"LOOKING AHEAD" - TECHNICAL SESSION"

MR. W. K. HEADLEY: Good morning. For the session format this morning we have chosen the two words "Looking Ahead". These words really mask what we have all known through the years as our technical session, but this year we are attempting to place emphasis on trends which are moving us ahead into the future of our industry. We hope you will find this session interesting and I am sure you will find it quite varied in terms of the subject matter discussed. We are going to be very tight for time, because there are a total of eight speakers. The first seven speakers incidently are also exhibitors at this convention. Therefore, we will have to set it up so that there will be no question and answer period for the first seven speakers. However, you are invited to come up and see them afterwards, or see them in their exhibit booths and put any questions to them which you may have. For the last speaker, since he is a guest from abroad, we will attempt, if we have time, to have a short question and answer period following his paper. So without further ado I would like to introduce the first speaker who will talk on the future trends and specifications of community systems and equipment. The speaker is Mr. Ken Simons, Chief Engineer of Jerrold Electronics Corporation. Mr. Simons.

MR. KEN SIMONS: Since the first CATV Systems in this country were installed, Community Television has come a long way. The early systems had few amplifiers and served relatively small towns. Almost without exception there were no satisfactory air signals in the areas being served. Today's Systems use dozens of amplifiers in cascade, extend for many miles and serve thousands of people. Very often a CATV System operates in direct competition with one or two good air signals. These facts strongly affect the technical requirements placed on the System. To compete against air signals the quality of the CATV pictures must be comparably good. To make the service attractive under these competitive conditions, the operator must provide many more channels than were needed in the earlier Systems.

This growth inescapably requires improvements in the techniques used for measuring and specifying System and equipment performance. In the pioneer years it was sufficient to measure signal levels and look at pictures. Looking ahead, with large capital groups investing hundreds of thousands of dollars in CATV, we must find ways of providing more meaningful specifications.

What makes a specification meaningful? It must mean the same thing to everyone who uses it. You would have trouble knowing how much cable to order if one manufacturer used a 10 inch foot and another used a 14 inch foot, and both called them "feet". When every one agrees on a 12 inch foot you can buy cable to fit between two points and know it will come out right.

The least meaning ful specification in the CATV industry today concerns amplifier output ratings. This is decidedly a "10 inch foot" proposition. There is no common agreement on test methods, nor on distortion limits. I can't tell you what these test methods and distortion limits should be, but I can tell you what Jerrold's practice is, and I would like to do this in some detail in the hope that this will help towards eventual agreement on this vital point.

The output level of a CATV System is almost always limited by cross modulation, "windshield wiper" effects due to passing many channels through single amplifiers.

The basic test for cross-mod is a simple one: FIGURE 1 shows a block diagram of the setup. A number of clean signals at the various channel frequencies are combined and fed through the amplifier or system under test. While viewing the output signal on a good television receiver, the output levels are increased until windshield wiper is just visible in the picture. The level at which this occurs can be called the maximum usable output of the system. This test gives surprisingly consistent results. If you will try it you will find it very easy to agree on the level at which overload occurs.

Figure 1.

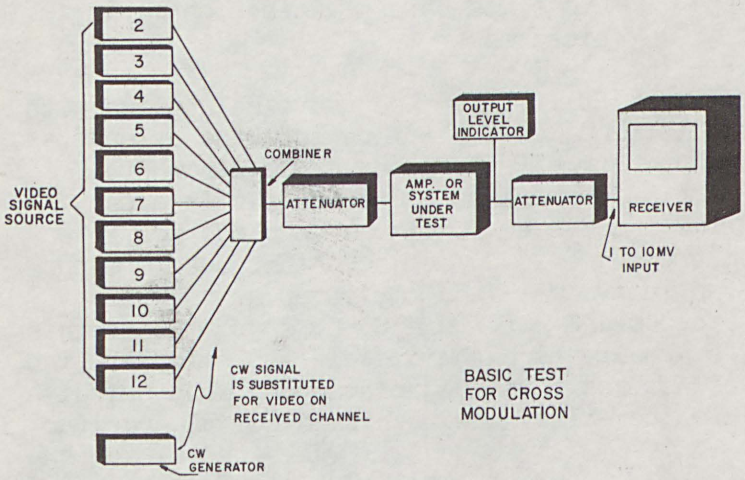
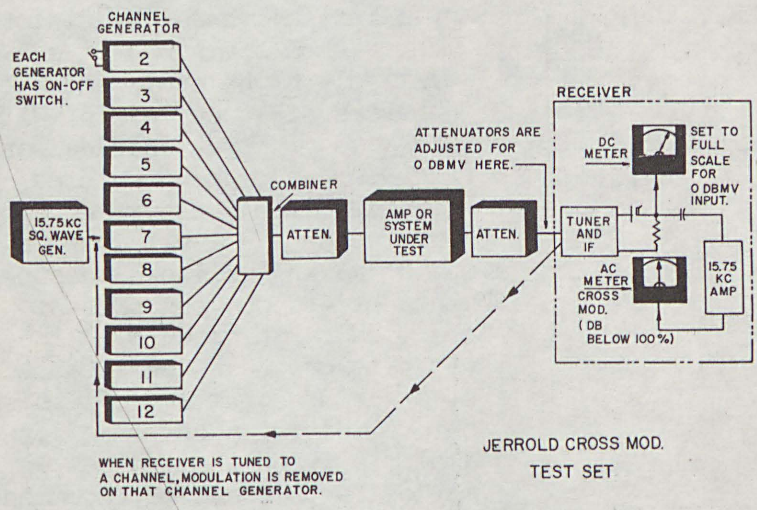


Figure 2



There is a weakness in the fact that, when viewing TV programs, windshield wiper can be seen much more readily on some pictures than on others. The accuracy of the test is greatly increased if a CW signal is substituted for the picture signal on the viewing channel. This provides a white screen which does not change during the test, so more consistent and critical observations can be made. Since System characteristics are generally not the sane for all channels, this test is complete only when it is made on each channel, the CW signal being substituted in turn for each of the channel signals. The maximum usable output is then that which gives barely visible interference on the worst channel.

The white screen test is the basis of all our amplifier output ratings. While it is a good basic test, it requires judgment so that it is not convenient for day-to-day use in the laboratory. For laboratory measurements we have developed the cross-mod test set outlined in FIGURE 2.

Any combination of twelve crystal controlled carriers is available. Each one is 100% modulated with 15.75 KC square wave except when the receiver is tuned to it. The receiver includes a DC meter measuring the detector output level and a tuned 15.75 KC amplifier with a meter to measure the AC modulation. This meter is calibrated in db below 100% modulation. This test set gives readings of relative cross-mod in db. To mean anything these readings must be related to the basic white screen test. We have conducted a great many tests during which a small group of engineers and others compared the performance of a given amplifier on the white screen test with its performance measured on the cross modulation tester. Excellent consistency is found in most cases, and the performance corresponding to certain cross-modulation numbers is shown on FIGURE 3.

These relationships are obviously approximate. Given a cross-modulation tester and a white screen setup any given group of people could come up with numbers varyind a db or so one way or the other.

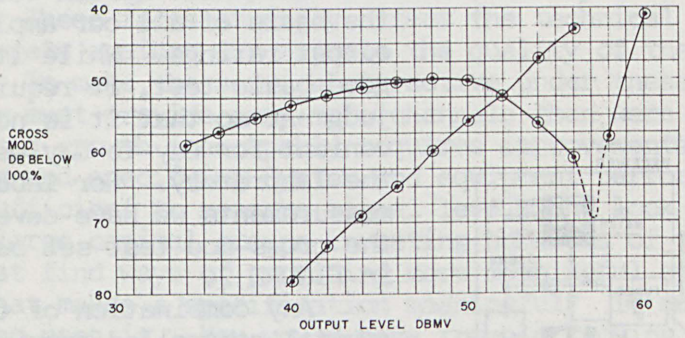
Figure 3

Cross-Mod. Reading	Picture Characteristics
-57 db	No visible cross mod.
-51 db	Cross mod barely visible on white screen
-45 db	Cross mod barely visible on moving pictures

All of the numbers shown represent SYSTEM limits. They must be applied with care to individual amplifiers. With distribution amplifiers and line extenders there is no great problem, since they are normally operated at levels where cross-mod is measurable. Main line amplifiers are more difficult. In a cascade System cross-mod doubles each time the System length is doubled; so, in a cascade of 32 amplifiers, the System cross-mod is 30 db above that due to each amplifier. Measuring distortion on an individual line amplifier at operating output level requires measurement of cross-mod more than 80 db down. Since this is difficult it is common practice to measure at higher levels and calculate the distortion at operating levels. This assumes that the relation between output level and cross-mod follows a simple mathematical law. This is not always true.

FIGURE 4 shows, for example, a plot of cross-mod vs. level for two different amplifiers ; a distributed amplifier (a) which shows a characteristic changing almost exactly 2 dv for each db change in level (following basic theory), and another broadand amplifier (b) where the distortion reaches a minimum at a relatively high level, and then increases at lower levels. With this kind of curve cascade performance cannot be predicted from high level measurements. Since we have not yet found a way of making reliable measurements at -80 db, our present practice is to measure in the vicinity of -60 db on a cascade of at least eight amplifiers before setting specs on a line amplifier, and until a better method is proposed we recommend this as a reliable procedure.

