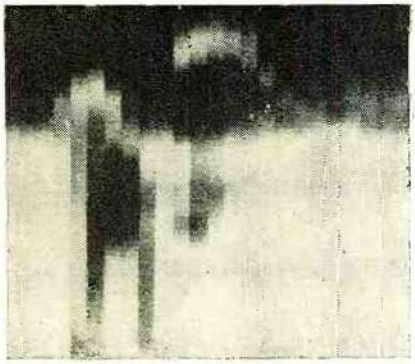
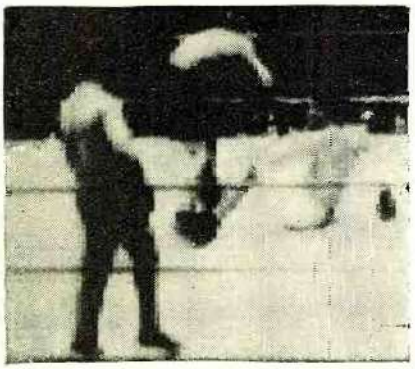
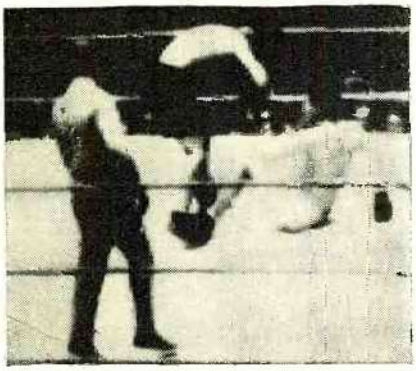
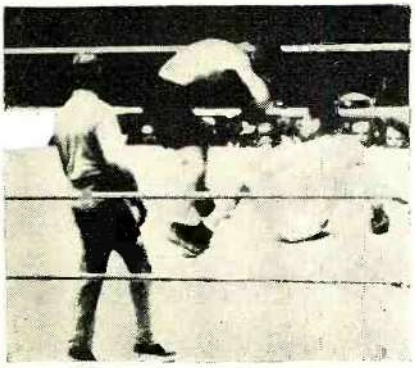








The MARCH

In Televising Scenes—

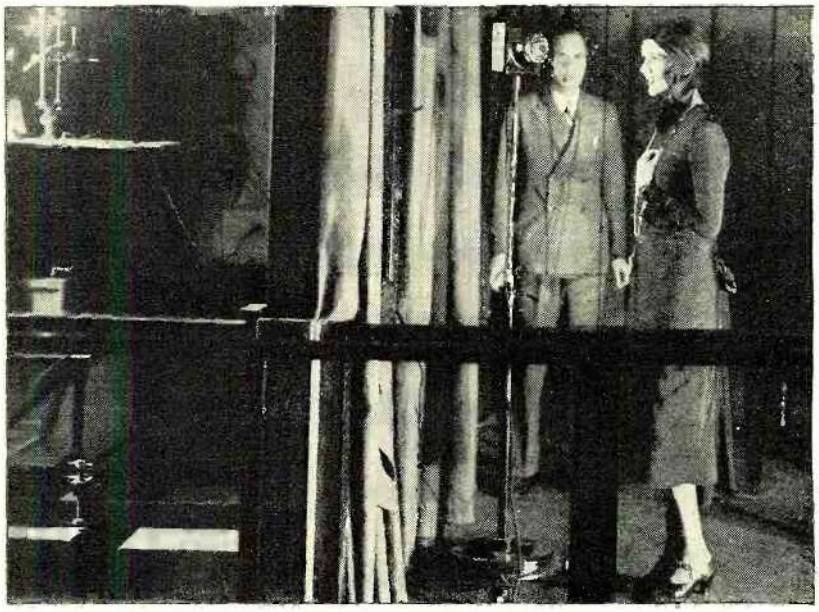
¶ *Which would you choose of the five television views at the left as having sufficiently clear definition for satisfactory home television? The Editors would appreciate hearing from readers as to their decisions. If you are interested, simply drop a note to the Editors,* RADIO NEWS, *giving the number of the picture you would choose, starting with number one at the top*

By Lieut. William

Part

IN recent years television research has been directed mainly toward the improvement of definition. This general term covers the clearness of the image, its size, and to some extent its color. On definition, or its vaguer corollary entertainment value, hinge all arguments as to what television is or is not today and all speculations about its future possibilities. Definition is quantitatively stated as the number of elements, or minute areas of varying light and shadow, into which the picture is separated by the scanning process. If the scanning proceeds along successive parallel lines, as it does in present systems, the number of these lines is roughly the square root of the number of elements. A single square inch of photographic magazine illustration may contain ten thousand separate elements, and would be spoken of as a "hundred-line picture." It is obvious that increasing the number of lines increases, also, the number of elements and therefore improves definition. In general, the number of lines used in transmitting and receiving scanners is the best single index of television progress, for this line number is in fact the yardstick of definition.

