, it was soon apparent that the specific requirements of computer service necessitated special tubes designed for excellent stability of characteristics over long periods of normal, stand-by, or cutoff operation. In addition, computer tubes must be able to withstand thousands of hours of "on-off" cycling without failure due to internal shorts or open circuits. It is also desirable that computer tubes be of miniature size to permit the design of relatively compact computer equipment.

The RCA computer line consists of six types, shown in Fig. 3, which cover the majority of computer applications. Type 5915 is a pentagrid tube having two independent control grids for use in coincidence (gating) circuits. Type 6197 is a sharp-cutoff pentode for use in frequency-divider and pulse-amplifier applications.

The other four types are medium-mu twin triodes for use in switching applications. Types 5963, 5965 and 6211 have separate terminals for each cathode and amplification factors of 21, 47, and 27, respectively. Type 5964 has a single cathode and an amplification factor of 39. These twin triodes are employed in multivibrator circuits, mainly of the binary-counter or "flip-flop" type, in frequency dividers, and in general amplifier service.

COMPUTER-TUBE REQUIREMENTS

Electron tubes for use in computer service must have several distinct performance characteristics. The most important requirements are:

1. High zero-bias plate current, initially and during life
2. Sharp cutoff characteristic of the control grid
3. Freedom from shorts, both permanent and intermittent
4. Minimum interelectrode leakage
5. Low heater power
6. Freedom from grid emission
7. Freedom from cathode-interface impedance

These varied, and sometimes conflicting, requirements make it necessary for the tube designer not only to develop special tube structures, but also to specify extra controls in the selection of materials and in the processes used in the manufacture of the tube and its elements.

TUBE STRUCTURE

The relationships among the various factors contributing to the tube characteristics can be illustrated by consideration of an ideal parallel-plane triode such as that shown in Fig. 2. The plate current, I_b, in amperes in such a tube is given by the following equation:

$$I_b = \frac{2.33 \times 10^{-6} A}{(d_{gk})^2} \left(\frac{\frac{E_b}{\mu} + E_c + e}{1 + \frac{1}{\mu} + \frac{4}{3}\frac{d_{gp}}{\mu d_{gk}}} \right)^{3/2}$$

where A is the effective cathode area in square centimeters, d_{gk} the grid-cathode spacing in centimeters, E_b the plate voltage, E_c the grid voltage, e the correction factor for contact-potential difference and initial electron velocities in volts, μ the amplification factor, and d_{gp} the grid-plate spacing in centimeters.

This equation indicates that plate current varies directly with the magnitude of A; therefore, the effective cathode area should be as large as possible for high zero-bias plate current. The cathode area is limited only by the heater power required to heat the cathode to its operating temperature. The heater power should be low, however, to minimize the overall power consumed and the heat generated by the entire computer installation. In a 5,000-tube computer using tubes which have comparatively low heater ratings of 1.9 watts, the total heater power required is 9.5 kilowatts. Effectively, the permissible amount of heater power, which is limited by the dissipation capabilities of the application, determines the magnitude of the cathode area, and, in turn, the amount of plate current attainable.

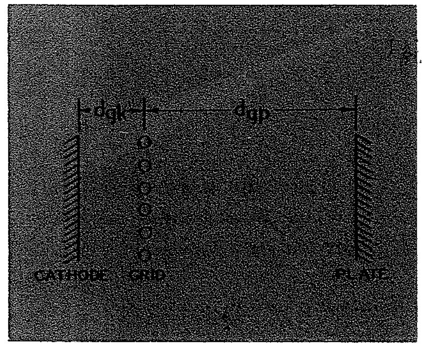
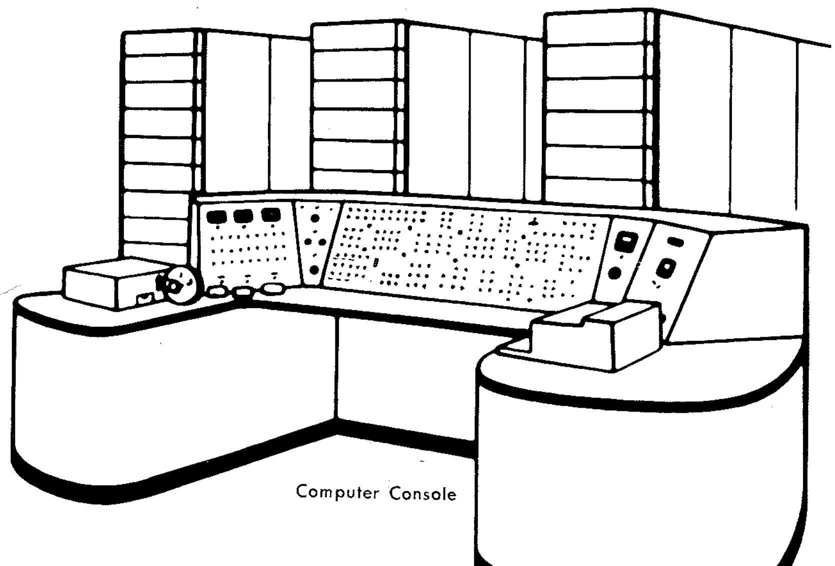


Fig. 2—Sketch showing plane surfaces in ideal parallel-plane triode.

The inverse square relationship between plate current, I_b, and grid-cathode spacing, d_{gk}, also affects zero-bias plate current. The spacing between grid and cathode may be as small as 0.005 inch. Any reduction beyond this value, however, is limited by manufacturing tolerances on the grid diameter and the cathode diameter. In addition, the possibility of intermittent or permanent shorts between grid and cathode increases as the spacing decreases.

The amplification factor, which usually is reduced in tubes designed for high plate current, must be kept at a medium value to achieve the sharp cutoff characteristics required of most computer tubes. The plate current of a tube decreases to zero as



Computer Console

Figs. 3—a, b, c, d, e, f, . . .
Six tubes designed for computer applications.

DESIGN OF COMPUTER TUBES
continued

the grid bias approaches the value of E_b/μ. When plate voltages of 150 to 200 volts are used, amplification factors in the order of 20 to 50 permit satisfactory cutoff voltages.

SELECTION OF MATERIALS

In computer tubes, as in all electron tubes, the chemical composition of the tube parts is extremely important in determining tube performance. The heater wire most suitable for computer applications is pure tungsten, which has a high melting point and low vapor pressure. The cathode base material is a nickel alloy having concentrations varying from approximately 0.005 to 0.25 per cent of reducing agents such as aluminum, carbon, magnesium, silicon, titanium, and tungsten.

The reducing agents present in the cathode nickel react with the emissive coating of barium, strontium, and calcium oxides on the cathode to produce a high, stable level of emission. The speed of this "activation" process increases with the quantity of reducing agents present. An "active" nickel alloy containing comparatively high percentages of reducing agents is easily activated. In a computer tube, however, an excess of reducing agents in the cathode may produce grid emission, interelectrode leakage, or an impedance layer at the interface of the cathode base material and cathode coating in the course of normal computer applications.

The interface layer is formed by a chemical reaction between the reducing agents in the cathode base material and the emissive coating. Unless the amount of silicon in the base material is kept to a minimum, an interface layer of barium orthosilicate may develop. The impedance of this layer will increase during life and cause a rapid decrease in plate current. The presence of sufficient quantities of titanium in the cathode base material may form a layer of barium titanate, with similar deleterious effects. Magnesium in the cathode base material must also be closely controlled. Because magnesium is volatile, it may evaporate from the cathode material, deposit on micas and stem leads, and possibly cause interelectrode leakage.

Because the reducing agents are necessary for cathode activation, the

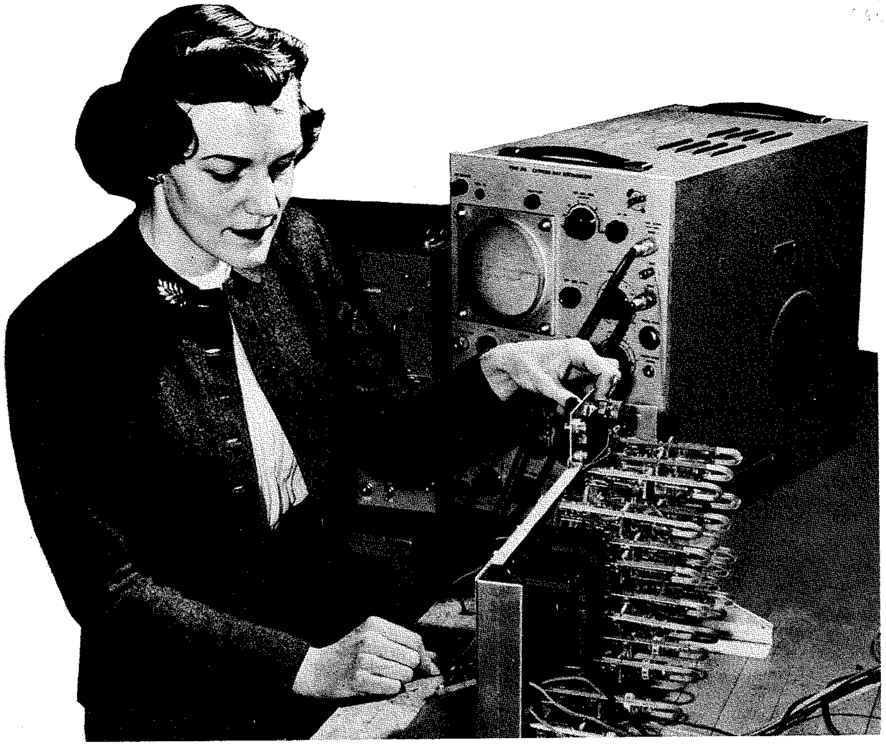
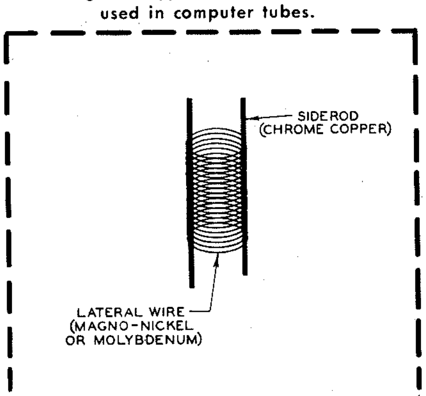


Fig. 6—Author determining performance of tubes under computer-circuit conditions.

Fig. 4—Typical grid structure used in computer tubes.



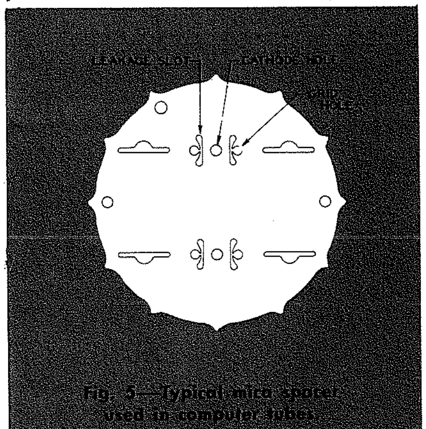


Fig. 5—Typical mica spacer used in computer tubes.

ANN HATHAWAY received the B.A. degree from Rutgers University, Newark, N. J. in 1956. She studied Electronics and Electrical Engineering at Purdue University, Lafayette, Ind. prior to joining the Tube Division of the Radio Corporation of America in Harrison, N. J. in 1944. She worked in manufacturing engineering on special-purpose tubes for a year, and then transferred to the Receiving-Tube Applications Engineering activity. In 1948, she became a member of the Receiving-Tube Design activity at Harrison. At present, her work is concerned primarily with the design and development of industrial tube types for computer applications.

selection of a suitable cathode base material is of considerable importance. Cathode base materials for computer tubes are either "passive" (having very low concentrations of reducing agents) or "normal" (between active and passive) nickel alloys. The chemical composition of the cathode nickel is closely controlled and checked by spectrographic analysis. In addition, each "lot" of cathode nickel is tested in sample tubes for initial characteristics and life performance. Quantities of approved material are then set aside for computer-tube use.

Several factors involved in the activation of the cathode, other than the composition of the nickel alloy, also affect tube performance. The processing of the uncoated cathode sleeve and the procedures used for tube exhaust and aging must be precisely controlled.

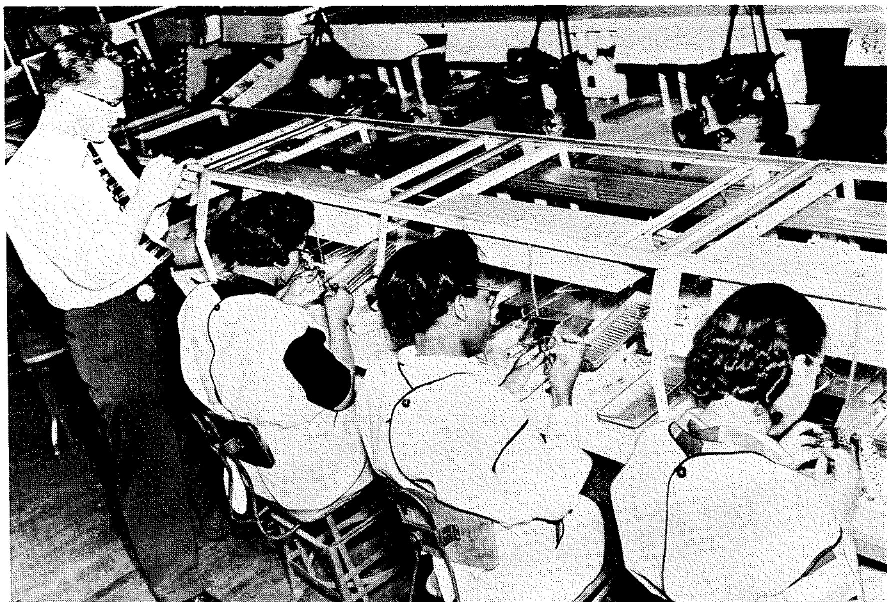


Fig. 7—Manufacturing engineer Joe Florek inspects computer-tube mount while operators Vivian Whiteside, Jacqueline Wallace, and Mattie Thompson (left to right) assemble additional mount cages. Prior to assembly, parts are kept in covered boxes at rear of bench. Plexiglass cover protects parts from foreign matter during assembly.

GRID DESIGN

The size and shape of the grid structure of the computer tube are primarily determined by the desired initial tube characteristics. However, two other factors must be considered in the grid design: (1) stability of structural dimensions during both production and operation, and (2) freedom from grid emission. It is important that the grid wire have adequate size and strength to minimize deformation during tube assembly. After assembly, however, the tube undergoes heating and cooling cycles which may alter the dimensions of the grid and its position relative to other elements of the tube. The materials used for the lateral wire and siderod wire are carefully chosen to minimize such changes.

A typical computer-tube grid is shown in Fig. 4. The siderods, which are made of chrome-copper or other materials containing copper, are stiff and have high thermal conductivity and "hot" strength. The lateral wire, which is made of molybdenum or magno-nickel (nickel alloyed with five per cent manganese), has high thermal conductivity and low thermal expansion. The grid structure as a unit is designed to have high thermal emissivity. For increased cooling of the grid, a radiating collar is often welded to the siderods. Grid emission, which is undesirable emission due to barium evaporated from the cathode and deposited on the control grid, is minimized by plating the grid lateral wire with silver or gold to increase the work function of the wire surface.

Fig. 8—Ann Hathaway watches operator Ann Davidson position tube for microscopic examination during final visual inspection of completed tube.

PLATE DESIGN

The plate material which provides the best initial characteristics and most stable long-life performance for computer tubes is nickel. The nickel strip material used for the plates is carbonized for improved thermal emissivity, and is then brushed on both sides to remove loose carbon particles which could cause internal shorts. The properties of nickel which contribute to its superiority as a plate material are its resistance to oxidization during storage and handling, and the ease with which it can be "degassed" (i.e., adsorbed and occluded gases removed prior to and during exhaust).

DESIGN OF COMPUTER TUBES
continued

MICAS AND GETTERS

The mica spacers for computer tubes are similar in design to those used in most receiving tubes. However, computer-tube micas are always coated with either aluminum oxide or magnesium oxide to produce a rough non-conductive surface on the mica and thus increase the length of the leakage paths between electrodes. In addition, slots are often stamped into the mica as shown in Fig. 5 to interrupt the formation of leakage paths across the mica.

The getter used in computer tubes contains barium as the active material. When the getter is "flashed" by means of an r-f current, free barium is released and deposited on the tube envelope. This free barium acts by physical adsorption and chemical combination with any residual gases to maintain low pressure in the sealed-off tube. A getter shield is used to prevent the formation of a leakage path across the mica due to the getter flash. This shield may be a metal strip welded to the under side of the getter, or an additional mica spacer placed between the getter and the main tube assembly.

TUBE ASSEMBLY

During assembly of computer tubes, precautions are taken to minimize dust and lint in the work area which might contribute to intermittent shorts in the finished tube. Tube parts are kept in covered trays and boxes, as shown in Fig. 7, until the start of the assembly operation. Plates and grids are passed through a stream of filtered air immediately prior to assembly. The completed assembly is tested for shorts and continuity, and is then covered to protect it from foreign materials. After sealing and exhaust, the tubes are aged at suitable operating voltages to complete the activation of the cathode and to promote stabilization of characteristics.

TESTING

Computer tubes are tested on a 100-per-cent basis in the factory for short and open circuits and for major electrical characteristics, such as zero-bias plate current, plate-current cutoff, and negative grid current. A transconductance test is also made on most computer types. In addition, several tests not usually performed on home-entertainment receiving types are required for computer tubes. These tests include 100-per-cent mechanical inspection of finished tubes, high-resistance (intermittent) shorts test, and tests for plate-current or cutoff balance between the units of twin triodes. Each tube is visually inspected (including microscopic examination, as shown in Fig. 8) to determine whether the internal structure, bulb, and base pins meet the mechanical standards required for computer tubes. The high-resistance shorts test, shown in Fig. 9, measures the resistance between the grid and all other elements of the tube, and indicates the presence of intermittent or permanent shorts which may be caused by loose particles in the grid region. In addition to the factory tests, a weekly sample is checked by both the Quality and Test Engineering activities for design and quality tests.

Samples of each week's production

Fig. 9—Manager of Miniature Tube Production Engineering, Carmine Caruso, watches operator, Helen Donahue, tap tube during test for intermittent shorts.

of computer tube types are also subjected to the following life tests:

1. Cutoff life, at typical computer-service conditions in which no plate current is flowing. The tubes are operated for 1000 hours, during which time the heater is subjected to on-off cycling. The tubes are checked regularly for such characteristics as plate current, negative grid current, cathode-interface impedance, and interelectrode leakage. Satisfactory 500-hour life-test results are required before each week's production is released for shipment.
2. Conduction life, at maximum dissipation ratings. The duration of this life test, the cycling of the heater, and the quality criteria are identical to those of the cutoff life test.
3. Heater-cycling life, at higher-than-normal heater voltage and with heater-cathode voltage applied. The tubes are operated for 168 hours, or 2000 on-off cycles consisting of one minute on and four minutes off. Upon completion of this test, the tubes are checked for shorts and continuity and tested for heater-cathode leakage.
4. Stability life, at maximum dissipation ratings. The tubes are operated for one hour, and then the major characteristic (usually plate current) is checked. The change between the initial reading and the one-hour reading must be less than ten per cent. This test is designed to assure early-hour stability.
5. Survival life, at maximum dissipation ratings. The duration of this test is 100 hours. The purpose of the test is to detect early-hour inoperatives due to mechanical defects. The survival and stability life tests are identical to those specified for premium tubes for military applications.

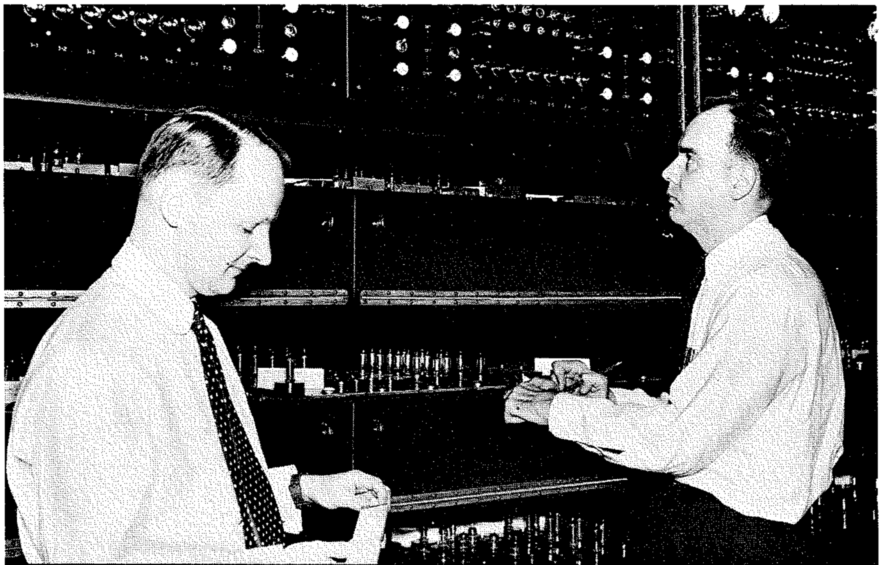


Fig. 10—Bill Cranmer of Test Engineering makes calculations while Frank Feyder of same activity checks voltages on life-test racks used for conduction and cutoff life tests.

Fig. 11—Design engineer Henry Stumman watches operator, Marie Brandt, take readings on tube after life test on survival and stability life-test racks.

Two additional life tests may be specified for particular computer types. In the "overdriven" life test, the control grid is driven slightly positive. This life test is made only on computer types used in critical applications requiring a positive grid-current flow of 100 microamperes or more. A grid-emission life test may also be made at cutoff conditions and higher-than-normal heater voltage. This life test is required only on computer types critical as to grid emission.

In addition, 5000-hour cutoff and conduction life tests are made on a sample of each week's production to obtain information. Life racks used for cutoff and conduction life tests are shown in Fig 10. Survival and stability life-test racks are shown in Fig.11.

Suitable operating conditions for an accelerated life test for the detection of cathode interface are presently being investigated. Such a life test would provide additional control of major characteristics affected by the formation of the interface impedance layer.

ACKNOWLEDGMENTS

The author wishes to thank R. E. Higgs, H. E. Stumman, Dr. I. F. Stacy, Dr. E. P. Bertin, and H. J. Prager for their aid in the preparation of this paper.

TRANSISTORIZATION OF SERVOMECHANISMS

By

H. W. DAY and E. D. PADGETT

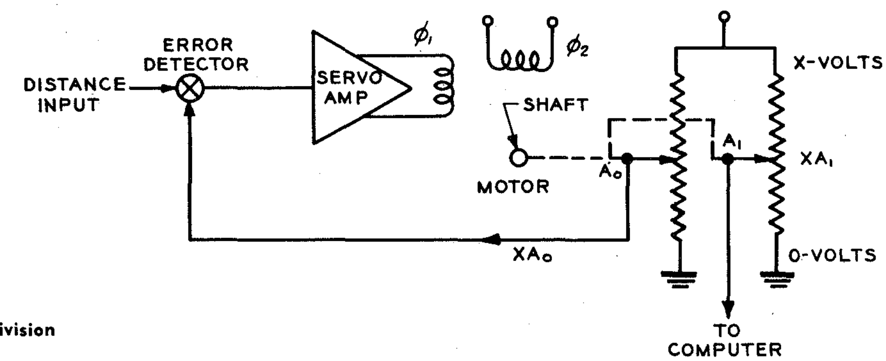
Component Reliability Engineering
Defense Electronic Products
Moorestown, N. J.

SERVOMECHANISMS are electromechanical devices used for the automatic and remote control of mechanical position during the regulation of system variables. Because of their unique properties, including economy, a new trend in automation is occurring in various departments of industry. For example, the textile and petroleum industries are installing these devices in appreciable quantities for the automatic control of such variables as fluid flow, temperature, pressure, speed, mass, and processing time.

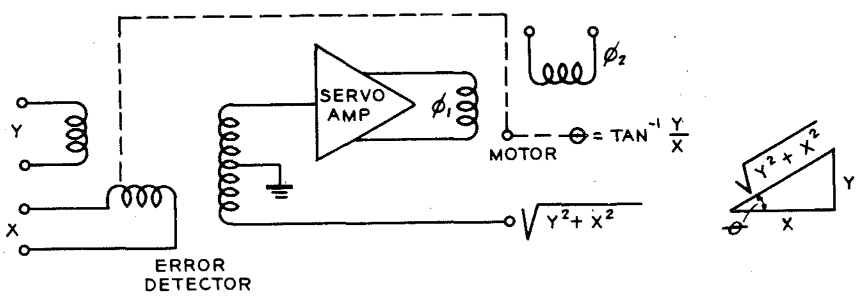
In Electronics, servos are used for processing the applicable variable in military equipment and in data handling and computing systems. Fig. 1 shows several servo applications.

In airborne computer servo applications, the ultimate in miniaturization and reliability must be obtained in order to conserve weight, space and power. In this respect RCA engineering Management promptly established early challenges which were, "small form factor, simplification, and reliability." To achieve these goals, investigations were guided by two simple *engineering fundamentals:* (1) Hooke's law must be applicable (the system must have elasticity), and (2) application of a properly timed impulse is necessary for satisfactory system operation.

A Servomechanism can perform the basic arithmetic functions and solve trigonometric equations. The uses of Servomechanisms are limited only by the imagination of the engineer.

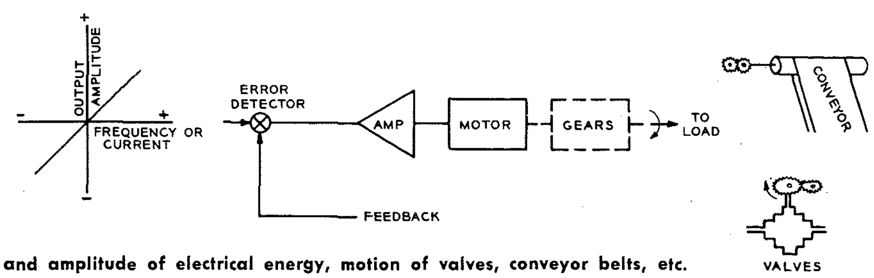


A. Multiplication and division



B. Triangle computation

Let X volts be applied to ganged potentiometers. If position, A_0, of pot arm is varied by mechanical connection to motor output shaft, the output of arm is XA_0, XA_1 —XA_N depending on number of pots in assembly. These outputs can be used for multiplication or division elsewhere in a computer. Here XA_0 is fed back to error detector and compared with input signal representing distance. When XA_0 equals distance signal, error signal is zero and position of pot arm is related to distance.
B. Triangle computation



C. Control of frequency and amplitude of electrical energy, motion of valves, conveyor belts, etc.

Fig. 1—Table showing three typical Servomechanism Applications.

Investigations governed by these fundamentals indicated that reductions in size of as much as 4 to 1 were possible in some servo applications, weight could be reduced by as much as 5 to 1, power requirements could be reduced by 10 to 1, and standby power reduced to less than ½ watt. Also, it was realized that important improvements in the design of instrument servomechanisms would be obtained by altering servomotor characteristics until they were suitable for use with power transistors.

THE SERVO MOTOR

The usual "closed loop" servomechanism consists of an error detector, an amplifier, a servo motor or motor generator, necessary gearing, and a controlled shaft to which the load is attached (see Fig. 3).

The induction servo motor is a two phase a-c machine. It has two input windings—a fixed-phase (ϕ_1) and a control phase (ϕ_2), wound on a stator and a rotor which is connected through bearings (often high-temperature units) to a mechanical output shaft.

Important characteristics of instrument servomotors are summarized as follows: The no-load speed of the output shaft is at maximum when the voltage applied to the control winding reaches 100% of its design value. Stall torque is proportional to voltage applied to the control phase, or, proportional to the square root of the product of fixed phase power and control phase power. For a linear torque-speed curve, maximum power output occurs at about half the no-load speed. Efficiency is the ratio of maximum motor power to stall power input.

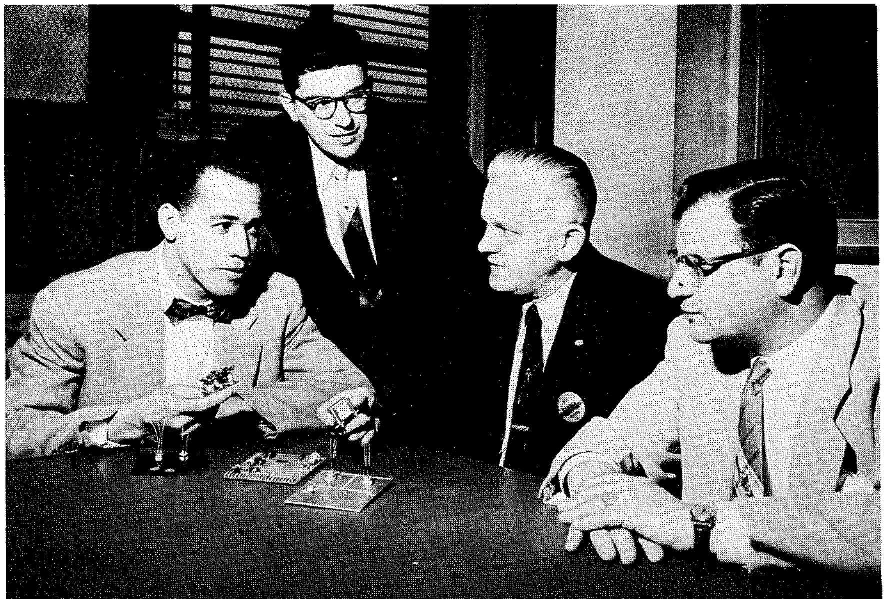
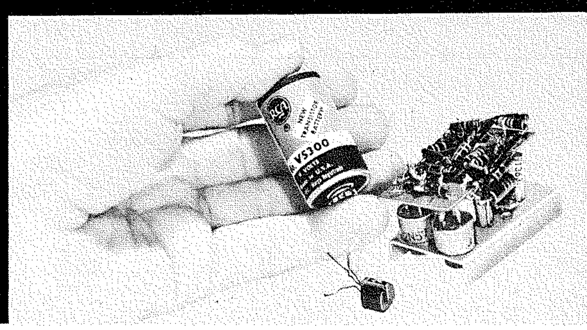


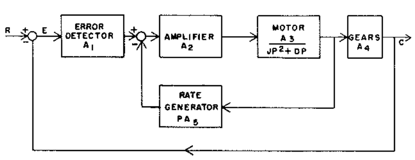
Fig. 2—Transistorized servo-amplifiers are adaptable for use with printed circuits. (L to R) H. W. Day, W. R. Bauer, J. V. Landis, Mgr., Inductive Components and J. C. Koenigsberg discuss methods of applying printed circuit techniques to transistorized amplifiers. Compare the size of the Servo Amplifier (held by Mr. Day and also shown in hand with miniature battery) to the size of a common output transformer held by Mr. Landis. Note that transistorized servo amplifier is about same size as transistor battery. Miniature input transformer is removed so readers can see relative size.



Stall torque efficiency is the ratio of developed stall torque to maximum theoretical stall torque. Efficiency increases as the number of poles is reduced and as the operating or system frequency is increased.

A common method of servo motor operation requires that the fixed phase of the motor be excited by a fixed reference voltage, and the control winding by a variable voltage separated in time by 90°. These voltages generate currents which produce magnetic fields at the rotor. If these fields (which are in space and time quadrature) are combined vectorially, the resultant is a rotating flux field of constant magnitude. The rotating field induces a voltage in the rotor conductors. The magnitude of this voltage is proportional to the speed of the field, and hence to the rotor speed. The induced emf generates currents in the rotor. The rotating field represents a force which acts on the current in the rotor with the resultant action being an acceleration of the rotor output shaft.

Improvements in the miniaturization of servomechanisms can be achieved by reducing the motor control winding voltage and/or power requirements. The explanation of this is as follows. As mentioned earlier, stall torque is proportional to the voltage applied to the motor control winding. Also, stall torque is a function of the square root of the product of power required by the fixed phase, P_f and control phase, P_c, as illustrated in Fig. 4. For balanced operation, fixed phase power equals



$\frac{E}{R} = \frac{\text{ERROR SIGNAL}}{\text{REFERENCE SIGNAL}}$ = RATIO OF ERROR SIGNAL TO REFERENCE SIGNAL.

$G = \frac{A}{JP^2 + DP}$ = TRANSFER FUNCTION

$A_1, \cdots, A_5$ = SERVO SCALE FACTORS, i. e., $A = \frac{T}{V_c}$ = STALL TORQUE PER CONT. VOLT.

D = VISCOUS DAMPING COEFFICIENT.

J = MOMENT OF INERTIA.

C = CONTROLLED VARIABLE (LOAD SHAFT).

P = TRANSFORMATION OPERATOR (LA PLACE).

$$\frac{E}{R} = \frac{1}{1+G} = \frac{JP^2 + (D + A_2 A_3 A_5)(P)}{JP^2 + (D + A_2 A_3 A_5)(P) + (A_1 A_2 A_3 A_4)}$$

Fig. 3—Block diagram of Closed-Loop Servomechanism.

TRANSISTORIZATION OF SERVOMECHANISMS

continued

control phase power, and stall torque is given by expression *KP*. Hence, balanced stall torque, T_{sb}, per total watts input is constant (equation 1, Fig. 4C).

For unbalanced servo motor operation the fixed phase power, P_f, does not equal the control phase power, P_c, and unbalanced stall torque is given by equation 5. Equations 4 and 5 have been normalized and plotted as functions of power unbalance, in Fig. 4. The importance of this is that for a power unbalance of as much as 0.6 (Fig. 4a) the stall torque per-control-watt increases approximately 100% (i.e., 100(2.0 —1.0)). For the same power unbalance the stall torque per-total-watt (Fig. 4b) decreases by about 21% (i.e., 100 (1 —0.79) = 21%). In other words, high torques per control-winding-watt can be obtained by unbalanced operation of a servo motor, and yet the amount of unbalance can become large before the decrease in stall torque becomes serious.

This knowledge, in many cases, can be made to work to advantage for the designer. Where long life and high reliability are of prime consideration, high motor gain (high torque output per-control-watt) can be achieved by selecting a servo motor with a higher stall torque rating than that required for the particular application. This scheme permits a high degree of unbalance, allowing fixed phase power to be much higher than control phase power.

MODIFIED DESIGN VERSUS CONVENTIONAL

Here is an example of how a reduction in the control-winding impedance can be used to produce a simplified design. The effective impedance (stalled) of the control winding of a conventional size 15 motor is 8800 ohms, while the control winding is rated at 230 rms volts (to produce a torque of 1.45 in. oz.) Assuming that E^2/R is a close approximation of control winding power, then

$$P_c = \frac{230^2}{8800} = 6.01 \text{ watts}$$

This is the normal power rating.

In our modified design the effective impedance (stalled) of the control winding is 150 ohms, and the control winding voltage is 30 rms volts (to produce a torque of 1.45 in. oz.) from push-pull power transistors. Control winding power is

$$P_c = \frac{30^2}{150} = 6 \text{ watts}$$

which is the normal rating of this motor. The reduction in control voltage requirement results in longer life and improved reliability of the transistorized amplifier by derating and stabilizing the power transistors.

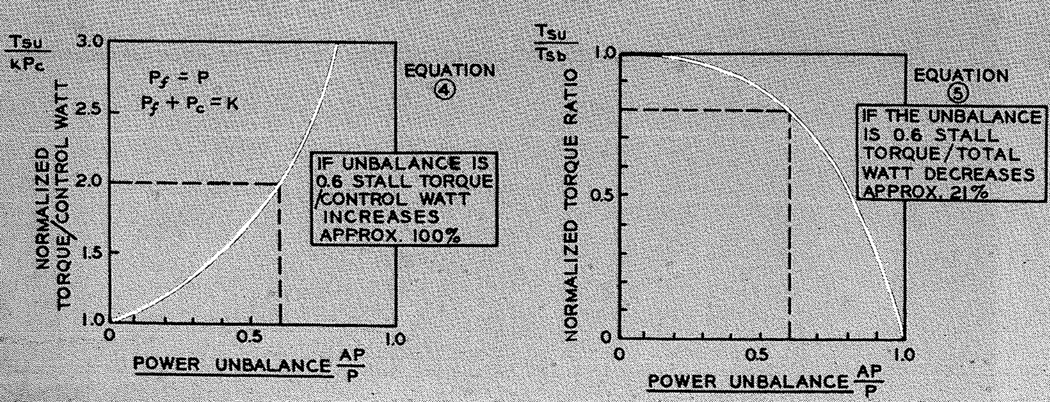
RATE GENERATORS AND ERROR DETECTORS

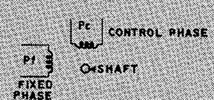
Both a-c and d-c type rate generators are used in servomechanisms. Rate generators are electromechanical devices which resemble small motors. The output voltage (usually expressed in volts-per-1000 rpm) of these devices is proportional to shaft velocity. A rate generator is attached to a servo motor whenever a signal is desired that is related to rate-of-change, or derivative of shaft position. Rate generators can be used as differentiators or integrators in data transmitting and computing servos. As shown in Fig. 3, the output from the rate generator is fed back to the amplifier to assist in stabilizing the system by creating an effect similar to viscous damping. Analysis of the transformation function of the servo system shows that the product of the rate generator constant, *A5*, and amplifier gain, *A2* is added to the viscous damping coefficient. Physically, this is as though the damping from the rate generator increased the damping coefficient *D*, to a larger value.

Several types of error detectors are used in servo work. Probably the most popular device for alternating current systems is the well-known combination of a synchro transmitter and a synchro control transmitter. A relatively new device, called the "magnetic modulator," shows promise for systems where d-c "error" signals must be converted to alternating current. The a-c output of the "magmod" is phase reversible. The magmod is promising because it has no moving parts and because it can be used in high ambient temperatures.

An example of the use of a synchro-transmitter (CX) and control-transformer (C-T) combination is in an error-detector system. Alternating current at the system supply frequency is applied to the rotor windings of the transmitter. The output leads are attached to the C-T termi-

Fig. 4-a, b and c—Curves and equations showing both Unbalanced and Balanced Servomotor operation.