Figure 4



EXTREME CASES
CROSS MOD. MEASUREMENTS

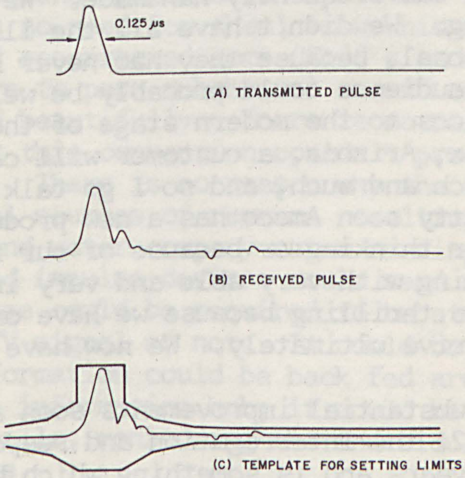
A second troublesome specification is concerned with the echo content or ghosting of the final picture due to the System. Echoes are generated in a CATV System wherever there is excessive impedance mismatch. Echoes result from mismatch at the input and output terminals of amplifiers, splitters and taps, as well as from mechanical irregularities in the cable. Although System performance can be controlled reasonably well by specifying the degree of match on each piece of equipment and by controlling the cable manufacture by careful sweep-frequency tests, it is difficult to find an overall System measurement which will provide a usable echo rating.

One fact is tied down. It was established at the Bell Laboratories by careful subjective tests some years ago that, with a studio-quality picture, a video echo signal producing a second picture clearly displaced from the first, would produce a visible ghost when it was less than 40 db below the main signal.(1) Other tests established the relationship between echo delay and degree of impairment.(2) One factor prevents applying these results directly to the Community situation. The annoyance effect of an RF echo depends not only on its amplitude but also on the RF phase of the echo carrier in relation to the main carrier. The greatest annoyance is produced when the RF echo is in phase (positive echo) or 180° out of phase (negative echo) with the main signal. An echo signal of the same amplitude will give less trouble when it's phase is between these two extremes.

A workable compromise which leaves much to be desired is to use an "echo rating" which says that the echo content in the received picture shall be no more annoying than a single well-displaced video echo 40 db down. This leave open a considerable area of discussion as to the relative annoyance value of a complex echo pattern as compared to a single echo.

There is an approach to the problem of measuring and specifying echo distortion which has been used in Europe much more widely than in this country. This is the sine-squared pulse test.(3) A signal corresponding to a single picture element is sent through the System and its shape at the receiver is compared with its shape at the head end. FIGURE 5 shows comparison of a transmitted pulse (a) with a received one (b) showing the effect of close-spaced and long distance echoes. One way of specifying System performance is to require that the received pulse fall within a set of limit lines, as indicated on the figure (c).

Figure 5



SINE SQUARED PULSE

Another area of confusion concerns hum modulation. Subjective tests were carried out at the Bell Laboratories (4) which show, for a studio-quality picture, that a hum signal 40 db below the video signal is barely perceptible. This 40 db specification need not be applied directly to the community situation because present-day receivers with keyed AGC circuits provide a considerable degree of protection against hum modulation. Considering this fact, our experience indicates that a 30 db limit (30 db lelow 100% modulation) is reasonable, but work remains to be done to evaluate the effect of receiver characteristics and establish a reasonable limit.

We have lived with many compromises during the growth of the CATV industry. Now that we are coming of age we will get along better if we can learn to speak the same language, to establish tests and specifications on the essentials of System performance that are clearly defined and understood by operators and manufacturers alike.

(1) See "Quality Rating of TV Images", Mertz, Fowler and Christopher, Proc. I.R.E. Vol. 38 Nov. 1950 pp 1269-1283.

(2) See "Influence of Echoes on TV Transmission", Pierre Mertz, Journal of SMPTE, Vol. 60, May 1953.
(3) For an excellent presentation see "Performance Testing of Television Channels", by Maurice E. Cookson pp. 28-34 TV and Communications, June 1964.
(4) See "Observer Reaction to Low Frequency Interference in Television Pictures," by A.D. Fowler, Proc. I.R.E. Vol. 39, pp. 1332-1336, Oct. 1951.

Thank you for your time. (Applause)

MR. W. K. HEADLEY: Thank you, Ken. As we proceed in our long and varied journey ahead this morning, at top speed necessarily, we will whisk you into the second subject, which concerns itself with solid state system concepts, and on this subject you will hear from Mr.Donn Nelson, Staff Engineer at Ameco, Inc.

MR. DONN G. NELSON: There was a thought provoking article written by General David Sarnoff of RCA and NBC fame in the May issue of Fortune Magazine. In this article, General Sarnoff predicts the future of not only electronics, but many other aspects of communications in the United States and for the whole world. He is an advanced thinker and among the things he predicts are these: he predicts that some day news can be typed out in one country and by a verifax satelite TV link be simultaneously reproduced many thousands of miles away. The news can happen and we can instantly receive it. He predicts that some day a personal communications link will exist, which will allow the mass public to talk to each other and look at each other in full color reproduction at any time. Now he does not say how this is to be accomplished, but I think that we have in the CATV industry a means whereby this could be achieved.

Roughly 15 years ago, the first CATV system was formed and it was formed for altruistic purposes rather than the reasons we form a system today, but during that period of time the equipment we worked with was frequently handmade. We made it ourselves. We had to do our own engineering. We didn't have all the illustrious brains in the engineering world at our disposal, because they had never heard of our industry. Many of you sitting in this audience could probably be well called design engineers, because you are contributors to the modern stage of the art. Frequently when I am at the plant in Phoenix, Arizona, a customer will call up and say, Donn, why don't you manufacture such and such, and so I go talk to somebody, and he talks to somebody else and pretty soon Ameco has a new product on the market and it wasn't because of our superior thinking or because of our ingenuity, it was because of the fact that we are dealing with very able and very intelligent people who are our customers. The future is thrilling because we have only scratched the surface, we don't know where we will arrive ultimately. We now have CATV, CCTV, ETV and STV.

The three areas in which we will have substantial improvements soon are: 1. rural TV, including long distance transmission, 2. the interrogation and response system which is something that has been known for years and is something which we are going to be forced to adopt, and 3. reliability, something in which we are all interested.

One of the foremost allegations that the FCC has against CATV is the fact that we cannot, nor do we offer service to everybody. If a farmer happens to live four or five miles out of town, even if there are a few other farms out there, we, as system operators, just plain ignore them because we can't afford the amount of money it would cost to hook them up. It might be 27 years before we get our money back. I was talking to Dick Yearrick, one of our salesmen out of the Harrisburg office in Pennsylvania, and he says that he has wired or sold the equipment for wiring many small towns together. If a town is maybe four and a half miles from another town, he has been able to use transistorized line extenders and offer economical service from one of these communities to another. This is something many operators have missed for a long time.

Bill Rheinfelder, Ameco's chief scientist, turned out a report in which he rated all of the Ameco amplifiers. He determined what he called a figure of merit. This figure of merit was based upon the noise factor and the output capability of each amplifier. One of the striking things which was disclosed by this report was that Ameco's line extender series has exactly the same figure of merit found in the more deluxe and expensive mainline series of equipment. This means that an operator can cascade line extenders, which sell for $69, less discount, again and again and again and deliver high quality pictures at the end of the transmission line.

Also, in our laboratory we have been working on an FM modulation system for long distance CATV transmission. It now appears that in the very near future, Ameco will have an even better means of propagating signals. There is no reason, based on scientific data, that Fm video could not be transmitted 50 or 60 miles without degradation of the video information or the sound. That would mean that we could economically replace many of the microwave hops which are so difficult to obtain with a cheaper reliable transmission system.

The second thing I would like to discuss is the interrogation and response requirement. In order that educational TV may really be effective, we must plan to have interrogation and response. The cripple, the shut-in, the person too feeble to leave home would be able to study a trade on educational television and, by means of the CATV system in his community, he could answer questions during tests from his bed. He could achieve diplomas, certificates or even degrees.

We have the equipment to accomplish the above conditions right now. In fact, at Ameco we had a requirement very recently to do this very thing. I found that many years ago, we used to build what we designated a CF 33. This was a small unit which bypassed an amplifier so that RF could go one way and audio or other lower frequency information the other way. The devices worked very well, but there was no need for them, so we hid them away with the old obsolete prototypes. I resurrected some CF-33's and used them with some of our new subchannel amplifiers to pass subchannel around one way and the regular VHF the other way. It worked beautifully. There is no reason why any one of the companies represented at this convention couldn't produce equipment to give interrogation and response. There is no reason why the CATV system of the future couldn't have additional sources of revenue resulting from this. Also, we could have a power company and water company meter reading service, whereby, we could punch a button and impulse devices would send out information over the CATV system. Every house could be required to be attached to the CATV system whether they use the TV signal or not. It could be a requirement of the power company. This coded information could be back fed around the amplifiers in the CATV lines to a central information hub; it could be decoded, fed into IBM machines from which utility bills, monitoring the individual homes in a community, could be processed in minutes.

Think of the revenue that would come to the CATV operator if he maintained a service like this. The CATV operator could also run public opinion polls interrogating consumers right from their homes. He could show a product on the TV screen and the customer could punch a yes or no button which would indicate approval or rejection of this product. There is no reason why in the CATV system of the future, we couldn't vote at election time, by having a keyed identification to be activated directly from our homes.