Technically praiseworthy though present 60-line television may be, it does not seem to attract any large proportion of the buying public. The great question in television development is: What definition must be attained before the average home owner will buy a televisor to install beside his radio? What will be "acceptable" definition? The answer depends largely on what the average home owner expects to see. If two or three people in semi-closeups were to remain the limit of television's field of view, the present 60-line picture might possibly suffice. But the public undoubtedly wants to see football games and public events of all sorts, the national air races, the chorus of a musical comedy—anything and everything that it hears now. Furthermore, it has been led to expect, by the predictions of prominent executives, that it will see them shortly. To get some idea of how a football game would look in a 60-line picture, one has only to visualize it in a square inch of ordinary newspaper photograph viewed through a magnifying glass. It is evident that a much clearer picture than this is required. Perhaps the



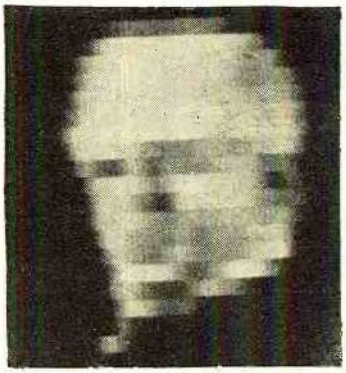
BEHIND THE SCENES IN TELEVISION

At the right is the artist being televised. At the left is seen a portion of the room in which the television transmitter is located

of TELEVISION

—In Televising Faces

¶ *Which would be acceptable, number one at top to number five at bottom? Number one pictures in both cases contain over 600 picture units, number two contain over 1,000 picture units, number three contain over 3,000 picture units, number four contain 12,000 and number five contain more than twice this latter number. You will note that, for faces, less detail is required than for televising scenes*



Bell Lab's Record Photos

H. Wenstrom, U.S.A.

Two

logical assumption would be that television must approximate the definition of home movies before it can take a permanent place in the home.

While home movie definition is vaguely familiar to most of us, for comparative discussion it must be evaluated in lines per picture. In the Bell Laboratories Record for April, 1931, is an article by D. K. Gaunett which includes several pictures of varying clearness, labeled with the number of elements to which each corresponds. A home movie projector was set up and operated until the moving figures on the screen approximated in size the figures in Mr. Gaunett's pictures. The projector was then stopped, both to immobilize the figures and to discount the integrating effect of motion on image clearness; and the figures on the home movie screen were compared with the still pictures. When the still picture corresponding in clearness to the home movie image was found, the number of elements was read directly beneath the former and multiplied by the ratio between the movie screen and still picture areas. Needless to say, the comparison was made several times with different types of movie scenes in order to check the accuracy, and the results are only approximate at best. But they are accurate enough to show that home-movie definition is far beyond present television definition. The rather startling result was that the home-movie picture could be considered as having about 190,000 elements; in other words, it was a 440-line picture. Considering the probable errors of the method, it is enough to say that home television should produce a 400-line picture before it will be on a par with home-movie pictures.

If this 400-line picture is the goal of television research, when will it be attained? Of course, this question cannot be definitely answered at the present time, but some inkling, more likely to be true than false, is offered by the increase of definition that has been attained during the last few years. In the 1927 demonstration the Bell Laboratories showed a 50-line picture. In 1931 home-television transmitters and receivers are being standardized on a 60-line picture. This 20 percent increase in definition, measured against four years of determined research, does not loom very large. Yet no one who has seen them in action can doubt the ability of the men engaged in television research, nor can he fail to admire their work. What, then, is the answer to this paradox of able workers and negligible (*Continued on page* 876)

CATHODE RAY TELEVISION RECEPTION

This is how faces appear when received over the Von Ardenne cathode ray system, which employs no scanning discs in its operation

The March of Television

(*Continued from page* 853)

results? It is, simply, that television research along present lines is restricted by severe limitations.