FOR BALANCED OPERATION $P_f = P_c = P$ AND TORQUE $= K\sqrt{P^2} = KP$ AND BALANCED STALL TORQUE, T_{sb}, PER TOTAL WATTS INPUT IS:

① $\dfrac{T_{sb}}{\text{TOTAL WATTS INPUT}} = \dfrac{K\sqrt{P^2}}{2P} = \dfrac{K}{2}$

FOR UNBALANCED OPERATION $P_f = P + AP$ AND $P_c = P - AP$ SO TOTAL WATTS INPUT $= 2P = (P+AP)+(P-AP)$ UNBALANCED STALL TORQUE IS:

② $T_{su} = K\sqrt{P_f P_c}$

UNBALANCED STALL TORQUE PER TOTAL WATTS INPUT IS:

③ $\dfrac{T_{su}}{2P} = \dfrac{K\sqrt{P_f P_c}}{2P} = \dfrac{K\sqrt{(P+AP)(P-AP)}}{2P}$

UNBALANCED STALL TORQUE PER CONTROL WATT IS:

④ $\dfrac{T_{su}}{P_c} = \dfrac{K\sqrt{P_f P_c}}{P_c} = K\sqrt{\dfrac{P_f}{P_c}}$

THE RATIO OF EQUATIONS ③ & ①, IS

⑤ $\dfrac{T_{su}}{T_{sb}} = \dfrac{\sqrt{P^2-(AP)^2}}{P} = \sqrt{1-\dfrac{(AP)^2}{P^2}}$

nals. The output of the C-T is applied to the input terminals of the servo amplifier. Let some external command signal (such as one from conveyor belts) move the transmitter and C-T shafts at the same speed. In this case, no error signal is produced by the C-T. If, for some reason, one of the shafts drops out of synchronism, an error signal is developed at the rotor of the C-T. The servo amplifier applies error signal to motor control windings. The motor, through suitable gearing, reproduces data at a speed and torque that permits the load to perform a compensating function.

CHOICE OF MOTOR AND GEAR TRAIN

Simplified methods are available for selecting the motor and gear train. "Closed loop" testing is a splendid way to establish "loop gain" since the gear train acts as a mechanical transformer, and the designer may reduce the number of transistors required in the amplifier (see Fig. 9). When load inertia and friction cannot be neglected, a graphical method can be used to establish the initial design. Assume a series of gear ratios and plot motor power versus gear ratio. Assume that the motor runs at a speed that operates the load at the speed C. Note the corresponding torque from the speed-torque curve. Motor power in watts is calculated from

$$P_m = \frac{NT}{1352}$$

where T is torque in inch-oz, and N is rpm related to the load speed, c, and gear ratio, n.

Then, for the same values of speed and gear ratio, calculate and plot load power, P_L, on the same graph. If prior knowledge of inertia, friction, and tracking requirements are not available, values for these items can be assumed for first order computations. At the load shaft, load power is

$$P_L = [C]\,[(F_L + n^2 F_M) + (J_L + n^2 J_M)\frac{dc}{dt}]$$

where c is load velocity, $\frac{dc}{dt}$ is acceleration, n is gear ratio, F_L and F_M are load and motor friction, and J_L and J_M are load and motor inertia.

The intersections of the two curves give the range of useful gear ratios, and the line along the axis of the P_M curve gives the value for greatest reliability. The motor is inadequate if the P_L curve misses the P_M curve altogether, or is tangent at only one point. (see curve of Fig. 6)

TRANSISTORIZED SERVO AMPLIFIERS

Advantages of transistorized servo amplifiers are small size and weight, simplified and standardized circuitry with a minimum of components, and adaptability to printed circuits.

The principle disadvantage in using transistors is that they are temperature sensitive devices. However, new materials and improved manufacturing techniques are overcoming this disadvantage. In fact, silicon junction transistors operate reliably in ambient temperatures above 100°C. Such high temperature operation will require development of new resistive and capacitive components that will withstand such abuse reliably.

Desirable characteristics of transistorized servo amplifiers are low noise, low output impedance, small phase shift, and a constant voltage gain over a wide temperature range.

Since appreciable amounts of power are required for driving a motor, the amplifier output stages are push-pull power transistors. Germanium power transistors liberate large amounts of heat in the collector junction area. Hence, adequate cooling must be provided; otherwise, overheating would destroy the junction. Cooling is achieved by mounting the junction on a copper stud, which is an integral part of the transistor case. The transistor case is firmly bolted to a metal chassis, or "heat sink." Heat flow is from transistor to "heat sink." Heat is dissipated from the "sink" by convection or conduction.

Careful design of the heat sink is essential, if the optimum performance of power transistors is to be realized. In general, the thermal resistance of the heat sink and mounting assembly is kept low. Materials of high thermal conductivity are used. Adequate area must be provided and allowance made for free air convection on both surfaces.[4,5]

Another advantage of transistorization is that the output transformer

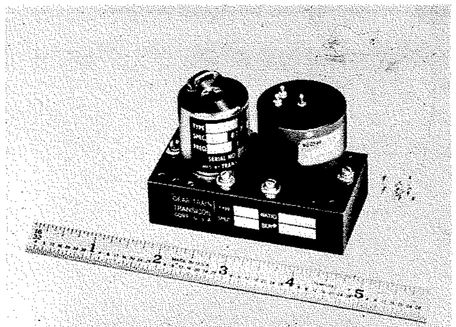


Fig. 5—Miniaturized Servo Assembly showing relative size of a #11 Servo Motor, gear train and potentiometer load. (Transicoil photo.)

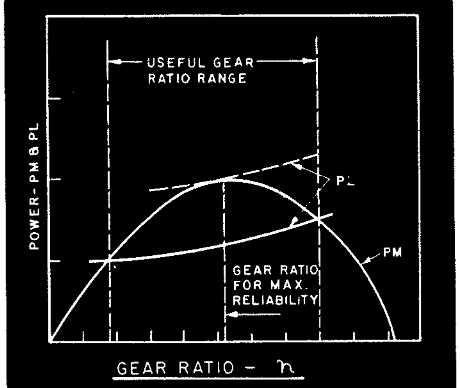


Fig. 6—Curves of Motor and Load Power versus Gear Ratio.

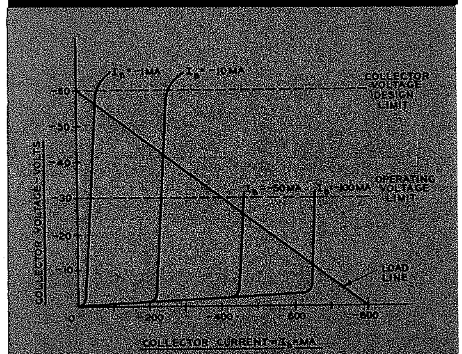


Fig. 7—Curves showing the common-emitter static characteristic of the 2N57 Power Transistor.

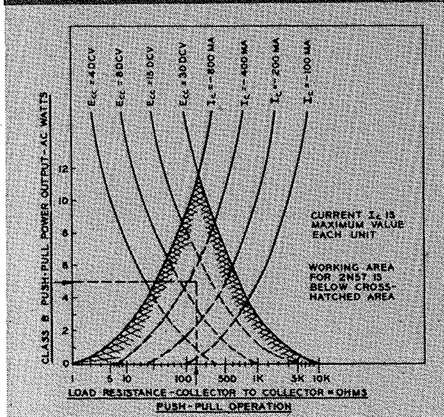


Fig. 8—Power output curves for Class "B," Push-Pull Operation using 2N57 Transistors.

TRANSISTORIZATION OF SERVOMECHANISMS
continued

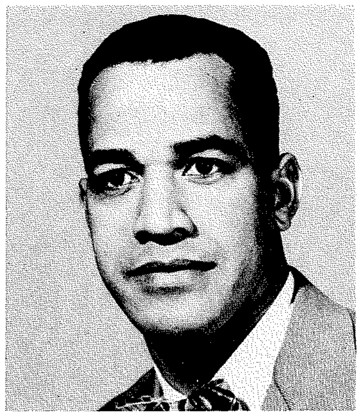
(used in conventional tube amplifiers to couple to the motor control winding) can be eliminated in most cases. By center tapping and rewinding the motor control phase to an impedance of about 150 ohms, to match the output impedance of commercially available power transistors, the motor control winding terminals can be connected directly to the output electrodes of the push-pull power transistors. The electrode d-c supply voltage is applied to the center tap on the control winding. Fig. 8 shows the transistor characteristic that permits this arrangement. The useful working region for this particular power transistor is shown under the cross-hatched area. Maximum sinusoidal power output occurs at the intersection of the $Ecc = -30$ volts, $I_c\ (max) = -800$ milliampere curves. For a 5 or 6 watt a-c excitation of the control winding of a size 15 motor, load impedance should be about 150 ohms (dotted lines, Fig. 8). This is an easy modification for most small motors used in instruments and computers.

An additional advantage of transistorization is that an efficiency of 70% or greater can be obtained from power transistors, at room temperature, in the push-pull configuration.

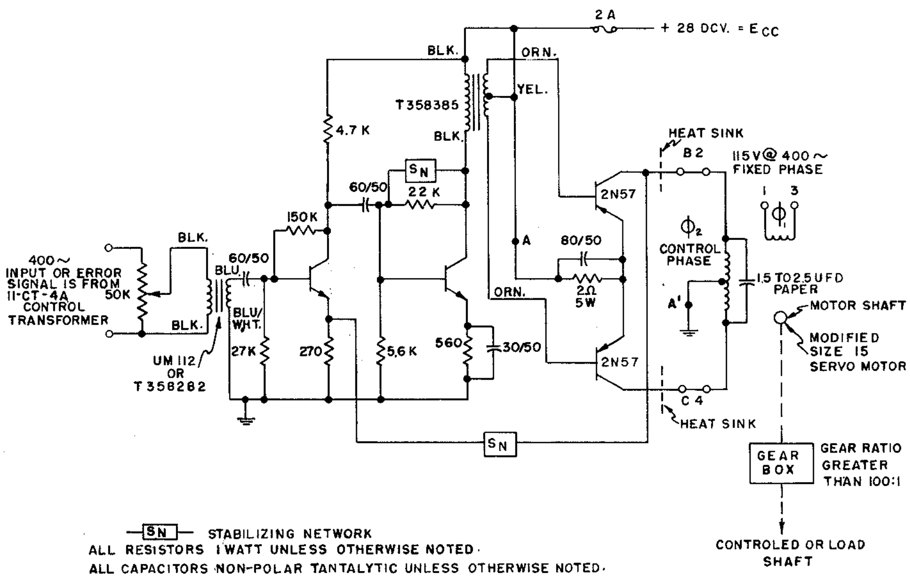
To design transistorized servo amplifiers it is necessary to analyze the characteristics of the chosen transistor types. The common emitter, static characteristic of the type 2N57 power transistor is shown in Fig. 7. The upper design limit for collector voltage is 60 volts. Maximum collector current is 800 milliamperes. Theoretically this transistor can handle a maximum power of 60 × 0.8 or 48 watts. In switching applications it will handle 40 watts. The output impedance of a single stage is 60/0.8, or 75 ohms. For push-pull operation the optimum a-c power output would be

$$\frac{E^2}{2R_L} = \frac{3600}{300} = 12 \text{ watts}$$

(see Fig. 8), or about 6 watts for a single ended stage. In actual practice



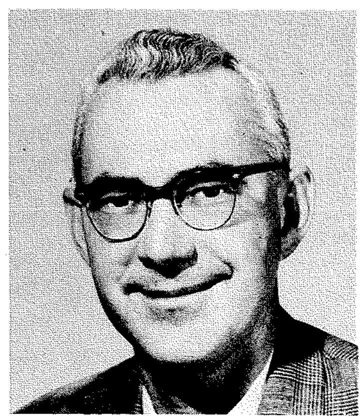
HARRY W. DAY received his B.S. Degree in Electrical Engineering from the University of Wisconsin in June 1951. Upon graduation he entered the Specialized Training Program of RCA Engineering Products Division. After completing assignments in Transistor Development, Cathode Ray Tube Tests, Antenna Coupling and Servo Design, he joined the Special Devices Section of EPD. He has had four years' experience in the design and development of servomechanisms, high voltage power supplies and R-F Amplifiers. Mr. Day has filed several patent applications in the field of Servomechanisms. He recently joined the Component Reliability Group in the Missile & Radar Engineering Section at Moorestown, N. J.



—SN— STABILIZING NETWORK
ALL RESISTORS 1 WATT UNLESS OTHERWISE NOTED.
ALL CAPACITORS NON-POLAR TANTALYTIC UNLESS OTHERWISE NOTED.
TOTAL NUMBER OF ELECTRIC COMPONENTS—26 (GEAR TRAIN NOT INCLUDED);
TWO OR THREE CAPACITORS CAN BE ELIMINATED BY USING DIRECT COUPLING.

Fig. 9—Schematic diagram of the basic circuit of Transistorized Servomechanism. The total number of electronic components is 26 (gear train not included).

EDWARD D. PADGETT received his Bachelors Degree in 1948 from New York University where he majored in Electronics, Mathematics and Physics. He is now a candidate for the PhD Degree at the graduate school. His prewar and pre-college occupational experience includes four years at NBC. During the war he was assigned to various classified electronic projects. Mr. Padgett has had nearly five years of experience in the development and design of specialized electronic and radar test instruments. Mr. Padgett has worked on servomechanisms and computers in the Aviation Fire Control Section. He is a member of the American Physical Society and the holder of two patents.



the transistors are derated from these values. The input impedance of this particular transistor varies from 10 to 200 ohms under full a-c drive.

Since the output impedance of the push-pull transistors is about 150 ohms, our original specification for the control winding of the size 15 motor called for an effective impedance (stalled) of 150 ohms, center tapped for push-pull operation, and rated at 6 watts. Such a motor warrants derating of power transistors so that reliability may be improved.

The basic circuit of a transistorized servo amplifier, suitable for use with modified size 15 and size 11 motors is shown in Fig. 9 The preamplifier driver stage consists of two silicon junction transistors. When load friction and inertia are small, the use of a large gear ratio permits the use of a minimum number of transistors and other components. Other preamplifier-driver circuits consist of from three to five transistors depending on the amount of gain and stabilization required. The power output stage of Fig. 9 consists of two push-pull germanium 2N57 power transistors—directly coupled to terminals 2 and 4 of a size 15 (or size 11) motor. Four push-pull transistors will provide additional gain, or drive.

The error signal for the amplifier is obtained from a synchro control transformer (error detector). To obtain a proper impedance match, the C-T is coupled to the preamplifier transistor through an input transformer (impedance ratio approximately 200:1). This stage is self-biased, and stabilized with resistors in emitter and base circuits. It is RC coupled to a stabilized silicon junction medium power unit, which is used as a driver for the high powered units of the output stage. Since current and power gain are desired, the pre-amplifier driver stages are operated in the grounded emitter configuration. The conventional by-pass capacitor for the emitter resistor in the pre-amplifier is replaced with a stabilizing network. Instability or oscillation will occur if the operating locus encloses the point $(-1, +j0)$. For stabilization against oscillations due to higher frequencies, various forms of RC stabilizing and feedback networks can be placed in the collector and emitter circuits of the driver stage. The driver stage is coupled to the push-pull germanium power output stage by a transformer with an impedance ratio of about 20:1.

A small resistor in the emitter circuits of the push-pull stages reduces the need of selecting output transistors for balanced characteristics, and protects the circuit and motor against "runaway" due to mismatched leakage currents. The conventional biasing resistor between base and collector (points A-A′ in Fig. 9) has been omitted, because the motor functions better if a small "dither" signal, such as that arising from distortion is present. The capacitor across the motor windings is used to "tune" the motor to the fundamental system frequency (i.e., 400 cycles). The collector voltage for the germanium p-n-p push-pull power output stages is applied through the center tap on the modified motor. The circuit is arranged for a 90 degree phase difference between fixed and control phases.

Fig. 10 shows collector, or control winding current and voltage, and servo error of a transistorized servo amplifier operating in a "closed loop" mode vs. ambient operating temperature. These data show that although the voltage gain (about 200) of the amplifier is constant, the increase in collector current means that sinusiodal power output decreases slightly at higher temperature because d-c collector dissipation increases due to increasing saturation current (I_{co}) as the ambient temperature increases. Nevertheless, performance is superior to many vacuum tube servo amplifiers.

Fig. 11 shows the transfer function (gain vs. frequency) of a transistorized servomechanism (operating in the closed loop configuration). This curve is similar to those of typical computer servomechanisms.[1,2]

CONCLUSIONS AND ACKNOWLEDGMENTS

Transistorization of servomechanisms will lead to the design of simplified, standardized, amplifiers of two or three basic types, that will operate from standardized power supplies, and serve as basic building blocks for engineers engaging in servomechanism design. Because of standardization, economies in size, weight, and power, transistorized servomechanisms will replace vacuum tube equipments in many applications.

This article would be incomplete without an acknowledgement of the supporting actions of the following managers and engineers: A. H. Kettler, G. H. Kunstadt, and W. R. Bauer.

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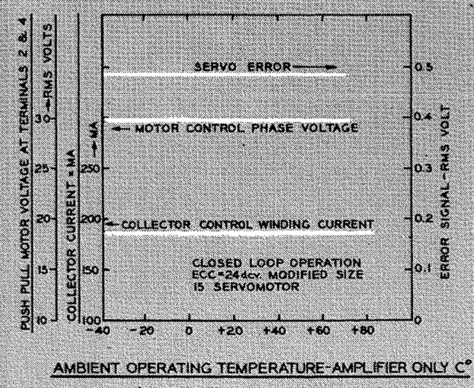


Fig. 10—Control Current and Voltage, and Servo Error (closed-loop operation) versus Ambient Temperature of Servo Amplifier.

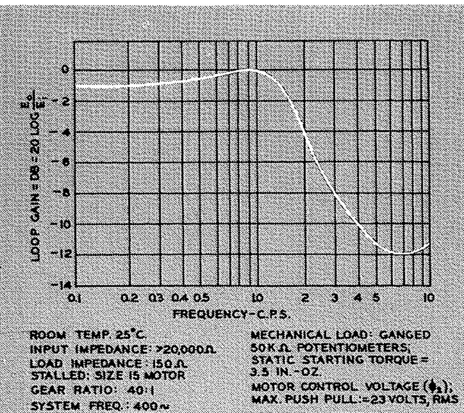
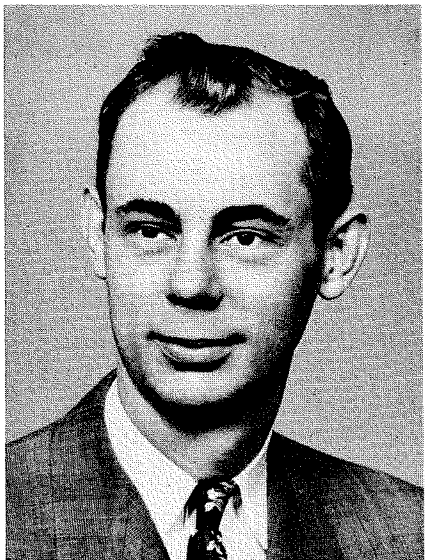


Fig. 11 — Closed-Loop Transfer Function of Transistorized Servomechanism (measured data).

A RULING ENGINE AT RCA

by **WILLIAM T. DYALL**
Tube Division
Lancaster, Pa.



W. T. DYALL graduated with a B.S. Degree in Physics in 1943 from Iowa Wesleyan College, and from the Massachusetts Institute of Technology with a M.S. Degree in Physics in 1948. During 1943, while attending graduate school, he held Teaching Fellowships at the University of Wisconsin and M.I.T. From 1943 to 1946 he served in the United States Navy as an Electronics Officer in both Atlantic and Pacific Ocean areas. In 1946 he returned to M.I.T. as a graduate student. While there he was a Research Associate at the Research Laboratory of Electronics. After graduation in 1948 he joined RCA as a Design and Development Engineer, where he was assigned to work on the design of Pickup and Storage Tubes and test equipment. In 1951 he became an Engineering Leader in charge of the same type of activity. In 1952 he was transferred to the Tube Development Shop as Supervising Engineer. In 1955 when separate Development Shops were established for Cathode Ray & Power Tubes and Color Kinescopes, he was appointed to his present position of Manager, Cathode Ray and Power Tube Development Shop. In addition to the work reported here, the Development Shop is engaged in the building of experimental tubes of the following types: Oscilloscope, Pickup, Photo, Storage, Image, Power and Gas.

Mr. Dyall is a Member of the American Physical Society, Senior Member of the Institute of Radio Engineers and he is the Chairman of the Lancaster Subsection of the I.R.E.

Certain branches of electronics today, involving both commercial and military applications, are critically dependent on the characteristics of pickup tubes such as the image orthicon and vidicon, and storage tubes such as the graphecon. To a great extent, the success of such tubes depends, in turn, on the quality of fine-mesh screens which they employ as collectors of secondary electrons or as target supports. These mesh screens must have 500 or more wires per inch, and very high light-transmission. Mesh consistency is a vital requirement, so that manufacture and quality control involve extremely meticulous and precise work.

Briefly, such meshes are made by an electro-deposition process, using grooves ruled in a glass master as a form.

In the fabrication of the glass mesh master, optically flat glass is first coated with an acid-resistant wax. The wax is then ruled, using a suitably shaped tool or stylus. After ruling, the glass plate is etched, and is then cleaned and covered by a sputtering process with a thin metallic layer. Rubbing with a plastic material removes the surface layer leaving the metal only in the etched grooves. The mesh is then formed by an electroplating process, and removed from the glass master.

One of the key processes in mesh manufacture is the ruling of the mesh master. A precision machine called the ruling engine is used for this task.

For several years RCA purchased its ruled glass mesh masters from a single vendor. This vendor, however, could not supply masters for meshes finer than 500 wires per inch. Faced with the necessity for masters for even finer meshes, and with the difficulties inherent in a single source of supply, attempts were made to find other vendors, not only in this country, but in England and in other parts of the world. None, however, was found. It was therefore decided that RCA must develop its own methods and equipment for making masters.

Full responsibility for the ruling engine was assigned to John D. Herrington. It was also decided that the assistance of an outside consultant would be sought in the final design and construction of the ruling engine, after the initial phases had been completed by A. M. Rennie and C. W. Henderson. Herrington not only worked with this consultant in completing the design of the ruling engine, but simultaneously, following the earlier work of D. J. Donahue, he developed, with the assistance of C. F. Shaffer, the processes for coating, etching, and ruling the glass masters. The design and construction of the machine were completed and the machine placed in operation in less than five months; Herrington was delivering high-quality 500-line mesh masters in less than six months from the start of the program.

The development of techniques for producing masters having higher-line numbers was begun immediately, and in less than three months masters having the phenomenally high light transmission of 58 per cent were produced.

John D. Herrington has been very instrumental in the success of this project. He has not only made improvements in ruling-engine design which permit the production of high-quality fine-mesh masters, but has also developed many materials, devices, and processing techniques used in their manufacture, including:

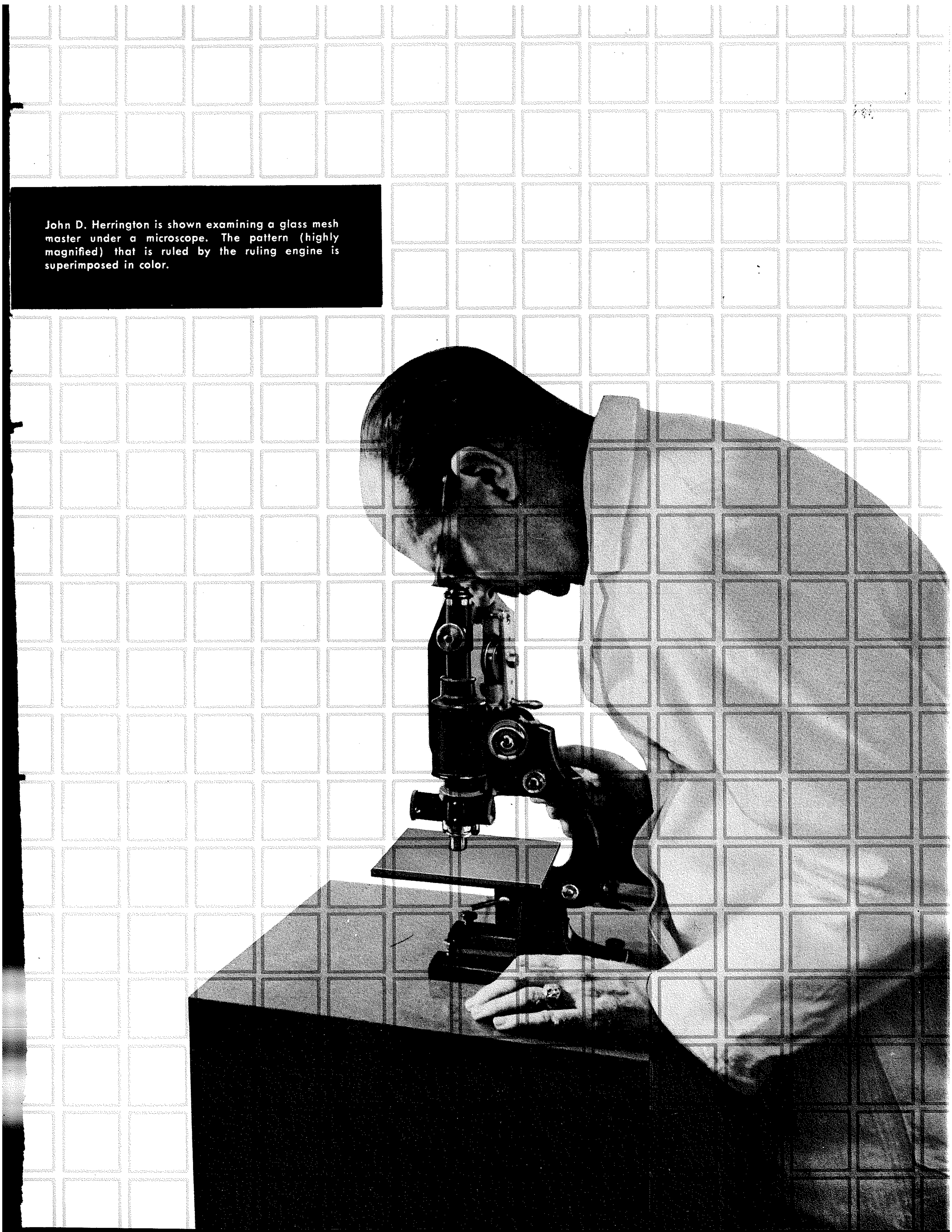
A. An acid-resistant coating with controlled mechanical characteristics in which clear and clean lines can be ruled.

B. A dipping mechanism for applying uniform coatings of resist to the glass plates.

C. A design for the optimum shape for the diamond tool used for ruling.

D. An acid etching solution, and means for its stabilization.

Herrington has also, by well designed and carefully conducted experiments, brought these developments to such a high state of perfection that masters of extremely high quality are now being produced for production use. In the article which follows, he describes the mechanical phases of these developments.



John D. Herrington is shown examining a glass mesh master under a microscope. The pattern (highly magnified) that is ruled by the ruling engine is superimposed in color.

A RULING ENGINE FOR GLASS MESH MASTERS

by **J. D. HERRINGTON**
Tube Division
Lancaster, Pa.

THE DESIGN of the Ruling Engine was undertaken with little more to go by than the determination to succeed, and the advice contained in the following statement by A. A. Michelson, Nobel Prize Winner, and an authority on Ruling Engines: "When the accumulation of difficulties seems to be insurmountable, a perfect grating is produced, the problems are considered solved, and the event celebrated with much rejoicing only to find the next trial a failure. One comes to regard the machine as having a personality—I had almost said a feminine personality—requiring humoring, coaxing, cajoling, even threatening."

The general concept of a ruling engine is that of a cutting tool shuttling back and forth on lubricated crossways, and pressing very lightly on the surface to be ruled. As the tool shuttles back and forth, it cuts only in one direction, lifts at the end of each cutting stroke, and returns for the next stroke. During the return stroke the surface to be ruled is moved laterally the required distance by a lead screw.

REQUIREMENTS OF RULING ENGINE

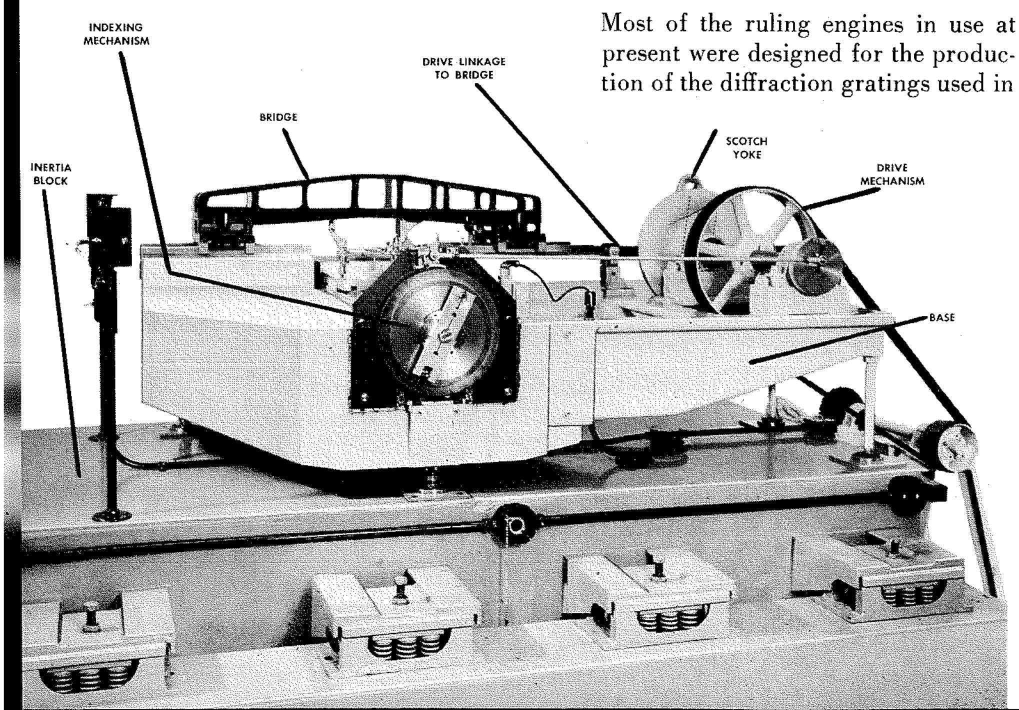
The RCA ruling machine was required to be capable of ruling perpendicular sets of parallel lines numbering at least 500 to the linear inch. The ruled surfaces produced by this machine were to be used as forms for producing the fine-mesh screens required by image orthicons and other pickup tubes, and various types of storage and storage display tubes. A typical 500-line-per-inch mesh used in an image orthicon has approximately 385,000 square apertures. Quality standards for these meshes are such that a mesh is rejected if there is a single defective square in the center area, and if there are more than four broken squares over its entire area.

The requirements of uniformity of width, depth, contour and spacing of the ruled lines are very difficult to meet. It is not easy to comprehend the minuteness of the grooves required; they are no wider than the filaments spun by a spider. Small as they are, they must be identical in width, depth, and contour.

The cross-sectional contour of the grooves in a finished master is a controlling factor in the removal of the mesh from the master after plating and is, therefore, extremely critical. Not only are the line width and depth critical, but also the ratio of depth to width. Furthermore, each intersection of perpendicular lines should form a sharp corner, although in practice, a small tolerance is allowed.

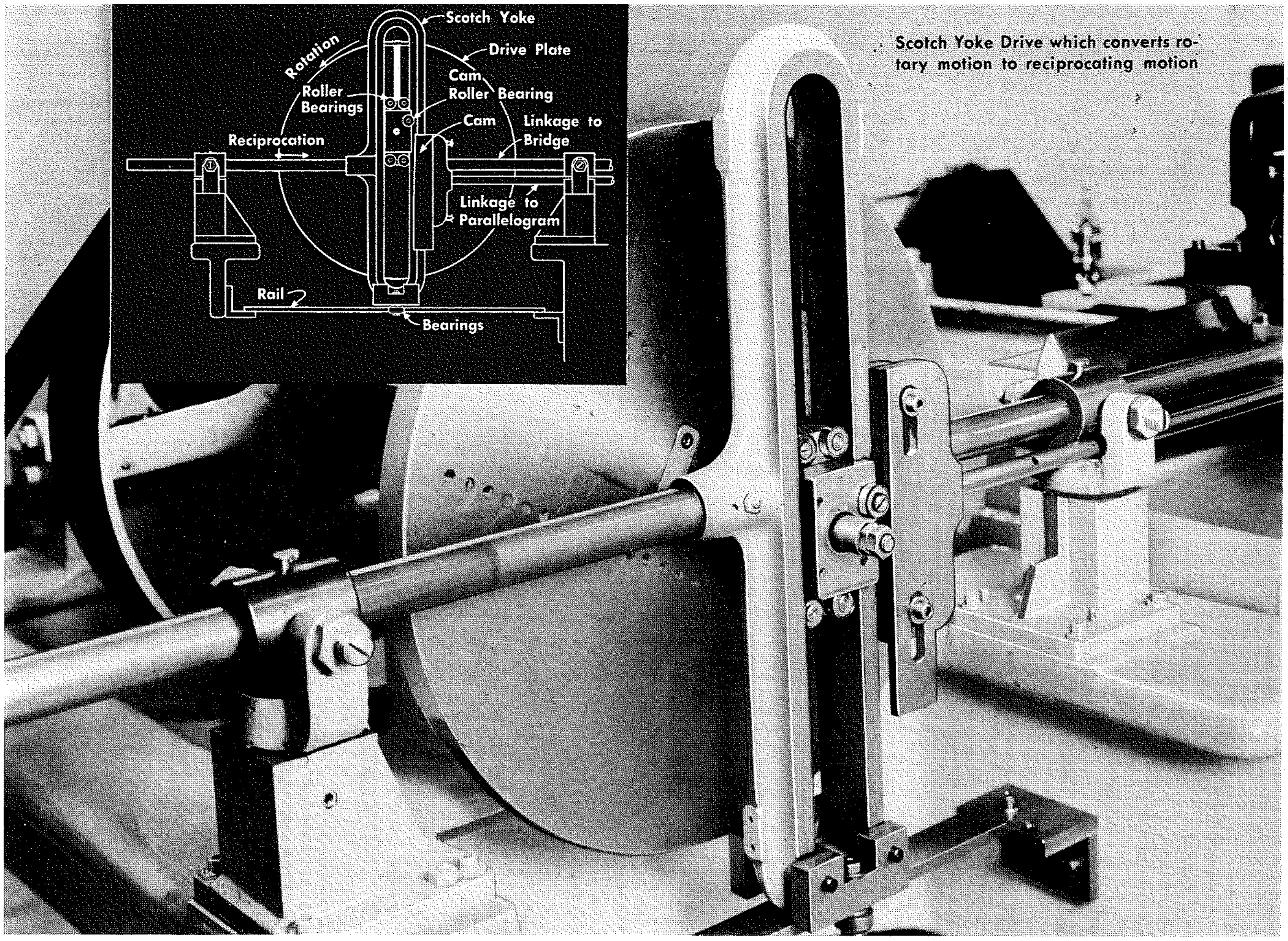
PRELIMINARY INVESTIGATIONS

Most of the ruling engines in use at present were designed for the production of the diffraction gratings used in spectroscopy. However, the call for fine-mesh screens and diffraction gratings is rather limited, and since ruling engines built fifty to sixty years ago are still in excellent operating condition, there are no experienced manufacturers producing them as stock items, or even on a custom-made basis. Investigation also showed that few ruling engines are built alike, further verifying the suspicion that they are not merely mechanical assemblies, but works of art. Fortunately for our investigations, ruling engines representing the three principal designs—those of Professors Rowland, Strong, and Anderson, were



Editor's Note The editors would like to give cognizance to the great accomplishment achieved at Lancaster in building a successful ruling engine, which the authors have been all too modest to tell. Albert G. Ingalls, in his article on ruling engines in **Scientific American,** June, 1952, has this to say of the mechanism: "It is so transcendently difficult to build and operate properly that it has challenged man's mechanical genius and humbled his pride for more than a century . . . the dream of building a ruling engine has haunted hundreds and ruined many."

The ruling engine operates on the ragged edge of the barely possible, with the tolerances of machine operation well beyond the limitations of available structural material and the abilities of the finest craftsmen and tools with which it is built. Its successful operation is achieved apparently only with a mutual harmony between operator and machine. Ingalls, in observing a ruling engine operation, says, "Bemused, you strain to see what else is done to make possible the impossible. But you finally give up; it must be something the technician whispers to the engine, to which he has been married for enough years to know its every kink. The ruling engine is a cantankerous prima donna . . ."



Scotch Yoke Drive which converts rotary motion to reciprocating motion

available for study at Johns Hopkins University.

Although the engines at Johns Hopkins were designed primarily for fabricating diffraction gratings, and are capable of ruling as many as 15,000 to 35,000 lines per inch, the principles remain the same for manufacturing any fine-mesh structure. Three of the ruling engines still in use at Johns Hopkins were built by Professor Rowland between 1890 and 1901.

Professor Strong's engine is far different from the Rowland type—so different, in fact, as to prompt the remark by one authority that Strong had "turned the ruling engine upside down" (although some think he found it upside down and turned it rightside up!). Practically all ruling engines in current use, including the RCA engine, follow the Rowland design.

Study of different machines in operation at Bausch & Lomb, Baird Associates, and David Mann, Inc., as well as at Johns Hopkins University, gave us a better understanding of the mechanics of ruling engines, and the writings of such authorities as A. C. Ingalls, G. R. Harrison, W. Stone, and Prof. Strong made it possible to formulate our thinking along the lines of a ruling engine that would be capable of producing masters for the fine-mesh screens and related products required by RCA.

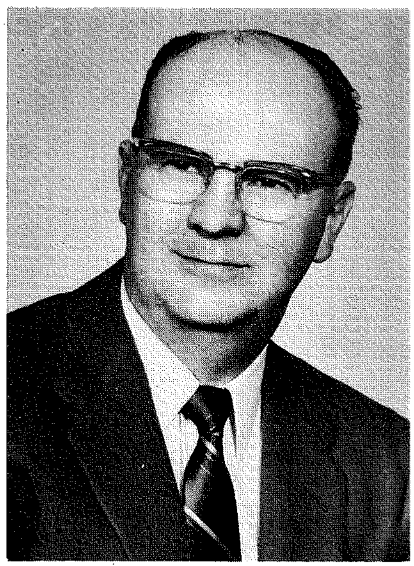
DESIGN DETAIL

The RCA ruling engine is shown in Fig. 1. This engine is designed to rule the 300 feet of lines necessary to make one 500-line per inch mesh master $3\frac{1}{2}$ x $3\frac{1}{2}$ inches in approximately nine hours. The lines are ruled at a rate of 900 per hour.