The third important area of system improvement which I foresee is that of reliability. Years ago many of our systems were "Jerry rigged"; many haphazardly thrown together. Some systems had Ameco equipment, Jerrold equipment, Entron equipment and SKL equipment, all operating in a given length of cable. These

These systems were inferior, incongruous and frequently a night-mare to keep operating. The engineering of modern CATV equipment has improved vastly. There is no major manufacturer of CATV equipment today who doesn't make pretty good equipment.

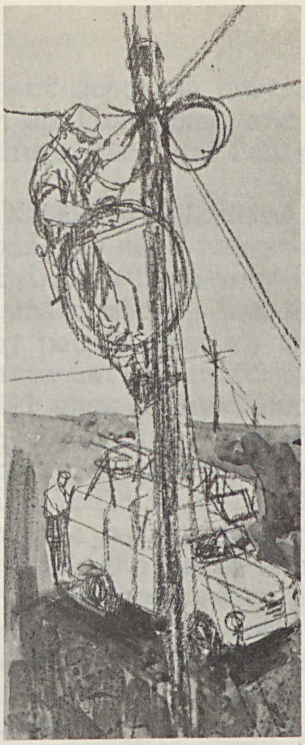
The cable connectors we use today are much better than the problematical ones we used to use. For example, we at Ameco have announced a new line of 75 ohm, matched, simple and durable cable connectors. Today we have cable coaxial which is far superior to any we have had in the past. The anticipated life of good aluminum cable is 20 years. Derrek Busby of Canada Wire Ltd. says, "Ours will last 35 years". I don't know if that was salesmanship talking, but I doubt it. But just think of that, 20 years! That's twice what we used to think of as the life of the entire CATV system. Our modern day systems are better, but they must be made even more reliable. If for instance, "Phonovision", which the telephone company is currently demonstrating, became popular and in demand, the CATV system would be an ideal medium for transmitting this video and audio. We have bands of unused RF frequencies between the FM spectrum and channel 7. We have all of the subchannels that could be filled with phase modulated video information. If AT&T would become interested in utilizing our industry for this purpose, they would insist upon one thing; that is system reliability. AT&T would probably not even consider renting or leasing services from a CATV system which had a low reliability index. Where amplifiers and component parts become very hot due to vacuum tubes and high voltages, the system can require frequent and extensive maintenance. The reliability of Transistors is dramatically superior to that of vacuum tubes. An anticipated life of 97 years makes these devices preferred amplifiers for now and the future.

The last thing I would like to say is that many of the things I have mentioned as "coming soon" are happening today. Ameco is now building a system in a relatively large Southern city in which we are including additional income for the CATV operator. We are adding a subchannel communication link to this productive CATV system. It will consist of a 10 mile closed link from the head end which will completely loop the activities centers of this Southern metropolis. It runs right through the center of town where it passes through the business and shopping areas. The loop unites the public schools, it goes by the public institutions, the parks and every place having something of interest for the citizens. This subchannel link will have 50 inputs. Each input will allow the origination of TV programming for community service and commercial purposes. The subchannel information will pass through the amplifier chain to the head end where it will be converted to a normal CATV channel. Local businessmen will advertise on this system. The CATV operator will be able to sell or give away time to display a grand opening of a new store, he can show sales promotions, he can show a library opening, he can show anything of civic importance to his CATV subscribers and his subscribers only.

Ameco is a manufacturer who is meeting future reliability requirements today. We feel that when we look to the future of CATV, we are looking to the future of CATV with Ameco. (Applause)

MR. W. K. HEADLEY: I'd like to make another short announcement here. I know that many of you have brought your children to the convention. It's been a pleasure having them and I hope they are having a wonderful time. I'm sure they are because I think you will all agree that the job George Barco and Bob Tarlton have done as co-chairmen of the committee has given you a convention that you will long remember. To prove the point that the planning is complete and detailed, some of you might be wondering what you will do with your children when you are attending the banquet tonight. Therefore, this is simply to announce that there will be a childrens' banquet in the Crystal Room at 7:00 P.M.

FIELD ENGINEERING



CATV CONSTRUCTION

COMMUNITY SYSTEM ADVERTISING (CSA)

COMMUNITY SYSTEM OPERATIONS (CSO)

Jim Stilwell
Engineering, System Planning, Equipment Evaluation and Design.

Joe Dickson
"On Time" Construction, Efficient Manpower Utilization, Experienced Knowhow.

J. Fred Weber
System Promotion & Advertising Programs, "AIDA" Promotion, Proven Subscriber Builders.

Charles Wigutow
System Management, Operating Techniques & Procedures, Personnel Training

What's So Good About TSC?

Good People... and TSC is staffed with the finest technical and management talent in the CATV industry. Each of us has grown up with every phase of the CATV business and in turn we have contributed engineering techniques, equipment, and advanced management programs that have helped the CATV Industry grow.

This creative approach to CATV has enabled TSC to build over 3,000,000 feet of plant this year . . . manage and operate 31 CATV towns . . . and sell over 13,000 connections for other systems through our Community System Advertising Department.

For You—we can evaluate a potential CATV community, plan and build the system, staff and train personnel for the system, sign up subscribers, and even operate your system for you!

Want more facts about the fastest growing team in the CATV business? ***Call TSC!***

TSC ®

TELESYSTEMS CORPORATION

113 South Easton Road, Glenside, Pennsylvania • 215 TU4-6635

The next subject concerns critical characteristics of coaxial cable for community television applications, and on this we will hear from David Karrman, Staff Engineer, Times Wire and Cable Company.

MR. DAVID E. KARRMANN: Looking ahead in providing quality systems with long life and trying to meet new standards for the industry, I would like to discuss what we think to be a very critical characteristic of cable itself. This is the impedance uniformity. Impedance uniformity should be measured by a return loss method. Many people measure the impedance uniformity of their cable by sweeping it for attenuation uniformity. An attenuation uniformity sweep will give an output that will show a level suckout at a particular frequency where there is a mismatch within the cable. Now in general, in trying to measure attenuation you are limited to a few tenths of a db of accuracy. A few tenths of a db of accuracy in attenuation could be related to a VSWR of about 1.5 to 1. This type of VSWR would represent a rather poor return loss quality from the cable, actually about 14 db. We think the cable should have a much higher quality than this and we propose using return loss sweep as a quality measurement. We sweep the cable for return loss using a return loss bridge. These bridges can have a dynamic range of 50 to 55 db which enables us to read impedance uniformities in the vicinity of 1.01 to 1 or better.

Before proceeding I want to define return loss. The return loss of a cable is the db difference between a signal applied to a cable and the signal which reflects back out the same end of the cable. This measurement is made by connecting a terminated length of cable to be evaluated to an impedance bridge (such as the Jerrold KSB-75) and sweeping the cable from 50 to 220 mcs and observing the reflected signal on an oscilloscope. A marker generator and variable attenuator are used to measure the frequency and amplitude of any spike in the pattern of the returned signal. The effective VSWR at that frequency can be found from figure C.

A return loss spike represents a unique situation within the cable, in that there are many little structural discontinuities, each of which are reasonably small and are located a half wave length apart at the frequency of the spike. The reflections from each of these discontinuities sum together to form the relatively large total reflection. At other frequencies the little reflections will add with a randum phase relationship, canceling each other, and therefore not being visible in the trace of reflected signal.

This measurement of return loss can be translated into a degree of picture degradation. Since return loss is a measurement of a reflected signal within a cable, and since a ghost is a reflection as viewed on a TV receiver, there is obviously a distinct relationship between these characteristics.

For the purpose of this work, we have taken the assumption that the reflection coefficients of all the discontinuities are equal, and therefore the reflections of all discontinuities are equal at the point of reflection. This is a justified assumption, in that they are generally introduced by a repetitive fault in the manufacturing process, the sharpness of the reflection spike is indicative of a cascaded fault, and even if the amplitudes of the individual discontinuities are not equal, the averaging effect of the summation makes this error negligible.

Obviously, the frequency of a return loss spike is a function of the spacing, and there are, therefore, a discrete number of discontinuities within a given length of line. The size of the cable and the frequency of the spike under study control the attenuation between the individual reflections and hence the reinforcement of the first reflection by subsequent reflections. These phenomena have been taken into consideration in calculating the set of curves shown in FIGURE 1.

This figure presents the magnitude of each individual discontinuity compared to the magnitude of the effective total as indicated by the return loss measurement for cellular polyethylene dielectric cables. The curves are presented as a function of attenuation at a given frequency rather than a particular physical size to increase the flexibility in extrapolation of data for all cellular cable constructions. For cables longer than those shown on figure 1, the lowest number indicated should be taken, as reflections from points beyond that length are individually so small compared to the total, and are attenuated so greatly, they do not further increase the total reflection. Figure B shows the relationship between two unequal signals when they are added.