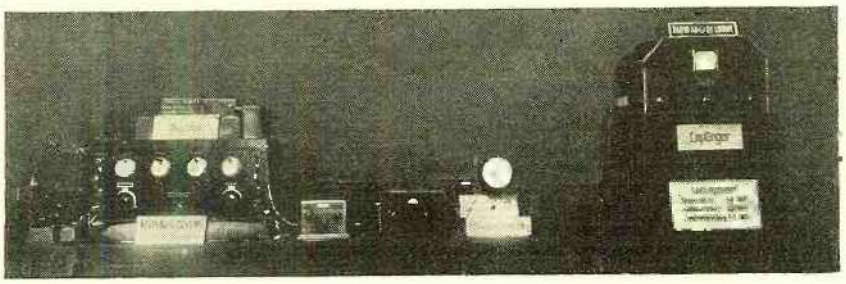
First, there are limitations of apparatus. These are more evident at the receiver, which must be comparatively small and cheap, than at the transmitter. If the image is to be viewed directly on a Nipkow disk (as it is in several present commercial models), home-movie quality demands about 400 holes on the spiral curve spaced at least two feet apart. As such a disk would be at least 200 feet in diameter, it is apparent that the method is preposterous for practical installation. With the drum-type scanner it might be possible to reduce somewhat the dimensions, but even then the drum alone would fill a fair-sized house. Present cabinet-enclosed disks and drums give a picture only about one and one-half inches square, which is made to appear somewhat larger (but not clearer) by a magnifying glass directly in front of it. But the disadvantage of the magnifying glass is that the observers must be huddled together within a fairly narrow field of view.

These limitations of apparatus size may be avoided by projection methods which, however, introduce difficulties of their own. One is adequate lighting, the difficulty of which increases as the square of the picture size. In other words, projection to the size of home movies would require something like one hundred times as much light as the present small pictures. Then too, there is the matter of clearness. A 60-line picture is no clearer projected on a screen than it is on the disk. To get 400-line definition on the screen, assuming a disk about ten or fifteen feet in diameter, we are faced with the problem of placing 400 lenses, perhaps an inch in diameter, along a spiral curve around the disk, each lens center being accurately located within less than one thousandth of an inch, and each lens being accurately ground to the same optical characteristics. However difficult, this problem is perhaps not impossible, particularly in theater television where the expense may be justified. Projection methods will bear watching in the future.

The great advantage of the cathode-ray systems is that the moving parts, comprising only an electron beam, have no inertia in the ordinary sense. But these systems have disadvantages of their own. The beam must be projected through a vacuum, which entails a glass bulb about three times as long as the screen is wide. For a cathode ray screen of home-movie size it is difficult to see how the tube itself could be less than six feet long. Most people would not want a vacuum tube filling half a room, even if they could afford to buy a replacement every year or so.

Perhaps the most serious limitation of the cathode-ray system is the tendency of the beam to spread with distance, due to the mutual repulsion of the electrons of which it consists. One cannot focus the bright spot of an ordinary cathode ray oscillograph down much narrower than an eighth of an inch or so. For a 400-line television picture with such a tube, the spot could be no wider than about one hundredth of an inch. It does no good to speed up the electronic scanning operation to the extent of a 400-line picture if the successive tracks of the spot greatly overlap; the net result is not a 400-line picture at all, but something far less clear.

It is one of the cardinal communication principles that the faster you wish to transmit intelligence (or the amount of it you wish to send in a given time), the wider must your electrical channel be. This theorem applies to telegraph, telephone and radio alike, and television is no exception. Larger pictures and more detail mean wider television channels. Wider channels, in turn, mean very special and expensive arrangements on wire lines; or in the case of radio, wide sidebands with consequent blanketing of other stations which might like to transmit also.



THE COMPLETE CATHODE SYSTEM

At the left is shown the complete Von Ardenne cathode ray tube transmitter for television, while at the right is the cathode ray receiver. These are being commercialized by Loewe in Germany

It is now standard television practice to provide twenty pictures per second. A 60-line picture has 3600 elements, corresponding to picture currents of frequencies up to 1800 cycles per picture. Thus the highest picture frequencies in 60-line scanning are around 36,000 cycles per second or 36 kc. Should the definition be improved enough to produce a 120-line picture, the highest picture frequencies would run around 144 kc. And should the definition be carried up to the home-movie standard of 400 lines, the picture frequencies would approach 1600 kc!