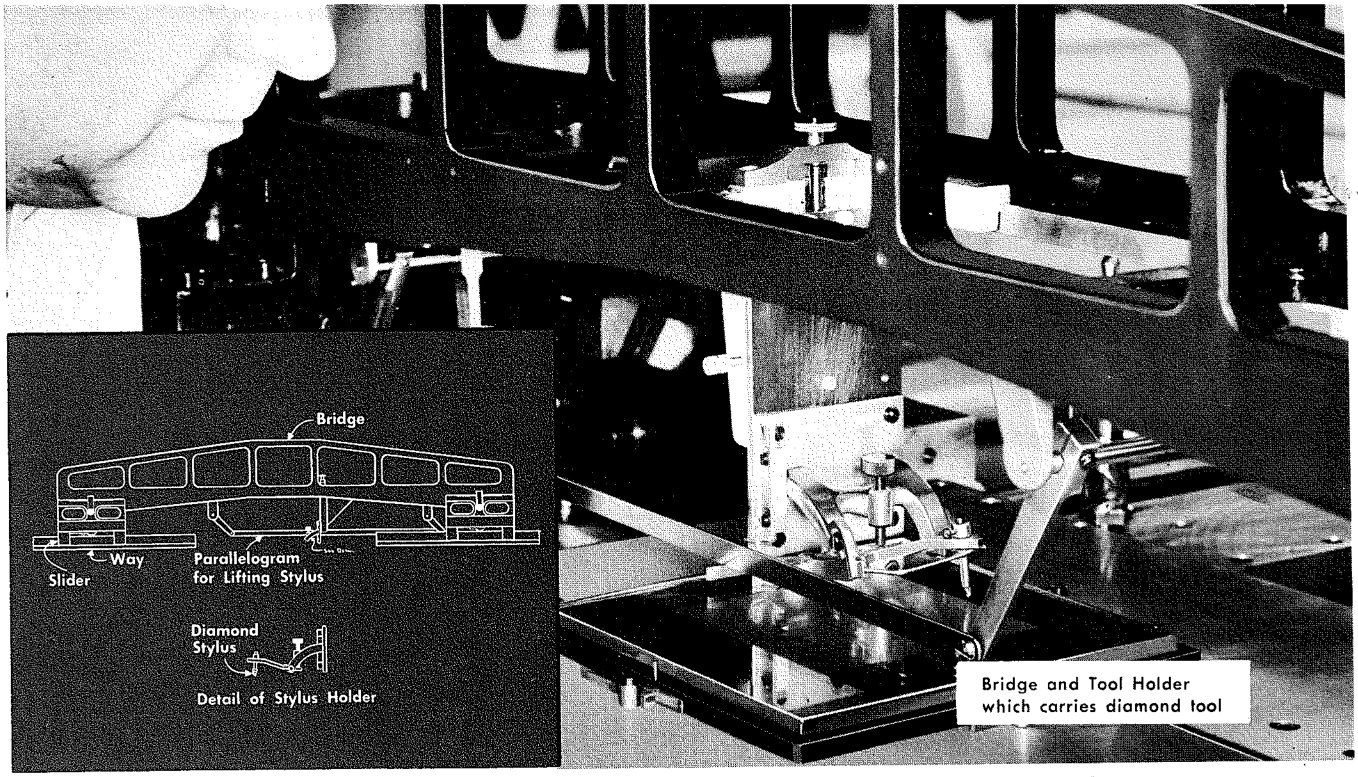
The principal mechanical elements of the engine itself are the bridge, the scotch-yoke drive, the indexing mechanism, and the motor drive unit. In addition, environmental control and precautions against vibration are of considerable importance. Each of these items will be discussed.

BRIDGE

The bridge (shown in detail in Fig. 2) is the conveyance which transports the diamond stylus back and forth across the glass mesh master. It is designed for maximum rigidity, yet is light in weight to keep friction at a minimum, and is supported by V-shaped steel ways at either end of the plate carriage.



JOHN D. HERRINGTON, Foreman in charge of Mesh Master Development, graduated from Stevens Trade School as a machinist in 1937. He joined RCA in 1946 as a tool and diemaker after previous experience with the Hamilton Watch Company, and as Supervisor of the Machine Shop of the Engineering and Research Corporation. In 1953 he was transferred to Ruling Engine Design and Development. He was placed in charge of this work in 1954. He supervises the design and construction of ruling engines, the development of methods for making glass mesh-masters and the application of these methods to the actual production of mesh-masters. He is a member of the American Society of Tool Engineers.



Bridge and Tool Holder which carries diamond tool

The sliders forming the contacts between the bridge and the steel ways of the base frame are made of Graphitar.* This material was found to be the best for this purpose because of its low coefficient of friction as compared to brass or bronze, and because of its ability to hold oil (thus maintaining a constant film of oil between metals). Graphitar is also very hard and has long wearing qualities.

The motion of the bridge draws the stylus across the master being scored. The process of lifting the stylus at the end of a cut, holding it up during the return, and lowering the stylus for the next cut is accomplished by means of a "parallelogram" operated by an adjustable cam on the "scotch-yoke" drive. The cam lifts the stylus approximately 0.005 inch from the ruled surface. Because the slightest bouncing of the stylus will ruin the line, the lifting and lowering motions must be very smooth.

The selection of a material for the ruling stylus was necessarily based on wearing quality. The need for good wearing quality becomes apparent when it is remembered that in order to produce a normal 500-line master the stylus must engrave approximately 300 feet of line without a change in the shape of its cutting edge. The diamond, therefore, was a natural choice.

Since the ruling is done on a wax surface, selection of the diamond provided an additional advantage: wax will not stick or pile up on diamond as readily as on steel or sapphire.

The shape of the diamond stylus is, of course, extremely critical. The experience and skill of an expert lapidary are necessary to produce an accurate, long-wearing stylus. He must consider grain structure of the diamond and grind it to shape within extremely close tolerances.

The diamond stylus is mounted on an arm in a fixture suspended from the center of the bridge. This fixture is provided with a universal adjustment making it possible to present the best cutting edge to the mesh master.

SCOTCH-YOKE DRIVE

The reciprocating motion necessary to drive the bridge and stylus is transmitted by simple harmonic motion through the "scotch-yoke" drive (shown in detail in Fig. 3). As the drive plate rotates counterclockwise, the bearing moves vertically and the scotch yoke oscillates from right to left. The horizontal movements of the yoke are transmitted to the bridge by a shaft linkage. Since the yoke must operate very smoothly and with the smallest possible amount of friction, no surging motion can be tolerated when the yoke changes direction. To correct any tendency towards surging, a bearing block with four small precision roller bearings was inserted in the vertical channel. The bearings are adjustable to compensate for wear. Since the bearing block has a total vertical stroke of 12 inches the yoke initially showed a tendency to wobble laterally. This tendency was corrected by the addition at the bottom of the yoke of two precision roller bearings which ride on either side of a guide rail running parallel to the yoke motion.

INDEXING MECHANISM

The lateral shift of the mesh master required between successive lines is accomplished by an indexing mechanism consisting of a ratchet, pawl, and 150-tooth wheel. The ratchet is actuated by an eccentric on the scotch-yoke drive, which allows the stylus to rule while the indexing mechanism is at rest. When the stylus is on the return stroke, the eccentric actuates the indexing ratchet, which then advances the indexing wheel, positioning the plate for the next line.

The motion of the indexing wheel is transmitted to the plate carriage through a precision lead screw and traveling nut. The lead screw has 20 threads per inch, is $1\frac{1}{2}$ inches in diameter, and 30 inches long. The number of teeth which must be indexed to produce a required mesh is determined by multiplying the number of teeth on the indexing wheel by the number of threads per inch on the indexing screw, and dividing the product by the number of lines per inch required in the mesh master.

As the lead screw turns, it advances both the plate carriage and an auxiliary nut carriage which helps to absorb vibrations and unnecessary motion.

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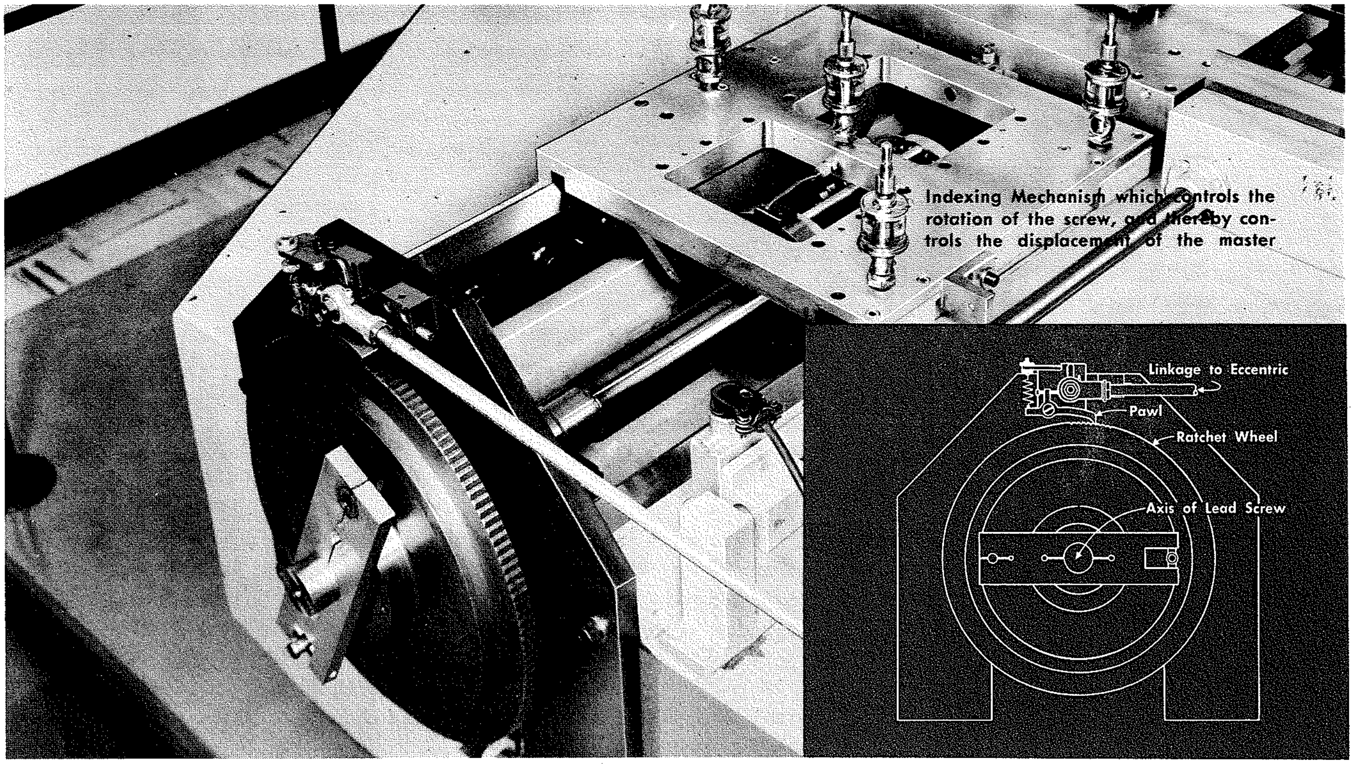
* Trade name.



Indexing Mechanism which controls the rotation of the screw, and thereby controls the displacement of the master

ENVIRONMENT AND VIBRATION CONSIDERATIONS

The fit between the lead screw and nut in the indexing mechanism is so nearly perfect that a single particle of dust between them will cause the screw to bind and throw the spacing off. While the indexing screw and nut are most susceptible to dust, similar difficulties may be caused by dust getting between other moving parts such as the bridge ways. Dust which accumulates on the resist-coated ruling plate is particularly detrimental because it results in ragged lines which etch unevenly. Extreme cleanliness must also be maintained in the preparation and application of the acid resist coating. Furthermore, the mechanical characteristics of the acid-resist on the masters are dependent upon the relative humidity of the air near them.

A rise or drop in temperature affects the precision of the ruling operation, particularly the shift of the master carriage during indexing, because it expands or contracts the parts of the engine unequally. The indexing screw and the bridge ways are particularly susceptible to the effects of metal warpage, and are therefore annealed carefully to eliminate strains. In order to minimize temperature changes the ruling engine installation at Lancaster is housed in two rooms. One room (the larger) contains the ruling engine itself. This room is air-conditioned and constructed with plastic-covered cork walls. This room is so well insulated that the temperature within the room is maintained to within ½° and relative humidity to within ½%. Since the body heat of a person entering the room will raise the room temperature ½° the room is closed during the ruling operation.

The engine rests on a base approximately seven feet square and the entire structure is approximately five feet high. In the design of the base casting and foundation for the engine, the principal objectives were rigidity of construction and the elimination of all possibility of vibration. It can be readily seen that the slightest vibration reaching the ruling stylus during operation would ruin the mesh master. To eliminate vibration, the engine is mounted on an eight-ton cast-concrete inertia block. This block, in turn, is spring-mounted on top of pilings which rest on bedrock twenty feet below ground-level.

The base casting for the ruling engine was designed for rigidity without excessive weight. It is 18 inches high, 54 inches wide, and 82 inches long. Cast in iron and nickel, the base weighs approximately 2½ tons. The base is supported in a kinetic design on the inertia block by three one-inch steel balls.

The elaborate precautions against vibration were put to a supreme test shortly after the ruling engine was completed. Workmen were blasting rock in a construction project less than 100 feet from the ruling engine at the time a mesh master was being made. When the completed master was examined, there was no noticeable pattern or effect from the explosion and shock.

DRIVE UNIT

In order to reduce vibration and heat, the drive unit for the ruling engine and various operating controls are housed in a separate room. The driving unit is a ¼-horsepower motor connected to a flywheel three feet in diameter and weighing 200 pounds. The drive is geared down to provide a selection of speeds from 3 to 60 strokes per minute. Extremely smooth starting and stopping are obtained by the use of an electric clutch, which also requires very little maintenance due to wear.

The drive unit is connected to the ruling engine by a 2-inch wide, 6-foot long flat leather belt which passes through a small opening in the dividing wall between the two rooms. This wall also contains an observation window.

In conclusion, it is desirable that we emphasize the wisdom of Dr. Michelson's statement, since we found that everything he said about the temperament of the ruling engine was true. However, with patience, careful attention to detail, and the compounding of previous experience, we have succeeded in producing highly satisfactory glass mesh masters, which, in turn, supply high-quality meshes for use in various types of RCA tubes.

THE INTERNATIONAL TELECOMMUNICATIONS MARKET

by **EDMUND A. LAPORT,**
Director
Communications Engineering
RCA, New York, N. Y.

ONE OF RCA's important markets for telecommunication equipment is in the foreign field. Here are vast needs for everything from the most elementary facilities to the most extensive. In this market we meet the competition of most of the familiar American companies as well as those of the European countries, Japan and Australia; yet the field is so great that I believe the RCA prospects for equipment sales will surpass those in the USA. RCA must provide ever better performance in order to maintain a position of leadership in the world telecommunication field. Engineers in RCA should recognize the technical challenge provided by the world telecommunication market, and adjust their thinking to the special requirements of that market. The purpose of this article is to explain something of how foreign business is done.

MARKETING AND ECONOMIC FACTORS

Our greatest handicap in foreign sales is from shortage of U.S. dollar exchange in most foreign countries. This gives the "soft currency" producer countries a corresponding advantage. The dollar availability in each country varies from year to year, from almost nothing to, at times, relatively large amounts. Sales to Colombia, for example, rose sharply when high coffee prices gave them over $100,000,000 more than normal. Depression in tin, rice and rubber prices leaves countries like Indonesia, Burma and Thailand, relatively poor in dollars. Venezuela and Saudi Arabia, with their large exports of oil, are perennially opulent countries, though Arabia is a very small telecommunication market except for sales to the companies that extract the oil. Venezuela is, per capita, one of the wealthiest countries in the world today, though their internal telecommunication development lags very far behind actual needs.

There is occasional important business with some of the advanced producer countries when they are not prepared to supply locally some particular line of products, or when their quality or price makes importation from the USA temporarily desirable. Then, too, there are occasional direct sales to the US government overseas, and to international bodies like the North Atlantic Treaty Organization (NATO).

One of our competitive advantages comes at times when we happen to have equipment in stock and delivery time is of importance. This occurred once with a large transportable microwave system (CW-20) to NATO. Most foreign producers build equipment against orders and seldom stock equipment. The range of needs is so great that it is only occasionally that we get this kind of advantage.

Domestic sales of telecommunication equipment is mostly to private users, for vehicular and microwave equipment. Equipment for the US government usually is custom-made for the appropriate department and seldom is such equipment saleable commercially; though US cooperation with foreign governments sometimes permits sale of declassified equipment.

Internationally, it is the usual pattern for Government to operate all telecommunications by radio and wire, along with Postal services, as a national monopoly. There are various degrees of relaxation to monopoly in undeveloped regions where no services exist, and where an enterprise may require communication. In such cases, governments usually allow private systems to be built. A few examples of this are oil, mining, agricultural, exploration, construction and transportation enterprises. By and large, however, RCA International's customers for telecommunication equipment and systems are governments, for both civil and defense uses.

EDMUND A. LAPORT attended Northeastern University, Massachusetts University Extension, and McGill University. In 1924 he joined the Westinghouse Electric and Manufacturing Company of Springfield, Mass., as a radio engineer. From 1933 to 1934 he was with the Paul Godley Company, Montclair, N. J., and from 1934 to 1936 with Wired Radio, Inc., of Ampere, N. J. In 1936 he became associated with the RCA Victor Division, Camden, N. J.; in 1938, Chief Engineer of engineering products in the RCA Victor Company Limited, Montreal; and in 1944, Chief Engineer of the RCA International Division, New York. Since November 1954 he has been Director, Communications Engineering, for the Radio Corporation of America. Mr. Laport is a Fellow of the Institute of Radio Engineers.

INTERNATIONAL COMPANIES

There are engineering and manufacturing RCA companies in Canada, Mexico, Brazil, Argentina and Chile that directly serve these countries. All of them are capable of developing and supplying engineering products to some extent, though there are cases where it is more economical to import from the USA. Then they act as distributors of RCA International. An RCA company in England has produced engineering products on Offshore procurements of the US government, though normally their work is RCA Photophone equipment. An RCA Company in India only distributes telecommunication equipment made here, or in Canada.

RCA International has distributors in almost every country in the world. These are private business firms engaged in import trade who operate under agreements with RCA. Some are very active in the sale of telecommunication equipment and maintain sales engineers and sometimes quite large engineering departments. Others are mostly consumer goods retail outlets who occasionally pick up a lead to a telecommunication project in their region and report it to New York, usually assisting in the negotiations. On very large projects in any country the customer usually wants to negotiate directly with RCA with incidental distributor assistance.

High-Frequency, Point-to-Point Communications

Outside of the USA, Canada and Europe, most of the world's radio telecommunications traffic is carried by high frequency, internationally and locally. High frequency is the easiest and cheapest way to provide low-capacity telephony and telegraphy over distances in excess of a few dozen miles. As a consequence the spectrum is jammed with high-frequency services, public, government and private, steady, intermittent and occasional. There is no reasonable alternative for trans-oceanic and marine services. In rugged or virtually impassable regions, high-frequency provides the easy answer for light communications, as it also is for mobile communications beyond practicable VHF distances. For this reason there is a constant demand for high-frequency transmitters and receivers all over the world. The availability of good metallic circuits in the USA means that there is almost no commercial market for high frequency except for aviation and marine mobile, and the expansion of overseas facilities by American common carriers.

RCA International has always maintained a line of high-frequency equipment to meet the needs of foreign customers. The volume is greatest in low-power transmitters, the 50-watt to 200-watt class. Above this the number of units sold annually decreases rapidly, with activity on transmitters above 5 kw rather occasional. By far the most important high-frequency equipment has been our ETM-50, a 50-watt transmitter-receiver with four spot frequencies between 3 and 12 mc, for simplex telephony and telegraphy. This is now being replaced with the SSB-1 equipment, a 60-watt single-sideband suppressed-carrier transmitter-receiver with four spot frequencies in the 3-15 mc range.[1] Both these sets are made for RCA International by the Radiomarine Corporation of America.

Other high-frequency transmitters in the line are ET-4339 (200 w), ET-10 (300 w), ET-11 (1 kw), ET-8049 (3 kw) by RMCA, and the ET-18 (15 kw) (Commercial Electronic Products) all multi-frequency sets covering at least the 2 to 20 mc range, and having a variety of individual specifications to suit the most typical needs of each class of service.

[1] See "Design of Single-Sideband Radio Communication Equipment" by Niles Barlow, RCA ENGINEER, Vol. 1, No. 6, April-May 1956.

There are occasional calls for low-frequency transmitters, and for this purpose there is the TE-260N (100-500 kc 2/4 kw, remotely-tuned) telegraph transmitter provided by RCA Victor Company Limited, Montreal.

There is also a steady market for communication receivers, simple and diversity, fixed-frequency and tunable. The CR-88 and CR-91 general purpose communication receivers designed by the Export Receiver Design Group in Camden have been popular since 1941, but are now about to be replaced by the Montreal-designed CR-188 (70-28,000-kc continuous precision tuning, continuously variable 300 to 10,000 cycle bandwidth) receiver. It represents a remarkable advancement in receiver techniques and operational effectiveness in pulling traffic through interference. Since many foreign customers are telephone and telegraph common carriers, we have to supply high-specification equipment of the most advanced nature, as well as simpler and cheaper equipment for the private user who only needs an intermittent service. Our product specifications must provide utmost versatility so as to be acceptable for a large percentage of users.

The (CCIR) opinions and recommendations have an important influence on transmitter specifications,

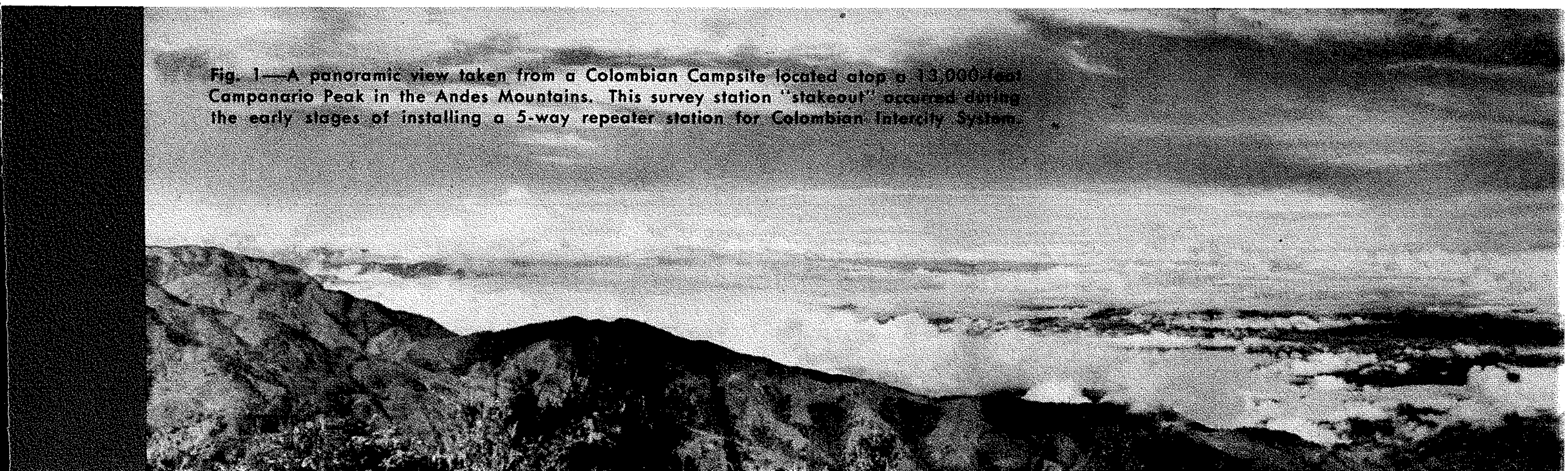


Fig. 1—A panoramic view taken from a Colombian Campsite located atop a 13,000-foot Campanario Peak in the Andes Mountains. This survey station "stakeout" occurred during the early stages of installing a 5-way repeater station for Colombian Intercity System.

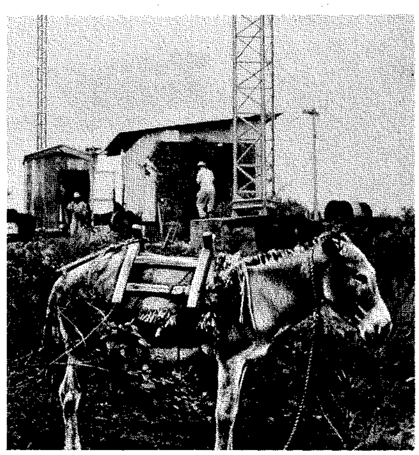


Fig. 2—View of another communications installation in Venezuela. This scene is at Mt. Picacoa (Orinoco Delta, July, 1955).

even before they are formally adopted by the International Telecommunications Union.

Telegraph Central Office Equipment

People not normally exposed to the telegraph business are always surprised at the complexities of modern telegraph operations, and central office equipment. RCA Communications, Inc. is one of the foremost radiotelegraph operators, and a branch of the RCA Laboratories specializes in research and development of telegraph terminal equipment. Printing telegraph has almost completely displaced Morse-code telegraphy on the major routes of the world and for many inland wire and radio circuits. Teleprinting over radio circuits has required constant technical evolution to overcome the effects of a variable propagation medium, interference, and noise, and to get better spectrum utilization and more traffic capacity.

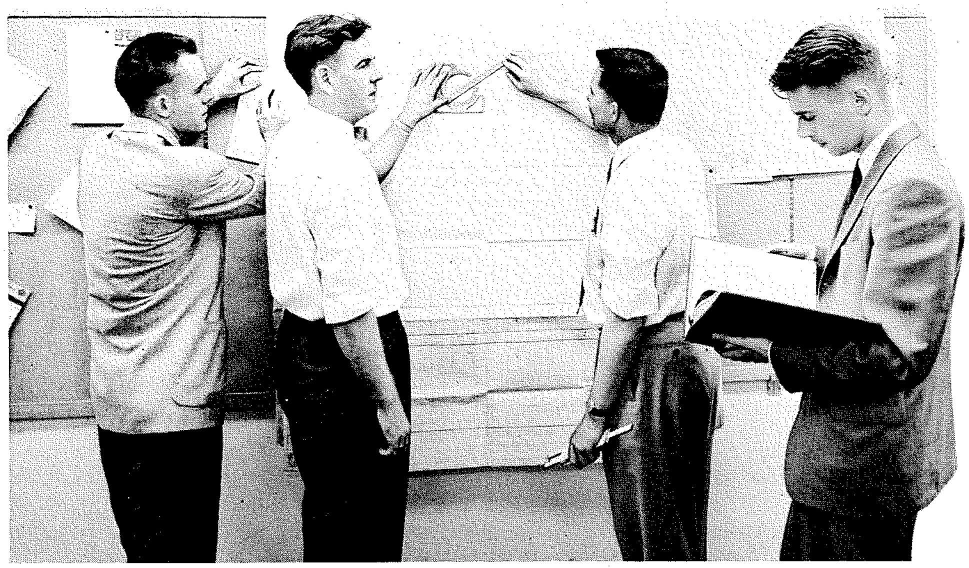


Fig. 3—RCA International Systems Engineers, M. Poarch, K. Ekeland, R. Hall and C. Passavant are shown planning the Colombian installation sites on a large map.

Fig. 4—Carl Bethel of RCA International Systems Engineering shown testing one of twenty large mobile communication vans designed for use by Indonesian Army.

Equipment of the kind used by RCA Communications, Inc. is sold to foreign radiotelegraph carriers by the RCA International Division. It includes time-division multiplex systems, frequency-division multiplex systems for single-sideband, automatic error correction systems (ARQ), subchanneling equipment, extensors, code converters and other radio telegraphic devices. In addition, RCA International is a distributor of Teletype Corporation products for printing telegraph, including page printers, typing reperforators, regenerative repeaters and a number of related devices.

Radio Relaying

The technique of radio relaying is now relatively commonplace here and abroad, following many years of experimentation. The first usable system we know of was an RCA system for experimental TV from New York to Philadelphia in 1933.[2]

RCA International finds this a fast-growing phase of telecommunications throughout the world. It has to have a variety of equipments to fit frequency bands allocated for this purpose in addition to those assigned for domestic use by FCC.

The RCA systems being sold abroad are the CTR-1 (40-88 mc, 6 voice

[2] E. W. Engstrom, "An Experimental Television System", Proceedings IRE, December 1933.

channels); CTR-140 (132-148 mc, 24 voice channels); CTR-250L (235-300 mc, 24 voice channels); CTR-250H (235-300 mc, 72 voice channels); CTR-500L (450-500 mc, 24 voice channels) and the CTR-500H (450-500 mc, 72 voice channels). All these are engineered and manufactured by the RCA Victor Company Ltd. in Montreal. In addition there are the systems designed by the Microwave Communication Engineers group of CEP in Camden—the CW-5 (890-960 mc, 4-6 voice channels), the MM-26A (2450-2700 mc) and the CW-20 (1700-1990 mc, 30 voice channels and soon to be 120 channels).

Most of the sales of radio relay equipment are on a system basis, where the complete system, installed and operating, is done on a contract basis. Relatively little equipment of this kind is sold as just equipment because a very great amount of engineering experience is needed for its successful use. To meet this growing field, a large organization known as the System Sales Section of the RCA International Division, directed by Mr. D. H. Pain, handles this business. The group is located at the new plant at Clark, N.J. It has commissioned many successful system projects in Venezuela, Dominican Republic, Lebanon, Saudi Arabia, Colombia and Israel. At the present time it has major projects going in Colombia (continuation of a large CTR-250H inter-city telephone system) and Cuba, where their largest system to date, by far, uses CW-20 equipment. For the latter there is participation by Commercial Electronic Products and RCA Service Company engineers. Both of these also cooperated with RCA International to supply a large system of transportable CW-20 stations to the Allied Air Forces, Central Europe, in 1952. The success of this project led to another contract of similar nature for the Royal Canadian Air Force in 1954.

The International Systems work takes its many capable men far afield, to work in all climates and altitudes, in many different languages, with enthusiastic, willing men of many races and cultures. The rich experiences are reward for some of the privation of working in windy plains, jungles, deserts and mountain-tops in the Andes, where men and equipment are severely tested, all for the purpose of providing needed communications to whole populations.

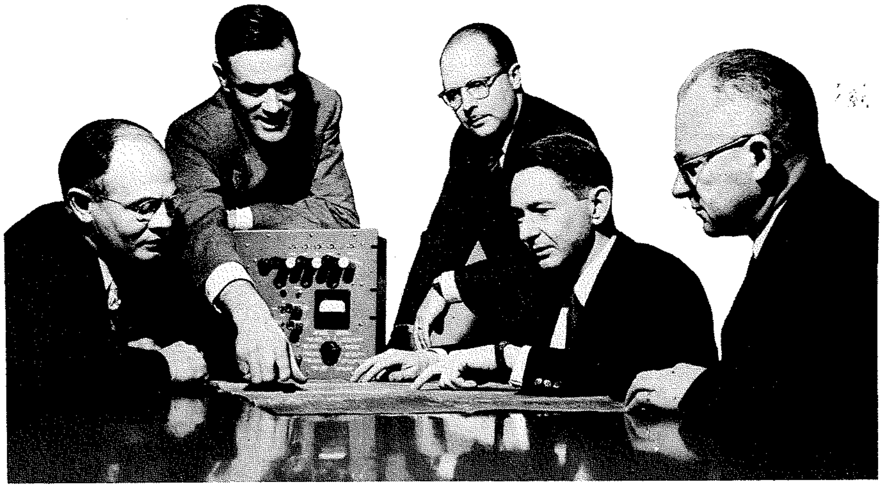


Fig. 5—Personnel of the Engineering Division, Engineering Products Department, Montreal, Canada, review the design of an FM exciter. Left to right, V. E. Issac, Mgr. Radar; G. F. Baylis, Mgr. Radio Relay; J. G. Sutherland, Mgr. Engineering; G. B. MacKimmie, Mgr. Broadcast and TV; and V. Ziemilis, Mgr. High Power Communications.

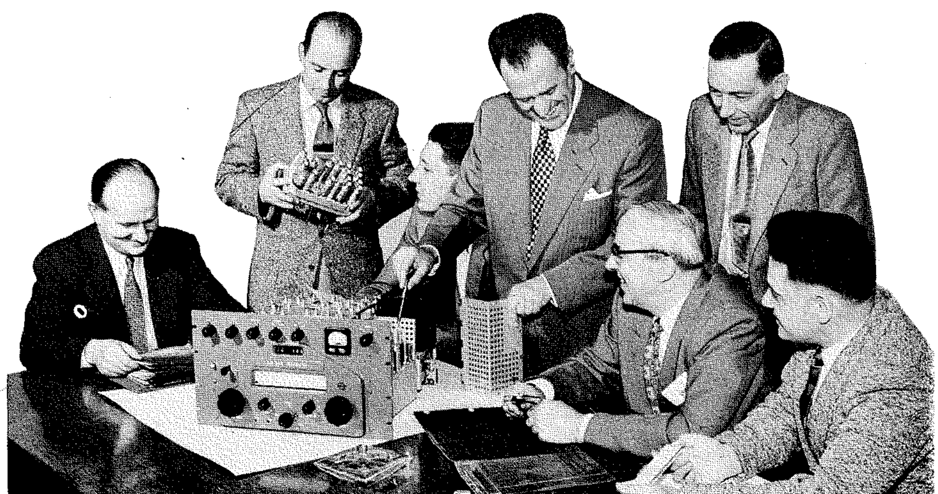
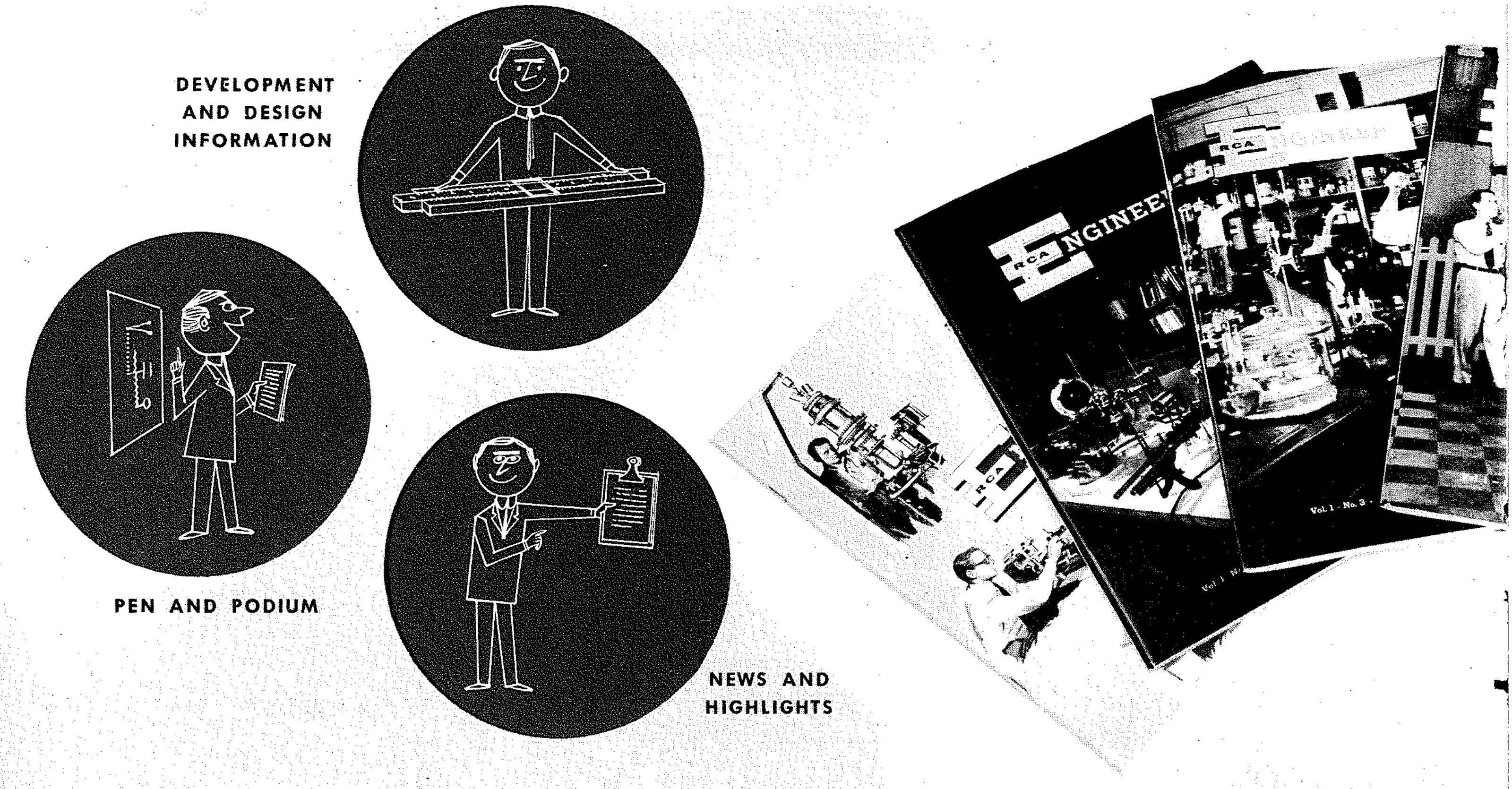


Fig. 6—Personnel of Home Instrument Engineering, RCA Victor Co. Ltd., Montreal, discuss CR-188 Receiver. Seated (l. to r.): W. B. Morrison, Mgr. Research and Development; H. Elbert; A. B. Oxley, Chief Engineer; E. Steiner. Standing (l. to r.): Eugene King, F. Papouschek and H. Lichtenberger. At left is a closeup of the CR-188, communications receiver, which is typical of products being designed for sale in foreign markets.



THE "RCA ENGINEER"—Its First Year

by **W. O. HADLOCK,** *Editor*

As your new engineering journal begins its second year of operation, we wish to acknowledge the active participation of our readers and the editorial representatives throughout the company who have provided capable assistance in editorial and planning phases. Most of these men have been introduced to you through the pages of the RCA ENGINEER; many of them you know personally.

However, it has not been possible for you to become acquainted with many of the people assisting the RCA ENGINEER staff, especially members of the Corporate Staff Marketing Services group and those of the Photographic Studio, Bldg. 7-4, Camden.

The Marketing Services group makes such contributions as artwork, cover photography, magazine layouts and production. Functioning as a unit, the combined effort of these groups has been a vital factor in the successful maintenance of a regular bi-monthly publication.

It is the aim of this article to introduce to you various members of the staff which includes the talents of several groups (see biographies and photos) and at the same time provide a brief review of the RCA ENGINEER's first year of operation.

EARLY PLANS

Perhaps you will be interested in a review of some of the early planning which went into the creation of the RCA ENGINEER magazine and led to the publication and distribution of six issues during the first year.

For some time, engineering management had been aware of the need for just such a technical publication as the RCA ENGINEER to provide a medium of interchange of information between engineering groups within the company. From a broad viewpoint, it was well understood that both the engineer and his company would certainly benefit from the existence of such a journal. Just exactly what form such a magazine should take had not yet been discovered, nor was it known whether such an undertaking could be carried out successfully on a company-wide scale.

In late 1954, however, RCA engineering management made the decision to go ahead with the task of launching a new journal for RCA engineers. In January 1955 preliminary work on the magazine started and a rough "dummy" book was completed by members of the Art and Production Department, who have served as members of the staff from the inception of the magazine.

