DEVELOPMENT OF THE RCA "PERSONAL" TV RECEIVER

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The small portable was a challenge from the time it was conceived in a skeletal form. Could high performance be obtained in the small dimensions desired? If so would the Public accept it? After careful study, a prototype was presented to top management, and the project was given their blessing. The continued encouragement and guidance of Engineering management played a very important part in carrying it through to successful completion.

Some conflicting opinions arose in the early design stages of the Personal TV. The smallest RCA receiver at the time, a 17-inch set, represented the minimum standard of performance that was considered acceptable. A picture smaller than 17 inches could not be a thing of the past; picture brightness lower than that afforded by a minimum of 12 or 13 kilovolts, a resolution below 300 lines, or sound output appreciably less than a watt were considered to be out of the question. The consensus, both within the Company and in the Industry, was that little could be done to advance the state of the art except through small evolutionary changes, on which the Industry had been working very hard right along.

Against this consensus, the Product Development activity of Black and White Television Engineering advanced a supposition that the "Big Boss", the Public, might have a different view. That, having conceded some minor reductions in performance of radios in return for reduction in size, cost, and weight, the Public was ready for a similar step in TV: that a compact, light-weight, and relatively inexpensive package, for use at shorter viewing range than the larger sets, and therefore with correspondingly smaller picture and lower sound volume, could be successfully introduced.

EARLY INVESTIGATIONS

Evaluations and demonstrations of the above points were started with a laboratory set-up of variable bandwidth video versus size of picture, designed by B. E. Nicholson, and of a very narrow, but very high-gain single-stage i-f amplifier by D. A. Comimini. These demonstrations proved quite conclusively that reduced bandwidth on a reduced-size picture meant a loss of only some finer detail, but not of the apparent overall sharpness; provided the overall "square-wave" response was corrected by adequate peaking of the higher video frequencies, and was free of any "smear."

An examination of this picture revealed a certain objectionable behaviour of phase response with adjustment of the fine tuning control. As a result of this analysis, corrective measures were instituted through partial staggering of the i-f circuit responses. When demonstrated to management, the pictures were concluded to be thoroughly satisfactory for commercial usage; particularly in view of the fact that all important transmitted information is generally carried by the lower-frequency end of the video spectrum and that some picture degradation due to loss of high frequencies is not objectionable on the 8-inch screen.

Fig. 1 illustrates the greater importance of adequate peaking and "square-wave" response over that of bandwidth response on the apparent sharpness of the picture.

There were two factors that finally determined the size of the "Personal": (1) the width of the smallest available tuner, which had to be nested beside the kinescope neck, and (2) the qualitative evaluation by management of the picture and package as a whole. The choice of the 8-inch kinescope as the smallest practicable size proved to be a wise one, for even with the small number of tubes and components, this minimum package has little room to spare.

THE CHALLENGE OF CIRCUIT LAYOUT

The various aspects of physical development of the chassis in locating the various functional groups of components were that they should be located: (1) in the most logical positions that
the space would permit; (2) in such positions that the heat generated and radiated by some would not be harmful to others, and so that the ventilation in the cabinet would have the greatest cooling effect; (3) in such positions that the effects of the high-power stages, such as the horizontal deflection, on points of high sensitivity, such as the picture detector, could be made negligible, and (4) in such positions as would allow greatest ease of manufacturing, and of serviceability in the field.

KINESCOPE DEVELOPMENT

Since the largest single component was the picture tube itself, it was essential that its contours be designed to provide maximum conservation of space without materially adding to necessary circuitry. This was achieved through the cooperation of Mr. C. W. Thierfelder, Manager of Black and White Kinescope Design at the Tube Division in Marion, Indiana, and whose efforts in every phase of development of the 2-inch kinescope have produced a picture tube of excellent quality and value.

Because the non-aluminized kinescope was used in the final design, a higher utor voltage was required. This higher utor voltage was somewhat greater than the value which would have been most economical to utilize.

DEFLECTION PROBLEMS

The problems of horizontal and vertical deflection and high voltage were assigned to H. D. Twitchell, Jr., who first started along the lines of sinusoidal scan, demonstrated by C. M. Hunt of Product Design a few years before. Mr. Hunt had shown that by blanking every other trace of the sinusoidal scan, and discarding the crowded edges, it was possible to obtain a usable picture on a wide-angle tube. But as quality requirements for the "Personal" were raised, it became apparent that standard circuitry would have to be used.