The upper frequency limits of open wirelines are, of course, not definitely fixed, but in general they are around 30 to 40 kc. In populous areas underground cables would be necessary and these, by special loading, could also be arranged to transmit frequencies up to perhaps 40 kc. Present 60-line television, therefore, is well within wire possibilities for countrywide service, and the same is true of the 72-line scanning used in the Bell Laboratories two-way system, except that the latter might require two special lines instead of one, separating the picture frequencies into appropriate bands by means of filters. But 120-line scanning would require about four special lines, while 400-line scanning corresponding to home-movie quality would call for something like fifty wire channels. Inasmuch as each of these fifty channels must be much more carefully balanced than for audible broadcasting wire lines of today, to say nothing of the difficulty of filtering out fifty bands of frequencies and recombining them, it is evident that nation-wide diffusion of high-quality television, comparable to present

chain distribution of audible programs, is far in the future if possible at all.

The radio probabilities are likewise limited. The 36-kc. picture frequencies of 60-line scanning call for two 36-kc. sidebands, one on each side of the carrier, or a complete radio channel 72 kc. wide. This is within the limits of present television bands in the neighborhood of 2000 kc. and 3000 kc. Should definition be increased to 120-line scanning, however, the channel width would be about 288 kc. This channel would require some rearrangements, but it would be entirely possible. Home-movie definition, however, would inordinately increase the channel width to over 3000 kc. If one of the present television transmitters attempted such broad modulation it would blanket all three present television bands and the ship, air and amateur bands between them, to say nothing of our entire present broadcast band! Even if such a station were permitted on the air it would not assure dependable television service to any great distance, because much of the time radio fading effects would mar the image before they got more than 25 to 100 miles from the transmitter. In addition, there is the difficulty of designing a receiver to cover such an enormous frequency band.

It is possible, by using ultra-short radio waves, to avoid both channel restrictions and nearby fading difficulties at one bound. With a carrier of 40,000 kc., 3000 kc. modulation does not bulk so large. Broadcasting on about 7 meters has been tested in Berlin during the past two years, and in New York City the RCA-Victor Company is said to be sending out experimental ultra-short wave television. Those waves gave excellent coverage in the comparatively open city of Berlin; but among the steel towers of New York results may be quite different. Ultra short-wave transmission, like everything else in engineering, demands a price for its boon. The waves are propagated practically like light waves with no reflections from the ionized layer, so that the range scarcely exceeds that of a visible beacon, being mainly dependent on the height of the transmitter above the ground.

Present Progress

These limitations show why television development has moved slowly in the past and continues to move slowly in the present. Rapid progress, it would seem, can only be initiated by the discovery of some entirely new principle. It would be far from the truth, however, to regard the art as static or to consider present efforts futile. An understanding of these limitations leads to better appreciation of results obtained in spite of them. A great deal of splendid research is steadily going forward.

The RCA-Victor Company and the Philco Company are said to be working on home televisors of the cathode-ray tube. Little information about them is available except that they may be ready within a "short time" and will give "excellent definition." It is difficult to see how this definition can approach the 400-line home-movie picture. Perhaps a more likely figure is something like 120 lines—a mere personal guess, of course, based on the limitations detailed above.

Everyone who converses over the Bell Laboratories two-way television system is delighted with it. You forget all about wires and whirling disks, so perfect is the illusion of an actual meeting in which you are participating. Burdened only with the task of transmitting clearly a single face, this 72-line system stands out in present relative perfection above others viewed. There is no reason why it could not soon be installed in the larger cities for regular service.

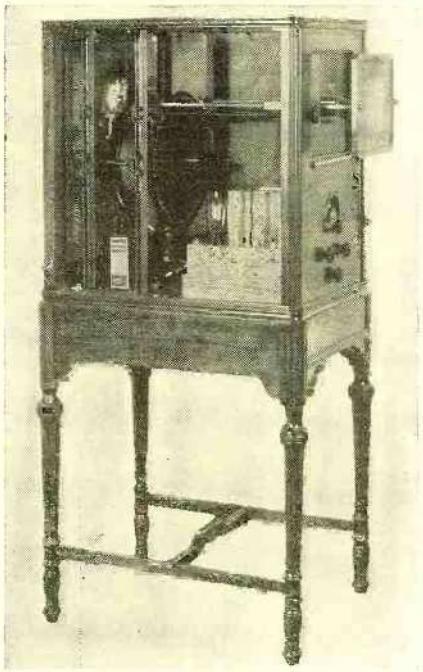
Another immediate possibility is theater television, which has received some atten-

tion from engineers of the General Electric Company and also from Sanabria. In the theater is placed for bulky and expensive apparatus that could never be installed in the home. The expense of elaborate equipment and multiple channels also, is better proportioned to the theater. Here, in the writer's opinion, may be the real beginnings of television as pure entertainment.