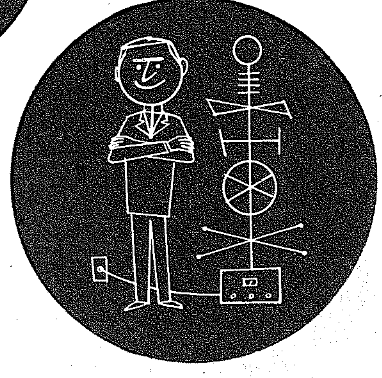
By March 1, 1955 the editorial portion of the staff consisted of an Assistant Editor, Editorial Secretary, and Editor.

MEETINGS HELD AT ALL LOCATIONS

During January, February and March a series of meetings was held at all engineering locations throughout the Corporation with the help of the Chief Engineers of the Product Divisions, their staffs, and members of other activities such as Personnel, Community Relations, and Product Engineering. As many as 12 meetings per month were conducted in order to review plans, discuss objectives and plot the course of a technical journal which would do justice to RCA's Engineering and its engineers.

Our problems were much like those of technical magazines which must appeal to the varying interests of en-

ENGINEERING MANAGEMENT



PRODUCT DESIGN

PATENT INFORMATION

gineers from numerous fields, i.e., electrical, mechanical, optical, chemical and physical, etc. One of the major goals of the editorial staff was to study the needs of engineers in over 20 RCA company locations, just as a trade journal would do when considering the needs of a score of equipment manufacturers.

EDITORIAL REPRESENTATIVES APPOINTED

Through the contacts made and knowledge gained at these meetings, it was possible to organize a group of nearly fifty engineers qualified to serve as editorial representatives. Because our manufacturing plants and offices are spread throughout the country, this arrangement was considered to be a vital means of maintaining a communications link with all engineering activities.

These representatives have become our avenues of direct contact with you, the reader. In effect, they help make it possible to observe your reading requirements more closely. They help us discover interesting and important subjects for publication in the pages of your journal. (See inside back cover for a complete list of Editorial Representatives.

SEVEN OBJECTIVES ADOPTED

During early planning meetings with the representatives, the selection of strong, worthwhile objectives was considered an important first step. The reactions and opinions of many engineers finally resulted in the adoption of the seven objectives. Each objective is a powerful factor in controlling the selection of topics for publication.

ADVISORY BOARD FORMED

Another important step was the formation of an Advisory Board which could function as a legislative or policy-determining body. As a group meeting regularly, they help assure fulfillment of the broad objectives established by Product Engineering Management, for the publication of a magazine benefiting both the engineer and the Corporation. In accomplishing this, board members review and compare the conformance of long-range editorial plans and policies with the general intent of the seven objectives. Distribution of the magazine, balance between product divisions and character of content are other areas of interest to Advisory Board Members.

The Board is comprised of sixteen members, including representatives from all Product and Service Company Engineering activities, Personnel, Community Relations, Organization Development and the RCA REVIEW. The assistance and guidance of the Advisory Board has been an instrumental factor in the success of the magazine.

OBJECTIVES

- *To disseminate to RCA engineers technical information of professional value.*
- *To publish in an appropriate manner important technical developments at RCA, and the role of the engineer.*
- *To serve as a medium of interchange of technical information between various engineering groups at RCA.*
- *To create a community of engineering interest within the company by stressing the interrelated nature of all technical contributions.*
- *To help publicize engineering achievements in a manner that will promote the interests and reputation of RCA in the engineering field.*
- *To provide a convenient means by which the RCA engineer may review his professional work before associates and engineering management.*
- *To announce outstanding and unusual achievements of RCA engineers in a manner most likely to enhance their prestige and professional status.*

64-PAGE BI-MONTHLY NEEDED

It was generally agreed that the RCA ENGINEER should become a bimonthly journal, published exclusively for the benefit of the RCA engineer. Out of these thoughts logically grew the slogan, "by and for the RCA engineer."

THE "RCA ENGINEER"
continued

In keeping with the idea that only a professional publication would be suitable for the engineer, it was decided that the magazine should be modern in its appearance, employ colorful covers, and make use of distinctive typography and printing. Early plans called for a standard 8½ x 11" size publication. After considerable discussion and study it was agreed that about 64 pages would be required to produce a journal of sufficient stature to meet the goals and requirements established by engineers at the meetings.

EDITORIAL GOALS

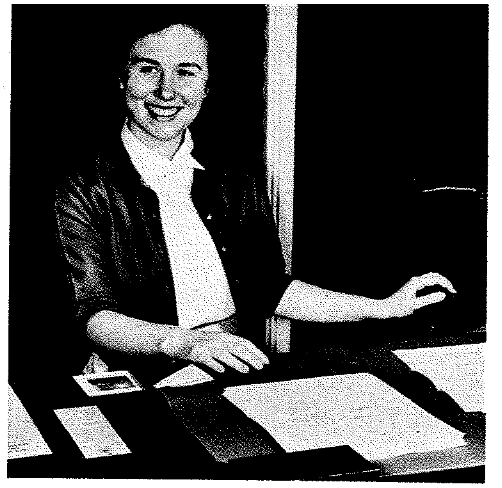
Once the general nature and approximate size of the magazine had been determined, editorial goals were considered. Of course, the selection of topics on the basis of their timeliness and practical benefit, and the maintenance of high editorial standards were accepted as inherent duties.

The representation of all product engineering activities was desired. Good editorial balance was sought by including the following broad areas of interest: (1) technical, semi-technical; (2) plants, engineering activities and services; (3) inspirational, engineering and management messages; (4) magazine departments, such as Pen & Podium, Patents Granted, News & Highlights. These approaches were adopted since they seemed to provide a wide variety of content capable of maintaining the reader's interest.

Thus, in order to establish a solid foundation for the magazine, the first three or four months of 1955 were devoted almost exclusively to preliminary work. After the basic planning was completed, the various editorial boards and groups of representatives started their work with the magazine staff in generating and scheduling suitable articles for several issues.

BRIEF "FIRST-YEAR" REVIEW

To accomplish the task of putting editorial plans into action, required



MARY LOU MALFARO, joined the RCA Record Department in 1949 as a stenographer and transferred to Record Advertising in 1950. From 1952 to December 1954, Miss Malfaro did secretarial work in EPD Advertising and Sales Promotion—first in the Communications Section and then later in the Broadcast and Television Section.

On January 1, 1955, she advanced to her present position of Editorial Secretary for the RCA ENGINEER. In addition to her secretarial duties, Miss Malfaro assists with the "Pen and Podium", "Patents Granted" and "News and Highlights" columns of the magazine. She assists with authors' biographical sketches and maintains a comprehensive filing system on RCA ENGINEER papers.

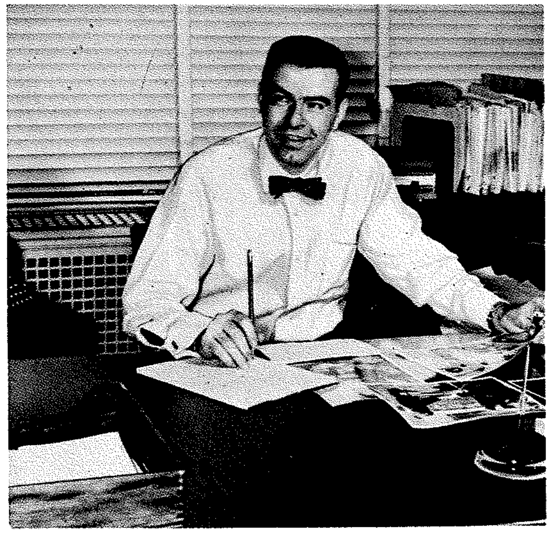
WILLIAM O. HADLOCK graduated from Clarkson College of Technology in 1934 with a B.S. degree in E.E. In 1934 Mr. Hadlock joined a newly formed Radio Engineering Group at General Electric where he worked in components engineering, and then on design of battery and farm radios. In 1939, he worked on design of TV Transmitters, and later transferred to Sales Engineering in GE's Electronic Tube Division. During the war he became Assistant Manager of Commercial Service activities. In 1944, he inaugurated and produced GE's series of Electronic Tube technical manuals. The project was done in 1½ years, requiring three volumes of over 400 pages each.

In 1947, Mr. Hadlock joined RCA, Camden, in E.P.D., Broadcast Equipment Section. This work included technical editing and writing in conjunction with the sale of TV and Broadcast Equipment. During this time, he had several papers published in Technical Journals. In 1949, he was appointed Managing Editor of "Broadcast News" and in 1950 became Manager of Broadcast and Television Advertising and Sales Promotion. Responsibilities included initiation of a series of nine catalogs on technical broadcast equipment totaling over 1000 pages, production of "Broadcast News", and planning of trade paper advertising.

In January 1955, Mr. Hadlock became Editor, RCA ENGINEER to assume the task of inaugurating, editing and publishing the new company-wide technical journal for RCA engineers.

MAY SINGLE is experienced in the many phases of production work including printing for Advertising. She started with RCA in stenographic work and later advanced to Secretary and Assistant to the Superintendent of the RCA Printing Plant.

In 1933, Miss Single transferred to the Purchasing Department to work in the group which bought printed material. Subsequently, she trained as a buyer and later transferred to Production work in the Advertising Department where she co-ordinates printing, typography and special advertising services. Miss Single handles typography work for the RCA ENGINEER.



RUSSELL J. HALL studied engineering at Rutgers University before going overseas with the U. S. Army Infantry in World War II. After the war he took a course in radio and television, and taught radio communications and television at Spring Garden Institute and Television Training Institute in Philadelphia.

Mr. Hall joined RCA Service Company in 1948 and two years later advanced to Journeyman Television Technician. During the next five years he taught radio, television and air-conditioning, becoming Leader of Technical Training for RCA Service Company. During this time he edited and produced technical manuals and home study courses for RCA technicians, including "Practical Color Television", of which 200,000 copies have been printed. Mr. Hall has written on such subjects as UHF propagation, color signal development and television installation and service.

In March 1955, Mr. Hall joined the RCA ENGINEER staff as Assistant Editor. In cooperation with Editorial Representatives and engineers, he helps plan cover ideas and possible topics for future papers. In addition to editing responsibilities, he maintains close contact with photographic, production and printing phases, and supervises the mailing lists and distribution. Mr. Hall is currently attending Rutgers University College at Camden.

the cooperative effort of a number of people. To appreciate the need for utilizing the combined talents of several groups, a brief review of the magnitude of one year's activity may be helpful.

Six issues, starting with the in-

Continued on next page

EMILY KRAUS, who joined the RCA ENGINEER staff in April 1956, works on the maintenance of the magazine mailing lists in cooperation with 25 engineering control officers. This involves processing 350 changes per month. Miss Kraus also answers inquiries concerning mailing lists, assists with the typing of manuscripts and helps expedite the approval of papers for publication.

JOHN L. PARVIN possesses a broad background in both Industrial and Fine Arts. In addition to the completion of a four-year course in Advertising Design, Mr. Parvin has studied composition at Grand Central School of Art; Painting at the Art Students League and at the Pennsylvania Academy of Fine Arts.

Mr. Parvin started work at RCA in 1929 in the Advertising and Sales Promotion Department of the RCA Radiotron Company, at Harrison, N. J. In 1944, he was made responsible for Art, Layout, and Advertising Production for all activities of the RCA Victor Division. This work involved window displays, color photography, catalogs, brochures and publications as well as album cover designs for RCA Victor Records. Mr. Parvin has received a number of awards for distinctive merit in the field of commercial art, for advertising pieces produced by his department. He is responsible for assuring a high standard for the design and decor of major company-wide functions such as the Award of Merit Society Dinner and the Twenty-Five Year Club Banquet.

Experienced in dealing artistically with technical products, Mr. Parvin has directed art and production of the RCA ENGINEER from its inception. He has paid particular personal attention to cover color photography and the overall appearance of the magazine.

PETER F. GALLO, who has had Advertising Agency, Art Studio and Printing experience, studied at the Philadelphia Museum School of Art. Mr. Gallo joined RCA in 1945 in the Art and Production Department at Camden, and has been actively engaged in this work for various divisions.

In addition to his work on the RCA ENGINEER Mr. Gallo provides the art and photograph requirements for numerous institutional and sales promotion pieces produced by the Art and Production Department.

Mr. Gallo co-ordinates the layout and artwork for all articles published in the RCA ENGINEER magazine. It is his responsibility to maintain the format established for the magazine in order to assure a consistency of character in its make-up.

← (L to R) W. E. Pilgermayer, R. B. Allen and J. O. Gaynor study photos in a printed magazine.

JAMES O. GAYNOR, who is in charge of the Photographic Studio in 7-4, Camden, started his career as a draftsman with General Electric Company, Harrison, N. J. In 1918 he entered into Industrial Photography for the same company. In 1933 Mr. Gaynor came with RCA to work in photography and subsequently organized and supervised his present Studio Group. This activity provides photographic services for company house organs, reports, patents, instruction books and advertising literature. Mr. Gaynor's staff provides black and white and color photography, projection slides and motion picture films for all activities in the Camden area.

RODMAN B. ALLEN studied at Brown University from 1930-1934. He also studied courses in painting and drawing at the Rhode Island School of Design and used the camera to fulfill set assignments. In 1935 Mr. Allen went with the Robert Yarnall Richie Studio in New York City and in 1936 opened his own Studio in Moorestown, N. J. In 1941 he opened a Commercial Photo Studio in Philadelphia and in 1942 became associated with the RCA Photo Studio. Mr. Allen has specialized in both black-and-white and color photography. His work includes the production of color covers for "BROADCAST NEWS," and the development of special lighting techniques for electronic equipment photography for the RCA ENGINEER.

WILLIAM E. PILGERMAYER started in photography in a portrait studio in 1936 where he continued to work for three years. He attended Winona School for Professional Photographers at Warsaw, Ind. during the summer of 1940, concentrating on commercial photography. Mr. Pilgermayer became associated with RCA in 1941 and later studied at Temple University Evening School. Mr. Pilgermayer specializes in "news type" photographs and films for special meetings and events.

augural edition (June-July 1955) and ending with Vol. 1, No. 6 (the April-May 1956 issue) involved 392 magazine pages. The six editions included about 70 different authoritative, professional articles contributed by RCA engineers. It is estimated that over the span of these six issues approximately 1500 engineers contributed in one way or another (with photos, captions, patents, pen & podium items, etc). Eighty-eight of them were authors!

It is interesting to note that every article is subject to careful consideration from the following standpoints before it is ready for publication:

a) Establish early plan for topic and schedule with representative
b) Preliminary outlines and early rough drafts by author
c) Editing by representatives and engineering editors
d) Local, divisional, and corporate approvals
e) Magazine staff editing
f) Photography, illustrations and captions
g) Galley proofs of type, checking of type and authors' approvals
h) Page layout by Art Department
i) Preparation of art and illustrations by Art Department
j) Page proof and final ok's by authors
k) Completion and arrangement of final dummy
l) Final ok by Advisory Board
m) Printing and Distribution

Each progressive step is essential in moving a proposed paper forward toward completion. Because of this rather long and complex cycle, it is necessary to plan several issues ahead in order to maintain a bi-monthly schedule. These are some of the reasons why editors require considerable "lead" time in their scheduling of articles. Plans for every issue must also include a reasonable surplus of papers to serve as a "cushion" against those articles which may fail to materialize on time, or those that do not successfully complete the approval circuit.

FUTURE PLANS

As stated in the objectives adopted, it is planned to continue to deal principally with engineering and development projects edited in a way that will interest you. Technical articles and topics will continue to be chosen on the basis of their timeliness and value to you. We hope to maintain high editorial standards in the choice of subject matter and the presentation of engineering activities.

Through frequent meetings with editorial representatives we plan to reveal a succession of interesting engineering developments and uncover unusual material for the RCA ENGINEER. These efforts will be supplemented and strengthened occasionally by direct contact with you, the reader, through personal contact, letters or questionnaires.

MARGARET C. KRICK has worked at RCA since 1951 in Mail Room activities, Purchasing, and in January 1956 joined Mr. Gaynor's staff. She processes photographic print orders, records assignment schedules and maintains a file of photo negatives of RCA equipment and personnel.

WILLIAM EISENBERG studied at Photography School in Denver, Colorado in 1942. From 1942 until 1945, he was engaged as an Army Air Force Photographer and in 1946 became a photographer at a Naval Air Experimental Station. Mr. Eisenberg joined the RCA Photo Studio Staff in 1951 and has been active in various types of photographic work.

PAUL ROEDIG worked as Press Photographer for the Philadelphia Inquirer from 1939 to 1942. From 1942 to 1945, Mr. Roedig worked in Photography for the Philadelphia Navy Yard. He went to work for the Zamsky Studios in 1945 and came to his present post as RCA Industrial Photographer in 1951. Mr. Roedig's work at RCA has included both equipment photography and personality photos.

(L to R) Mrs. Krick, William Eisenberg and Paul → Roedig shown in Photo Studio, 7-4, Camden.

THE INTERNATIONAL CONFERENCE on the PEACEFUL USES OF ATOMIC ENERGY

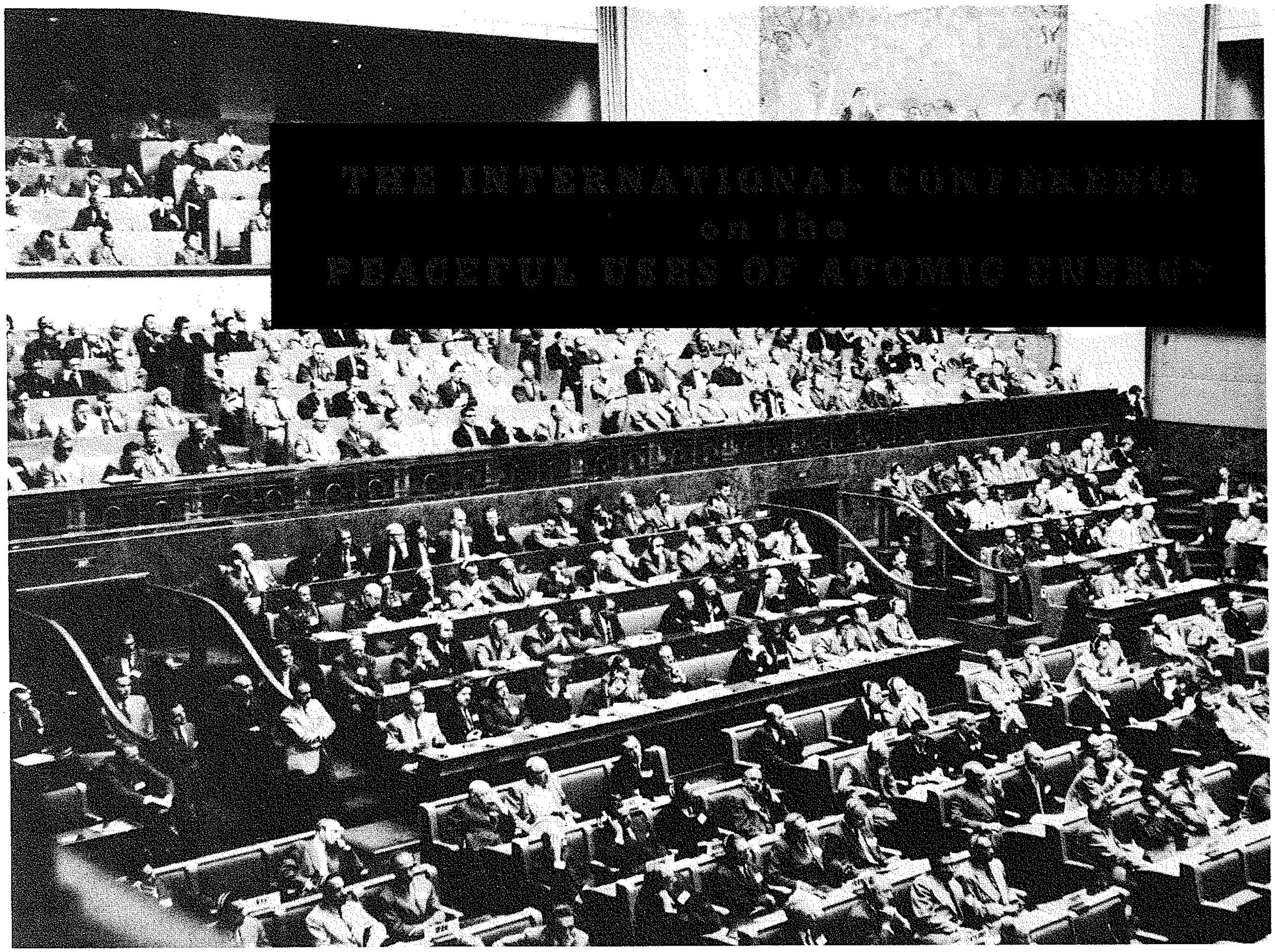


Photo Courtesy of U.N.

By

DR. E. G. LINDER

RCA Laboratories

Princeton, New Jersey

Editor's Note: — This article has been prepared to give a general description of the Geneva Atomic Conference held August 8-20, 1955, and of some post-conference developments. Coverage of the technical papers (460 in number) is not attempted. They are now available in published form. The article is concerned mainly with other aspects of the conference thought to be of interest and value. The author attended the Conference as an official member of the United States Delegation.

THE INTERNATIONAL Conference on the Peaceful Uses of Atomic Energy was under the auspices of the United Nations, and the main center of activity was the Palais des Nations in Geneva, Switzerland. This is the former headquarters of the League of Nations, and the present European headquarters of the United Nations. The U.N. estimated that over 5000 people attended the Conference, including 1400 delegates, 3000 observers and 900 press correspondents. A partial breakdown is as follows:

Country	Delegates	Staff	Industrial Rep.
United States	249	100	30
United Kingdom	130		18
France	100		
Germany	69		
USSR	55		
Belgium	30		
Canada	26		

The U.S. Delegation was headed by Admiral Lewis L. Strauss. The other four official representatives were Willard F. Libby, I. I. Rabi, Detlev Bronk, and Shields Warren. George Weil acted as director of the Delegation.

The U.S. Headquarters was in the Hotel du Rhone, where most of the fifth floor was occupied by offices and was a restricted area accessible only to those carrying proper passes. In general the writer was impressed with thoroughness of organization of the U.S. Delegation, its range and detail, and the preparations to cope with possible contingencies both scientific and political.

Private industry did not seem to be strongly represented. Of the 249 United States delegates, only 30 were from industry. Furthermore, only a small fraction of the papers presented were from industrial laboratories, the great majority being from government owned or operated institutions. However, in the case of Great Britain the situation was somewhat more favorable to industry. A substantial portion of her 160 delegates were said to be from industry but the exact

PEACEFUL USES OF ATOMIC ENERGY
continued

figures have not been available to the writer. It is reported also that as many as 1000 industrial representatives from Britain had planned to attend the Conference although not as delegates. France had 100 delegates and an estimated 150 unofficial industrial visitors. In the case of the U.S.S.R. private industry, of course, does not exist and such a breakdown cannot be made.

The writer was impressed by the extent of the participation of private industry in the atomic energy field as revealed by the Industrial Exhibit. The extent of the European participation in particular was unexpected since most of the European countries are behind the United States in developments in this area. It should be remarked, however, that a large number of the exhibits contained equipment not used exclusively for atomic energy applications, such as vacuum pumps, filters, high-voltage generators, aluminum, electronic instruments, and television equipment.

COMMENTS ON PAPERS

The most evident activity of the Conference was the presentation of papers. These were 460 in number presented orally, and with others to be printed in the Proceedings, made a total of 1061. Papers were read in one of four official languages; English, French, Spanish, or Russian, and each paper was simultaneously translated so that by the use of earphones it could be heard in any of the four. Television was used for the more important sessions so that an over-flow audience could see and hear the speakers in adjacent rooms. This was provided in both English and French. A verbatim record was made of all sessions. Questions and comments on papers were accepted only in written form submitted to the chairman, and were called for at his discretion. This was apparently one of the measures taken to avoid the introduction of contentious political questions and to preserve the scientific character of the Conference.

It is not the purpose of this article to give a full report on the technical papers, but only to comment on several particularly interesting and significant ones. Copies of papers may be purchased from the United Nations Headquarters, Sales Section, New York, N.Y. All papers are in process of being published in the Proceedings of the Conference, which is scheduled to appear this year. Several publishing companies also are planning to issue volumes of selected papers.

The number of papers contributed by the leading participants is as follows:

Tabulation of Papers

Country	Oral Papers	Total Papers
U.S.	180	525
U.S.S.R.	70	94
U.K.	68	100
France	33	60
Canada	12	13
Norway	11	16
Total	460	1061

The first two and one half days of the Conference were devoted to general sessions in which the papers of the most widespread interest were presented. The opening session comprised addresses by the Swiss President, M. Petitpierre, the U.N. Secretary General, Dag Hammarskjold, and Conference President, Homi Bhabba. The address of Bhabba was outstanding and contained an unscheduled and unexpected reference to the possibility of a controlled fusion reaction "within the next two decades." Although there was no material directly related to this subject on the formal program, Bhabba's mention of it led to numerous informal discussions, and engendered considerable publicity.

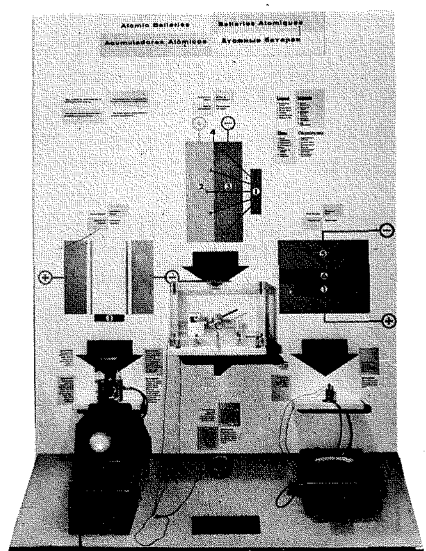


Fig. 1—The display of atomic batteries at Geneva. Three types are shown with the semiconductor p-n junction type, supplied by RCA, in the lucite case in the center. It is connected to a small transistor audio oscillator directly below.

On the second day two papers of unusual interest were presented on the subject of nuclear reactors for electric power generation. The first was a Russian paper entitled, "The First Atomic Power Station in the U.S.S.R. and the Prospects of Atomic Power Production," read by Prof. D. V. Blokhintsev. This paper had received considerable pre-conference publicity by the Soviets. Apparently most delegates were impressed with the Russian power plant as described. However, in the discussion following the paper, it was evident that some information was being withheld, and several technical questions were given evasive answers.

The second paper was by W. H. Zinn (U.S.A.) and entitled, "Design and Operating Experience of Prototype Boiling Water Power Reactor." This paper was generally considered as the U.S. counterpart of the preceding U.S.S.R. one, and as a description of the first U.S. power plant for peaceful purposes. (The U.S. submarine electric power plants could not be discussed under Conference rules since they have been constructed for military applications.)

There were numerous good papers on radiation effects including biological, medical, agricultural, chemical effects, and radiation damage to materials. Polymerisation induced by radiation and its industrial applications were discussed. A particularly good review type paper entitled, "The Theory of Lattice Displacements Produced During Irradiation" was presented by F. Seitz. An interesting paper by B. Cassen described "A Gamma-Ray Insensitive Semi-conductor Fast Neutron Dosimeter Using Single Crystal Germanium." Resistance change was used to indicate the radiation dose. Another important review type paper entitled, "Theoretical Aspects of Radiation Damage in Metals" was presented by G. J. Dienes of the Brookhaven National Laboratory. Considerable attention was given to radiation damage in reactor materials. A particularly good review of this subject was presented by D. S. Billington, of the Oak Ridge National Laboratory. In general, it was evident that the field of radiation effects is one of considerable interest and importance; one that is receiving considerable attention and growing rapidly.

There were numerous papers on the uses of isotopes in industry. Among these was one by P. C. Aebersold of the United States Atomic Energy Commission. This paper emphasized tracer applications and stressed also the rapid increase in use of reactor-produced isotopes. An interesting paper entitled, "Large Scale Production of Radioisotopes" was presented by A. F. Rupp of the Oak Ridge National Laboratory. He emphasized the rapid increase in the use of radioisotopes and stated that in 1954 that the number of curies shipped exceeded 27,000. The benefits of isotopes to industry may be judged by a statement by A. E. C. Commissioner, Willard Libby, in which he said that isotopes have saved industry as much as one billion dollars.

Papers on the disposal of radioactive wastes were presented by A. Wolman of Johns Hopkins University and also by E. Glueckauf of the Atomic Energy Research Establishment at Harwell, England. The disposal problem is a difficult one and promises to become even more difficult and troublesome in the future when larger and larger amounts of fission products are expected to be produced.

EXHIBITS

Although the technical papers constituted the most important phase of the conference insofar as the main body of the delegates was concerned, nevertheless the exhibits were unquestionably of great interest and value. They provided a rapid and concrete means of estimating the work that has been done in the atomic energy field both collectively and individually in other countries.

During the conference there were two completely separate exhibits in Geneva dealing with the peaceful uses of atomic energy. One of these was the official exhibit, under the auspices of the United Nations, and held at the Palais des Nations. The other was called, "The First International Exhibition of the Peaceful Uses of Atomic Energy." It was organized by the Swiss and Geneva governments and was held at the Palais des Expositions (Exhibition Palace) near the center of the city of Geneva. Of the 72 nations represented at the conference, only 7 contributed official exhibits. These were: the United States, Russia, United Kingdom, France, Canada, Belgium and Sweden. Of these, definitely the most impressive was that of the United States and the highlight of all the exhibits was the United States reactor shown in actual operation.

RCA contributed to the instrumentation exhibit, supplying samples of photomultiplier tubes and scintillator type detection instruments, see Fig. 2. RCA contributed also to an exhibit of atomic batteries in which three types of atomic batteries were shown, namely, a contact potential type, made by Tracerlab, Inc.; a direct-

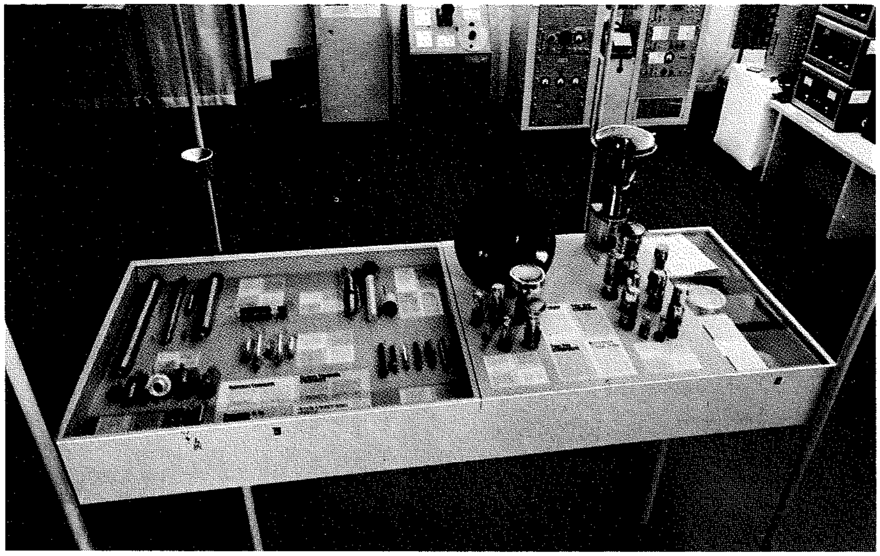


Fig. 2—A part of the nuclear instrumentation display at the U.S. exhibit. Most of the multiplier phototubes on the table in the foreground were supplied by RCA.

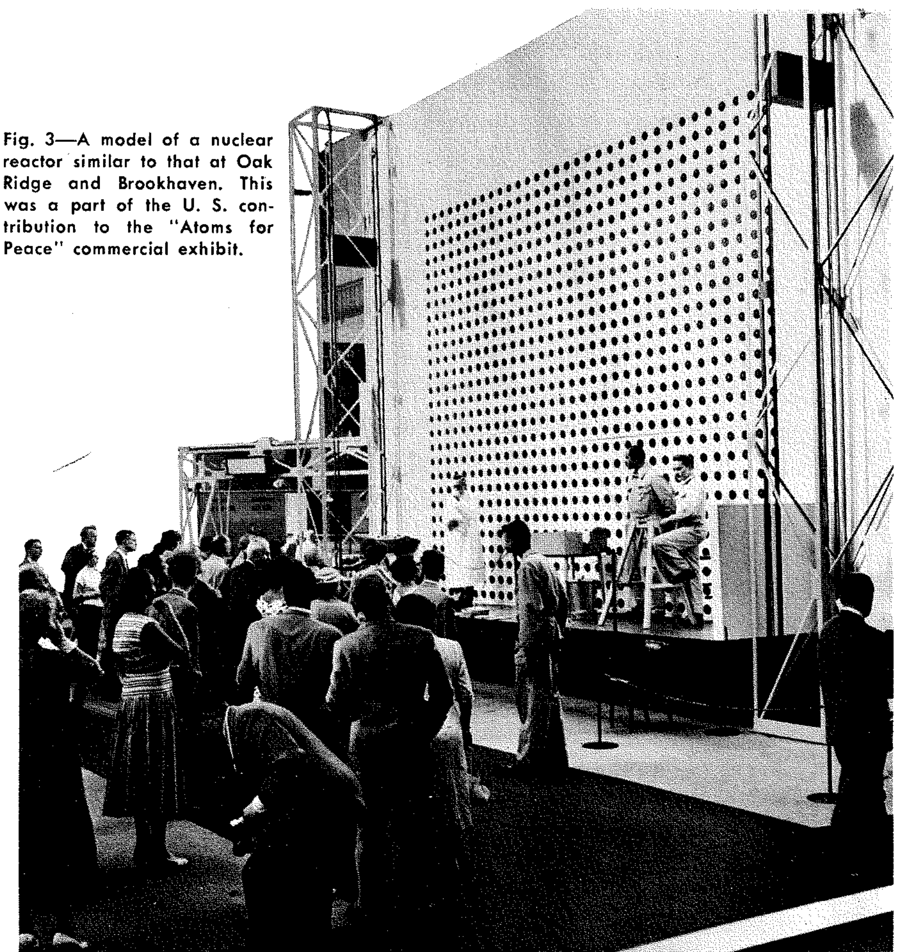


Fig. 3—A model of a nuclear reactor similar to that at Oak Ridge and Brookhaven. This was a part of the U. S. contribution to the "Atoms for Peace" commercial exhibit.

charging type, made by the Radiation Research Corp.; and a semiconductor type supplied by RCA; see Fig. 1. This battery exhibit attracted considerable attention and performed satisfactorily throughout the two weeks of the exhibit.

Next to the U.S. exhibit that of the U.S.S.R. probably attracted the greatest interest, since it gave most attendees for the first time a glimpse of atomic energy equipment produced behind the Iron Curtain. The Russian exhibit occupied about the same amount of floor space as that of the United States. The main feature was the model of the 5,000 kilowatt nuclear power plant which has been mentioned above in the section on technical papers. Films describing this were shown both in the exhibit and in the Palais Cinema Hall. Except for this power plant, the Russian exhibit emphasized the production of radioisotopes and their medical and industrial applications. These included: cancer treatment, investigations of the wear of machine parts, metallurgical studies, diffusion and sublimation of metals, detection of defects by gamma rays, determination of thickness or weight, radioactive tagging, radioactive bottle counters, level gauges and manometers.

It was difficult to locate Russians in the Russian exhibit since they wore no identification of any sort as was practiced by other exhibiters. However, when located they appeared to be friendly and cooperative in answering questions, but usually the services of an interpreter were required. The writer saw very little in the Russian exhibit which was not already substantially known in this country. Their exhibit on the whole did not approach in sophistication and technical detail that of the United States.

In addition to the exhibits mentioned above, the United States also had on display in a separate room, an extensive technical library dealing with the atomic energy field and including an apparently quite complete collection of books, journals, and unclassified technical government reports on atomic energy or related subjects. Here also were on display special editions of sets of books prepared to describe the United States program, a set of each of which was presented as a gift to each of the official delegates of all the other nations.

The industrial exhibit was held at the Palais des Expositions near the center of Geneva and lasted for the same two week period covered by the United Nations Conference. These exhibits were both commercial and educational. Outstanding among the educational features was a presentation by the United States Information Agency. This offered a popular explanation of nuclear energy and demonstrated some of its peaceful uses. Films and models were used and the audience was conducted by a lecturer. One especially realistic model represented was that of the reactor at Oak Ridge; see Fig. 3. It was 30 feet high. This was used to illustrate the production of radioisotopes. Many uses of atomic energy were illustrated by the use of animated displays, functional models, actual equipment and photos.

RESULTS

No doubt one of the most important results of the Conference was the interchange of ideas and information between large numbers of the world's atomic scientists. This helped to encourage a scientific climate suitable for future progress. An important aspect of this new climate was the relaxation of secrecy on some non-military scientific data, and it appears likely that further relaxation will probably take place on an international basis. The frankness and detail of many of the discussions and also the many new personal contacts between scientists of different nations will no doubt also prove to be important factors.

The political effects were perhaps no less significant than the scientific ones. There is no doubt that the United States made a good impression on other nations, including the U.S.S.R. There was an air of authority and completeness of detail in

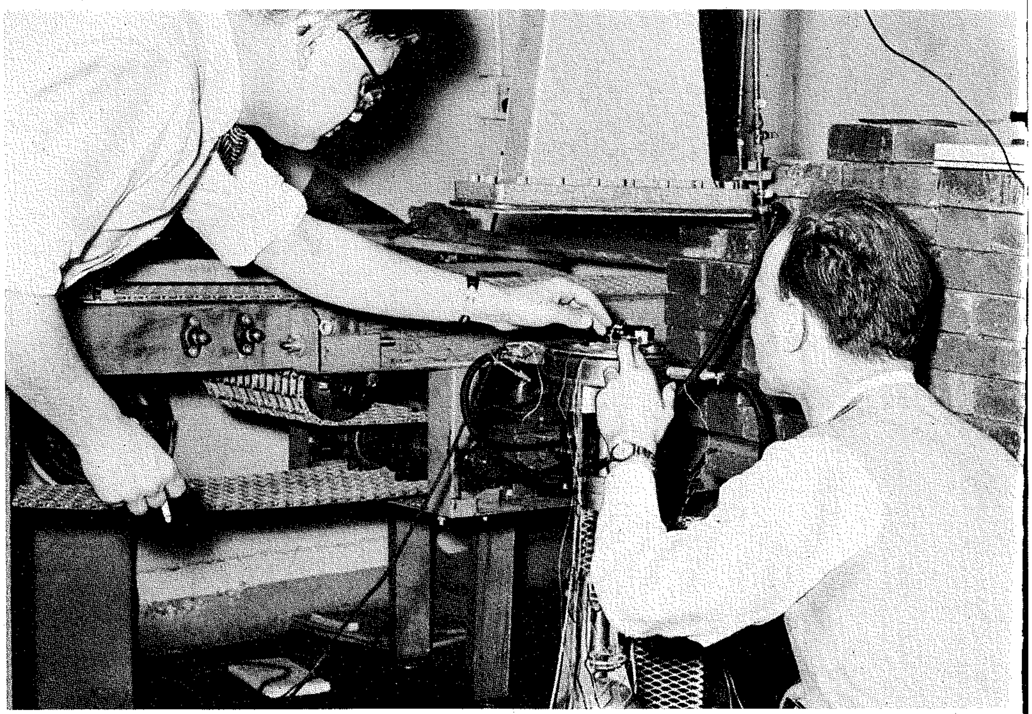


Fig. 4—Dr. J. J. Loferski (left) and Paul Rappaport, of RCA Laboratories, making tests with a Van de Graaff machine to determine the effects of electrons with energy in the nuclear range on semiconductors.

many of the important United States papers and in the United States exhibit, which was not approached by other nations. There was also a marked frankness of discussion and willingness to answer all questions quite thoroughly which could not have failed to impress. This was no doubt a consequence, at least in part, of the careful planning done by the United States Delegation to see that the United States part in the program proceeded smoothly and in the desired direction.