Proceeding along conventional lines, Mr. Twitchell evolved a horizontal deflection transformer and circuit layout that are unique in compactness and shape, to fit the limiting clearances around the bell of the kinescope. Since the +B and filament power consumption of the deflection section of a receiver is generally be-

RADICAL SOUND CHANNEL DEVELOPED

Development of what is believed to be the most economical sound channel in any commercial TV receiver was carried out by E. B. Smith (Fig. 3). In spite of space, voltage, and power limitations, he obtained the needed sensitivity and quality using a single dual-function tube and three crystals, and by reflexing the low-level audio through the 4.5 megacycle i-f pentode. This reflexing, or re-using of the 4.5 megacycle amplifier a second time, for audio, brought in some new problems. Intermittent "Holes" in the carrier envelope were caused by excessive plate swing with pulses of audio in series with the tuned circuit. The "Outer grid effect" (electrons returned to the #1 grid region by the negative excursion of the outergrid, i.e., plate, in this case) also occurred, aggravated by the combination of low plate voltage and high plate impedance, which was needed for the sake of sensitivity. Teaming up with Mr. Comminos, who handled the development of the picture i-f and the second detector, he established the criteria for adequate sound sensitivity without interference of sound with the picture.

I-F PERFORMANCE

A "Sound bump" circuit was added by Mr. Comminos in the first i-f stage, to peak up the sound carrier and to provide additional gain. A boost in sound gain was required because the narrow over-all band width, necessary to achieve the sensitivity for the picture, allowed less gain for
the sound i-f carrier. The cost of the
"hump" circuit was small compared
to that of the full stage that would
have been needed for a similar result.
The overall i-f curve (composite of
the converter, the first i-f on the tuner,
and the second i-f on the chassis) is a
rather sharply pointed "haystack",
and it required extensive studies of
a number of possible alignment tech-
niques, with a view of obtaining maxi-
mum sensitivity on weak signals, yet
allowing maximum shift and widening
of the curve as the AGC bias is in-
creased. D. A. Comminns, who handled
all these problems, is shown in Fig. 4
checking the overall alignment of a
production unit.

R-F PERFORMANCE
The problems of r-f performance were
assigned to G. E. Skorup. In a series
of carefully planned comparative tests
of various types of tuner arrange-
ments, he proved out the advantages
of the one proposed by J. C. Achen-
bach's Tuner group, and was quite
instrumental in its final adoption. In
its application to the chassis, as well
as modifications of the input circuit
and filters, extensive coordination be-
tween Mr. Skorup and L. A. Horowitz
and R. Barone of the Tuner group
was required. Mr. Skorup also con-
tributed to the development of the r-f
raster centering attachment and mount-
ing, and of the beam bender and its
adjustment. The latter was made diffi-
cult by the shielding enclosure of the
kinescope neck. Fig. 5 shows Mr.
Skorup measuring light output ver-
sus adjustment of the beam bender.

OVERALL PERFORMANCE AND DESIGN
The overall operation of the receiver,
as well as the "square-wave" re-
sponse, synchronization, and stability
of the picture were handled by B. E.
Nicholson. Overall receiver operation
included the problems of heat, both of
the components and the cabinet, and
of electrical interferences between
functional sections. The compactness
of the chassis, and the proximity of
high-power deflection circuits to pic-
ture detector required the use of a
shield over the yoke; the proximity
of the power transformer to the kine-
scope neck required the use of a
shield over the neck. The tempera-
ture rise of the power transformer,
the effect of its heat, and of heat from
the deflection tubes on the walls of
the cabinet, and the shape and size of
ventilation louvers, all required ex-
tensive heat runs. Some rearrange-
ment of components was necessary
before satisfactory results were finally
obtained. In these heat runs he was
assisted by A. A. Bowen, technician,
who also wired the "rear" chassis,
assembled the complete chassis and
instrument, and collected the wiring
information. Fig. 6 shows Messrs.
Nicholson and Bowen with one of the
developmental chassis in an unfolded
position, examining a problem in
wiring.