With present 60-line equipment the foundations of television artistry and showmanship are now being laid. High up in the New York headquarters of the Columbia Broadcasting System is a new television studio, where, daily, well-known artists perform in the flickering light of the flying spot. On Fifth Avenue the Jenkins Company, also, sends out regular programs, well presented and entertaining. Other stations in the city and elsewhere are in daily operation. Creditable receivers, such as the Jenkins and the Baird, are on the market.

Outstanding among the smaller research organizations is the Jenkins plant at Passaic, New Jersey. Here a television camera has been developed which can be pointed and focussed with the ease of a standard movie camera on any well-lighted object, near or distant, inside or outside. The operator, looking into a combined view-finder and monitor on the camera, sees the picture resynthesized by the same disk that has analyzed it, in light from a neon tube connected to the amplifier output. This camera opens to television the whole field of artistic lighting as developed in the theater and the movies. Another Jenkins development is a projection receiver giving a picture a foot square. This, in the present magnifying-glass era, should arouse enthusiasm, particularly if the definition can be advanced beyond the 60-line picture. And in larger form, it has distinct possibilities for the theater.

Thus the slow march of television is a forward march showing definite gains against severe limitations. One of these days someone may evolve an entirely new principle before which the limitations will fade away. It is said that a short time before the Wright Brothers flew at Kitty Hawk, learned men in Europe proved conclusively by mathematics that human flight was impossible. Perhaps something similar will happen in television. But until the thing is done we might remember the phrase, "figures do not lie."



PROJECTION TELEVISOR

In this new Jenkins receiver which employs the lens scanning disc, the received pictures are projected on a ground glass section which enables everyone in the room to view the living objects

Quartz-Crystal Receiver

(*Continued from page* 838)

of which is considerably favored by the audio correction circuit. The result is, on a quiet night less background will be heard on the ordinary super while the reverse is true on a noisy night. (The tube hiss, however, is quite negligible. Reference is made to it only as an interesting point, and in an effort to provide an impartial picture of what the Stenode is and what it will do.)

The fundamental circuit is shown in Figure 6. No values are given, nor is the super switch indicated. These details are reserved for the constructional article to follow.

The switch is mounted on the shaft of the balancing condenser, so that when the balance control is turned all the way counter-clockwise, the following changes are made: The primary of the correction transformer is opened, the first audio stage being changed to a resistance—coupled stage with an impedance leak (the secondary of the correction transformer). The crystal is thus shorted out. The center tap to the bridging condensers is opened, and the lower side of the first i.f. secondary is grounded making available the entire winding, thus increasing the gain.

It will be observed that the circuit is fundamentally that of a superheterodyne, the input i.f. stage being tuned with the quartz crystal. The radio-frequency amplifier is preceded by a band-pass pre-selector and immediately followed by the first detector. A simple oscillator, with a specially-designed tracking condenser, is employed in preference to the usual padding arrangement. The output of the tuner, whether operated as an ordinary superheterodyne or as a Stenode, has a straight-line audio characteristic and may be input to any high grade power amplifier, such as the Loftin-White or the special amplifier to be described later in these articles.

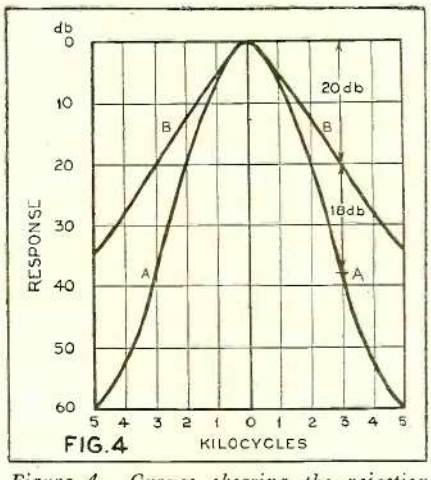


Figure 4. Curves showing the rejection and audio-frequency attenuation characteristics of the receiver

The dial is provided with two ratios—the low ratio, (5 to 1) being employed for