ERNEST G. LINDER was awarded the Ph.D. degree by Cornell University in 1931, and the M.S. and B.A. by the University of Iowa in 1927 and 1925 respectively. He served as instructor at the California Institute of Technology 1927-28, was Detroit Edison Research Associate at Cornell 1928-31, was a member of the Research Division of the RCA Manufacturing Company 1932-41, and has been with the RCA Laboratories since 1941. Dr. Linder has research experience, publications and patents in the fields of thermoelectricity, photoelectricity, crystals, electrical discharges in gases, mass-spectrography, microwave tubes, microwave propagation, electron physics, radar, semiconductors, nuclear and solar batteries. He is a member of the American Physical Society, Sigma Xi, and a Fellow of the Institute of Radio Engineers.

The discussions of the possibilities of a controlled thermo-nuclear reaction and the disclosure that this was being worked on in the United States and elsewhere is probably a further important result of the Conference. This will probably lead to a stimulation of considerable further work along this line. As a matter of fact, only a few days after the end of the Conference Senator Clinton Anderson, Chairman of the Joint Congressional Committee on Atomic Energy, stated that we should "mobilize our scientific and industrial power behind an effort to achieve control of thermo-nuclear reactions with all possible speed."

POST-CONFERENCE DEVELOPMENTS

At the time of this writing, after the elapse of about seven months since the Conference, it is possible to assess some of the long-term effects. Already there are plans for a new meeting, and the U. N. Conference Advisory Committee has remained in existence to continue work along this line. Another Trade Fair to be held in 1957 in Geneva's Exhibition Hall has been announced by the Swiss Government. In Washington, last March, representatives of 12 nations gathered to draft a statute for the proposed International Atomic Energy Agency originally suggested by President Eisenhower. Also steps are being taken to organize "Euratom," a European, six-nation atomic energy authority. Twenty-five nations have entered into bilateral research reactor agreements with the U.S., and others are negotiating.

In the national sphere, peaceful applications appear to have been greatly stimulated and progress is being made at a fast pace. Considerable business is developing, especially with Europe. The Government has just allocated 40,000 kilograms of U-235 for European use. This is a supply estimated to last six to nine years. One reactor has been sold to Europe, one is contracted for, and discussions or negotiations are under way regarding 23 others. AEC Commissioner Murray has proposed a government investment of $1 billion to construct 2 million kilowatts of demonstration atomic power plants. Declassification of AEC documents is proceeding rapidly. Of 31,000 documents reviewed, 30,000 were secret and 1,000 confidential, now 25,300 have been made available to industry under the AEC civilian application program. RCA is included among the industries having the required access permits. The Congressional Panel on the Impact of the Peaceful Uses of Atomic Energy, of which RCA President Frank Folsom was a member, has issued a report of a broad survey type, making recommendations to Congress for the development of peaceful uses of atomic energy in all aspects.

Within industry there is increasing interest in possible atomic energy applications, for many purposes other than power generation. The radiation instrumentation field grew from $20 million in 1952 to $32 million in 1955. Radioisotopes are now used by 1,200 firms resulting in an estimated annual saving of about $100 million. Applications of nuclear radiation to industrial processes seem to be developing into one of the more important areas. This will probably be of especial significance to the food, chemical and oil industries. Food preservation by irradiation is being intensively studied. Numerous new or improved processes are being tested and evaluated in chemical and oil manufacturing. Applications to plastics seem especially promising. RCA's interest in possible uses of nuclear radiation is evidenced by the new research reactor planned for the Princeton area. In addition to the reactor itself the laboratory will probably include a Van de Graaff machine, a powerful gamma ray facility, and a high-level radiation laboratory.

OPTICS FOR THREE TUBE COLOR CAMERAS

by

D. J. PARKER
General Engineering Development
Defense Electronic Products
Camden, N. J

THE DEVELOPMENT of television cameras for color pickup has emphasized the importance of some rather old but little-used techniques in optics. The utilization of these techniques has been dictated to some extent by the limited state of development in the field of television pickup devices. However, regardless of this, the basic problem remains, namely that three video signals must be generated corresponding to the three primary color components of the scanned image.

The most desirable pickup device would be one in which the three signals would be generated from scanning a single optical image on the face of a single tube. This would put color cameras optically in a class with monochrome cameras (and photographic cameras) where a single objective lens simply projects an image of the scene on a sensitive surface. Though considerable progress has been made toward the development of a single pickup tube for color, present approaches involve severe limitations which make commercial application impractical. Thus we are faced with the necessity of following some other approach.

The method which has proved itself most practical and flexible is to use three separate pickup tubes, one for each primary color. It follows that the optics of the color camera must furnish separate red, blue, and green images of high quality to these three tubes. This requirement can be met if the optical system includes a system of suitable mirrors and color filters which split the light into three paths on the basis of spectral distribution. Numerous schemes have been tried, each having its own merits and disadvantages. Some of these involve the use of color-selective reflecting surfaces which are made by depositing thin films of metal salts on glass plates. Such surfaces are called "dichroics."* They have the advantage of high efficiency in light transmission as compared to absorption filters, and at the same time perform the function of mirrors required in the system, thus reducing the number of pieces.

Another technique is the use of non-reflecting coatings on the back sides of mirrors. Glass plates used for mirrors must be thick for stability; hence duplicate images from back surfaces must be eliminated as completely as possible. A highly efficient type of coating developed by RCA bears the trade name "Magicote C." It is actually an etching of the glass surface produced by immersing the glass in a corrosive solution under carefully controlled conditions.

Both dichroic and non-reflective surfaces are used extensively in all color TV cameras. Some of the more successful arrangements are described in the following discussions of cameras which have been built for experimentation, or in other cases for commercial usage in broadcasting.

*"A New Dichroic Reflector and Its Application to Photocell Monitoring Systems," by G. L. Dimmick — Journal of SMPE, Volume XXXVII, January 1942. "Review of Work on Dichroic Mirrors and Their Light-Dividing Characteristics," by M. E. Widdop — Journal SMPTE, Volume 60, April 1953.

THE RCA LIVE IMAGE ORTHICON COLOR TV CAMERA

This camera is built around the image orthicon, a high quality tube possessing good red, green, and blue sensitivity, whose photosensitive surface has a working area roughly an inch by an inch and a quarter. In order that the camera should have a suitable maximum field of view of the order of 35°, this image size dictates a minimum focal length for the camera lens of two inches. There is not sufficient space between such a lens and its focal plane to split the light beam into three color bands, conventional TV camera lenses having only about $1\frac{1}{8}$ inch between the end of the lens assembly and this plane.

Two solutions have been used to meet this fundamental space problem. One solution, used on one of the first RCA experimental cameras built at the David Sarnoff Research Center, is to place a separate lens before each tube, splitting the light into three colored but otherwise identical beams by means of beam splitting

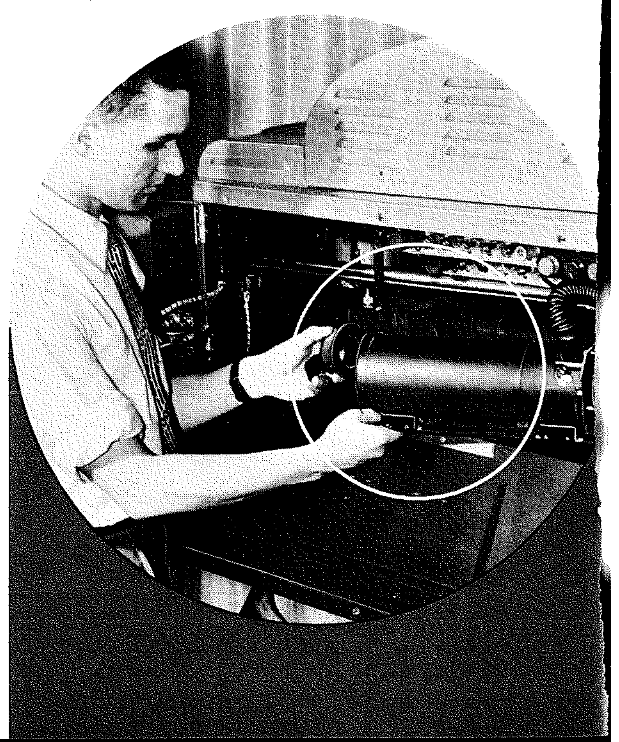


Fig. 1—Jim Walter, co-op engineering student from University of Cincinnati, presently employed in Television Systems Engineering Group, is shown working with the TK-41, Studio Color Camera. This product makes use of optical principles to fulfill three major functions:
(1) formation of primary image
(2) reproduction of this image at a different physical location and,
(3) separation of white light beam into 3 primary channels.
The circle indicates the general location of the optical assembly shown in Fig. 2. In this photo, Jim is shown rotating the blue image Orthicon from its normal operating position behind the block of dichroic mirrors.

mirrors located in front of the lenses shown in Fig. 3. It is necessary that the production camera have a readily selectable field of view. This could have been attained, as in the monochrome camera, by use of a rotatable turret containing a number of lenses differing in focal length from 8″ or more (narrow angle) to 2½″ or less (wide angle). The use of wide angle lenses on the turret, however, causes the beamsplitters and the camera to become undesirably large. Also, in order to maintain registration of the three images when the turrets are rotated to change focal length (field of view) the focal lengths must be very carefully matched. Furthermore, the lenses must be located on the turret with great precision. This is costly and practically impossible to do with adequate precision. Another approach to the problem was required for a production camera.

The optical system of the production camera includes a lens of fairly long focal length to transfer or relay the primary image formed by the turret lens to a secondary location about 22″ beyond primary image. (Shown in Fig. 4). The distance from the rear end of this "relay" lens to the secondary image (which was chosen to be slightly larger than the primary image) is in excess of 8 inches, giving ample room to split the white or mixed beam into red, green, and blue beams for presentation to the three image orthicons.

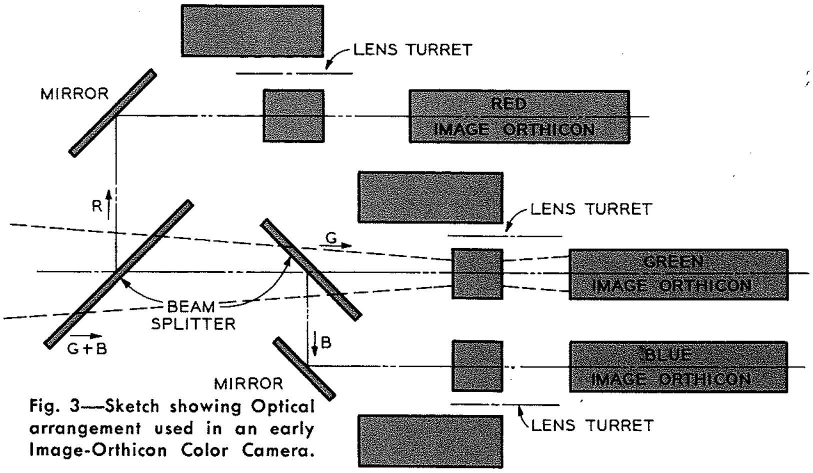


Fig. 3—Sketch showing Optical arrangement used in an early Image-Orthicon Color Camera.

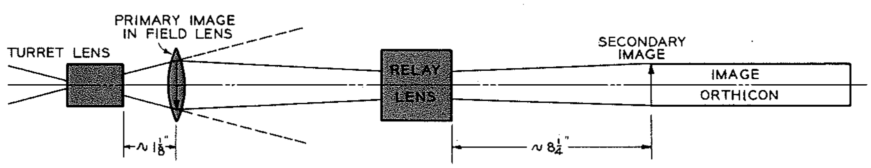


Fig. 4—Basic form of "Relay" type Optical System used in present Studio Cameras.

The sketch of Fig. 4 shows that the primary image is located inside a "field" lens. In the absence of this lens, the rays proceeding to the off-axis portions of the image would continue on their path, as shown by the dotted lines, and would never enter the relay lens. The secondary image would thus suffer from lack of light in the corners, and the resultant picture would be severely vignetted or "portholed." In general, each turret lens requires a field lens of a different focal length, so a field lens turret is provided which rotates integrally with the main lens turret.

In Fig. 5, a 3-channel relay optical system is shown, complete with beam splitters for separating the colored beams. Each of the beam splitters is a sandwich of two plane parallel optical flats (flat to about 25 millionths of an inch), hermetically sealed about the edges. The inside surface of one plate of the sandwich carries a "dichroic" or semi-reflecting color selective film applied by evaporation techniques. The other three surfaces of the sandwich are treated with RCA "Magicote C," an acid skeletonizing process which reduces the normal reflection of a glass-air surface by a factor of about 12, thus eliminating troublesome ghost reflections.

The beam splitters, being tilted with respect to the optical axis and located in a convergent light beam, introduce serious astigmatism into the optical system, i.e., difference in focal position between fans of rays in a horizontal plane and those in a vertical plane. This is completely elim-

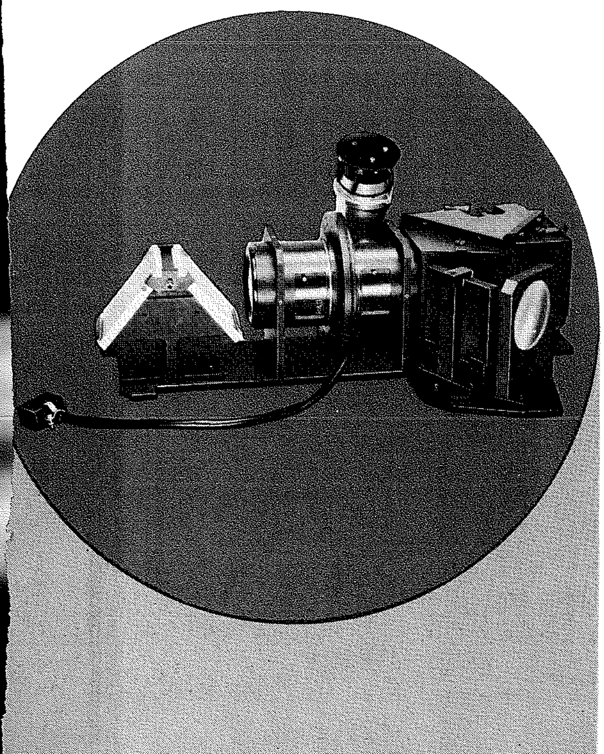


Fig. 2—This Optical Assembly "color-separates" the white light, and relays the primary image to the three image orthicons.

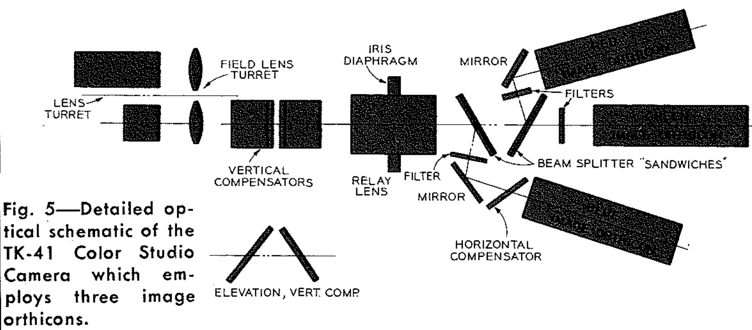


Fig. 5—Detailed optical schematic of the TK-41 Color Studio Camera which employs three image orthicons.

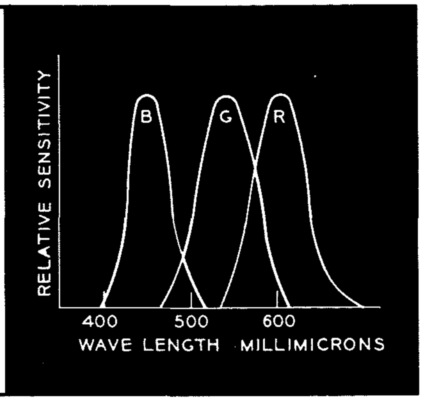


Fig. 6—The red, green and blue curves above indicate optimum system color sensitivities for the three channels of the TK-41 Studio Camera.

inated by the introduction of a similar pair of tilted glass plates (known as vertical compensators) on the other side of the relay lens, rotated 90° about the optical axis from the orientation of the beam splitters. A plate known as the horizontal compensator is also introduced in the blue channel to make this path optically identical to the other two.

The dichroic reflectors split the white or mixed beam broadly into red, green and blue beams. Each color channel must have the proper sensitivity at each wavelength within close limits (Fig. 6 Curves) to accomplish true color fidelity, and this is attained by the additional use of subtractive color filters cemented in glass. These, incidentally, also serve as windows to seal the beamsplitter assembly from dust and contamination of any kind. Since the three optical channels do not yield proper relative light transmissions in this curve matching process, and individual image orthicons also do not have identical absolute sensitivities, correct relative channel sensitivities are achieved by insertion of neutral density filters in two of of the optical channels.

In contrast to black and white practice, the color camera image orthicons must be operated so that all highlights in the scene are located on the linear portion of the video-signal vs. scene-brightness curve. This requires regulation of the illumination on the photosensitive surfaces of the image orthicons, which is accomplished by means of a remotely controlled iris diaphragm located in the relay lens. This diaphragm limits the f/number of the optical system to f/4, even if the f/number of the turret lenses is lower than this value.

Critical focusing of the color camera is accomplished by longitudinal movement of the whole lens turret relative to the rest of the optical system. Lens focus and focal length selection controls are located at the rear of the camera, where the operator may examine the results of these actions on a monochrome electronic viewfinder.

THE RCA 3-VIDICON COLOR FILM CAMERA

This color camera is built around the vidicon tube, which has been demonstrated to have excellent characteristics for the reproduction of motion picture film. The camera was developed to work with several film and slide projectors that operate in a multiplex arrangement, to achieve the flexibility of operation previously accomplished in black and white equipments.

The beam splitting problem in this camera is quite different from the live image orthicon camera, partly because of the much smaller dimensions of the vidicon scanned area (about ⅜ inch by ½ inch). It is required that images of this size must be produced from objects ranging in size from about .3 by .4 inch (16mm film) and .6 by .8 inch (35mm film) to 1

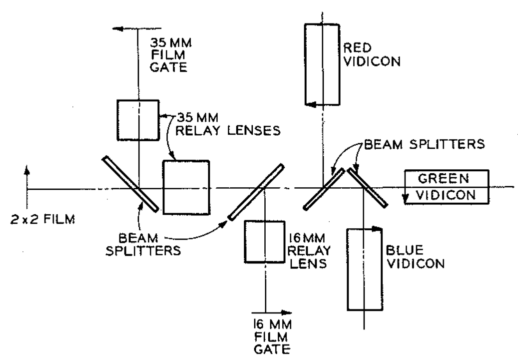
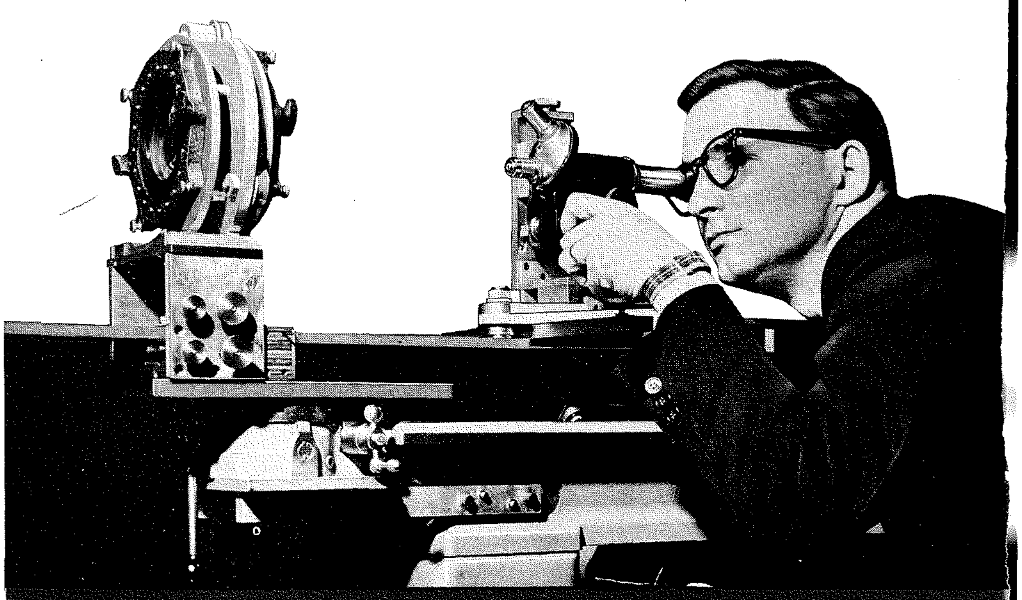


Fig. 7—Sketch showing "Direct-Relay," 3-Vidicon Color Film Camera. No intermediate image is utilized in this arrangement.



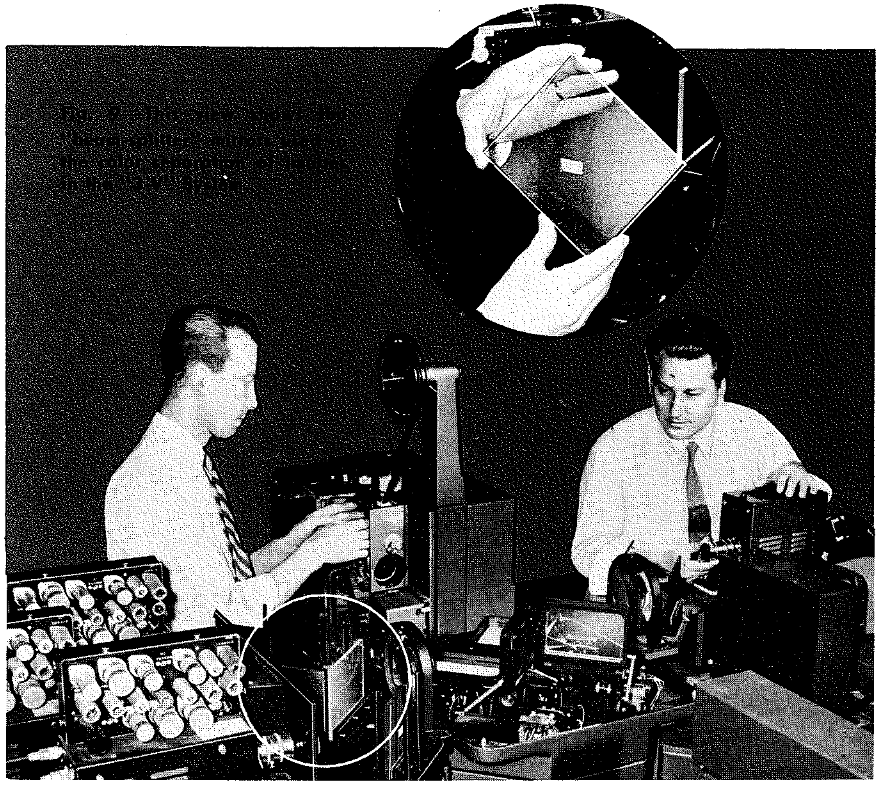


Fig. 10—K. H. Hardiman, mechanical engineer, and A. Reisz, electrical engineer, both from the Broadcast Studio Engineering Group, are shown setting up a complete multiplexed "3-V" Color Film System. Circle indicates the general area of the "beam-splitter" mirrors of Fig. 9. In addition to three Vidicon Camera Assemblies, the photo shows a professional 16 mm. projector, optical light control unit, preview camera, slide projector, opaque projector and multiplexer—all utilizing principles of optics and mirrors.

by 1¼ inch (double-frame 35mm transparencies, commonly known as 2 x 2's). A direct relay system, similar to the image orthicon live camera would therefore need three stages, each operating at a different magnification from object to image. Such an arrangement is clumsy, but might appear as shown in the sketch of Fig. 7. Due to the geometry of the projectors and of the vidicon camera, each of the relay lenses would have to be quite long in focal length, of the order of 8 or 10 inches. Furthermore, for reproduction of the very dense films that are sometimes encountered, an optical speed of at least f/2 was desired to provide a comfortable margin of reserve light. Long focal length, high speed lenses of this sort are not capable of producing small enough spot size (circle of confusion) to give acceptable performance with a picture height as small as ⅜ inch (the ratio of picture height to spot size is a good primary criterion of ultimate reproduction capabilities and should be pushed as near to 1000/1 as possible).

It can be appreciated that an operational film camera chain must be simpler and much more flexible than that allowed by the arrangement in Fig. 7. A very convenient optical array may be obtained by use of a common image plane intermediate between the film projectors and the vidicon camera. The film projectors project images of identical size into this image plane, as pictured in Fig. 11. Each vidicon is equipped with a short focal length, high quality, high speed lens which focuses on this intermediate image plane. Thus there are three relay lenses in this system. The properly colored images are distributed to the vidicons by a combination of dichroic beam splitters and subtractive color filters. The "on air" projector is selected by suitably positioning movable front surface mirrors located on the projector side of the field lens.

As in the live color camera, the intermediate image plane is inside a field lens. The function of this lens is to redirect the rays passing through the off-axis portions of the image into the vidicon camera or relay lenses, thus eliminating any portholing. It is interesting to note that this requirement is fulfilled only when the field lens images the exit pupils of the projector lenses in the entrance pupils of the vidicon lenses, for two important collateral requirements are thereby imposed on the design of the system:

(1) Each projector lens must be located on the extended center line, or optical axis, of the vidicon cameras; otherwise the images of the projector lens exit pupils will be located off the optical axis, and will not properly enter the Vidicon camera lenses. This eliminates the possibility of off-axis projection as used in the iconoscope film cameras.

(2) Each projector lens must be located approximately the same distance from the field lens; if not, the image of one or more of the projector lens exit pupils will be formed either in front of or behind the entrance pupils of the vidicon camera lenses, resulting in nonuniform illumination of the final images ("shading"). The "throw" distance from each projector lens to the field lens is regulated by choice of its focal length.

The dichroic beam splitters of the 3-V film camera, being tilted with respect to the optical axis, introduce astigmatism. The situation here, however, is very different from the live color camera. First, the arrangement is such that the green image, which under the NTSC color system carries the major portion of the fine detail information, is reflected without passing through any beam splitters; it therefore suffers no astigmatic degradation. The red image carries the astigmatic contribution of only one beamsplitter, and the blue image, which carries the least amount of fine detail information, is the only one taking the astigmatism introduced by both beam splitters. Second, the astigmatism introduced into the red and blue images is reduced by the square of the magnification from the field lens to the final image. This magnifi-

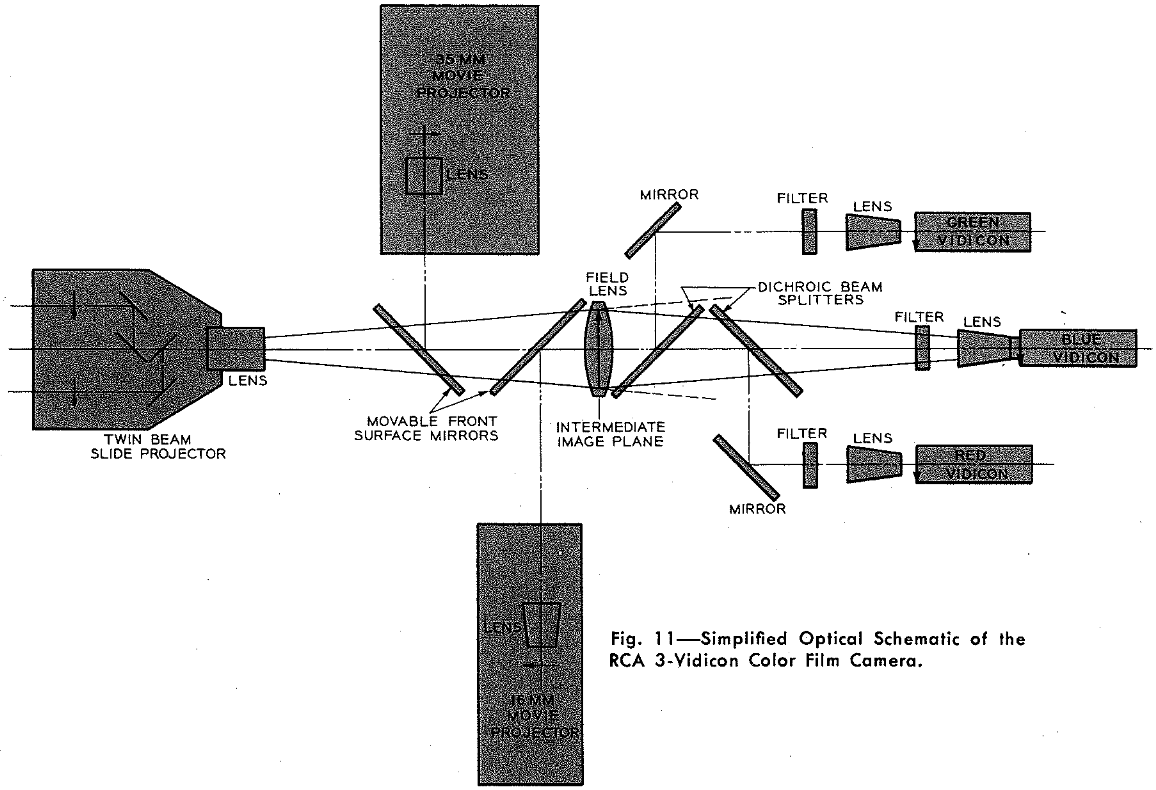


Fig. 11—Simplified Optical Schematic of the RCA 3-Vidicon Color Film Camera.

cation is about 9X, so that the astigmatism is reduced 81 times and is negligible even for the blue image.

Normal projector and camera lenses are designed for a long object distance, and when used in the 3-V film camera, at a very short object distance yield curvature of the image, concave toward the vidicon lens; the field lens also introduces curvature of the same sign. The vidicon camera lenses used on the RCA 3-V film projector were specially designed by Wollensak Optical Company to flatten the image surface and give optimum performance all over the field.

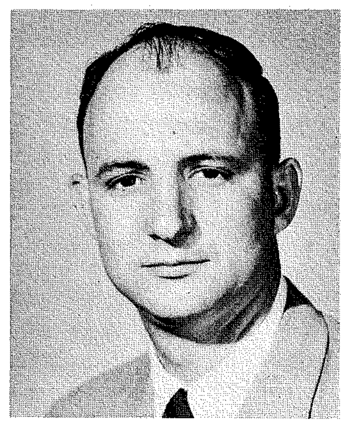
OPTICAL COMPONENTS

The selection of high quality camera and projector lenses suitable for each of these applications was of vital importance to their successful operation. This selection was based primarily on measurements made with the General Engineering Development Electronic Lens Tester. The Lens Tester, founded on the work of Dr. O. H. Schade of RCA Harrison, yields an objective evaluation of lens quality in a form extremely easy to use in determining overall television system performance (i.e., a "frequency response" curve). In many cases, commercially available lenses were found which met our requirements; in others, it was necessary to have lenses specially designed or modified.

Tolerance specification and quality control of the optical parts was given very careful attention. Systems containing so many optical elements, particularly such a large number of mirrors, are susceptible to cascaded quality degradation. Rigid prism and flatness specifications were set up for all the flat glass, and careful control maintained by 100% inspection with an optical flat and autocollimator. Other optical components such as field lenses, camera lenses, filters, and dichroic mirrors received equally careful attention.

ENGINEERING CONTRIBUTIONS

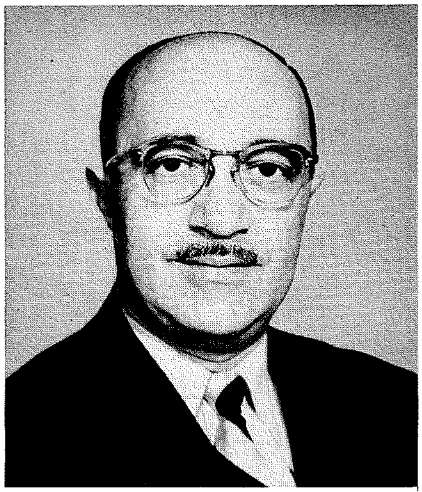
The conception, development, and commercial realization of this family of optical systems was a cooperative effort involving all members of the General Engineering Development Optics Group and many members of Broadcast Studio Engineering, as well as engineers of the RCA Laboratories Division and NBC. The experience, special abilities, and suggestions of all the persons involved were so freely offered and so freely drawn upon that it would be more fair to commend all concerned on their excellent working partnership in these tasks than to single out individuals for special mention.



DONALD J. PARKER graduated with a B.S. in Optics from the Institute of Optics, University of Rochester, in 1950, and immediately began working in optical engineering with the Advanced Development Group of the Engineering Products, Dept. 595. Since that time he has been engaged in the engineering of optical systems and components for TV, Radar, Motion picture recording and projection, and numerous other applications involving electronics and optics. He is presently leader of the Optics Group of General Engineering Development Section, Defense Electronic Products. Mr. Parker is a member of the Optical Society of America, the Society of Motion Picture and Television Engineers, and the Society of Photographic Engineers.

INVENTIVE PROGRESS

by
MORRIS A. RABKIN
Domestic Patent Operations
Commercial Electronic Products
Camden, N. J.



MORRIS A. RABKIN received a B.S. degree in Chemical Engineering from Massachusetts Institute of Technology in 1924, and degrees of LL.B. and M.P.L. from Washington College of Law (now part of American University) in 1928. He was admitted to the District of Columbia Bar in October, 1928. Mr. Rabkin entered the Examining Corps of the U. S. Patent Office in January, 1925 and remained there until February, 1929 when he joined the Patent Dept. of RCA. Mr. Rabkin is Manager, Commercial Electronics Products, Domestic Patent Operations, and is located in Camden. He has had two U. S. Patents issued to him, one sole and one joint.

He is a member of Sigma Omega Psi (Engineering), Alpha Kappa Sigma (Law), and of the Philadelphia Patent Law Association. Mr. Rabkin served as a member of the City of Camden (N.J.) Board of Education 1948-1951.

Editor's Note: C. D. Tuska, in his article in the inaugural issue, titled, "Increasing Creativeness in Engineers," presented an approach for increasing inventiveness in engineers. In this, our First Anniversary Issue, it is only fitting that we again reflect the importance of patents to RCA engineers.

Morris A. Rabkin, in this article, points out the chronology in the growth of inventiveness, and the legal protections involved.

JONATHAN SWIFT, in his "Gulliver's Travels," tells us of a discussion which Gulliver had with the King of Brobdingnag concerning politics and government in his native land. Denouncing the politics described to him by Gulliver, the King goes on to state as his opinion "that whoever could make two ears of corn or two blades of grass to grow upon a spot of ground where only one grew before, would deserve better of mankind, and do more essential service to his country than the whole race of politicians put together."[1]

In the present era of world-wide political unrest, when greed and lust for power, rather than the best interests of the populace, seem to dominate political thinking in many quarters, the King's opinion might be well worth pondering over. Perhaps, if there is merit in this opinion, it can afford one some comfort to think—and hope—that those of you who devote your major efforts to creative thinking and inventing, who make one electron tube do the work of two, or who cause the tiny transistor to do the work of the mighty tube, will some day be the ones through whose efforts eventual salvation may come to a troubled world.

INCENTIVE TO INVENT

Inventing is a limitless pursuit. As in other pursuits, one usually has to have an incentive to invent. True, some inventions are the result of accident, but these are few and far between. In nearly every case, incentive plays a large part in inventing. Perhaps the most common incentive is the hope of financial gain. Both the Government and private industry have recognized this and have offered various plans of cash awards for inventions and for suggestions on how to improve efficiency. Frequently, necessity or convenience affords the incentive to invent. Faced with the need to provide a solution to a problem, many a man has turned inventor to solve the problem. A less common incentive for inventing is the opportunity which it gives one for expression of his talents. Man takes pride

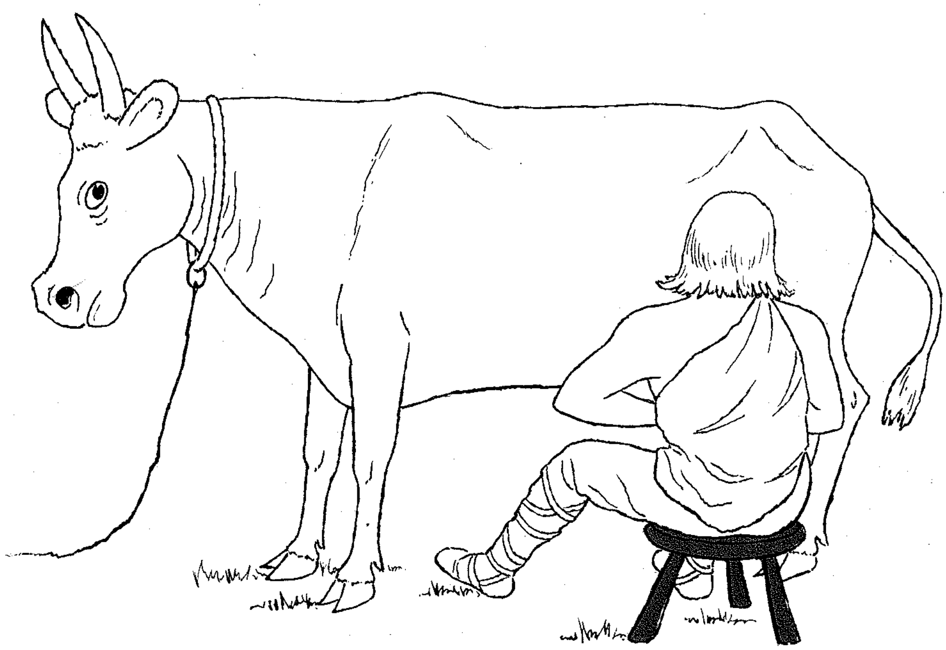


Fig. 1 — Three-Legged Milk Stool

[1]Gulliver's Travels, Part 2, "A Voyage to Brobdingnag," Chapter VII

in his latent ability. Invention affords him an opportunity to make this known to his fellow-men.