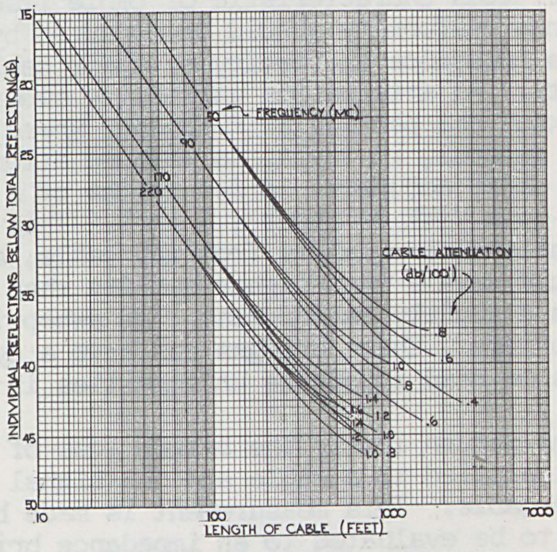


FIG.1 RELATIONSHIPS OF TOTAL REFLECTED SIGNALS TO INDIVIDUAL REFLECTIONS AT EACH DISCONTINUITY

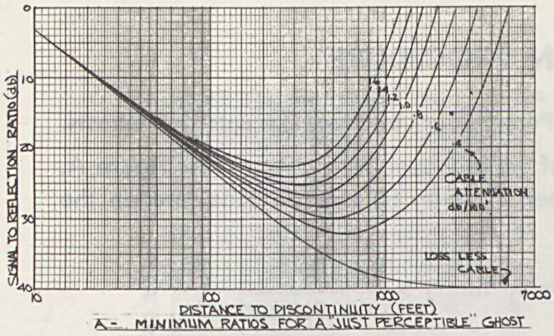
We must now take into consideration the effect of delay time on the perceptibility of reflections as viewed on TV screen. Figure A shows the relationships between the reflection magnitude and its delay relative to the desired signal for a "just perceptible" or "just acceptable" ghost. The larger reflection which can be tolerated with short delays is due to the loss in picture resolution of two closely spaced signals.

In considering reflections coming from a cable, the attenuation of the reflections must be considered. A reflection coming from any point in the cable will be delayed and attenuated by twice the transit time to the point of reflection. Taking the attenaation of the reflection and the relationship of amplitude and delay in mind, the critical point in a cable was found. Figures 2A and 2B show the minimum signal to reflection ratios at the point of reflection ratios at the point of reflection for a "just perceptible" or "just acceptable" ghost. Again the curves are plotted as a function of attenuation for full flexibility in consideration of various cable sizes and constructions as well as operating frequency.

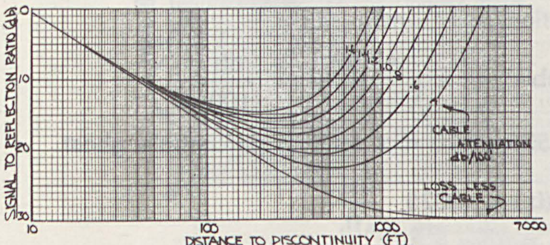
We can now convert our "return loss" measurement into picture degradation with the aid of the relationships established in figures 1 and 2. By summing the individual reflections over a 2 microsecond delay time centered at the critical point of the cable, the magniture of the resulting picture degradation can be calculated as a function of the signal to reflect in ratio as measured by a return loss sweep. This has been done and the results are shown in figure 3 as minimum return loss at any channel for several typical cable.

It must be kept in mind that this discussion includes only the effect of the discontinuities within the cable and that there will probably be other impedance mismatches in the system (taps, in and output matches to amplifiers, connectors, and splices) which will introduce additional ghost degradation. Therefore, a return loss specification of 26 db at Channel 2 with a weighting factor of 3 db per octave appears to be a minimum quality level for a system which is slightly better

Figure 2



A - MINIMUM RATIOS FOR A "JUST PERCEPTIBLE" GHOST



B - MINIMUM RATIOS FOR A "JUST ACCEPTABLE" GHOST

FIG.2 - SIGNAL TO REFLECTION RATIOS AS A FUNCTION OF CABLE ATTENUATION AND LOCATION OF REFLECTION POINT FOR CELLULAR POLYETHYLENE DIELECTRIC COAXIAL CABLES

than "just acceptable." A system designed for the highest picture quality should incorporate 30 db return loss cable.

Although the degradation introduced by devices inserted in the line often is considered more significant than the effect of the cable, the overall long term performance is certainly improved by at least starting with good cable in the system, cable which will still provide top quality when the degradation introduced by other system components is reduced by advances in the state of the art.

Acknowledgements:
The author wishes to thank Mr. Ken Simons for the information used to set the signal to ghost ratio versus delay for a minimum acceptable standard.

Thank you. (Applause)

Figure 3

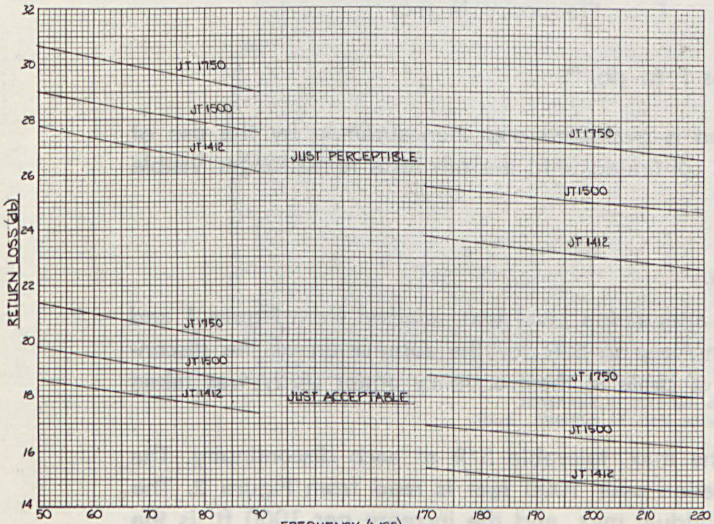


FIG.3 RETURN LOSS VS. PICTURE DEGRADATION

CALCULATION PROCEDURE

I. Critical S/R vs. Location for "Just Perceptible" or "Just Acceptable" Ghosts.

The tolerable S/R for time delays of up to 9 usec were taken from Figure A. These delays were converted to feet of cable, taking into consideration the two-way transmission time.

$$\text{Cable Length (ft.)} = \text{Delay (usec)} \times \frac{1 \text{ (ft.)}}{.0025 \text{ (usec)}}$$

Since this tolerable S/R is at the viewing point, it can be increased by twice the cable attenuation to the reflection point under study.

$$\text{S/R (min. at A)} = \text{S/R (tolerable)} + 2\left(\frac{\text{A (ft.)}}{100} \times \alpha \frac{\text{db}}{100 \text{ ft.}}\right)$$

Example: Min. S/R at 500′ of JT1500 at 90 mcs for just perceptible ghost.

$$\text{Delay} = \text{Cable Length (ft.)} \times .0025 \frac{\text{usec}}{\text{ft.}}$$

$$\text{Delay} = 1.25 \text{ usec}$$

$$\text{S/R (Min.)} = 36 \text{ db} + 2\,(5 \times .8 \text{ db/100 ft.}) = 28 \text{ db}$$

II. Total S/R or Return Loss (RL) for the Sum of Many Small Reflections for L Feet of Cable at Frequency F.

$$\text{RL Total} = \sum_{0}^{L} rl_1 + (rl_2 + 2S\alpha) + \ldots + (rl_n + 2S(n-1)\alpha)$$

where rl_n = return loss of each discontinuity

S = separation between each discontinuity

$$S = \frac{984 \times .81}{2F} \qquad F = \text{Frequency in mcs}$$

α = attenuation at F in db/ft.

Each term in this expression is evaluated and then summed by the use of Figure 3. The summation is continued until the nth term is no longer visible in the total.

III. Return Loss vs. Ghost Effect.

The critical portion of each attenuation level was selected from Figure 1 and the S/R noted. The total increase in S/R for the summation of the discontinuities in 800 ft. (2 usec) of cable at the frequency under study was taken from Figure 2.

The sum of these equals the max. tolerable S/R of each discontinuity. The total increase in the summation over 1000 feet is read from Figure 2. The difference between the individual max. and the increase per 1000 ft. is the maximum RL that can be tolerated for a 1000 ft. cable.

Max. RL = (Critical S/R + Increase in S/R for 800 ft. summation) − Increase in S/R for summation of total cable.