MECHANICAL DESIGN
E. C. Lick, Mechanical Engineer, was
assigned to the mechanical design of
the overall instrument, including the
chassis and the cabinet. Ably assisted
by R. A. Norman, also of the Me-
chanical Design group, and by J. D.
Luber and F. G. Schoelbo, of Drafting,
he faced the very difficult task of
meeting the spacing requirements for
a number of electrical components in
the chassis design, which resulted in
a three-level "front" base. The cabinet
styling requirements were solved to
include a very special shape of louver
to ventilate the chassis. The "rabbit-
ears" antenna also presented serious
problems, particularly of electrical
contact between several sets of parts.
The interlocking of the power lead-in
between the cabinet and the chassis
proved to be a problem point because
of safety margins required under lim-
ited space conditions. The excellence
of the solutions to these problems is a
credit to the mechanical design
team who solved them.

FIELD TESTS
Field tests of the circuits in various
stages of development were conducted
in a number of locations under vari-
ous conditions of reception. Evalua-
tion of picture and sound quality,
of overload and cross-modulation

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from Robert College, Istanbul, Turkey, in 1928, and
his M.S. in E.E. from Michigan College of Mining
and Technology in 1930. His experience covers, in
main, seven years with Philco and nearly eighteen with RCA.
The latter includes development of the second "Per-
sonal" radio, the BP-12, development and design
work on probe ammeters and airborne radar, and a
Television.

In the Black and White TV Engineering, he is the
Manager of Product Development group which has
been responsible for a number of RCA and industry
"firsts" such as the receivers with metal kinescopes,
receivers with "wide angle" deflection, 21-inch re-
cievers, receivers with 90° deflection, as well as many
deluxe, top of the line models. The group spearheads
the continuous search for better and cheaper circuits,
techniques and products.
characteristics, of sensitivity, selectivity, noise immunity, airplane flutter, and of the effects of various alignment procedures, and combinations of video peaking on the sharpness of the pictures obtained from various transmitters, was almost a continuous process. Facilities of the RCA Service Company's Browns Mills Laboratory, strategically located as "semi-fringe" for a large number of stations, were used again and again. The assistance of E. A. Hildebrand and W. G. Manwiller, RCA Service Company Quality Control, and their wide experience in field testing were valuable contributions.

Among other types of tests, particularly exacting were those required by the Underwriters' Laboratories, (see J. W. Fulmer's article in Vol. 1, No. 3, RCA ENGINEER), and in these the guidance of Mr. Fulmer, of the Engineering Services, played a most decisive role. The assistance and guidance of F. B. Stone, the tube coordinator for TV Division, in various problems of tube and crystal application have also been invaluable.

The work of L. T. Fowler and his Components group, particularly of A. C. Thompson and K. G. Weamer, in obtaining and maintaining the uniformly high quality in the new and physically smaller components has been responsible for the relative freedom from trouble in the factory, as also were the efforts of J. M. Wright and his Resident Engineering group in Bloomington, and particularly C. J. Blume in piloting the factory into smooth and uniform production.

In conclusion, the RCA Personal TV presents a relatively new concept in television home viewing. It is the first set on the market to provide true portability and small-set convenience, modestly priced for the "second-set" market. The teamwork that developed in the design engineering phases helped promote a greater understanding between the members of the Product Development group and between this group and others who contributed their specialized knowledge to the project.

Fig. 4.—D. A. Commins checking overall receiver alignment. Particular care was taken in this phase of design to provide a convenient alignment procedure.

Fig. 7.—Group meeting of Product Development, discussing the final design of the Personal TV. Left to right: B. E. Nicholas, B. A. Bowes, D. A. Commins, H. D. Twitchell, Jr., G. S. Skovp, E. C. Lick, H. A. Bond, F. G. Sheibel, J. D. Luber, S. I. Townsho, Mgr., and E. B. Smith.
Fig. 5—G. E. Skarup measuring light output versus ion-trap magnet adjustment. Notice the special tool for adjusting the ion-trap inside the kinescope neck shield.

Fig. 6—B. E. Nicholas (left) and R. A. Bowen examining an early "breadboard" version of the Personal TV. This "unfolded" set-up provided ease in accessibility to all components for test.