A still less common incentive for inventing is the desire to enhance the welfare of others. This latter incentive may be found most often in the field of basic research, as in medical research, for example. Whatever the incentive may be, however, if the resulting inventions will enable "two blades of grass to grow . . . where only one grew before," then it may well be that the inventors responsible for them will have performed a very essential service to humanity.

PROTECTION OF INVENTORS

The framers of the Constitution of the United States clearly appreciated that the progress of the new nation would depend to a great extent upon the creativeness of its people. History from the days of the Guilds in Europe in the Middle Ages on through the Statute of Monopolies in England in 1623, and the events preceding the American Revolution, showed that certain types of monopolies stimulated trade, manufacture and invention and could be beneficial. To provide a basis for monopolies that would be in the public interest and that would, at the same time, stimulate the exercise of creative talent, there was included in the Constitution of the United States, Article I, Section 8 which reads as follows:

> "The Congress shall have power . . . to promote the progress of science and useful arts, by securing for limited times to authors and inventors the exclusive right to their respective writings and discoveries."

It is under this provision of the Constitution that various patent laws have been passed from time to time for the protection of inventors, and copyright laws for the protection of authors, composers, artists and the like.

The patent law now in effect (Title 35, U. S. Code) provides, in part, that

> "Whoever invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may obtain a patent therefor . . ,"[2]

Fig. 2 — Improved Type, Three-Legged Milk Stool

> "Whoever invents or discovers and asexually reproduces any distinct and new variety of plant, including cultivated sports, mutants, hybrids, and newly found seedlings, other than a tuber propagated plant or a plant found in an uncultivated state, may obtain a patent therefor . . ,"[3]

and

> "Whoever invents any new, original and ornamental design for an article of manufacture may obtain a patent therefor . . . ,"[4]

provided certain conditions have been met.[5] These are more fully discussed and explained in "Patent Notes For Engineers"[6] with which it is assumed the reader is familiar.

[2] Title 35, U. S. Code, Section 101
[3] Title 35, U. S. Code, Section 161
[4] Title 35, U. S. Code, Section 171
[5] Title 35, U. S. Code, Section 102
[6] C. D. Tuska, "Patent Notes for Engineers," 6th Ed., Chapter III
[7] Except officers and employees of Patent Office (Title 35 U. S. Code Section 4)

Fig. 3—Four-Legged Stool

QUALIFICATIONS FOR PATENTS

For present purposes, it is sufficient to point out that any person,[7] regardless of age, sex, nationality, religion or color, may obtain a patent for his invention provided that (1) it comes within one or more of the classes of invention for which the grant of a patent is authorized by statute (viz., a process, machine, article of manufacture, composition of matter, ornamental design, and certain types of plants), (2) it is new, (3) it is useful, and (4) it is truly an invention.

Not everything that is new can be patented. For example, if what has been newly created is something that the average worker in a given field might be expected to suggest if he were faced with a particular problem, that creation might not involve invention and therefore might not be patentable. Here, the thing created might involve merely the exercise of expected skill of the calling. Similarly, a mere change in size or shape without producing an unexpected and new result by such change would not justify a patent. Again, a novel method of keeping books, or of teaching dancing, or of performing a mathematical operation in the ordinary manner would not be patentable because these do not come within any of the statutory classes of invention. Many other examples might also be given. Assuming, however, that an invention can meet the tests of novelty, utility, etc., and that all of the conditions prescribed by law can be met, what does one get when he is granted a patent for an invention?

WHAT "EXCLUSIVE RIGHT" MEANS

First of all, it should be understood that a patent is a contract between the Government (representing the public) on the one hand, and the inventor on the other hand. As in all valid contracts, there must be consideration flowing from each party to the other. In the case of a patent, the consideration from the inventor is such a full and complete disclosure of the invention as to enable those skilled in the art to which the invention pertains to practice the invention. In return, he is granted the so-called "exclusive right" to his invention.

One of the most prevalent misconceptions concerning patents is the nature of this "exclusive right." There are many who believe that a patent confers upon the patentee the right to make, use and sell the patented invention. It does no such thing! Others who may be somewhat more astute believe that the patent confers this right upon the patentee to the exclusion of anyone else. They, too, are wrong! The patent grant confers upon the patentee no right whatsoever to practice or enjoy his invention. What a patent does do, however, is to give to the patentee, for varying periods from the date of the grant depending upon the type of patent, the right to go into a Federal Court and obtain an injunction to exclude others from making, using and /or selling the patented invention throughout the United States. If there are no prior, unexpired, dominating patents which can be asserted against him, an inventor who has obtained a patent is, of course, free to practice his invention; but if there is such a prior patent, it can be asserted against him in the same way that he can assert his patent against others. Thus, the right to exclude others for a limited period is the nature of the "exclusive right", or the monopoly, granted by a patent in this country.

PROTECTION DEFINED BY CLAIMS

This question now arises: "From what can a patentee exclude others?" Those familiar with patents know that each patent contains one or more claims whose office it is to define the metes and bounds of that which the inventor considers to be novel and which he wishes to reserve unto himself. Thus, the monopoly extends not to all that is described or shown in a patent, but only to that which is defined in the claims. The inventor should, therefore, exercise great care in pointing out to his attorney precisely what it is that he has invented so that the attorney can be guided by this knowledge in drafting claims that will afford the inventor maximum protection. Where it is known to him, the inventor should also point out carefully the relation of his invention to others that have gone before. The inventor who fails to do these things usually fools no one but himself in the long run.

HOW PROGRESS EVOLVES

The progress of science and the useful arts cannot be measured by any one invention, or any particular group of inventions. Usually, progress results from a long series of inventions any one of which is an outgrowth of one or more earlier inventions. The modern electronic marvels have had their beginning in the simple electron discharge tube. Between this simple tube and today's television receiver, for example, thousands of inventions were made which are interrelated in a complex maze. To illustrate, in a simple fashion, how one invention grows out of another and how inventions and patents are interrelated, let us consider, briefly, the following hypothetical situation:

STEP #1—PATENT NO. 1

Assume a time in our country's history after establishment of our patent system, and assume also that milk stools were unknown. A farmer (Farmer A) milking his cows kneels down on the ground as he performs his chores. Having sensitive knees, he finds that they ache him badly after each operation. Wondering what he might do to alleviate his discomfort, he finally conceives of a three-legged milk stool (Fig. 1), builds one, and finds that it has solved his difficulty **(Incentive: personal convenience).** Being patent minded, he applies for a patent and obtains one with the following claim:

> *A support for the human body comprising a seat and a plurality of legs supporting said seat.*

He now has the satisfaction of knowing that he has not only solved his personal problem, but that there is recorded in the Patent Office, in perpetuity, a record of his contribution to society.

STEP #2—PATENT NO. 2

One day, Farmer B from up the road comes by and sees Farmer A milking his cows while seated comfortably on his milk stool. "What a wonderful idea!" thinks Farmer B to himself, and he proceeds to build one for his own use (thereby becoming an infringer of Farmer A's patent). Now, Farmer B is a much heavier man than Farmer A and he is far less gentle with his milk stool than is Farmer A with his. After a short period of use, Farmer B finds that the legs on his stool have become loose and the stool is rickety. This troubles him—but not for long! To obviate his difficulty, he conceives the idea of interconnecting the legs with rungs **(Incentive: necessity).** And now he has an improved milk stool (Fig. 2) for which he takes out a patent with a claim that reads:

> *A support for the human body comprising a seat, a plurality of legs supporting said seat, and rungs interconnecting said legs.*

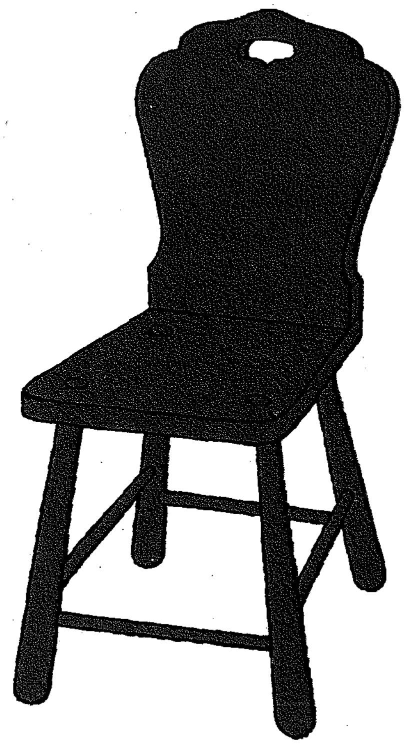


Fig. 4—Chair with Back

INFRINGEMENT OF PATENT NO. 1

Farmer B is a rather enterprising individual. Realizing that other farmers might be glad to have such stools, and knowing that he has an improved stool, he goes into the stool manufacturing business. Imagine his great surprise when he finds himself faced with an infringement suit by Farmer A which results in an injunction against him that prevents his continued manufacture and sale of HIS OWN IMPROVED milk stool, and an award of damages against him for past infringement of Farmer A's earlier, dominating patent.

Obviously, in building his improved stool with the rungs interconnecting the legs, Farmer B necessarily included the seat and the legs supporting the seat. This, however, is covered by Farmer A's basic patent. This is the subject matter for which Farmer A acquired a monopoly, the "exclusive right", when he received his patent. This, therefore, is the area from which Farmer A has a right to exclude Farmer B—and everyone else—in the absence of a license from Farmer A to enter this field. By the same token, even though Farmer A has a basic monopoly on stools of any sort that embody a seat and legs or their equivalent, he, in turn, cannot put rungs on his stools, for in so doing, he would become an infringer of Farmer B's "improvement" patent.

Fig. 5 — Chair with Arm Rests

STEP #3—PATENT NO. 3

In due time, a traveler (Mr. C.) from the city, passing through the country of Farmers A and B, notices their respective milk stools with seats low to the ground. Immediately the thought strikes him that if the legs were made longer, and if he made the seat square rather than round with a leg at each corner, he would have a higher stool (Fig. 3) that would be useful at a table and would be quite sturdy. His enthusiasm knows no bounds as he contemplates the great sales of such a stool, and he proceeds to apply for a patent **(Incentive: hope of financial gain).** But he is doomed to early disappointment, for he soon finds out that the changes he proposed involve merely changes in shape (square seat instead of round) and degree (four long legs instead of three short ones) with no unobvious or unexpected results. For such changes, no patent can be gotten. However, Mr. C. is not to be stopped. On further contemplation, he conceives of a chair with a back against which the user can lean for comfort (Fig. 4). He thereupon applies for a patent for this newly improved chair and is awarded a claim which reads:

> *A support for the human body comprising a seat, a plurality of legs supporting said seat, and a backrest mounted on said seat adjacent to an edge thereof.*

INFRINGEMENT SEARCH

Now, Mr. C. has learned to be cautious, so before he undertakes to make an investment in plant and equipment to manufacture his novel chairs, he has an infringement search made. His attorney finds the two patents of Farmers A and B and advises Mr. C. that, although he succeeded in obtaining a patent for his chair, such chair would infringe Farmer A's patent because it includes a seat and legs supporting the seat; and if he included rungs between the legs of his chair, the chair would also infringe Farmer B's patent. To solve his dilemma, Mr. C. buys licenses from both Farmer A and Farmer B, and he then becomes free to engage in the manufacture and sale of his chairs.

STEP #4—PATENT NO. 4

Some time later, in an effort to further improve his product, Mr. C. conceives of a chair with arm rests **(Incentives: more financial gain, but also to give expression to his talent).** For this chair (Fig. 5), he may obtain a patent with a claim which reads:

> *A support for the human body comprising a seat, a plurality of legs supporting said seat, and a pair of arm rests on said seat along the sides thereof.*

STEP #5—PATENT NO. 5

Mr. C.'s business grows by leaps and bounds. With no competition to face, he can hardly supply the market demand. He is now a very wealthy man, but he has one great sorrow—an invalid wife who is largely bedridden. If only she had a comfortable chair to sit on, and on which she could recline if she wished! Why not? With a little more thought, Mr. C. invents a tilting chair with padded seat and back and a foot rest that slides out **(Incentive: welfare of others).** Thus, Mr. C.'s inventions grow in number and complexity, each flowing from one or more earlier inventions, all interrelated, and all adding to the comfort and enjoyment of living.

LIMITLESS OPPORTUNITY

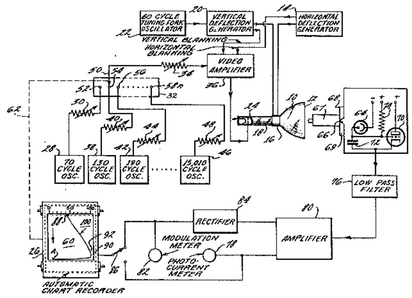
The foregoing illustrates the opportunities that are open to the creative individual. The inventions which are yet to come may not solve all of humanity's ills, but the opinion of the King of Brobdingnag seems not without merit. For those who may wonder just how great the opportunities are in the future, the inscription above the main entrance of the Archives Building in Washington, D. C. is noteworthy. This inscription reads "ALL THAT HAS GONE BEFORE IS PROLOGUE." The story is told that when a Washington taxi driver was once asked what that means, he replied, "That means you ain't seen nothin' yet." The field of invention is as long as the day and as broad as the universe. Those who enter into it are bound, at least cumulatively, to bring into being many wonders like which "you ain't seen nothin' yet." In so doing, they not only can take pride in their accomplishments, but may well earn the gratitude of their fellow-men for having performed an essential service which will outrank that of all the politicians put together.

Patents Granted

TO RCA ENGINEERS

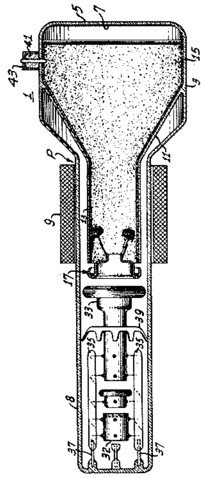
Based on Summaries Received over a period of about two months

APPARATUS FOR MEASURING THE QUALITY OF A KINESCOPE (Patent No. 2,731,597)—granted January 17, 1956 to Otto H. Schade, Tube Division, Harrison, N. J. To obtain the optical sine-wave response of a kinescope 10 a raster is produced on the screen 12 thereof by means of the vertical and horizontal deflection generators 20 and 14, respectively. A plurality of sine-wave oscillators 28, 38, 42, etc., are connected sequentially to the grid of the kinescope 10 through a stepping relay switch 32 for the purposes of applying thereto signals of a frequency differing progressively from an integral multiple of the vertical deflection frequency by a few cycles per second. Thus, an optical sine-wave pattern is caused to drift vertically on the screen 12 of the kinescope 10 with a frequency of said few cycles per second. A phototube 64 converts the light at a point on said screen 12 into signals modulated at the drift frequency. The output signals of the phototube 64 may be displayed on indicating means, such as a chart recorder 26, as the optical sine-wave response curve.



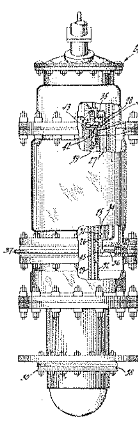
Pat. No. 2,731,597

SECOND ANODE FOCUSING ELECTRODE (Patent No. 2,734,141)—granted February 7, 1956 to Richard H. Hughes, Tube Division, Lancaster, Pa. A shield electrode is mounted between the second anode of an electron gun and the phosphor screen in a projection type cathode ray tube. The shield is centered within the neck of the tube and is supported therein by a plurality of resilient members which contact an internal conductive coating. The shield prevents cold emission electrons, produced at the second anode, from reaching the screen. Also, a process for assembling the gun is described.



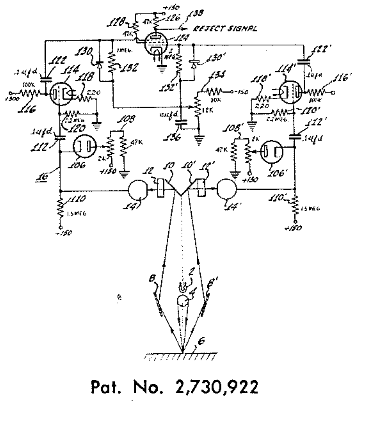
Pat. No. 2,734,141

ELECTRODE POSITIONING MECHANISM (Patent No. 2,734,144)—granted February 7, 1956 to Merle V. Hoover, Tube Division, Lancaster, Pa. A mounting head has a curved bearing surface which is seated in a V-groove which is part of an electrode tensioning arrangement. The curved surfaces make two line contacts with the V-grooves allowing better heat conductivity and reducing vibration.



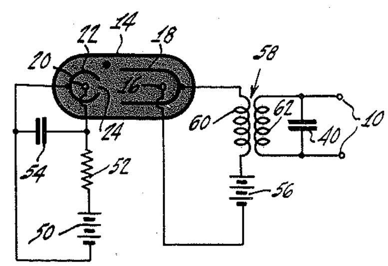
Pat. No. 2,734,144

PHOTOELECTRIC INSPECTION BY A COINCIDENT METHOD (Patent No. 2,730,922)—granted January 17, 1956 to Arthur D. Beard, Defense Electronic Products, Camden, N. J. Makes use of two separate mirror-photocell-amplifier circuits to discriminate between specular and diffuse reflections picked up from a surface being inspected. Only increases in diffuse reflection are significant. Outputs from the two photocells are fed to a discriminator circuit which distinguishes between reflections picked up by both mirrors simultaneously and each mirror consecutively.



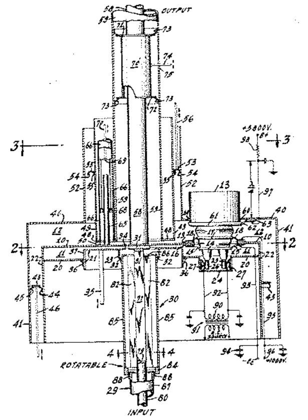
Pat. No. 2,730,922

ELECTRONIC INVERTER SYSTEM (Patent No. 2,730,669)—granted January 10, 1956 to W. M. Webster, Jr., Tube Division, Harrison, N. J. A gas tube 14, such as the plasmatron, in which the functions of ionization and providing work current are separated, is employed as a d-c inverter. The ionization electrodes such as the auxiliary cathode 20 and the garrotte 22 or the auxiliary cathode 20 and the main cathode 16 are connected in a relaxation oscillator circuit, but a substantially pure sine wave is provided at the anode 18.



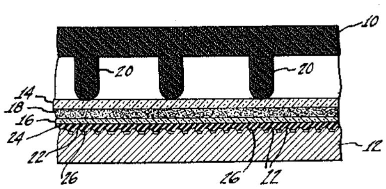
Pat. No. 2,730,669

POLYGONAL MULTIPLE TUBE SYSTEM (Patent No. 2,740,848)—granted April 3, 1956 to Charles J. Starner and Franklin E. Talmadge, Commercial Electronic Products, Camden, N. J. It was known to operate a plurality of vacuum tubes in parallel in common cylindrical input and output cavities. According to the invention, cavities are made in the geometrical form of a polygonal prism with a coaxial prismatic re-entrance therein, the prism and the re-entrance having an equal number of sides, and the prism and the re-entrance being disposed with the corners of one opposite the sides of the other. Advantages —high power at higher frequencies, suppression of circulating modes and economy in construction.



Pat. No. 2,740,848

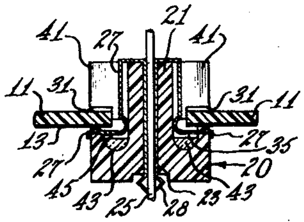
DIELECTRIC HEATING ELECTRODE (Patent No. 2,734,982)—granted February 14, 1956 to HENDERSON C. GILLESPIE and JOSEPH E. JOY, COMMERCIAL ELECTRONIC PRODUCTS, Camden, N. J. The electrode structure is particularly useful in bonding together two sheets of thermo-plastic material which are separated by a batting material such as cotton. The electrodes provide a pattern for the bonded material so that it resembles quilting. The lower electrode is formed with a knurled surface for concentrating the heat at the raised portions of the knurl. The amount of pressure necessary to bond the material is reduced by virtue of the knurled lower electrode.



Pat. No. 2,734,982

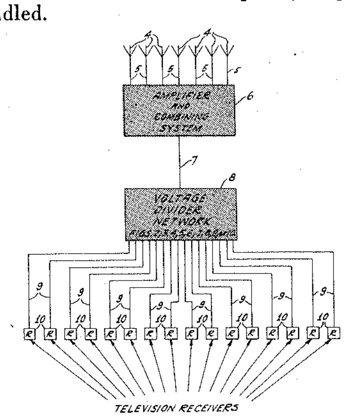
METHOD OF REMOVAL OF THERMO-PLASTIC RESINS FROM CONDUCTORS AND TINNING THEREOF (Patent No. 2,734,000)—granted February 7, 1956 to LEOPOLD PESSEL, TUBE DIVISION, Camden, N. J. Improvement in method consists in dipping the coated wire into a composition consisting essentially of a benzoic acid derivative and then applying molten solder. The acid derivative so treats the insulation that it is removed by the molten solder which also tins the wire.

SLIDING CONNECTOR (Patent No. 2,730,683)—granted January 10, 1956 to JAY J. AYRES and LEROY H. SHANIN, DEFENSE ELECTRONIC PRODUCTS, Camden, N. J. The connector comprises an elongated member 21 having grooves 31 on either side to receive the edges of the circuit boards 11. Spring contact members 27 are disposed in transverse apertures 23 extending through the block and the free ends thereof terminate in notches beneath the board 11. Elongated cams 43 are placed in troughs 35 beneath the grooves 31 and cause the contacts 27 to be engaged or disengaged with the board terminals 13. Vertical conductors 25 extend through the member 21 to provide connection between adjacent connectors.



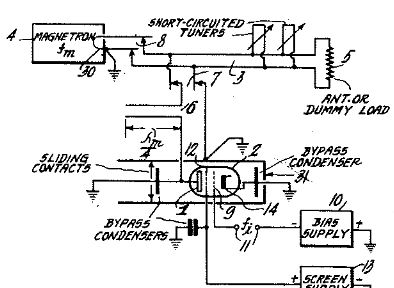
Pat. No. 2,730,683

VOLTAGE DIVIDER NETWORK (Patent No. 2,738,464)—granted March 13, 1956 to ROY C. ABBETT, COMMERCIAL ELECTRONIC PRODUCTS, Camden, N. J. The invention is used for directing a television signal received by a common antenna to a plurality of lines going to individual television receivers. A number of different circuit arrangements, each utilizing bifilar coils, provide different numbers of outputs while maintaining the desired impedance relationships and minimizing the losses in the network to the radio frequency signals handled.



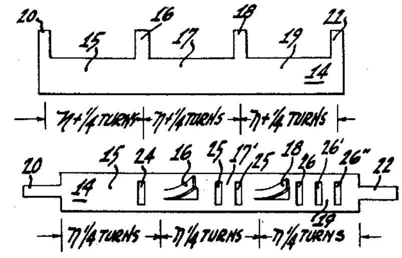
Pat. No. 2,738,464

FREQUENCY CONTROL (Patent No. 2,738,422)—granted March 13, 1956 to LESLIE L. KOROS, COMMERCIAL ELECTRONIC PRODUCTS, Camden, N. J. Controllable loading device is coupled to the output of magnetron oscillator, and this loading device is fed by a control voltage of stable frequency (which is a submultiple including unity of desired magnetron frequency) to cause it to periodically absorb output power from the magnetron at the stable frequency.



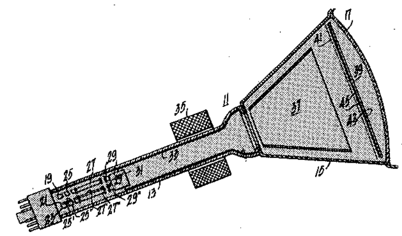
Pat. No. 2,738,422

BALANCED MULTISECTION INDUCTANCE UNITS FOR HIGH FREQUENCY SIGNAL SYSTEMS AND THE LIKE (Patent No. 2,727,149)—granted December 13, 1955 to WILLIAM F. SANDS, RCA VICTOR TELEVISION DIVISION, Cherry Hill, N. J. The inductor unit comprises a ribbon conductor which is apertured at predetermined intervals along its length, and has connection tabs struck from the surface of the ribbon conductor. The conductor is spirally wound so that the connection tabs extend radially from the axis of the spiral, the inner tabs extending through the aligned apertures in the ribbon. The inductance sections comprise the portions between the conductive tabs.



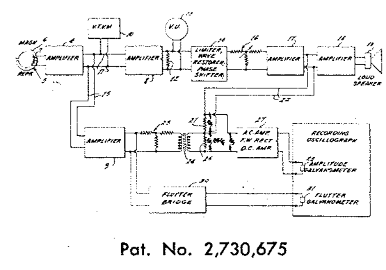
Pat. No. 2,727,149

MULTI-COLOR KINESCOPE SCREEN (Patent No. 2,733,164)—granted January 31, 1956 to ARTHUR L. J. SMITH, TUBE DIVISION, Lancaster, Pa. Multi-color luminescent viewing means with manganese activated zinc phosphate phosphor as the red-emitting component.



Pat. No. 2,733,164

SMALL AMPLITUDE MEASURING SYSTEM (Patent No. 2,730,675)—granted January 10, 1956 to KURT SINGER, DEFENSE ELECTRONIC PRODUCTS, Hollywood, Calif. To measure small amplitude variations without amplifying the steady state signal. This is accomplished by dividing the signal into two portions, one portion being limited, restored, and shifted in phase 180 degrees by unit 14, and the other portion being left normal. By impressing the portions at equal amplitudes across two resistors 21, 25 in series, the differential variations are obtained. These are amplified and rectified and impressed on a recording galvanometer 28. The original signal is also impressed on a flutter bridge 30, the output of which is impressed on a recording galvanometer 31 directly under the galvanometer 28, so that effect of amplitude modulations on flutter may be obtained.

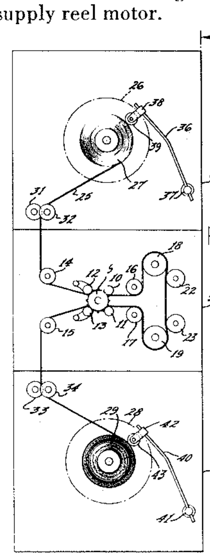


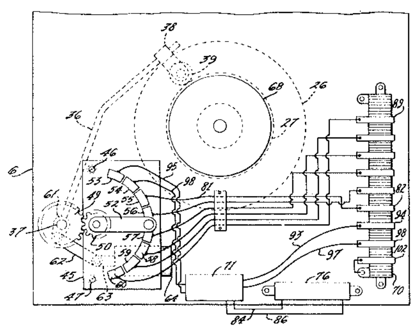
Pat. No. 2,730,675

PATENTS GRANTED

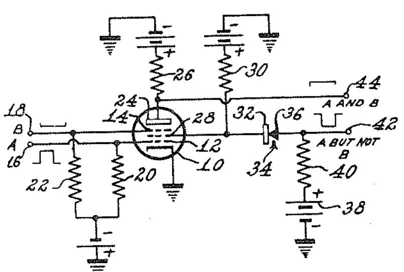
Continued

FILM REEL TENSIONING SYSTEM (Patent No. 2,733,875)— granted February 7, 1956 to Carl E. Hittle, Defense Electronic Products, Hollywood, Calif. Invention is an electrical system for maintaining substantially constant tension in a film loop from a supply reel 26 and in a film loop to a take-up reel 28. An arm 36 having a roller 39 on the film roll 27 varies a wiper arm 52 over electrical conducting segments 53 and 60, inclusive, to vary the voltage to the motor 68. The same type of circuit is used for each motor, and varied according to whether it is being used for the take-up or supply reel motor.



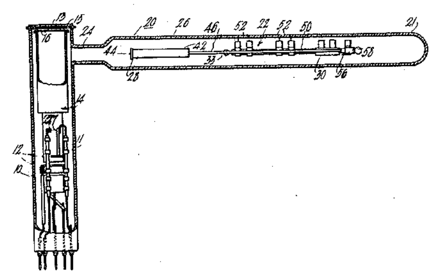


Pat. No. 2,733,875



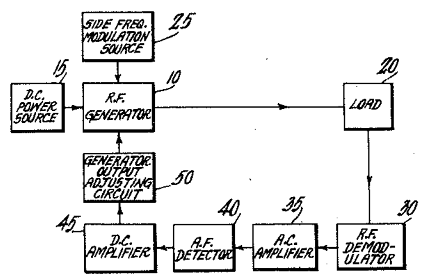
Pat. No. 2,734,134

APPARATUS FOR EVAPORATING CHEMICALS (Patent No. 2,733,115) — granted January 31, 1956 to Benjamin H. Vine, Tube Division, Lancaster, Pa. An electron tube envelope is provided with a side appendage. Electrical contact pins are embedded in the wall of the side appendage and are connected to a voltage source. An evaporator adapted to be inserted into the side appendage carries a quantity of chemical to be evaporated onto the inner surface of the face plate. The evaporator is provided with conductive contact wings which rest on the pins when the evaporator is inserted into the tube in position for evaporation of the chemical. In this position current flows from the source through the evaporator and heats the chemical to vaporization temperature.



Pat. No. 2,733,115

WAVE AMPLITUDE CONTROL FOR HIGH-Q LEAD (Patent No. 2,733,340)—granted January 31, 1956 to Lloyd P. Garner and William N. Parker, Tube Division, Lancaster, Pa. The output of an RF generator 10 is modulated by a side-frequency and applied to a high Q load 20. The amplitude of the side frequency voltage is detected and fed back to the RF generator to control its output and maintain the amplitude of the RF power in the load 20 substantially constant.



Pat. No. 2,733,340

SIGNAL RESPONSIVE CIRCUIT (Patent No. 2,734,134)—granted February 4, 1956 to Arthur D. Beard, Defense Electronic Products, Camden, N. J. Use is made of the screen grid current in a pentode to achieve the logical gating function of "either but not both." Two input signals are applied to the control and suppressor grids, respectively, of the pentode. Under these conditions, with the screen and suppressor grids normally at cutoff potential, screen grid current of an intermediate value is drawn when the voltages at both control grids are above cutoff potential. But screen grid current of a higher magnitude is drawn when the voltage at the control grid is above cutoff potential, and that at the suppressor grid is at cutoff potential.

CODE CONVERTER CIRCUIT (Patent No. 2,731,631)—granted January 17, 1956 to Spencer W. Spaulding, Defense Electronic Products, Camden, N. J. This invention avoids addition of currents by splitting the digital code into two portions and providing a voltage proportional to the number value of each portion. The voltages are combined in the utilization device itself. A four-bit binary code is converted to a voltage amplitude by a system shown in simplified form in Fig. 1. A voltage proportional to the most significant of the four digits is provided by the resistance divider 18 and a switch 48 (which may be electronic as shown in Fig. 2). The other three digits of the code form eight code combinations, each of 7 of which is represented by one of the dividers 11-17 and the associated switch 41-47. Only one of the seven parallel switches 41-47 is operated at any time. Thus, for each digital code input, a voltage is provided from one of the dividers 11-17 proportional to the number value of the lowest three digits. A voltage is also provided proportional to the most significant digit by the divider 18. These two voltages are combined additively in a utilization device 60, which may be a CRT having electrostatic deflection as shown in Fig. 2.

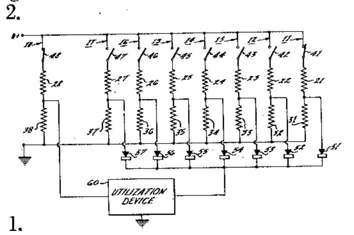


Fig. 1.

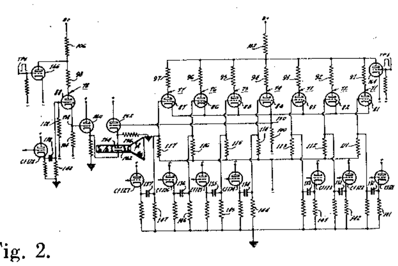
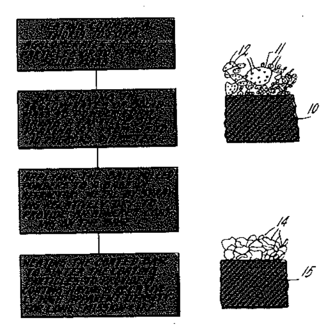


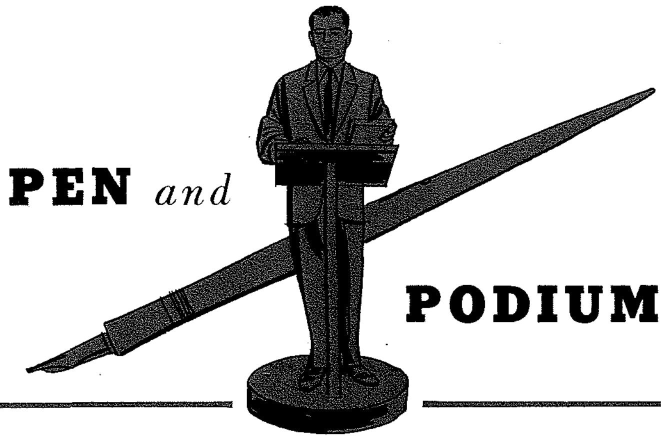
Fig. 2.

Pat. No. 2,731,631

THERMIONIC CATHODE WITH THORIA COATING (Patent No. 2,726,178)—granted December 6, 1955 to M. N. Fredenburgh, Tube Division, Harrison, and Herbert Nelson, RCA Laboratories, Princeton (formerly located at Harrison). A cathode for an electron tube comprises a core (10) and a coating (14) of thoria thereon. The thoria coating has a particle size of from .01 to 1.5 microns in diameter and peaking at a size from .05 to .10 microns in diameter. This provides a coating having increased apparent density for prolonging cathode life.



Pat. No. 2,726,178



PEN *and* PODIUM

BASED ON REPORTS RECEIVED OVER A PERIOD OF ABOUT TWO MONTHS

NEW DEVELOPMENTS IN VHF TV TRANSMITTERS . . . by F. E. TALMAGE, COMMERCIAL ELECTRONIC PRODUCTS, Camden, N. J. Presented at the NARTB Convention on April 19, 1956. This paper describes new developments in TV Transmitters which include a unique type of enclosure providing a maximum degree of accessibility with a considerable reduction in floor area requirements. Also described are some new circuits providing inter-carrier frequency control, linearity correction, and a centralized control system. This, together with a high degree of circuit stability, will permit operation without adjustment over extended periods of time.

THE CREATION OF LIGHT . . . by G. E. CROSBY, TUBE DIVISION, Lancaster, Pa. Presented at Couples Club of First Presbyterian Church, Lancaster, Pa., January 24, 1956; Youth Banquet of Otterbein Evangelical Church, Lancaster, Pa., January 31; Father-and-Son Banquet of Lafayette Lions Club, Lafayette, Pa., February 15. Also given at Father-and-Son Banquet of Evangelical United Brethren Church, Lemoyne, Pa., March 15. This paper describes the magnitude of details implicit in the biblical quotation "Let there be light, and there was light." Various methods of producing light are demonstrated, including emission reflection from a specially painted board, luminescence of materials under ultra-violet light, reaction of chemical solutions, and emission from electroluminescent panels.

A REVIEW OF SURFACE-BASED ANTI-AIRCRAFT GUIDED MISSILES AND THEIR GUIDANCE PRINCIPLES . . . by N. I. KORMAN, DEFENSE ELECTRONIC PRODUCTS, Moorestown, N. J. Presented on March 14, 1956 to the Lancaster Chapter of the IRE, Lancaster, Pa. The author described various missiles such as Terrier, Talos, Nike, Bomarc, Hawk, and discussed guidance phases, such as capture, midcourse and terminal. The necessity for trainable launchers in some cases, and the possibility of fixed vertical launchers in other cases was pointed out. The discussion included missile dispersion during the boost period and the necessity for their stabilization during boost, tracking during boost, or a wide beam capture system. Midcourse flight programs, such as the line-of-sight flight program and a program where there is first, the climb to altitude, a cruise and finally, a dive were discussed. Terminal guidance, including such factors as the possibility of merely extending a midcourse phase with tightened servos and the use of various homers employing passive means, semi-active radar means and active radar means were considered.

MECHANICAL AND ELECTRONIC PROCESSING OF ENGINEERING DATA AS AN AID TO STANDARDIZATION . . . by SIDNEY KAPLAN, COMMERCIAL ELECTRONIC PRODUCTS, Camden, N. J. Presented at the Washington Section of the Standards Engineering Society, April 25, 1956, Washington, D. C. The evaluation and correlation of engineering information is an unending task for standards engineers. The filing and indexing of such data for future retrieval is the classical library and intelligence problem. Techniques and equipment for treating this problem were discussed. Maintenance of records on environmental and fatigue conditions and their effects on wear-out of engineering products is an important province of engineering standards. Application of multivariate and factor analysis to such data should materially aid in engineering design. For this and for reliability determinations intermediate size computers should prove valuable. Perhaps the greatest application of data processing equipment in standardization is in the correlation of engineering notebooks.

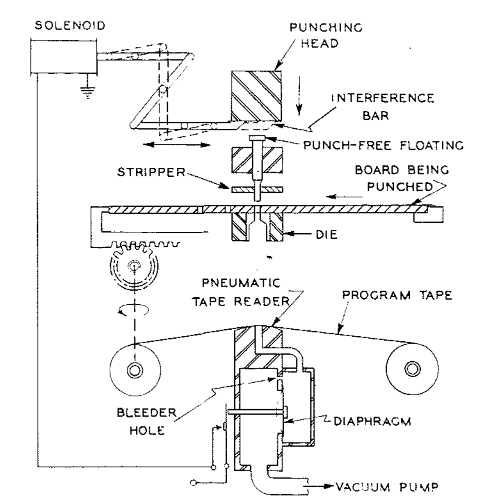
PRINCIPLES OF COLOR TV FOR THE LAYMAN . . . by D. G. GARVIN, TUBE DIVISION, Lancaster, Pa. Presented at Ashland Rotary Club, Ashland, Pa., March 28, 1956. This paper outlines the development of compatible color television by RCA, and compares compatible color with mechanical non-compatible systems of reproduction. A brief description of the operation of color television is given, including the use of the image orthicon in the studio camera and the use of the color kinescope in the receiver in the home. The Lancaster plant where these tubes are manufactured is described, and the major products of the plant are listed. Present development work on color-television tubes and plans for future are outlined.