Figure A

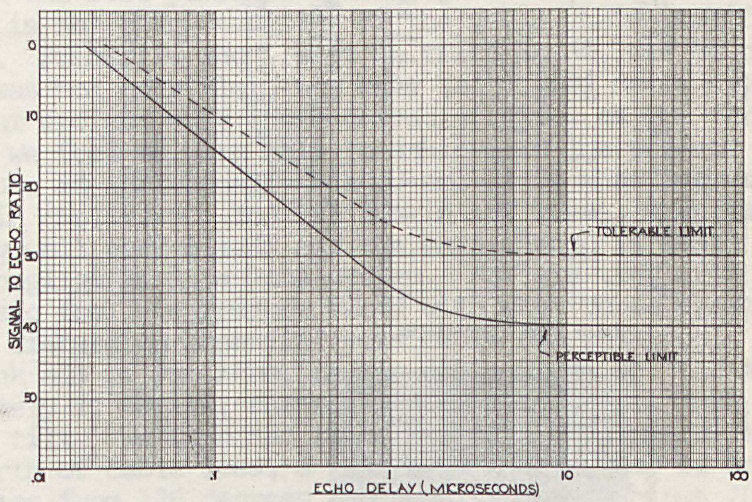


FIG.A. APPROXIMATE TOLERANCES OF ECHO AMPLITUDE AS A FUNCTION OF ECHO DELAY

Figure B

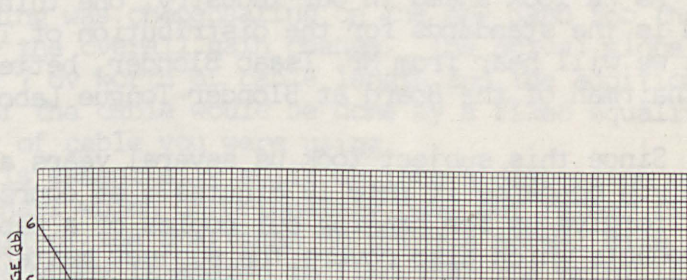


FIG.B ADDITION OF TWO UNEQUAL SIGNALS

Figure C and D

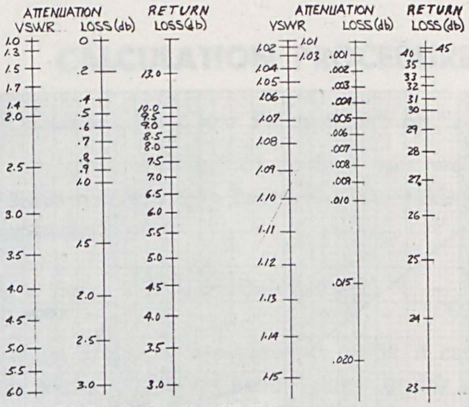


FIG.C- VSWR NOMAGRAPHS

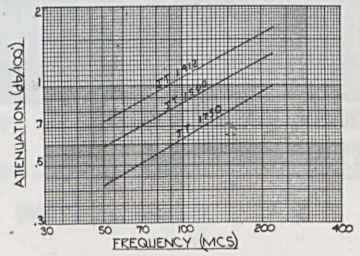


FIG.D ATTENUATION CHARACTERISTICS OF ALUMINUM SHEATH COAXIAL CABLES

MR. W. K. HEADLEY: As we look ahead in our industry, one thing that is important to keep in mind is the standards for the distribution of TV by coaxial cable. On this subject we will hear from Mr. Isaac Blonder, better known to most of us as Ike Blonder, Chairman of the Board at Blonder-Tongue Laboratories.

MR. ISAAC BLONDER: Since this subject took us several years at our plant, and, one might ask, can you condense it into 10 minutes?; of course our answer is no. I hope you will forgive us for handing out copies of a paper commercially designed to sell our products which also covers the subject matter.

However, let me just give you some of the gist of the design philosophy behind the cable compensation which we have attempted to do.

First of all, we investigated the entire range of amplifier and amplifier capabilities. I think all of you know there is a latitude possible in system design between noise figure and output capability. The merit of the system or its dynamic range determines the number of problems that the system can encounter and still survive. The most severe one as far as we are concerned, really resides in the cable, where as you undoubtedly know, the cable slope changes with temperature. In a system that may have as many as 20 amplifiers, if there is a variation between amplifier stages of lets say 1 db, we are likely to wind up with a 20 db variation between one end of the band and the other and since the dynamic range in most long systems is not as high as 12 db obviously you are going to run into either noise or cross-mod.

The first problem that we ran into of course is the amplifier, and there we simulated virtually everything that has been built or that we could think of building, keeping in mind the db per dollar problem, the installation problem and the reliability problem. Since transistors have not yet achieved the output capabilities that we would desire, we had to regretfully delay their usage until technology improved. This left us with tubes. Going into the very big bottles that burn up lots of energy, represented a real cost problem, and the increased output capability did not look to us as if we could justify their use. We finally determined that we would have to sit with a distributed or chain type amplifier with the best possible noise figure and one other characteristic which unfortunately is not characteristic of the usual chain amplifier, and that is a constant gain. Primarily then, what we tried to do, was to come up with an amplifier that was not only flat, not only had a good noise figure, good output capability, but did not vary these characteristics as you varied the gain setting and this we feel we were able to achieve in the present amplifier, the 1232. Each tube is individually biased and it is what one would describe as a constant gain amplifier. You can put in hot tubes, weak tubes and we have run this thing well over a year and the gain change is small enough to be called negligible in a long system. Now starting with this amplifier, having the basic tool, we are now faced with what to do about the cable and the subject of my discussion essentially is cable compensation.

As I think all of you know, as the cable warms up, the signal goes down, and unfortunately it varies, channel 2 does not lose as much as channel 13, so there is a tilt. We then had to make a tilt compensator and for the approximate 23 db worth of cable loss, a tilt compensation can be achieved with about a 2 db variation from 120 degrees fahrenheit down to minus 20. So we designed an equalizer using channel 2 as the pivot point and therefore we came up with our model 3349 which is essentially the thermo-slope equalizer. Now to this was added a gain control which compensated the cable against the fact that you had a loss at both 2 and 13 and this is essentially a square wave step gain control, that was fed to the AGC input of the amplifier, for compensatinn on a flat basis across the band. The combination was put into a single unit called model 3348, I don't want to bore you with these numbers, but essentially what we are doing was compensating on the one hand for the slope change, on the other hand for the overall gain change. The actual slope compensation came to something like 7 dv worth of cable length and the additional amounts required for the rest of the cable would be done by a fixed equalizer which compensated for the amount of cable you were using.

The paper is essentially split up into a discussion of the individual instruments. A chart which unfortunately came out rather fine, I think it's rather the habit of the draftsman to print a normal size and then when it is stated down everybody is amazed to find that the print is a little too small to be read, but if you put on your reading glasses you can see it and I think the explanation is fairly clear. And then finally we set up a typical design problem showing what would happen with about five miles of cables and the fact that we had what amounted to full compensation. We have transistorized pilot carriers and wherever the transistors can be used usefully, they have been used for reliability. We have also included an alarm system which some perceptive system owners may care to purchase. I sometimes think there seems to be a reluctance to put money into equipment and much more into the pocket than perhaps may be wise for the operation of the system, but we have tried to include all the features that are necessary for a quality system. We have set up such systems and operated them and it's more than amazing to find that the theory has gone out into fact, that you have a system that you can apparently put boiling water on and throw it into a carbon monoxide bath and have it wind up with the same quality signal.

At the risk of sounding like a poor salesman, that's the end of my speech. (Applause)

MR. W. K. HEADLEY: The next subject to be treated here certainly well fits into the format of this session, "Looking Ahead". It is the subject of transistorized microwave for CATV. Delivering a discourse on this subject is Mr. Paul Hertel, Assistant Director of Engineering at Collins Radio Company.

MR. PAUL HERTEL: Two years ago I appeared before this group with comments about new devices and some new areas in which we were working at the time and attempted to make a guess as to what microwave equipment CATV people would be using a few years in the future. In looking back a few years and an equal number of "megabucks" of investment in engineering, I feel a little bit embarrassed, somewhat surprised, and I guess a little impressed at how slow new devices develop. However, over the years I think we have made substantial progress both in the area of performance and in the area of reliability. We are now manufacturing microwave equipment with a range of power outputs from 50 milliwatts through 10 kilowatts and frequencies from 4,000 megacycles through 13,000 megacycles. I might add that there is much more interest in the CATV market in the 50 milliwatt equipment than there is in the 10 kilowatt equipment. The 10 kilowatt microwave equipment, of course, is for tropospheric scatter systems. We have at our disposal today components which do allow us a wide range and type of operation, and by integrating these into numerous product lines, we are able to invest considerably more money in our development effort than one product line along would justify.

I would like to go through a rapid sequence of slides since we do not have a great deal of time. Our main effort in the past four or five years has been toward improvement of performance and reliability primarily by solid state design. Our first effort in transistorization was of the power systems. We have believed from the beginning of our efforts that the power supply reliability of a microwave system was predominant in determining the overall system reliability. Our first microwave systems offered battery powering as an option. This was accomplished with rotary machinery which was not veryattractive to us or to the user. As soon as the power transistor came along we applied the transistor approach to the powering system first. Our development effort in microwave transistorization was toward a series of improvements in specific areas rather than attempting in one big step to design a whole new product. This allowed us to do some of these things much faster than would have been possible if we had waited until, for example, we had transistors good enough to build wide band i-f amplifiers. The economical power transistors arrived in the market considerably earlier than the wide band type transistor which allowed us to design transistor i-f amplifiers. As I said previously, most of the equipment we are now delivering is transistorized with the exception of the r-f generation. We are doing considerable work in the solid state r-f generation area, but we feel it may be many years before we approach the performance of the klystron and TWT systems we are now manufacturing. We now have a number of five-watt TWT systems in operation. The first one was installed some 2 1/2 years ago in Venezuela. This system contains five-watt transmitters at each end of a two-way communication link. This link spans 175 miles between two mountain peaks. I have just received the record of propagation performance over a one-year period of time in which the reliability was 99.9927%. This performance over such an unusually long path was made possible by high power and by the use of both frequency and space diversity.

My first slide illustrates the direction taken to improve the power supplies. In this system 24 VDC battery voltage is converted to high voltage. This particular power supply operates a one-watt klystron and produces 750 volts and 1,200 volts DC. The technique used is to coarse regulate the input from a 24 volt system at 20 volts DC which operates most of the transistorized equipment including the klystron power supply. In some cases it is necessary to have considerably higher voltage, because of the voltage swing needed from some amplifier. In this case a converter is used for 130 volts or 60 volts. To operate from 48 volts we use the same basic system but substitute a regulating 48 to 24 volt converter for the coarse regulator. For 115 volts the same basic equipment is used, but the 20 VDC is supplied from a saturating transformer regulated power supply operating from 115 volts.