RECENT IMPROVEMENTS IN THE RCA-21AXP22 COLOR KINESCOPE . . . by R. B. JANES, L. B. HEADRICK, and J. EVANS, TUBE DIVISION, Lancaster, Pa. Presented at IRE National Convention, New York City, March 22, 1956. The 21AXP22 has proven to be a high-quality color kinescope which is readily adaptable to quantity production. As a result of manufacturing experience obtained during the production of thousands of tubes and changes made in the construction and processing, nearly perfect color purity and white uniformity have been achieved. A good deal of the processing improvements are due to changes made in the "lighthouse" on which the phosphor screens are exposed. After a brief review of the principles of the tube and data on its operation, both the tube and lighthouse changes are explained.

APPLICATION OF CORRELATION TECHNIQUES TO QUALITY CONTROL . . . by MARTIN GELLER, SEMICONDUCTOR DIVISION, Harrison, N. J. Presented at Metropolitan Section of American Society for Quality Control, New York City, March 15, 1956. This paper explains basic statistical terms and calculations and gives examples of their application to quality-control procedures. Various tests for the significance of correlation in data are described. The use of correlation techniques helps the quality-control man to develop process control, to find assignable causes, and to reduce testing costs. The value of these techniques as a quality-control tool are summarized, and the danger of prediction beyond the known limits of correlation is pointed out.

STATUS OF TRANSISTOR ELECTRONIC EQUIPMENT . . . By H. J. WOLL and K. E. PALM, DEFENSE ELECTRONIC PRODUCTS, Camden, N. J. Presented January 5 at Rome Air Development Center, Rome, N. Y. The application of transistors to military equipment was discussed. The reduction in size, weight, and power consumption was outlined. Particular attention was given to areas in which transistors provide performance not obtainable with vacuum tubes such as in low noise amplifiers, complementary symmetry circuits, and switching of heavy currents. The design of transistor equipments for operation over wide temperature ranges was covered. The advantages and disadvantages of wide temperature range circuits were compared with those of circuits operating in a controlled environment. The present state of transistor circuit development was examined. Availability of transistors to fulfill design requirements was discussed.

ADAPTING PRODUCT DESIGN TO AUTOMATIC CONTROLS . . . by F. M. HOM, DEFENSE ELECTRONIC PRODUCTS, Camden, N. J. Presented at the Fifth Annual Spring Conference of the American Institute of Industrial Engineers on March 15, 1956. Mechanization and eventually automation of the steps in the production of electronic equipment requires that the product be designed to be fully compatible with the machines and automatic controls. The techniques of printed circuit layout, design parameters, manufacturing steps, machines and various types of controls used in DEP are described. Questions were raised concerning (1) restrictions on freedom of design imposed by machine limitations and, (2) economic justification for use of complex controls.

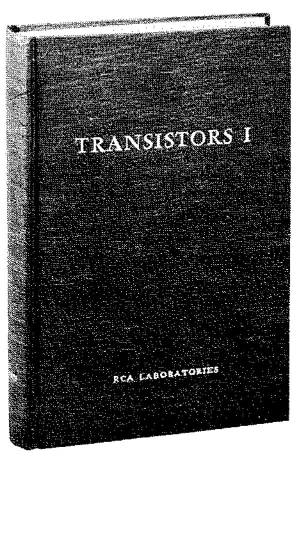


Sketch showing principle of operation-programmed punching machine

TRANSISTORS I

CONTENTS

TRANSISTORS I . . . This new 676-page book, published by "The RCA Review" contains 41 technical papers by RCA scientists and engineers. All but ten of these are new papers never before published. A few previously published papers have also been included to help round out the over-all picture and thus enhance the usefulness of the book. In addition, the book contains abstracts of 46 other previously published technical reports by RCA scientists, dealing with the transistors and semiconductor devices. The authors include scientists and engineers throughout the company. "Transistors I" is priced at $4.50 (regular employee discounts apply) and is available from "The RCA Review", David Sarnoff Research Center, Princeton, N. J.



COST REDUCTION THROUGH WORK SIMPLIFICATION . . . By W. A. HOFFMAN, TUBE DIVISION, Harrison, N. J. Presented at SAM 10th Annual Conference on Cost Reduction Know-How, Newark, N. J., March 22, 1956. This paper describes "work simplification" briefly and explains its purpose. Various tools used in Work Simplification programs are discussed, including observation technique, work distribution analysis, conference technique, process charts, motion study, and "brainstorming." Examples are given of the use of some of these tools, and the success achieved in individual cases. The importance of group participation and cooperation in a Work Simplification program is emphasized.

APPLICATION OF TRANSISTORS TO BATTERY-POWERED PORTABLE RECEIVERS . . . By J. W. ENGLUND, TUBE DIVISION, Harrison, N. J. Presented at IRE National Convention, New York City, March 21, 1956. This paper presents design considerations for the application of alloy-junction p-n-p transistors to broadcast portable receivers. Optimum operating conditions are given for both mixer-oscillator and converter input stages as regards signal-to-noise ratio and conversion transconductance. Various intermediate-frequency amplifier circuits are discussed, including (a) base input, common emitter, (b) unilateralized, (c) emitter input, common base, and (d) split input. Considerations for design of networks for unilateralization at the optimum operating point are given. Problems involved in the application of automatic gain control to the if-amplifiers are also discussed. The various if-amplifier circuits are evaluated for changes in input and output impedance, unilateralization, gain, and selectivity with operating point and with temperature. The relative merits of transistors and diodes in a second detector circuit are evaluated. An audio system using a typical driver and class B push-pull arrangement is briefly described.

HEAT-FLOW CONSIDERATIONS IN THE DESIGN OF HIGH-DISSIPATION RECEIVING TUBES . . . By O. H. SCHADE, JR., TUBE DIVISION, Harrison, N. J. Presented at IRE National Convention, New York City, March 21, 1956. This paper discusses considerations in the design of high-dissipation receiving tubes for keeping grid temperatures low. The cathode radiation intercepted by the grid is analyzed, and means of removing heat from the grid structure are discussed. The advantages of using stem heat-flow characterstics are described, as well as how these characteristics may be obtained. An approximate series of simple calculations for the determination of grid temperature distribution is presented. The application of design considerations to a tube such as the RCA-6CB5 horizontal-deflection amplifier (for color-TV sets) is described.

IMAGE ORTHICON FOR PICKUP AT LOW LIGHT LEVELS . . . By A. A. ROTOW, TUBE DIVISION, Lancaster, Pa. Presented at IRE National Convention, New York City, March 21, 1956. This paper describes a new image orthicon developed by RCA to extend the range of useful sensitivity to extremely low light levels. The new design substantially reduces the time lag and noise level at low light levels. The primary difference between the new tube and the standard image orthicon is an increased spacing between the glass target and the mesh screen. Theoretical considerations involved in the design of the new tube are explained. The tube characteristics and examples of applications are discussed.

TECHNIQUES OF COLOR FILM REPRODUCTION . . . By H. N. Kozanowski, Commercial Electronic Products, Camden, N. J. Presented at the NARTB Convention, April 15, 1956. Television broadcasters are rapidly expanding their activities to include the Color reproduction of Color Film and slides. The characteristics of 35mm and 16mm film prints are discussed with particular emphasis on practical methods for obtaining best Color TV results with currently available material. The role of electrical masking is described. Recent developments in 3-V equipment make it possible to include high quality reproduction of Color opaques and live commercials in the Color TV programming schedule. The versatility provided appears to have great commercial significance.

A UHF TV SWEEP-FREQUENCY GENERATOR FOR GENERAL SERVICE AND PRODUCTION-LINE USE . . . By H. F. Hanthorn, Tube Division, Camden, N. J. Published in Electronic Design, March 15, 1956. The rapid expansion of ultra-high-frequency television has emphasized the need for a reliable, moderately priced sweep-frequency generator for use in production-line testing and in general service. This article describes the design of a uhf TV sweep-frequency generator, the RCA WR-86A, which combines the accuracy required for laboratory testing with the necessary versatility and ease of operation for service work. This unit features a center-frequency tuning range of 300 to 950 Mc and a continuously adjustable sweep-frequency width up to 10 per cent of the center frequency. Some of the problems experienced in the development of the unit are also described.

APPLICATION OF CORRELATION TECHNIQUES TO QUALITY CONTROL . . . By Martin Geller, Semiconductor Division, Harrison, N. J. Presented at the Metropolitan Section of the American Society for Quality Control, New York City, March 15, 1956. This paper explains basic statistical terms and calculations and gives examples of their application to quality-control procedures. Various tests for the significance of correlation in data are described. Applications of the use of correlation techniques to develop process controls to find assignable causes, and to reduce testing costs are explained. The value of these techniques are summarized, and danger of prediction beyond known limits of correlation is pointed out.

AUDIO AUTOMATIC VOLUME CONTROL CIRCUIT . . . By B. D. Griffith and J. Tom, Defense Electronic Products, Camden, N. J. Presented February 16, 1956 to IRE-AIEE Conference on Transistor Circuits at the University of Pennsylvania, Phila., Pa. An absorption type of avc circuit was described in which the input impedance of a common base transistor stage is used to absorb a portion of the microphone output signal. This prevents its reaching a linear amplifier. At low levels no energy is absorbed and the full microphone signal is delivered to the amplifier. At higher levels a portion of the output signal is rectified and is used as emitter current for a common base transistor stage used for control. The impedance which absorbs energy is an inverse function of emitter current. At signal levels above the avc break point an increase in input level of 30 db is compressed to an output change of only 5 db. The harmonic distortion does not exceed 5 per cent.

CONTROL OF ORGANIC CONTAMINANTS IN HERMETICALLY SEALED RELAYS . . . By A. N. Gardiner, Tube Division, Camden, N. J. Presented at the 4th National Conference on Electromagnetic Relays, Stillwater, Okla., April 17-19. This paper describes a method of designing relays for operation at higher temperatures while at the same time improving relay life, insulation resistance, low-level or "dry-circuit" performance, and reliability in general. The major feature of the new design is the addition of an adsorbent material called a "getter" which, like its counterpart used in the manufacture of vacuum tubes, improves relay performance throughout life. The effect of organic and metal vapors on relay contacts is described, and test results given for relays with and without getters at room temperature and 125°C.

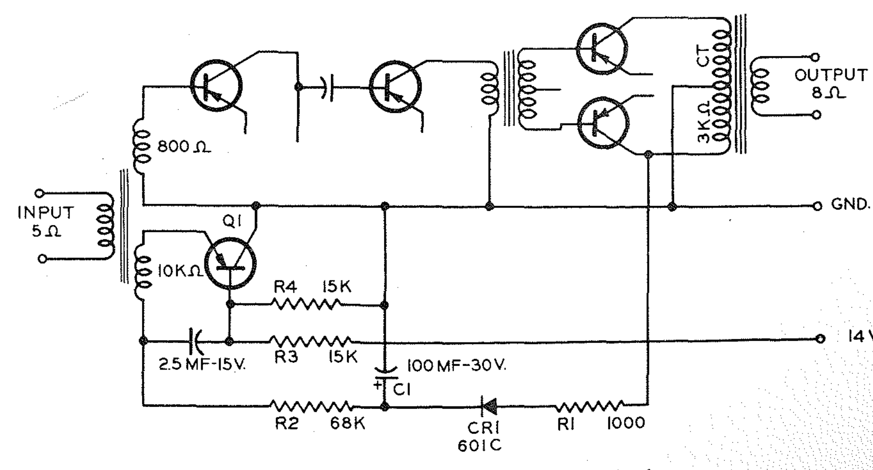
INVESTIGATION OF POWER GAIN AND TRANSISTOR PARAMETERS AS FUNCTIONS OF BOTH TEMPERATURE AND FREQUENCY . . . By A. B. Glenn and I. Joffe, Defense Electronic Products, Camden, N. J. Presented on March 22, 1956 at the IRE National Convention. In order to intelligently design equipment over wide temperature ranges, it is important to know how the performance of individual components used on the equipment is affected. This is especially true in equipment utilizing transistors since transistors are known to be temperature sensitive. The purpose of this paper is to present the results of an investigation made to determine the effects of temperature and frequency on the power gain and equivalent circuit parameters of both alloy junction germanium and grown junction silicon high frequency transistors. The temperature and frequency range covered was —55°C to +125°C and 0.5 to 4.0 megacycles.

A COLOR CAMERA FOR CLOSED-CIRCUIT APPLICATIONS . . . By W. L. Hurford, Commercial Electronic Products, Camden, N. J. Presented at the IRE National Convention on March 19, 1956. Based on a paper prepared by L. E. Anderson, Commercial Electronic Products. A 3-vidicon color camera was described which is useful for applications where sufficient light can be made available. The camera has been used in several closed circuit demonstrations of medical television and has been field tested by NBC. Broadcast commercials involving well lighted product displays or opaques and outdoor pickups on bright days are practical. Because of its small size and low operating cost the camera will extend the uses of color TV to applications in education, industry.

A LONG-LIFE C-BAND MAGNETRON FOR WEATHER RADAR APPLICATIONS . . . By W. F. Beltz, and R. W. Kissinger, Tube Division, Harrison, N. J. Published in Proceedings of N.E.C., March, 1956. This paper describes a developmental C-band, medium-power, pulse magnetron designed especially for use in weather radar equipment. This tube, which operates at a peak anode voltage of 15 kilovolts and a peak anode current of 13.5 amperes, has a rated minimum power output of 75 kilowatts at an operating frequency of 5400 megacycles per second. Unlike most magnetrons used in military equipment, which are designed for operation near their maximum ratings to conserve weight and space, this tube is designed for operation at more conservative ratings to provide long life.

Because the anode of this developmental magnetron has a large number of resonators, large anode and cathode diameters are required. These large diameters decrease both the anode-dissipation density and the cathode-current density. The cathode and its supporting structure are designed to minimize cathode-temperature variations due to back bombardment. The electrode spacings keep the electric fields as low as possible to eliminate arcing. Because of space limitations, a choke output is not feasible. A resonant iris utilizing a ceramic window acts as a vacuum barrier in the waveguide output. This output is designed for operation at altitudes up to 16,000 feet without pressurization.

MULTIPATH DISTORTION OF TV SIGNALS AND THE DESIGN OF A CORRECTIVE FILTER . . . By A. V. Balakrishnan, Defense Electronic Products, Camden, N. J. Presented on March 22, 1956 at the IRE National Convention. In the transmission of information by Electromagnetic waves a source of possible distortion is the presence of multipath interference. In the present paper, the multipath distortion of TV video signals is studied using the methods of statistical communication theory. The measure of distortion adopted is based on the normalized cross-correlation between the transmitted and received signals and is closely related to the mean square error between them. Both amplitude and frequency modulated systems are examined and the distortion before and after demodulation is evaluated. The problem of designing a linear passive filter that minimizes the distortion due to multipath is considered and is shown to have a physically realizable solution. The optimal filter transfer function is derived and the reduction in distortion possible is evaluated.



Schematic of Automatic Volume Control Circuit

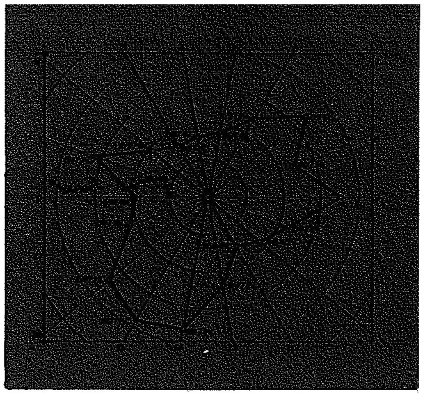
DC INDUCTIVE RATINGS FOR ELECTRIC CONTACTS . . . By S. T. East, Tube Division, Camden, N. J. Presented at the 4th National Conference on Electromagnetic Relays, Stillwater, Okla., April 17-19. This paper discusses some "ground rules" for setting up DC inductive ratings and methods for determining them. Theoretical considerations governing DC inductive break are described, and practical considerations for specifying inductors are discussed. Experimental results obtained on a standard inductor are given, and types of defects which should be looked for are listed. An approach for establishing inductive ratings is suggested.

COLOR TELEVISION . . . By J. F. Wilhelm, Tube Division, Harrison, N. J. Presented at the Metropolitan Supervisors' Club of P.R.R., New York City, April 2. This paper describes the RCA compatible color-television system, defines "compatibility," and discusses its advantages from the standpoint of the viewer. A brief history is given of progress in the television field, culminating with the development of color television. The picture tube used in a color-television receiver is described, and cost factors involved in the development of color television are reviewed. Present Color-TV programming and probable trends for future are discussed.

TRANSISTORIZED INTERCOM . . . Bv A. L. Cleland, Semiconductor Division, Somerville, N. J. Published in Radio and Television News, April, 1956. This paper describes a small, light-weight, experimental intercom using the RCA-2N104 junction transistor and featuring a self-contained, long-life battery supply designed for use in such aircraft. The over-all amplifier is housed in a small plastic box which fits into a shirt pocket. Two headphone jacks are connected in parallel with the output of an aircraft receiver to provide complete two-way communication between pilot and passenger and also permit both to listen to the radio. Design considerations for the intercom are given.

AN ELECTRONIC LENS CAP FOR IMAGE ORTHICONS . . . By R. G. Neuhauser, Tube Division, Lancaster, Pa. Presented at the NARTB Convention, Chicago, Ill., April 19. This paper described an electronic "lens cap" for an image-orthicon camera which can greatly increase effective tube life. Tube life is prolonged by capping the camera when no useful picture is required. The "lens-capping" function is performed by a simple toggle switch on the camera control unit which removes the positive voltage normally applied to the target and substitutes a slightly negative voltage. The use of the lens cap is described.

PRINCIPLES OF CIRCUIT DESIGN FOR AUTOMATION . . . By H. S. Dordick, Commercial Electronic Products, Camden, N. J. Presented on March 21, 1956 at the IRE National Convention. The equivalence of circuit design requirements for high volume automation and jobshop automation was shown. A technique of analysis known as sub-modularization was described. This results in circuit elements of standard size, content, configuration and manufacturing processing. These elements are applicable to many diverse types of equipment, creating a mass produced type of product within the jobshop. A mathematical representation was given to aid in standardization of circuits and systematizing the analysis. The technique is applied to a variety of products and the resultant standardized package shown.



Field Intensity Curves

INPUT AND OUTPUT DEVICES IN THE RCA BIZMAC SYSTEM . . . Presented by J. A. Brustman, Commercial Electronic Products, Camden, N. J., at the National IRE Convention on March 21, 1956. Based on a paper prepared by Mr. Brustman, K. L. Chien and D. Flechtner of Commercial Electronic Products. This paper describes the functional characteristics and some of the design features of the following equipments: Tapewriter — A manual keyboard device which creates punched paper tape. Tapewriter-Verifier — Permits a character-by-character verification of a previously prepared tape. Paper Tape Transcriber—Transfers information from the punched paper tape to magnetic tape. Card Transcriber—Translates information from punched cards to Bizmac code on magnetic tape. Electro-Mechanical Printer—The major high-speed output printer of the Bizmac System. Magnetic Tape Transcriber—Transfers information from magnetic tape to punched paper tape in the RCA Bizmac code. Interrogation Unit—Permits direct access to the Tape File for a rush random interrogation.

UNUSUAL ASSEMBLY METHODS USED IN DEVELOPING A NEW THYRATRON . . . By N. R. Goldstein, Tube Division, Lancaster, Pa. Published in Electronics, March, 1956. This paper discusses several novel assembly and processing techniques employed in the development of a new thyratron having a high current rating. The following techniques are discussed:

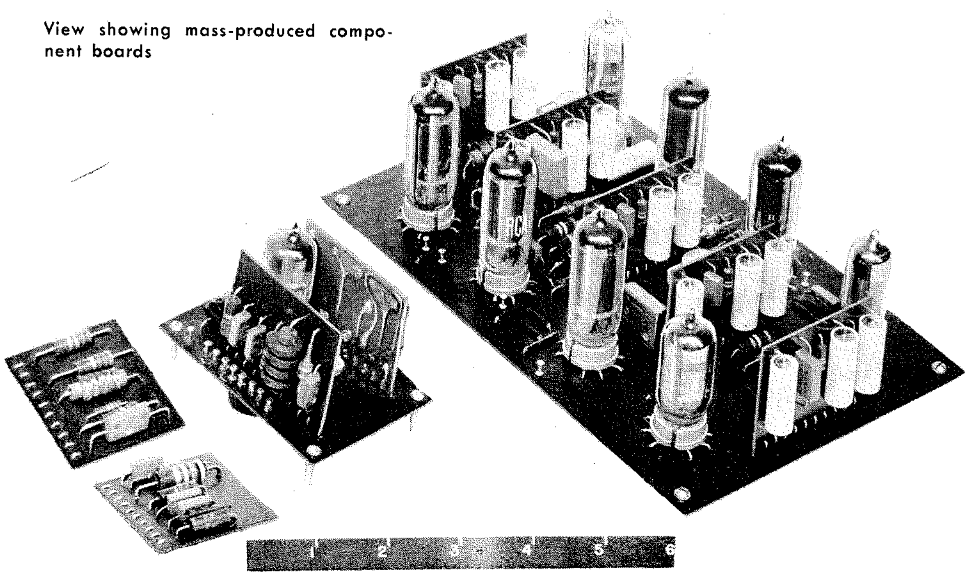
1. The use of the Graham Stud Welder in the fabrication of mount-support assemblies.
2. A method of removing chrome oxide using a solution of potassium permanganate and sodium hydroxide.
3. Two methods of low-temperature oxidation of Cr-Ni-Fe for glass-to-metal seals, the first by use of chrome plating and the second by frit spraying.

FIELD-INTENSITY MEASUREMENTS ON INDUCTION-HEATING EQUIPMENT . . . By T. E. Nash, Tube Division, Lancaster, Pa. Presented at IRE National Convention, New York City, March 22, 1956. This paper describes the program undertaken at the Lancaster plant to reduce and measure radio-frequency radiation from a large number of induction-heating equipments. The Lancaster plant is a complex radiating source containing more than 100 separate installations which operate over a frequency band from 150 kilocycles to 15 megacycles and include frequencies from the fundamental through the 10th harmonic. The program, which required the better part of two years to complete, consisted of three main steps: (1) determination of the magnitude of the radiation, (2) modification of equipment to reduce radiation to an acceptable level as prescribed by FCC requirements, and (3) the actual certification measurements.

TRANSISTOR CIRCUITS FOR DIGITAL COMPUTERS . . . By D. E. Deuitch, Defense Electronic Products, Camden, N. J. Published in ELECTRONICS, May, 1956. Junction transistors can perform all operations required in electronic portions of a digital computer. Circuits given include: two-input and gate, four-input or gate, flip-flop, counter, pulse amplifier and shaper. Also given are a counter and a flip-flop using point-contact transistors.

COMPATIBLE COLOR TELEVISION . . . By J. W. Wentworth, Commercial Electronic Products, Camden, N. J. Presented on April 14, 1956 at the IRE Spring Meeting in Cincinnati, Ohio. This lecture consists of a simplified technical derivation of the standards for compatible color television as approved by the Federal Communications Commission for broadcast use. It is shown that compatible color television is based upon principles which are logical extensions of the principles used in *monochrome* television, in that means for controlling hue and saturation are added to the conventional means for controlling brightness in the reproduced images. The role of the primary color process in color television is explained, and the electronic multiplexing techniques used to combine the three independent components of a color signal for transmission through a single channel of limited bandwidth are described. The talk is concluded by a summary of all the major processes used in compatible color television.

View showing mass-produced component boards



AN ELECTRONIC ANALOG OF THE EYE . . . By O. H. SCHADE, SR., TUBE DIVISION, Harrison, N. J. Presented at Stevens Institute, Newark, N. J., March 27. The visual information transmitted by an imaging system is generally judged by the eye. The objective analysis of an imaging system such as a TV system or photographic process yields transfer characteristics, frequency characteristics, and signal-to-noise ratios, but it does not answer the pertinent questions: "what can one see," "how sharp is the image," or "is there a visible grain structure."

The construction of an analog for the visual system from observed data, however, can furnish answers to these questions. The analog is patterned after a television system and can duplicate quite accurately the monochrome performance of the eye up to the "computer," the brain. It is necessary to review briefly the principles of image analysis and the physical meaning of Fourier theory and sampling theory in order to understand the approach used in constructing an analog system which does neither violate basic principles nor disagree with observed performance data of the process of vision. There are ten related functions each for the rod and the cone system of the eye, which must be determined. Only two of these can be computed directly, the others must be developed by successive approximation because only one or several points are known.

The simultaneous solution of the system of functions is obtained by graphic methods and illustrates the advantages of a physical concept of mathematical operations.

THE INSTALLATION AND MAINTENANCE OF COLOR TELEVISION . . . By E. R. KLINGEMAN, RCA SERVICE COMPANY, Cherry Hill, N. J. Presented at the NARTB Convention on April 16, 1956. With the installation rate of color television receivers approximately 1,000 per week, the cooperation of the broadcaster in supplying color programs, and especially color test signals, is invaluable to the service man. Receiving antennas and test equipment for color receiver installation and service are readily available, and training of service men by RCA and other manufacturers, and their distributors, has been increasing steadily since 1954. New and unconventional circuitry is materially reducing the number of tubes and components in the receiver. Both VHF and UHF color television reception are completely satisfactory, although problems sometimes develop in small localized areas. With close cooperation between the station's technical staff and local service man, these problems can be solved.

SMALL-SIGNAL LOW FREQUENCY AMPLIFIERS . . . By F. L. PUTZRATH, DEFENSE ELECTRONIC PRODUCTS, Camden, N. J. A general tutorial lecture was given at the University of Pennsylvania on April 10, 1956. The three basic connections of transistors, corresponding to a common emitter, base or collector, were described, together with the peculiar features of each connection. Power gain, current amplification, and impedance levels of the various connections were compared. Multistage amplifiers, using transformer coupling, R-C coupling, direct coupling, and complementary symmetry were considered, along with practical circuits incorporating techniques for stabilizing gain variations with temperature. The influence of operating point and circuit impedances on noise in transistor amplifiers was considered. Means for controlling gain by variation of operating point were shown.

AN INNOVATION IN LIFE TESTING ELECTROMAGNETIC RELAYS . . . By W. T. WEIR, DEFENSE ELECTRONIC PRODUCTS, Camden, N. J. Presented at the National Relay Symposium, Oklahoma A & M on April 19, 1956. The paper describes a relay testing circuit. Results of the tests run to date were discussed. The principal conclusions were drawn from curves which show how decreased coil current gives longer life. This is attributed primarily to the fact that the relay operates slower under decreased coil power giving less contact bounce. The second conclusion is that derating contacts from two amperes to 750 milliamperes gives a marked increase in the life of the relay. Carrying this derating to 20 milliamperes does not give a comparable gain. This indicates that the relay has an electrical and mechanical life. At a contact load of two amperes, the electrical load governs performance. It is noted that the relay performance at +80°C is better than that at room temperature.

SYSTEMS PLANNING FOR COLOR TELEVISION STUDIO EQUIPMENT . . . By A. F. INGLIS, COMMERCIAL ELECTRONIC PRODUCTS, Camden, N. J. Presented at the NARTB Convention on April 17, 1956. The adoption of compatible color television was advantageous from a systems standpoint, not only for the receiver portion of the system, but also for the studio. The use of compatible color in the studio permits complete integration of color and monochrome original handling facilities, and it is recommended that broadcast engineers plan their installation on this basis. Some of the important factors to be considered in this planning were discussed including: advantages and disadvantages of switching simultaneous color signals, linearity and frequency response requirements, non-synchronous operation, timing problems, and special effects.

UNUSUAL ELECTRON-TUBE EFFECTS OF CONCERN TO CIRCUIT DESIGNERS . . . By W. E. BABCOCK, TUBE DIVISION, Harrison, N. J. Presented at IRE Section Meeting, Houston, Texas, March 27. In many applications the circuit designer may be completely unaware of the existence of certain electron tube phenomena and thus be at a loss to explain the peculiar effects noted with certain circuits or with certain tubes. The phenomena of cathode interface, Whippany effect, and dc shift in electron tubes and their effect on circuit performance were discussed. Other electron tube phenomena, such as stray emissions, leakages, snivets and Miller effect were also described. Various methods of minimizing difficulties arising from these effects were pointed out.

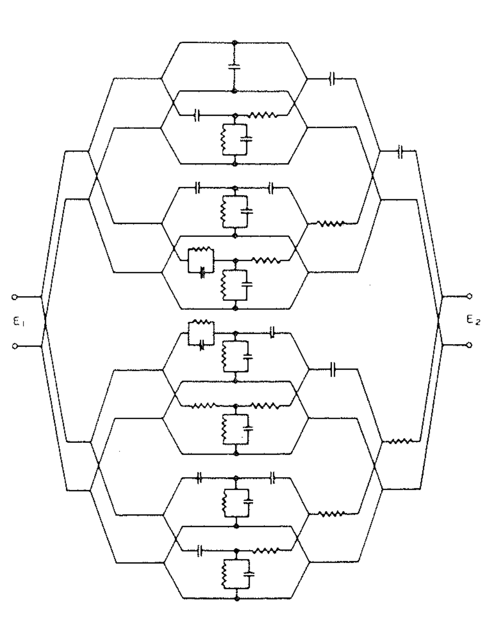
LOGIC DESIGN OF THE RCA BIZMAC COMPUTER . . . By A. D. BEARD, L. S. BENSKY, D. L. NETTLETON and G. E. POORTE, COMMERCIAL ELECTRONIC PRODUCTS, Camden, N. J. Presented by L. S. Bensky on March 21, 1956 at the IRE National Convention. The RCA Bizmac computer has been developed as a major element of the Bizmac system, and may be described as a general-purpose three-address stored-program machine. It has certain specialized features which make it adept in cyclical accounting applications: completely variable word length in all internal operations; highly-flexible instruction complement directed toward data-organizing ability; a control philosophy which offers great operational flexibility and simplifies troubleshooting and maintenance. The present paper outlines organizational concepts of the computer.

A PACK TYPE TELEVISION SYSTEM . . . By W. B. HARRIS, DEFENSE ELECTRONICS PRODUCTS, Camden, N. J. Presented on March 20, 1956 at the IRE National Convention. The Pack Type Television System is a battery operated, self-contained television pickup and transmitting station, suitable for man-carried operation. A 525 line, 30 frame interlaced picture is produced and transmitted over a one-half mile range. This equipment permits rapid relocation and penetration of areas inaccessible to conventional equipment. The portable equipments comprising the Base Station provide standard RETMA composite video.

SOME FACTORS TO BE CONSIDERED IN THE APPLICATION OF ELECTRON TUBES . . . By D. P. HEACOCK, TUBE DIVISION, Harrison, N. J. Presented at IRE Section Meeting, Baltimore, Md., April 11. This paper discusses some aspects of tube usage which are not discussed in published data and which are frequently ignored or misunderstood. The factors considered are generally detrimental to circuit performance and reliability unless considered in the early stages of circuit design. Included are the cause, effect, and cure (where possible) of such phenomena as grid current due to leakage, emission, gas, and contact potential; hum, microphonics, cathode interface, and Whippany effect.

SYNTHESIS OF TCHEBYCHEFF RC BAND-PASS FILTERS . . . By D. HELMAN, COMMERCIAL ELECTRONIC PRODUCTS, Camden, N. J. Presented on March 22, 1956 at the IRE National Convention. Methods for synthesizing RC filters have been presented by several authors. These methods, however, are limited to the case of low-pass or high-pass filters. This paper presents a method for synthesizing an RC band-pass filter, which has a Tchebycheff transmission characteristic in the pass band and a monotonically decreasing transmission in the stop band. Since no limitation is placed on the position that the pass band occupies along the frequency axis, the results are applicable not only to band-pass filters, but also to low-pass and high-pass filters as special cases. Maximum gain considerations for the filter in the pass band are also discussed.

Diagram of RC Band Pass Filter



ENGINEERING ANNOUNCEMENTS IN DEP

In recent organizational announcements, several significant changes have been made in the titles of the top engineering management in the Defense Electronic Products organization.

C. A. Gunther has been named Chief Defense Engineer of DEP with functional responsibilities extending over the following newly appointed Chief Engineers: O. B. Cunningham, Chief Engineer, Surface Communications Engineering; J. C. Smith, Chief Engineer, West Coast Engineering; R. C. Willman, Chief Engineer, Missile and Surface Radar Engineering, and J. D. Woodward, Chief Engineer, Airborne systems Equipment Engineering.

In other changes, G. L. Dimmick has been named Chief Development Engineer, General Engineering Development, reporting to C. A. Gunther, and N. I. Korman has been named Assistant Chief Engineer, Missile and Surface Radar Engineering, reporting to R. C. Willman.

O. B. Cunningham, Chief Engineer of Surface Communications Engineering, earned his B.S. degree from the University of Kentucky in 1935. Shortly afterward, he joined RCA as a special tester on transmitters. His transfer into the Engineering Department in 1937 brought him into development work on mobile, shipboard and airborne communication and navigation gear.

In 1941, Mr. Cunningham entered Aviation Communications as a group leader and served successively as unit supervisor and manager. May, 1953, saw his appointment as Chief Product Engineer, Surface Communications Engineering. Mr. Cunningham is currently a senior member of IRE, a civil member of the American Society of Naval Engineers and a Tau Beta Pi and Sigma Pi Sigma member.

Jerome C. Smith, Chief Engineer of RCA's West Coast Engineering, graduated in Arts from the College of Idaho in 1925. In 1927 he received a B.S. in E.E. from the University of Minnesota. Joining G. E., he was given special assignments as a member of the G. E. Advanced Engineering Course. He transferred to RCA in 1930 and spent several years in varying assignments in advanced development work. In 1934 he was assigned to a newly formed Automobile Receiver Development group, and in 1937 was advanced to lead this group.

In 1941 Mr. Smith was assigned to head a group responsible for the design of FM altimeters and associated military gear. Following V-J Day, he served as section chief for airborne radar and navigation equipment. In 1946, Mr. Smith moved to California and following several years of work in a private capacity, he joined Hughes Aircraft in 1949. He returned to RCA in 1951 in Los Angeles and was appointed to EPD Los Angeles Engineering, where he now serves as Chief Engineer of West Coast Engineering.

Mr. Smith is a member of Tau Beta Pi, Eta Kappa Nu and IRE.

Richard C. Willman, Chief Engineer, Missile and Surface Radar Engineering holds a B.S.E.E. degree from the University of Washington. He came to RCA Photophone in 1929. Later, Mr. Willman was assigned to the RCA International Division. He planned RCA studio sound installations in many foreign film studios, recording some of Europe's first sound pictures. From 1933 to 1935, Mr. Willman headed RCA's Hollywood Recording. Back in Camden, he designed many advanced sound recording items for the motion picture industry. With RCA International Division Sales for the next four years, Mr. Willman was appointed Manager of the London Recording Department.

During World War II, Mr. Willman did project engineering in RCA's Government Sound Engineering. He became manager in 1948. For his work on naval fire control equipment during the war, Mr. Willman received a Navy Certificate of Commendation. In 1951, he was appointed Chief Government Design Engineer; in 1955, Manager of Government Engineering Administration.

John D. Woodward received the B.S. degree in E.E. from Lehigh University in 1930. From graduation until World War II he worked in Airborne and Ground electronic equipment design for Bell Telephone Laboratories, United Air Lines, the consulting engineering firm of McNary and Chambers in Washington, D. C., and Bendix Radio Corporation.

In 1943 his full time services were requested by the Air Force and he served for two years as civilian Chief Engineer of the Radar Navigation Unit in the Radar Laboratory at Wright Field. For his work with the Air Force he received the Civilian Citation for Meritorious Performance.

At the end of the war, Mr. Woodward joined RCA as Supervisor of Government Communications in the Aviation Engineering Section and in 1947 he was placed in charge of the entire Aviation section. He is now Chief Engineer, Airborne Systems Equipment Engineering.

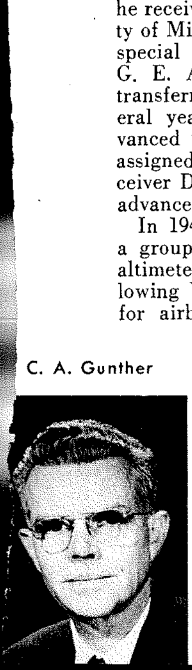
He is a Senior member of the IRE, a member of Aircraft Owners and Pilots Association, and a member of the American Society of Naval Engineers. He also serves as RCA's representative on the Radio Technical Committee for Aeronautics.

Glenn L. Dimmick graduated from the University of Missouri in 1928 with the degree of B.S. in E.E. While an undergraduate he was a member of Tau Beta Pi honorary engineering fraternity, and shortly after graduation a member of Sigma Xi, honorary scientific society. Upon graduation he entered G.E. as an engineer on talking motion picture equipment. In 1930 he was transferred to the RCA Victor Plant in Camden, N. J., as a development engineer in sound recording. During the following eighteen years he was active in the development of sound recording methods, sound powered telephones, recording galvanometers, dichroic mirrors, etc. Mr. Dimmick has eighty-seven U. S. Patents to his credit. Early in 1955 he was appointed Manager of General Development Engineering for the Engineering Products Division of RCA, and became Chief Development Engineer in 1956. He is a Fellow of the SMPTE. His many technical papers in the SMPTE Journal won him the Progress Medal Award of the Society for the year 1941. In 1949 Mr. Dimmick received the RCA Victor Award of Merit and in 1952 the Academy of Motion Picture Arts and Sciences presented him with the Award of Merit for outstanding achievement. In March, 1955, he received the "Missouri Honor Award for Distinguished Service in Engineering."

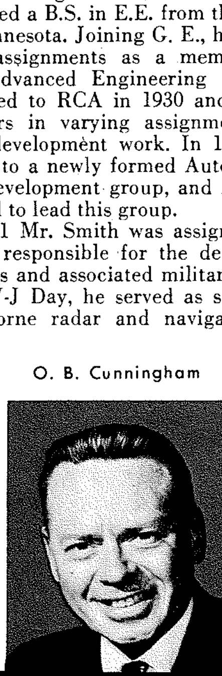
Nathaniel I. Korman, Assistant Chief Engineer, Missile and Surface Radar Engineering, who guides systems engineering activities, was a Charles A. Coffin Fellow at Massachusetts Institute of Technology and received his S.M.E.E. degree from that school, as well as a B.S. degree from Worcester Polytechnic Institute. He has been associated with RCA for 18 years, during which time he has concentrated his efforts on the technical direction of its radar and guided missile activities. He developed RCA's monopulse radar and conceived a radar system making possible the first effective fire control for military tanks.

The Department of Defense valued Mr. Korman's services as chairman of the Surface-Borne Surveillance Radar Subpanel of the Research and Development Board. He has originated 21 patents. He is a member of Sigma Xi, a Fellow member of the I.R.E., and a member of the RCA Victor Award of Merit Society.