Next slide. The TWT system is slightly different in that we have somewhat higher power requirements. The TWT operates at about 2,000 volts on the collector and 3,000 or so on the helix and about 1500 volts on the anode. The helix and anode supplies are low current supplies and employ separate blocking oscillator type power supplies. The high current supply operates from an inverter, supplying 135 volts AC 500 cycles.

Next slide. In designing a transistorized product the object was to be as universal as possible in order to meet as many needs as possible and we came up with a packaging scheme we call our "Universal Microwave Group" in which we use many of the same components for system powers of 1/10 watt, 1 watt and 5 watts. The purpose of this slide is to attempt to show in a pictorial fashion the common use of equipment between systems. If amplifiers for example are used not only for video products, but also for 960 channel communication systems.

Next slide. In addition to improving reliability by solid state design, we also had to improve performance particularly for the message systems, and we have increased voice channel capacities to 600 and 960 channels. We have given a lot of effort to thermal design; for example, the low power klystrons employ a thermal control device which sometimes is called the "beer can" which controls the klystron temperature by its own heat. Hence, it does not require any additional power. More recently a thermal chamber has been designed for the one-watt klystron which employs vapor cycle cooling. This particularly has been helpful in stabilizing the differential gain on video systems and the intermodulation distortion on the message systems.

Next slide. This is a simplified diagram of the receiver. We have been using eight-cell preselectors for a number of years to allow quite high density arrangements without interference between systems. The i-f amplifier is broken into four parts - preamplifier followed by a filter equalizer section, i-f amplifier and limiter discriminator.

Next slide. This is the five-watt transmitter which we drive with either 1/10 watt or 1 watt klystrons, depending on linearity requirements and drive. The TWT itself needs very little drive since it has a 35 to 40 db gain so a few milliwatts is quite adequate. Another device which has been added to this system to improve linearity has been the linearizer and this, of course, has been put in for improved intermodulation performance on message systems and better differential gain on TV systems.

Next slide. This is a picture of the TWT. We believe, like the designer of Telstar, that the TWT is going to be around for a while to come. We have picked this device because of its power capabilities, its high gain, and its efficiency. Where we need powers in excess of one watt, we feel that the TWT will be the tube we will have to use for quite some time. There are problems in the solid state devices which do become limiting at these power levels.

Next slide. This is the i-f amplifier, which consumed a good portion of our development effort. We have been helped in this task by the rapid improvement in technology and transistor manufacture. The IF contains considerable control in the bandpass and envelope delay characteristics which effect the differential gain and phase of TV systems and we have done a considerably better job even than we were able to do with similar tube systems. It certainly is a much less costly thing from the operation standpoint, compared to the 25 mc vacuum tube equivalent. Tube receivers with similar performance typically had 20 to 25 vacuum tubes of the frame grid type.

Next slide. This is a picture of the transistor preamplifier with a 3 db maximum noise figure. It is an example of the rapid change in the transistor technology. When we started the project we thought we might have to use nuvistors for the front end to meet our noise figure objective since the transistors available at that time could at best provide about 6 db noise figure. By the time we had finished the main i-f amplifier design portion, the transistors had developed to the point where we were able to obtain slightly better noise figures than were possible with our previous vacuum tube preamplifier.

In closing, I would like to say that I think considerable advancement has been made in the past two or three years. I think a lot will be accomplished in the future. We are now limited in power output only by our capabilities to pay the money and by FCC's limitations on licensing so power output is no longer a microwave systems design problem. Battery power and low power consumption microwave systems are expected to become increasingly more common in CATV's systems in the future, particularly as transistor designs become available for the head end equipment. (Applause)

MR. W. K. HEADLEY: Following along the growing trends of today and looking ahead to the requirements you will have to meet and the opportunities you will want to realize in the future, comes the subject of long line RF cable transmission. Here to deliver a paper on that subject is Mr. Dick Cullinane, TV Systems Engineer at Spencer-Kennedy Laboratories.

MR. RICHARD X. CULLINANE: Thank you very much Mr. Headley. I think we'd better start first of all with what our concept is of "long" in speaking of a long line cable transmission. The word "long" - like many other descriptive adjectives - denotes a condition or characteristic which is entirely relative in nature. Therefore, for the purposes of this discussion, we must seek a definition of what we mean when we speak of long line RF cable transmission.

Notwithstanding the advance through the years of developments in RF transmission equipment, coaxial cables and in the techniques of their application together in systems, it has heretofore been difficult to achieve and maintain acceptable signal quality in lines with amplifiers cascaded over 18 miles or so. Even in these cases, accumulative noise and distortion buildup at the end of the lines has been such that the installations have necessarily served a point-to-point function, without sufficient signal quality at the terminating end to feed a further distribution network satisfactorily. Probably the longest RF lines in operation today are in South Carolina, where Southern Bell Telephone Company has installed runs of nearly 30 miles in straight cascade, using SKL low band trunk line amplifiers. However, these lines (which are used to interconnect public schools for purposes of closed circuit instructional television on a point-to-point basis) carry only two or three channels, with no demands placed upon them for feeding a distribution network after the end of their runs.

It is therefore proper, I think to set the definition of long line RF cable transmission as a line of 15 miles or more in length. But we must demand of this line a capacity for carrying up to 8 television channels simultaneously and with a signal quality at the terminal end of an order to serve a wide band distribution network of more than 100 system miles throughout with pictures meeting entirely acceptable quality. Quite naturally, as the length of the long line is extended, its output into a distribution network will be such that limitations must be set on the length of such network. But even with a long line of 80 miles, for instance, carrying four channels simultaneously, we would demand from it a quality to serve from its output a wide band distribution system of 50 network miles.

How can such standards as these be achieved? Current practice in transmission line design is to set a minimum tolerable specification at the terminal end of the system, then to improve this minimum by an arbitrary safety factor - say 3 db. Using the more conservative resulting specification, the system designer would then go to curve charts and determine the maximum allowable gain of the repeater amplifier then available to him, consistent with factors of economy to meet system requirements. He would of course be further guided by factors of noise and cross-modulation inherent in his amplifier and their effect on system characteristics. He would know that these factors have been treated theoretically by asymptotically converging curves of noise and cross-modulation versus number of amplifiers in cascade. But he would also be aware that even theoretical cascaded limits have not been attainable. For one thing, the theoretical assumption is that both transmission equipment and coaxial cable are perfectly matched, both in characteristic impedance and in gain-loss relationship. In practice these conditions simply are not so, and a downward system design compromise must be made. Further, as the number of repeater amplifiers in cascade is increased, theory dictates a higher input and a lower output level for each repeater. Again, from a practical standpoint, what results is an uneconomically and unrealistically high number of relatively lower and lower gain amplifiers in cascade as the length of the trunk line is increased. These problems have combined in the past to limit severely the lengths of RF lines.

Again, how then can such greatly increased line lengths and performance standards as we previously described be achieved? The answer, of course, lies in the availability of a repeater amplifier so far superior to those which have been previously used that it can actually add a new dimension to RF transmission - the dimension of length - lengths of 20, 40, 50, 90, 100 miles and more. Its operating gain must be high enough to be economical - let us say 28 db - and its bandwidth broad enough to accommodate up to 8 channels. Its noise figure must be low - around 7 db. Its multi-channel output level must be reasonably high, again for reasons of economy. We will set the output level requirement at 40 db above a millivolt. And yet its distortion characteristics must be remarkable at this + 40 dbmv level - specifically we will ask that cross-modulation be down 100 db and second order beats down70 db. Then and only then can these line lengths, which have seemed way beyond practical consideration to us in the past, be used with assurance in various system design applications. We are happy to report that we have developed such an amplifier at our company, and feel confident that it will make a great number of useful contributions to the CATV industry where maximum cascaded lengths of point-to-point lines are desired with minimum distortion characteristics at their terminating outputs.

With our sights now reset, what practical uses do we find for greatly extended coaxial cable lines? We hasten to say that the long line amplifier does not appear on the scene as a direct replacement for microwave. It is obvious that microwave - widely used to serve CATV systems - is the logical technique for many extended signal delivery requirements. But there are many more situations where the use of microwave may prove impractical or uneconomical as against a coaxial line. And I am sure we are all aware of other situations where microwave is simply unobtainable by FCC permit.

Let us conceive of a city of 70,000 population, with two local TV stations and located 115 miles away from a major city having five TV stations, including an educational outlet and an independent station with highly desirable programming. Between the major city and our city of 70,000 people, and fifteen miles from the latter, lies another community of 20,000 population. A tall tower is erected 85 miles from the major city and a complete head end receiving station is installed at this location. The five major city stations are picked up and carried 15 miles via long line to the 20,000 population community, where a side trunk is derived to feed this town, using regular CATV distribution and associated system components. The long line continues on to transmit the five signals the additional 15 miles to the city of 70,000 which again is served by a standard distribution network. One head end serves both communities, and the two local stations are picked up at very little expense and put into the input of each distribution system. Because of the distance involved to the major city, the only alternative method of bringing its signals in would be via microwave. But, first, what do you feel would be the prospect of securing an FCC microwave permit in a case like this to serve areas with two local television stations already operating in them? And second, over a five-year amortization period, the cost of installing and maintaining the 30 mile long line would be less than a five-channel microwave service at typical common carrier tariff rates. Third, at no increase in cost, other than signal receiving or originating equipment at the head end, as many as three more signals could be added to the long line as the occasion might call for them and transmitted to the two communities.

As a second example of long line application, we will set up the hypothesis of two cities lying 20 miles apart, each with about 15,000 population. Along the highway between them lie two small communities, each with a population of approximately 2,000. The most distant signals desired for distribution originate from a city 80 airline miles to the north of the two 15,000 population towns and located more or less at the top point of an isosceles triangle encompassing the three communities. The problem here is how to reach the primary market of 30,000 people without a big cost in duplicated tall-tower antenna sites, and at the same time to pick up the market of 4,000 people in the two small interlying towns, which normally would be much too marginal even to consider service to them. A centrally located antenna site is the obvious answer, but with regular CATV trunk line amplifiers, the runs from the tower of ten miles each way to the larger communities, and wide band distribution systems involving perhaps another 8 or 9 miles each of trunk amplifiers in cascade, would cause signal levels to deteriorate to intolerably low quality toward the ends of the lines. Multi-channel microwave from the central tower to the small towns, then on to the communities of 15,000 population, would be absolutely inconceivable in cost for this application. But by long line cable, with the kind of transmission capabilities we have described, the entire market of 34,000 people is reached with real economy from one head end location.

Incidentally, in regard to economy, it is important to remember that by the very nature of its point-to-point function over long distances, the long line in most cases will be running along the highway in rural areas, where direct burial of the cable is naturally indicated. With present ploughing techniques and spacing of the long line amplifiers nearly a mile apart, the installed long line cost per mile will be substantially less than the average cost per strand mile of a wide band distribution system.

I think it would be appropriate at this point also to make reference to another development which bears upon our discussion of RF transmission over long distances. The development as interesting as its possibilities may be, is not new, either as a concept or as an accomplished fact. Unlike open wire, with which most of you are probably familar, the mode of aerial transmission known as G-line, is not subject to climatic conditions, and its use therefore may be indicated under certain circumstances. However to reach a practical status in the art of long line transmission, greater flexibility in its application must be achieved.

Even though we are talking of long lines of 100 miles or more as fully feasible technically, present day applications will more often center around problems of extending 6, 7 or 8 signals perhaps 8, 12 or 18 miles. It is here that the long line technique has its most numerous possibilities currently. In this latter area I am sure many of you can think from your own experience of situations where profitable opportunities could be realized by extending runs substantially without having to make a self-defeating sacrifice in the quality of signals resulting thereafter for distribution. That suburb a few miles beyond the end of your present trunk, that little town 8 miles out from your community where 96% of the residents have been clamoring for service for years, perhaps that military base 16 1/2 miles each of your tower, for which you could get the contract to wire all 3200 dwelling units, but which has seemed as unreachable as the sun because of its distance and its large distribution area after that .. all of these opportunities can now be turned to money-making actualities with long line cable extensions carrying many channels many miles with such an extremely low build-up of noise and distortion that the quality of signals at the input and the output of the long line seem nearly identical.

As we have said, many of today's long line applications, under our new reference standards of length, are for situations involving relatively short "long runs". But let's take the theme of this panel this morning and see what might be on the horizon when we are "Looking Ahead". Chairman Henry of the Federal Communications Commission recently reminded an audience that "America is being wired for sight and sound". America is a very large country, ladies and gentlemen, and it is studded with thousands of sizeable communities. As television is itself extended as a many-faceted medium, its transmission will surely be extended in degree and to points which we can barely anticipate today. And just as surely, the unique advantages of multi-channel closed circuit cable transmission will be recognized and exploited to carry video and audio information at RF frequencies over greater and greater distances.

A number of you, after the close of this convention, will be visiting the World' Fair in New York, where you will be fascinated by exhibits which project your attention into the future of our world, our scientific achievements and our human society. If I may be permitted onesmall personal commercial reference, I would like to refer to our company's exhibit at this "World"s CATV Fair" here in Philadelphia. A 16-foot mural in our display depicts a long RF coaxial cable transmission line carrying the signals from New York, the World's Fair City to our hotel here in Philadelphia, our convention city. We had this mural made up in the spirit of good fun and of a colorful demonstration taking some artistic license. While the close circuiting of World's Fair events to the Bellevue-Stratford Hotel by this means would undoubtedly fall into the category of a simple tour de force with questionable practicality, the point I want to emphasize seriously is that this feat can be accomplished - now - with new transmission achievements that are available to you all and which may in the very near future open great new areas of opportunity, and profit to each of you.

Thank you very much. (Applause)

MR. W. K. HEADLEY: Since the session opened you may not believe it, but you have heard six speakers and are about to hear the seventh. So I think it's fitting now, remaining more or less in your places, to take a short seventh inning stretch. (Pause) We have talked about the growing need for longer and longer point-to-point transmission. Another facet, of course, which many of you are facing today is the requirement of the larger and larger distribution system. The next discourse you will hear on that subject is entitled, "Problems of Signal Distribution in Large Communities". Here to cover that subject for you in Heinz E. Blum, Vice President in charge of Engineering at Entron, Incorporated.

MR. HEINZ E. BLUM: Gentlemen, the excellent presentation of my co-panelists might have given you the impression that certain manufacturers have specialized in the work of individual system components. However from the association with my friends in the associate membership group I know that all of us have experience embracing the entire field of CATV. Therefore in my following presentation I shall not mention the model designations nor the name of the company with which I am associated. Incidently I'm associated with Entron Incorporated and we have a display at this side of the room showing a system and a workable picture presentation on receivers at the end of a 20 mile system.

The CATV industry has, in the past, applied the engineering principles and the technical know-how of related sciences and industries. It is a part of the electronic equipment manufacturing and of the communication installation industry and has adopted - with modifications, of course - techniques which are being used by these industries. This fact is probably known to everyone familiar with the CATV industry, and it is stated here only to reiterate that CATV equipment and system design follows the same laws and principles with which other fields have to cope.

The CATV system's operator makes it his business to deliver to his customers, through his elaborate distribution system, signals which will produce a television picture on a standard TV receiver which the customers will find "acceptable." In the absence of industry-wide standards it is up to the equipment and system designer to determine exactly what the characteristics of the signal must be to produce an "acceptable" picture.

First, the signal must be such that it can be processed by the customer's TV receiver to yield a likeness of the originally transmitted picture. It must consist of a carrier of a receivable frequency modulated with synchronization, video, color burst, and audio information as standardized by the Federal Communications Commission (FCC). Secondly, it must be of sufficiently high level so as to override, at the TV receiver, any other present and undersirable signals - such as noise - to such an extent that the undesirable signals do not interfere with the desirable ones. Thirdly, the signal must not contain undesired information - such as noise, intermodulation distortion, harmonic distortion, or "beats" - of a level which interferes noticeably with the desired information. Various organizations have established experimentally upper limits of the magnitude of undesired information which can be tolerated as part of the desired information. One of the most extensive research projects was carried out by the Television Allocations Studo Organization (TASO), who, in its 1959 report to the FCC, established, for example, that a signal-to-noise ratio of 42 db has such a small effect on picture quality that viewers rate as excellent pictures having such a signal-to-noise ratio. Therefore, a signal-to-noise ratio of 42 db can be established as design goal for a CATV system. Similar tests and experiments lead to the establishment of a 48 db signal-to-cross-modulation limit. We can intelligently design systems of various sizes at the best possible cost only with such a set of performance standards.

Considering the trunkline problems for large area CATV distribution first, we can see that our established performance standards can be obtained by the following procedure;

1. Determine maximum length of trunkline.
2. Compute trunkline attenuation at Channel 13 for various cable types.
3. Divide the total attenuation by the spacing (operational gain) of the amplifier to be used. The operational gain is generally specified by the amplifier manufacturer for best noise figure, cross modulation, and automatic level control performance.
4. Check whether the system meets the earlier established performance standards by the 3 db per - amplifier-doubling method, which means that every time the amount of cascaded amplifiers is doubled, the signal-to-noise ratio decreases by 3 db, and the output level of each cascaded amplifier must be reduced by 3 db to maintain the same level of cross modulation distortion.

Going through these steps, the maximum number of cascadable amplifiers can be determined.

For instance, at the present state of the art, systems of up to approximately 2000 db attenuation can be constructed utilizing 64 repeater amplifiers. Using a cable having an attenuation of 1.45 db per 100 feet (Foamflex 1/2" or equivalent at Channel 13), a total trunk length of 2000 ÷ 1.45 = 137,931 feet = 26 miles can be constructed. Better cable already available can be used for even longer trunklines.

It can now be readily seen that a further increase in trunkline length can only be realized if and when cables with lower attenuation and amplifiers having higher output handling abilities and lower noise figures are available. At the present time, it appears unlikely that much lower noise figures can be achieved and the development is moving primarily in the direction of amplifiers with higher output handling abilities.

With increasing system size the questions of reliability and obsolescence become more important. While some reliability studies have already been made, much more work in this particular area has to be done to determine the most economical initial-cost-to-maintenance ratio.

The Intercontinental Submarine Cable System and its problems can be cited as an example of a long communication system so similar to the systems with which we are familiar. The latest system which was put into service in 1963, provides communication means for 128 3 kc wide channels in both directions over a single coaxial cable. Transmission in one direction is carried in the frequency band of 108 - 504 kc and in the other direction in the band of 660 - 1052 kc. The total cable transmission loss is approximately 9000 db at the highest frequency. One hundred eighty (180) remotely powered and tube equipped repeater amplifiers with tilted response curves are utilized to offset this cable loss.