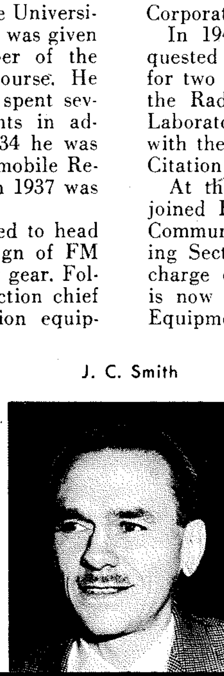
C. A. Gunther



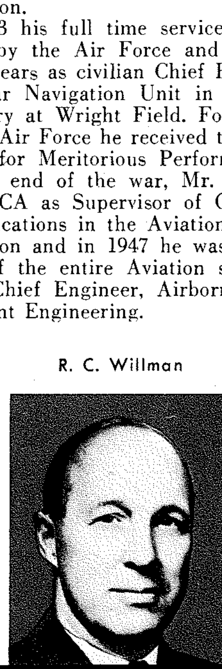
O. B. Cunningham



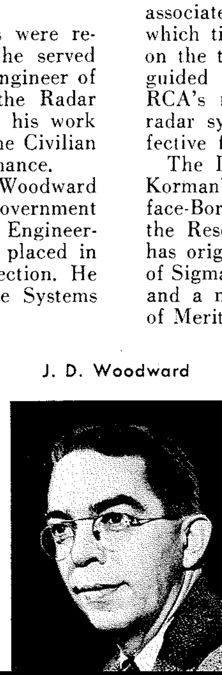
J. C. Smith



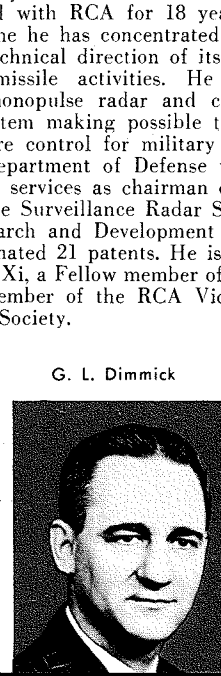
R. C. Willman



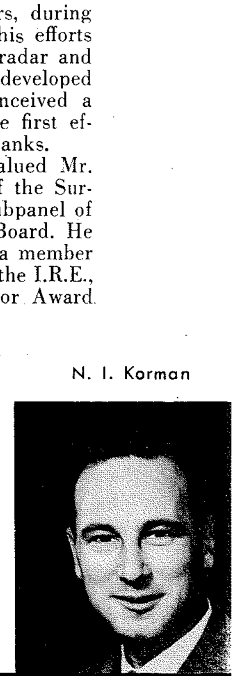
J. D. Woodward



G. L. Dimmick



N. I. Korman



H. I. REISKIND DIES SUDDENLY IN NEW YORK

Members of RCA were saddened to learn of the sudden death of Hillel I. Reiskind, Manager of Engineering, RCA Record Division, Indianapolis. Mr. Reiskind died of a heart attack on May 7, in New York's Polyclinic Hospital, while on a business trip to that city. He was 49 years old.

Mr. Reiskind, who had over 25 years of experience in the radio and record engineering field, graduated from Rensselaer Polytechnic Institute with an E.E. degree in 1928. He joined RCA in 1936 from the motion picture industry, and worked as liaison between field and engineering on motion picture recording equipment. In 1942, he organized the Recording Engineering Group in Indianapolis, which was part of Sound Engineering. In 1945 he was appointed Manager, Engineering, RCA Victor Record Division.

One of Hillel Reiskind's major contributions was his influence on management thinking that record products could be improved through engineering. Up to then much of the art had been determined empirically, from skills developed in production, and had reached the highest state of potential development with existing materials and techniques. By organizing the RCA Victor Record Engineering activity and gaining management support, Mr. Reiskind left a significant imprint on the recording art.

Some of the notable achievements directed by Mr. Reiskind included the development of new plastic record materials and plastics processes, for which he received the RCA Award of Merit for 1946.

The 45 rpm and 33⅓ rpm LP records were brought to perfection under his guidance. Along with the new speeds came continuing improvements in recording and processing techniques resulting in the highest quality product in the 50 year history of the industry.

Of major significance in Mr. Reiskind's work was his part in RCA's development of the New Orthophonic High Fidelity Sound characteristic, which has been adopted as the industry standard.

Mr. Reiskind was a Senior Member of the IRE, a Fellow in the Audio Engineering Society, a member of the SMPTE and ASA. He was Chairman of the R7 Committee on Phonograph Combinations and Home Recordings, RETMA, and an Associate Member of Sigma Xi. He was active in national and community affairs, being on the board of directors of the National Jewish Welfare Fund, and a member of the Indianapolis Community Relations Council.

Mr. Reiskind was very active in his work on the RCA ENGINEER from the inception of the magazine. His article "Engineering in the RCA Victor Record Division", Vol. 1, No. 1, set a pattern for subsequent general articles on engineering activities in RCA.

COMMITTEE APPOINTMENTS

TUBE DIVISION

Hans K. Jenny, Manager, Microwave Tube Engineering, Tube Division, Harrison, is chairman of the newly formed JETEC 13.4 Sub-committee in Traveling-wave Tubes. This committee covers traveling-wave tubes and backward wave oscillators of both the O and M types. Mr. Jenny is manager, Microwave Tube Development.

S. B. Deal, Engineering Leader, Product Development in the Lancaster Chemical and Physical Laboratory, Tube Division, is on the national ASTM Committee D-22 (Methods of Atmospheric Sampling and Analysis).

T. A. Saulnier and D. J. Donahue, both Engineers, Product Development in the Lancaster Chemical and Physical Laboratory, Tube Division, participated in American Chemical Society news broadcasts over a local radio station, WLAN. The programs were entitled "Headlines in Chemistry", and were presented on April 24th and May 22nd.

Dr. L. B. Headrick, Staff Engineer, Color Kinescope Engineering, and D. R. Bronson, Administrator, Inventory Controls, were elected Vice-President and Director respectively of the Lancaster Chapter of the Society for Advancement of Management at the April 17 meeting in York.

In July, Dr. Headrick will have completed 25 years service with RCA. Bronson joined RCA in February 1951. Both have been very active in SAM and have contributed much toward the growth of the Lancaster Chapter.

RECORD DIVISION

M. L. Whitehurst, Record Engineering, Indianapolis, has been elected president of the Indianapolis Branch of the American Electroplaters Society. Dr. A. M. Max, Manager Advance Development Section, Record Engineering, was elected to the Board of Managers.

COMMERCIAL ELECTRONIC PRODUCTS

J. Wesley Leas, Chief Product Engineer, BIZMAC Engineering, was elected Chairman of the Philadelphia Chapter of the IRE Professional Group on Engineering Management for the coming year at their final meeting of the current year on May 10th at the Engineers Club.

H. C. Wright, Broadcast and TV Engineering, has been reappointed to the 16mm and 8mm Motion Picture Committee of the Society of the Motion Picture and Television Engineers. The committee is occupied with making recommendations and preparing specifications to improve the quality of 16mm and 8mm motion pictures.

H. J. Benham has been appointed to the Screen Brightness Committee of the Society of Motion Picture and Television Engineers. Mr. Benham is Leader of the Theatre Projection group, Detroit, Theatre and Sound Products Engineering.

DEFENSE ELECTRONIC PRODUCTS

R. H. Baker, Manager, Standards and Services, Defense Engineering will serve on the Administrative Committee of the national Professional Group on Component Parts of the Institute of Radio Engineers.

DEP Standards Engineering

J. J. Lamb has been appointed Secretary of the ASTM D-14 Committee on Adhesives.

R. P. Dunphy has been appointed Secretary of the SAE Panel on Modular Iron (Div. 9, Panel 13).

The following are active in RETMA Special Quality Committees: J. Dzwonczyk, S.Q. 7.4 Electrolytic Capacitors; M. Kozak, S.Q. 11.4 Transmission Lines; H. Froehlich, S.Q. 12.4 Current Capacity of Wire; B. Schwartz, S.Q. 6 Resistors; R. Berger, S.Q. 9 Connectors, and I. K. Munson, G-3 Test Equipment.

CHANGES IN DEP ENGINEERING STANDARDS ACTIVITIES

Standards Engineering, DEP Engineering Standards and Services, has established a Standards operation at the Moorestown location. This has been done in order to more adequately serve Moorestown personnel in the field of Component Applications and Standards. They are providing service in the application of components, assistance through consultation service on component selection of materials, processes, and component measurements. In addition they are responsible for keeping Moorestown personnel informed on the component picture throughout the industry. They will also handle consultation on suppression and measurement of radio interference.

The group includes seven people. They are as follows: R. H. Berger, Leader, Electronic Components and Devices; J. N. Breen, Leader, Mechanical and Materials Engineering; G. J. Conroy, components; R. Lending, Electronic Devices; Alex Rende, Radio Interference; L. P. Poller, Engineering Coordinator and P. S. Chadwick, Foreman, Test Equipment Maintenance.

A luncheon was given by the Standards Activity of Electronic Products in honor of the aforementioned engineering personnel previously located with that activity in Camden, in recognition of their being chosen to represent the Standards Activity at the Moorestown location.

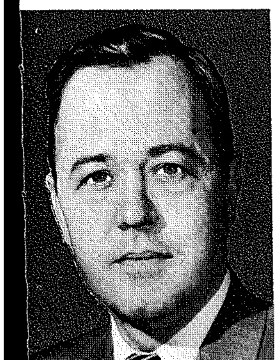
The Component Design activity of Engineering Standards and Services, DEP, has been relocated on the fifth floor of 10 building, Camden, in order to get the additional room required to house the transformer design activity which was transferred from the Tube Department to DEP on Jan. 1. This laminated core transformer activity includes 10 engineers with experience ranging from four to fourteen years and a complete model shop capable of building military type transformers. The transformer factory remains physically in Building 1-2 but has now been set up under Mr. C. M. Ledig, reporting to J. E. Beezer, of the Fabrication Plants.

Two members of the Component Design Activity have been assigned to the Moorestown operation. These assignments were made in order to expedite the design services required at the Moorestown Plant. Mr. S. Krasney handles Transformer Design problems and Mr. A. Nasitano handles printed circuits.

NEW EDITORIAL REPRESENTATIVES APPOINTED

Thomas P. Canavan has replaced W. M. Patterson as a member of the DEP-CEP Editorial Board from Airborne Fire Control Engineering, Defense Electronic Products.

Mr. Canavan received an A.B. Degree from Fordham University in 1944 and his B.E.E. and M.E.E. Degrees from New York University in 1949 and 1954 respectively. His occupational experience has included three years as a Research Assistant at New York University Research Division and seven years as Assistant Professor in the Electrical Engineering Department of Manhattan College. While teaching, he worked during the summer months at Sylvania Electric and the Eclipse-Pioneer Division of Bendix Aviation. Mr. Canavan joined RCA in July of 1955 and is presently with the Airborne Fire Control-Design Group. He is a member of the IRE, AIEE, Tau Beta Pi and Eta Kappa Nu.



T. P. Canavan

F. R. Arams

F. R. Arams has been appointed Assistant Editorial Representative for Microwave Tube Engineering, Tube Division at Harrison.

F. R. Arams was born October 18, 1925 in the Free City of Danzig. He received a B.S.E. in Electrical Engineering and a B.S.E. in Mathematics from the University of Michigan in 1947, a Master of Science degree in Applied Physics from Harvard University in 1948, and a Master of Science degree in Business Management from Stevens Institute of Technology in 1953. He is presently studying for a doctorate in Electrical Engineering at the Polytechnic Institute of Brooklyn. During World War II, he served as Communications Chief in charge of Radio Receiver Station WXH, Ketchikan, Alaska.

Mr. Arams joined RCA in 1948 as a Specialized Trainee, and subsequently joined the Microwave Engineering Laboratory at the RCA Tube Division, first at Lancaster, Penna., and presently at Harrison, N. J. From 1950 to 1953 he was engineer on various magnetron and traveling-wave tube design programs. From 1953 until early 1955 he served as Administrative Assistant to the Manager of Microwave Engineering, and at present he is in charge of Microwave Tube Application Engineering.

Mr. Arams was a 1944 Donovan Scholar at the University of Michigan, and is a member of Eta Kappa Nu and Tau Beta Pi. He received a Tube Division Golden Achievement Year citation in 1955 for outstanding performance.

DEVELOPMENTS IN MILITARY ELECTRONICS ANNOUNCED AT MOORESTOWN PLANT DEDICATION . . . Announcement of RCA activity in the new air defense missile program was made during dedication ceremonies at Moorestown, N. J., marking a major enlargement of the RCA Missile and Surface Radar Engineering Plant, DEP, to house the "Talos" project, as well as development of RCA's abilities to design and produce complex electronic systems for the military services. The ceremonies, which included demonstrations and displays of some of RCA's latest developments in military electronics, were witnessed by the Board of Directors of RCA, the National Broadcasting Company, and RCA Communications, Inc., military and government representatives, and by more than 1,500 employees at the RCA plant. Highlight of the ceremonies was the announcement by Brig. General David Sarnoff of RCA's participation in the Nation's new Air Defense Missile Program, in development and producing land-based tactical launching and guidance systems for the "Talos" guided missile. "Talos" is a surface-to-air guided missile developed by the Johns Hopkins Applied Physics Laboratory for the U. S. Navy, Bureau of Ordnance.

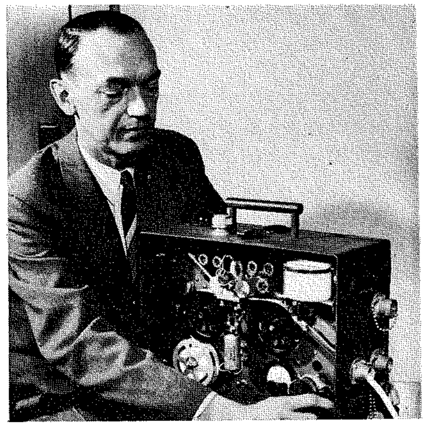
Three major developments in the field of military electronics were demonstrated during the dedication ceremonies, which were:

A portable electronic detector for "nerve" gas—developed by the Army Chemical Corps and RCA. The first such detector accepted for military use, the unit not only can serve as a field alarm for military personnel and installations, but also can be utilized for gas-detection protection of population and industrial centers. It has possibilities as a detector for hazardous industrial and commercial gases.

An RCA-developed wide-spaced image orthicon tube, or television camera tube, which can be used for televising scenes and objects under light conditions as low as those of a moderately cloudy moonlit night. Also described was the "Cat Eye" electronic light-intensifier, resulting from research of RCA in conjunction with the U. S. Air Force. This device is capable of viewing objects in almost total darkness to produce clearly defined television pictures.

Noise-cancelling microphones and headsets for aircraft intercommunications systems, which RCA has developed and is producing for the U. S. Air Force were exhibited. The highly selective and sensitive equipment provides clear communication under noise conditions which would make intelligible conversation virtually impossible by other known means.

Brig. General David Sarnoff (left) and Harry R. Wege, Manager, Missile and Surface Radar Operations shown at the unveiling of a plaque at dedication ceremonies marking expansion of the RCA Missile and Surface Radar Plant at Moorestown, N. J.

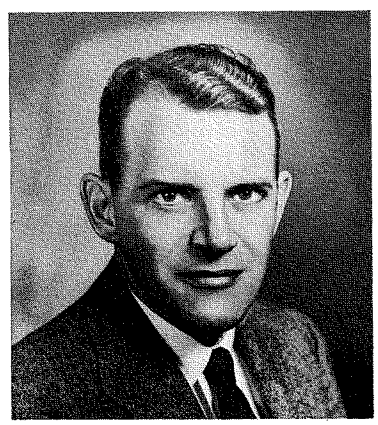


T. A. Smith, Vice President and General Manager, DEP, examines a portable electronic detector for invisible, odorless, deadly "nerve" gas. Detector, developed by the Army Chemical Corps and RCA, is the first to be accepted for military use.

W. T. WARRENDER APPOINTED GENERAL MANAGER OF NEWLY FORMED RCA COMPONENTS DIVISION . . . William T. Warrender, manager of the tube plant of the RCA Tube Division at Marion, Indiana, has been appointed general manager of the recently created RCA Components Division, with headquarters at Camden, N. J. Mr. Warrender will be succeeded as plant manager at Marion by Leonard Gillon, manufacturing manager there since 1954.

Mr. Warrender attended Newark College of Engineering and Rutgers University before entering the electronics field in 1925. After 11 years as factory engineer with several tube manufacturing firms he joined RCA in 1936 at the Harrison, N. J., plant. A year later, he was transferred to the company's Indianapolis factory in factory engineering and production control, and in 1942 he was made superintendent of production, becoming department manager in 1944.

In 1945, Mr. Warrender was appointed department manager in the record division at Camden, N. J., and in 1946, general plant manager. Two years later he became chief engineer of the record division. When RCA acquired the Marion plant in 1949, he was made plant manager.



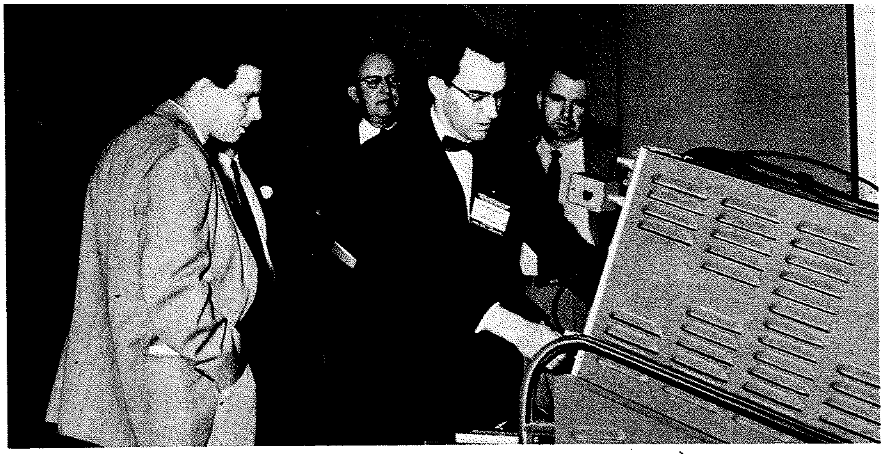
W. T. Warrender

DR. E. W. ENGSTROM HONORED BY SWEDISH ENGINEERS . . . E. W. Engstrom, Senior Executive Vice-president, RCA, has been elected a Foreign Member of the Royal Swedish Academy of Engineering Sciences.

The announcement followed the presentation to Dr. Engstrom of the John Ericsson Medal by the American Society of Swedish Engineers at its annual dinner in New York on February 11. The medal was presented for ". . . distinguished achievements in science and engineering." Established to honor the Swedish-American engineer among whose many outstanding developments was the Monitor of Civil War fame, the John Ericsson Medal is given at 2-year intervals, alternating between a person of Swedish descent in the United States and a citizen of Sweden.

F. W. Alexanderson, pioneer in radio and electrical engineering, presented the medal, praising Dr. Engstrom for "ability and creativeness" and for his leadership of important team research in the field of electronics.

"It is rare that outstanding scientific and engineering ability is combined with outstanding executive ability," said Dr. Alexanderson, "but now we find Dr. Engstrom a senior executive vice-president and a director of RCA, responsible for research, engineering and manufacturing."



J. W. Wentworth, TV Terminal Equipment Engineering, CEP, demonstrating color equipment to a group of interested bystanders at the NARTB Show.

RCA ENGINEERS OPERATE COMPLETE COLOR TELEVISION STUDIO, INTRODUCE NEW BROADCAST EQUIPMENT AT NARTB SHOW . . .

The first public showing of smaller, more efficient, and more economical radio and television broadcast equipment, much of it operating in a complete color TV studio, featured RCA's participation in the 34th annual trade show of the National Association of Radio and Television Broadcasters, April 15-20, at the Conrad Hilton Hotel, Chicago.

In addition to dramatizing engineering advances in equipment for colorcasting, the RCA exhibit placed considerable emphasis on new studio equipment for AM broadcasting. The RCA displays included the following: *A simple optical color filter* which converts RCA's 3-Vidicon film camera system for use with the new Eastman Kodak developed Lenticular 35mm film.

The RCA playback optical color filter, which was demonstrated with the film, will permit simple, economical conversion of the 3-Vidicon camera system for reproducing true color images from the black and white Lenticular film. The optical system enables the 3-V camera to reproduce standard 35mm color, monochrome, or Lenticular films interspliced in any combination.

A low-cost 6-kilowatt lowband television transmitter (TT-6AL), which requires appreciably less floor space than any transmitter in its power class. This is one of a new series of lowband VHF television transmitters ranging from a 2-kw unit (TT-2BL) to a 25-kw transmitter (TT-25CL).

A complete 50-kilowatt AM "Ampliphase" transmitter, so compactly designed that it requires only four standard cubicles —or approximately half the space of conventional 50-kw equipment.

A 1-kilowatt AM radio transmitter (BTA-1MX), requiring less than half the electron tubes normally utilized in comparable transmitters.

Three new audio consolettes for radio and television studios. All utilize etched-wiring amplifiers in modular construction and such built-in features as power supply, speaker relays, and monitoring amplifiers to obviate the need for external wiring.

RCA's recently announced *"midget" power supply unit* (WP-15) for use with television studio equipment. It provides an output of 1500 milliamperes, requires only 10½ inches of rack space.

A transistorized ac or battery-operated *portable remote amplifier* (BN-6A)—a four-channel type which weighs approximately 10 pounds and designed for remote broadcast use.

A TK-41 *live color camera chain*, set up in a studio complete with lighting and scenery, were utilized as a continuous source of live color pictures.

A complete, operative *3-Vidicon color film camera* system was demonstrated, together with an extension lens system which enables the 3-V camera chain to produce live color commercials.

Additional RCA displays featured studio 3-speed turn-tables, tape recorders, broadcast microphones, antennas, and other essential radio and television broadcast equipment.

MEETINGS, COURSES AND SEMINARS

IRE NATIONAL CONFERENCE . . . F. C. Collings, Manager, Component Design, DEP, served as moderator of a Technical Session on "Circuits" at the IRE National Conference on Aeronautical Electronics which was held in Dayton on May 14, 15 and 16.

ANALYTICS OF SHOCK AND VIBRATION . . . R. A. Di Taranto, DEP Standards Engineering, has conducted an Environmental Seminar on Analytics of Shock and Vibration. The two-session seminar was presented in April.

HIGH VOLTAGE ENGINEERING . . . H. Ingraham and J. J. Lamb; DEP Standards Engineering, recently conducted a two-session seminar on High Voltage Engineering at the Moorestown Engineering Plant.

STOCHASTIC PROCESSES . . . Dr. A. V. Balakrishnan, General Engineering Development, DEP, is giving an RCA-sponsored course on Stochastic Processes. The course is of an advanced mathematical nature, developing the subject from measure theory and leading up to recent contributions to the field. The course is being given weekly at the Camden Plant and is attended by engineers from different engineering activities.

STATISTICAL DATA ANALYSIS . . . G. H. Beckhart, General Engineering Development, DEP, was the instructor in an after-hours course on Statistical Data Analysis for Engineers. The course intent was to familiarize engineers with the fundamentals of statistical design and evaluation of experiments. The course was given at the Camden Plant. Its attendance, however, was made up of engineers from the whole Camden-Moorestown area, and from several divisions. Sessions were weekly and ran until May.

'ELECTRONIC MESSENGER' . . . Field Service Personnel of Technical Products Department, RCA Service Company were recently given training on the Electronic Messenger (facsimile transmission and receiving equipment) manufactured by Air Associates. This equipment will be installed and serviced by RCA on a National basis.

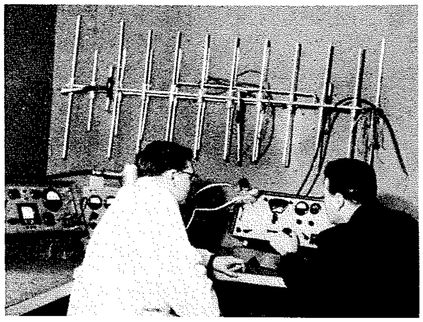
EE COURSE AT NEWARK COLLEGE . . . M. Magid (Microwave Tube Application and Test, Tube Division, Harrison) is teaching an Electrical Engineering course this year at the Newark College of Engineering.

The special courses taught at the Newark College of Engineering are designed to provide people in industry with a broadened concept of the technical problems encountered in industry.

The courses are given at a level between that of a technician and engineer, broader in aspect than that normally taught to technicians, less in depth than that taught to engineers. Certificates are issued on completion of a specific program which usually involves three years with classes three nights per week.

MICROWAVE TUBE ELECTRONICS . . . F. Sterger and F. E. Vaccaro have prepared and are carrying out a series of 20 lectures for the staff of Microwave Tube Engineering and Fabrication, Harrison. The course covers the general theories of all known microwave tubes, their performance, applications and limitations. It aims at giving all engineers a better understanding of microwave tube theory and design.

The above is part of an educational program instituted in the Microwave Tube Activity to (1) complement present knowledge to meet immediate needs, (2) arouse interest of the individuals to improve their professional status and to prepare them for increasing responsibility and (3) build up the capability of the department to handle future projects. A. H. Dayem, R. R. Reed, and F. E. Vaccaro and other members of the Microwave Engineering Education Committee are responsible for organizing this program.



Shown here is J. R. Shoaf II (on right) in the oscillator radiation test house of the German factory producing receivers for the RCA International Division.

J. R. SHOAF RETURNS FROM EUROPEAN TRIP . . . James R. Shoaf II, of the Export Engineering activity, Radio and "Victrola" Division, Cherry Hill, recently returned from a trip to Germany and Switzerland where he visited Radio-Fernseh-Elektro G.m.b.H., RCA's associate company in Frankfurt, and Laboratories RCA Ltd., in Zurich. While in Zurich, Mr. Shoaf represented the RCA Victor Radio and "Victrola" Division at the David Sarnoff anniversary dinner sponsored by the Swiss associate company.

R. A. Newell

MOORESTOWN ENGINEER AWARDED SLOAN FELLOWSHIP TO M.I.T. . . . Russell A. Newell, Leader in Antenna Pedestal and General Mechanical Engineering, at RCA's Moorestown Engineering Plant, has been designated one of the 34 young executives from American industry who have been awarded the prized Sloan Fellowships this year at the Massachusetts Institute of Technology.

In June, Mr. Newell started the 12-month Executive Development Program provided by the Sloan Fellowships at the M.I.T. School of Industrial Management. His participation in the program, leading to the degree of Master of Science in Industrial Management, is sponsored by RCA.

RCA's Sloan Fellows are selected through the procedures of the company's Management Development activity, which is concerned with the evaluation, training and development of supervisory and managerial personnel. As part of this program, selected supervisory employees each year attend various university programs in the fundamentals of management.

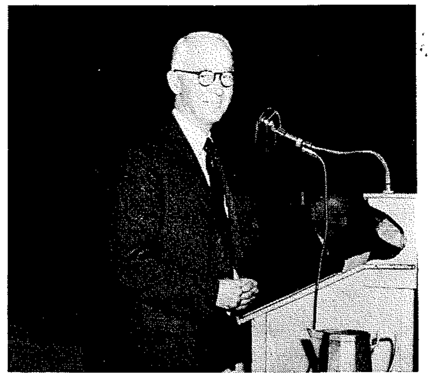
He entered Rensselaer Polytechnic Institute in 1946, earning his B.S. degree in Mechanical Engineering in three years. During his senior year, served as an instructor at Renssalaer. He has been attending Drexel Institute, working towards his Master's degree in Mechanical Engineering.

R. J. TULLAR RETIRES . . . On April 30th R. J. Tullar of Defense Electronic Products retired after thirty-five years with RCA Victor. More than four hundred friends and associates took cognizance of the event at a luncheon given him at Kenney's Restaurant, Camden. Among the speakers were: P. C. Lindoerfer who served as Master of Ceremonies; W. P. Paul; J. B. Coleman; and A. K. Weber. As a token of esteem, Mr. Tullar received a Hi-Fi tape recorder and a Hi-Fi three speed phonograph.

Robert J. Tullar was graduated from M.I.T. in 1913 with a B. S. degree in Mechanical Engineering. After graduation he spent four years in the Pittsburgh district on mechanical design work involving gas producers and blast furnaces.

The next four years Mr. Tullar spent at the Naval Aircraft Factory, at Philadelphia, Pa. as chief draftsman of the heavier-than-air equipment. He joined the Victor Talking Machine Company in 1921 and has held various positions in the engineering and manufacturing departments.

In 1922, under the General Superintendent, G. W. Smith, Mr. Tullar, in collaboration with Walter Bloom, designed and built the first Victor radio receivers housed in standard Victrola Cabinets. These sets were built for the purpose of protecting the Victor trademark for use with radio receivers. One of the first models of this receiver has been turned over to Mr. Dodelin of the "Hall of Progress."



Mr. R. J. Tullar at retirement dinner

RAYMOND J. ECKERT and IAN McWILLIAMS, Philadelphia, Seniors from St. Joseph's College, are "Co-op" students at RCA, Camden. They have been awarded the National Science Fellowships for advanced studies in Physics. Under the provisions of the grants they will be provided with stipends of $1400 a year in addition to tuition costs at any University which they choose to select.

REGISTERED PROFESSIONAL ENGINEERS

Continuing our practice of publicizing Registered Professional Engineers at RCA, the following additional names have been submitted:

Tube Division (Lancaster)	*Section*	*State*	*Licensed As*	*License No.*
H. H. Chapman	971	Ohio	Elect. Eng.	20793
J. M. Forman	920	Penna.	Prof. Eng.	11347
W. H. Freund	27	Penna.	Elect. Eng.	7498
L. C. Herman	941	Penna.	Elect. Eng.	3071-E
M. B. Lemeshka	29	Penna.	Chem. Eng.	13361
H. H. Licht	27	Penna.	Aero. Eng.	7627
J. A. Markoski	49	Penna.	Chem. Eng.	12146
A. G. Nekut	971	Penna.	Elect. Eng.	10276
E. E. Spitzer	900	Penna.	Elect. Eng.	11809

Tube Division (Harrison)	*Section*	*State*	*Licensed As*	*License No.*
C. Nakrosis	818	N. J.	Mech. Eng.	Training
A. Wohlgemuth	691	N. J.	Prof. Eng.	7920
		N. Y.	Prof. Eng.	26839 P-E
Sidney Davidson	695	N. J.	Prof. Eng.	7964
Fred Stephensen	695	N. J.	Prof. Eng.	5839
Henry Hartmann	690	N. J.	Prof. Eng.	9027
Robert Walton	858	Missouri	Chem. Eng.	E-6393
J. Gallup	655	N. Y.	Prof. Eng.	8353
A. W. Peterson	655	Mass.	Prof. Eng.	500
E. S. Thall	655	Prov. of Ont. Can.	Prof. Eng.	8568
E. G. Widell	655	N. J.	Prof. Eng.	8433
Robert Mendelson	675	N. Y.	Prof. Eng.	PE 27175

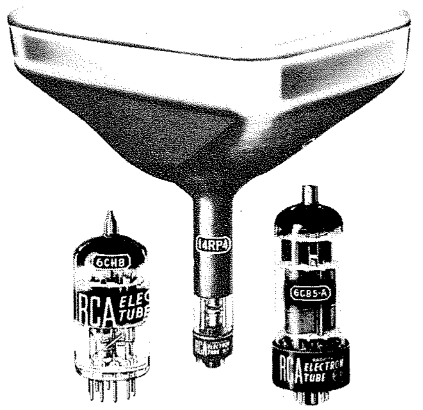
Tube Division (Woodbridge)	*Section*	*State*	*Licensed As*	*License No.*
(Mrs.) Janet L. Deckert	...	N. J.	Elect. Eng.	7944

Tube Division (Cincinnati)	*Section*	*State*	*Licensed As*	*License No.*
Thomas E. Swander	...	Ohio	Prof. Eng.	19667

Tube Division (Camden)	*Section*	*State*	*Licensed As*	*License No.*
L. Pessel	...	Penna.	Prof. Eng.	5247

Tube Division (Marion)	*Section*	*State*	*Licensed As*	*License No.*
P. W. Wolverton	...	Indiana	Prof. Eng.	5548
L. B. Hall	...	Indiana	Prof. Eng.	7084
J. R. Bumke	...	Indiana	Prof. Eng.	7550
R. E. Salveter, Jr.	...	Indiana	Prof. Eng.	7373

Semiconductor Division (Harrison)	*Section*	*State*	*Licensed As*	*License No.*
A. E. Chettle	...	N. J.	Prof. Eng.	6596



NEW RCA TUBE TYPES

RCA-5FP15-A is a 5-inch oscillograph tube featuring high resolution capability and an extremely short persistence characteristic. It is intended particularly for photographic recording of electrical phenomena including radar signals.

Employing magnetic focus and magnetic deflection, the 5FP15-A is designed with a high-resolution gun which gives a maximum line width of 0.010 inch measured with ultor current of 200 microamperes, ultor voltage of 4000 volts, and 49-line shrinking raster. The 5FP15-A has a deflection angle of 53° and a minimum useful screen diameter of 4¼".

RCA-6CH8 is a general-purpose multiunit tube of the 9-pin miniature type containing a medium-mu triode and a sharp-cutoff pentode in one envelope. It is intended for a wide variety of applications in black-and-white and color TV receivers.

The pentode unit, featuring high transconductance and low grid No. 1-to-plate capacitance, may be used as an intermediate-frequency amplifier, video amplifier, agc amplifier, and reactance tube. The triode unit, which has a relatively high zero-bias plate current is well-suited for use in low-frequency oscillator, sync-separator, sync-clipper, and phase-splitter circuits.

RCA-14RP4-A is a short, lightweight, directly viewed, rectangular, glass picture tube of the low-voltage electrostatic-focus and magnetic-deflection type for low-cost portable TV receivers. This type has a spherical Filterglass faceplate, an aluminized screen 12⅛" x 9⅝" with slightly curved sides and rounded corners and a typical projected screen area of 108 square inches.

Employing wide-angle (90°) deflection, the 14RP4-A has a very short length—a length approximately 2 inches shorter than a type having the same size faceplate and 70° deflection.

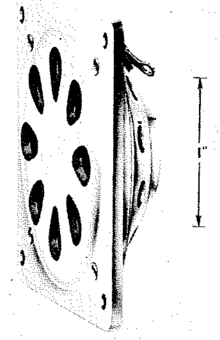
RCA-6883 is a beam power tube for use as an r-f power amplifier and oscillator as well as an a-f power amplifier and modulator in mobile equipment operating from a 12-volt storage battery. Except for its heater rating of 12.6 volts/0.625 ampere, the 6883 is identical with the 6146 which has a 6.3-volt/1.25-ampere heater.

RCA-6CB5-A is a high-perveance beam power tube of the glass-octal type. It is designed especially for use as a horizontal-deflection amplifier tube in color television receivers. Utilizing a button-stem construction in a T-12 envelope, the 6CB5-A is smaller and more compact than the 6CB5 with which it is electrically interchangeable.

NEW PRODUCTS

NEW MINIATURE SPEAKER . . . RCA has announced a new miniature speaker—Generic Design 239S1. This speaker is of the permanent-magnet type, 2⅛ inches along its sides, has a depth of less than ¾ inch, and can handle a 250-milliwatt input. It is specially designed for transistorized radio receivers and other miniaturized equipment where a speaker having high sensitivity and small size is an important design consideration.

The cone of the 239S1 is located within the magnetic structure, has high sensitivity, good frequency balance, and substantially uniform response over its entire frequency range.



RCA STARTS PRODUCTION ON NEW PORTABLE TAPE RECORDER MODEL . . . Start of production on a new lightweight portable tape recorder—third member of a new line being manufactured by RCA—was announced by RCA Victor Radio and "Victrola" Division.

The New model is the "Congressional" (Model 7TR2), a push-button, two-speed recorder in a tan simulated leather case.

The "Congressional" contains many of the same features as the "Judicial" high fidelity recorder which was introduced earlier this year.

Featuring a four-tube (including rectifier) amplifier, the "Congressional" has a 5 by 7-inch 3.2 ohm v.c. speaker. A specially-designed ceramic high-impedance microphone with seven-foot cable is included.

The new recorder is being manufactured at RCA's Cambridge, Ohio plant.

NEW PRODUCTS INSTALLATIONS . . . Commercial Electronic Products Communications Dept. has been awarded a contract by the Texas Gas Transmission Corp. to build its longest continuous microwave system, extending from the eastern Texas gas fields to the Ohio Valley. The installation will provide 60 talking circuits over a 32 station relay system. Total value will exceed $750,-000.

ENGINEERING DATA AND PUBLICATIONS

RCA SERVICE CO. ANNOUNCES PUBLICATION OF NEW BOOK ON COLOR TV SERVICING . . . Publication of a new 92-page illustrated reference book, "Servicing Color Television Receivers," announced by RCA Service Company, is designed principally for reference use by dealer and independent servicemen who have attended the many color TV clinics and workshops throughout the nation sponsored by the RCA Victor Television Division and its authorized distributors.

The book deals specifically with the current RCA Victor 21CT660U series.

TUBE DIVISION APPLICATION NOTES . . .
AN-164, "Conversion Factors for Tube Characteristics".

This note describes a method for determining the approximate characteristics of an electron tube when all the electrode voltages are changed in the same proportion from the published or measured values. Conversion factors for the principal characteristics are given in a nomograph which is easy to use and provides direct reading. Although these conversion factors have been available in curve form for some time, the nomograph is more convenient to use than the log-log curves.

AN-165, "Use of the RCA-2N109 P-N-P Junction Transistor in Class B Audio Applications." This note describes the use of the RCA-2N109 p-n-p alloy-junction transistor in class B operation in the output stage of battery-powered portable radio receivers and other types of portable low-powered audio amplifiers.

ENGINEERING MEETINGS AND CONVENTIONS

June-August, 1956

JUNE 4-6
Second Annual Radome Symposium, Ohio State Univ., Columbus, Ohio.

JUNE 6-8
10th Annual Convention of the American Society for Quality Control, at Le Palais du Commerce, Montreal, Canada.

JUNE 25-27
Symposium on the methods, materials and processes involved in the uses of high temperature in science and industry, sponsored jointly by Stanford Research Institute and the Univ. of Calif., on the University's Berkeley, Calif., campus.

JUNE 25-29
AIEE-Summer and Pacific General Meeting, San Francisco, Calif.

AUGUST 15-17
The National Telemetering Conference, sponsored jointly by the IRE, the AIEE, the IAS, and the ISA, in Los Angeles, Calif.

AUGUST 20-21
National Telemetering Conference, Biltmore Hotel, Los Angeles, Calif.

AUGUST 20-21
AIEE-IRE-ISA Telemetering Conference, Ambassador Hotel, Los Angeles, Calif.

AUGUST 21-24
WESCON Show, Pan Pacific Auditorium, Los Angeles, Calif.

AUGUST 22-SEPTEMBER
23rd Annual British National Radio Show, Earls Court, London, England.

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