The signal-to-interference ratio of each repeater amplifier is at least 90 db. Applying our 3 db per-amplifier-doubling method, we arrive at a 67 db signal-to-interference ratio for the entire system.

Every tenth repeater amplifier has a manually adjustable gain and tilt control, which was set when the cable was laid. No further automatic gain or tilt control is required since the system is installed on the ocean floor where the temperature is constant at 3° C or 37° F.

It is interesting to note that the organization which has developed the transistor and which has done a tremendous amount of research in the semiconductor field has decided that - at the present time - vacuum tubes will better serve the purpose of reamplifying communication signals in a system of remotely powered cascaded amplifiers. This system has been built for commercial applications and initial cost, maintenance cost, reliability and performance have been carefully weighed to obtain the most profitable system.

It is of particular interest to the CATV Field that long systems are not only feasible, but are already in operation after all known engineering aspects have been carefully considered.

With full confidence in its reliability the CATV industry can again make use of techniques previously developed for other communication purposes.

There is one field, however, in which the CATV industry has been unique, and this is the field of VHF signal distribution to cable connected receivers. A large amount of receivers have to be connected so that each one derives the best possible picture quality from the CATV System without introducing any interference into the system. Cities were divided into sections and clean signals were brought via the trunkline to central distribution points in each section. At the central distribution points the signal was taken from the trunk line and fed into distribution amplifiers where it was brought up to a level suitable for distribution and where, at the same time, isolation between distribution and trunklines was obtained. The distribution amplifiers then fed the signal into the distribution cable to which the individual subscribers were connected. Due to the choice of the frequency spectrum within which the signal was distributed, it was possible to utilize simple tap-off devices for subscriber connection. Increased demands for more programs and, therefore, a wider frequency spectrum of the transmitted signal necessitated a more sophisticated method of subscriber connection. This method of the matched multiple subscriber connection device has the advantage of not unnecessarily disturbing the distribution system and the signals carried thereon. Now it becomes possible to space these connection devices as closely or as widelyapart as required by the density of the subscriber population. The distribution line length can now be determined by signal level calcaulations alone without the previously necessary considerations for response curve deterioration and mismatch due to non-matched elements in the line. It becomes advantageous to feed the highest practical signal level into the distribution lines to avoid unnecessary reamplification in these distribution lines. The high level distribution amplifier has become the signal source for many thousands of distribution line miles. Heavily populated, as well as large areas, can be served effectively.

Multi-dwelling buildings obtain their signals from these new connection devices and because these signals are of predetermined quality, as well as of predetermined and stable level, they can be amplified for in-building distribution, if necessary. The initial calculations of signal-to-interference level must include the distribution amplifiers as well as the trunkline repeaters if the previously established performance standards are to be satisfied. This will require that distribution originating amplifiers or bridging amplifiers have to be operated below their individual maximum output level to deliver clean signals to the subsequent extender or in-building distribution amplifiers.

Large area CATV distribution can be economically and effectively achieved only after thorough analysis of all problems involved, but - and this is the main fact - these problems can be solved.

Equipment manufacturers supplying the CATV industry have succeeded in providing the hardware for the ever increasing demand to improve the services which our industry provides. These services are not only recognized but also greatly appreciated by an ever increasing number of our fellowman.

It can safely be assumed that future engineering developments will help the further growth of the CATV industry. Thank you very much. (Applause)

MR. GEORGE J. BARCO: The man who is presiding over this morning's session, is the associate representative on our Board of Directors of the NCTA. In the ten years it has been my pleasure to serve on that Board, I have not known of anyone who has been a finer gentleman, or who has made a more able representative for his associate members, or who has made a greater contribution to the industry, in such a short time. You should also know, that Bob Tarlton and I are most grateful to him for taking on the entire responsibility for the preparation of the program Monday afternoon on the all band conversion, as well as this morning's program. May I ask you to join me in publicly expressing to him our appreciation for his very fine efforts. (Applause)

MR. W. K. HEADLEY: Thank you George. This being Thursday, and after Wednesday night, Tuesday night and Monday night and so on, if I had enough blood left I would be blushing. As I said at the outset of this meeting, because it is so loaded with speakers and our time is limited, we have not had question and answer periods for each of the speakers, but because each of them represents companies who are exhibiting here, again I would ask you that you would direct your questions to them either after the meeting up here or in their respective exhibit booths.

In the case of the next speaker, however, we will attempt to have a question and answer period after his discourse, and if you have questions to put to him, I would very much appreciate your using the floor microphones which are spotted around at various locations.

As our world grows smaller and our CATV industry grows larger, it is important that we be familiar with what is happening in CATV outside our country. We are particularly fortunate today to have with us a man who can give us from intimate experience a picture of techniques being used in the United Kingdom and in Western Europe, and a glimpse into the future as he sees it from his vantage point.

He is an American abroad, and it is a real pleasure to introduce to you Mr. J. R. (Jack) Evans, Managing Director of Teleng Limited in England. He will speak on "The Advance of CATV Techniques in Europe".

MR. J. R. EVANS: Thank you very much, Bill. I am extremely pleased to be here this week at the NCTA Convention and am honored to have the opportunity to address this session. The growth of CATV Systems in the United States has been quite remarkable over the last few years, and now, after meeting so many of you for the first time this week, I am not at all surprised with the results you are obtaining.

In Great Britan today, anyone doing anything unusual or out of the ordinary in the Telecommunications field is likely to be labelled a "pirate". You have undoubtedly read of the famous pirate ships broadcasting off our shores. Although these pirates have been attacked by the Government, the BBC, (which is a power unto itself), and recording Companies, to name only a few, the service they are providing is in great demand and a force has been created too strong to combat. The Government is now trying to make local broadcasting legal, the BBC is rallying its forces in an effort to meet this demand of local broadcasting, and at the same time subdue all competition. I have not heard what action the recording Companies are taking; however, I imagine they have shuttle boats delivering records to destinations on the high seas.

CATV operators in Europe have at many times in the past found themselves in the same boat, in that they have had to set the pace and virtually force advancement through. The only thing is that CATV operators have been called worse names than "pirates". Actually, there are CATV systems operating in Europe today in countries whose laws forbid these operations. I shall not refer to these systems specifically for fear of promoting a "buccaneers scrimmage" prematurely.

The theme of today's session is "Look Ahead", and I am to tell you of "The Advance of CATV Techniques in Europe". This is of course a vast subject, and I could not even outline the major headings involved in this very specialized industry in the few minutes available to me. Therefore I shall limit my remarks to the general overall picture of the industry today in the light of what has been done, and what we shall be doing in the future.

In order to understand present CATV operation in Europe, we must first briefly look back into history and this will be confined really to English history. CATV systems on the European Continent have only been erected during the last few years which I will explain and come to later.

Relay began in England in the early 1920's. One of the first systems to be installed was in Lytham St. Annes in 1922, and radio programmes were distributed over pairs of wires. Radio relay systems sprung up all over the country in areas of poor radio reception and by 1939 there were approximately 500,000 subscribers being served. Expansion ceased during the war, but it is interesting to note that these systems played an important part in the early warning in cities such as London.

After the war when television became available, the same areas of poor reception for radio were equally poor for television. The existing operators were faced with the new problem of distributing T.V. and new thinking and ingenuity had to be applied. You must visualize that these operators had miles of cables erected which represented very large investments. The natural approach was to develop a system to include provision for television which would fit in with the existing networks as much as possible. The H.F. (High Frequency) system was evolved.

Very briefly the technique used in this system is as follows: Normal off air T.V. broadcast signals are demodulated. The video signal then remodulates an H.F. carrier and distributed on a pair of wires, the accompanying sound signal being impressed on the same pair, but at high level audio frequency. Each channel therefore demands a pair of conductors and these are usually provided in the form of a multi-pair cable. Special television terminal units are required to receive these signals and standard domestic T.V. sets can only be used if modified, or by the attachment of special frequency conversion adaptors.

The H.F. system has been developed to a great extent over the years and the technical as well as the commercial achievements can only be admired.

However this is only one of the two basic types of distribution systems in Great Britain today. The other is the coaxial type of CATV, known as the VHF (Very High Frequency) system, which follows essentially the same technique which has always been employed universally by you in this Country. I am associated with the latter.

VHF systems were first installed in England in 1951. Growth in the use of VHF techniques has been steady, and today there are over 200 systems in operation. The majority of these are considered small, i.e. less than 10,000 houses wired but there are a number of systems with 20,000 - 25,000 houses wired. In this figure of 200 quoted, I am not of course including the many hundreds of small housing estates which are wired and are not licensed by the Post Office.

Until recently this VHF camp had not been exploited by large capital interest as had the HF camp, but the gap is more than being made up.

So - we have two types of systems in Great Britain, the HF and the VHF. The total number of Television relay subscribers is approximately 670,000 and HF type systems predominate in subscriber numbers at present. However, in recent years the swing has been towards the VHF system, and I am confident that the terrific expansion of the CATV industry, which is just upon us in Europe, will be via VHF techniques. (Incidentally it is of interest to mention here that in addition to TV subscribers, there are still approximately 900,000 sound radio relay subscribers only. These numbers are however, decreasing rather than increasing annually).

I believe that VHF techniques will obviously become the standard distribution method in Europe. Experts have written lengthy theses for both camps and books have virtually been written promoting the arguments of both sides. But it is essentially a local argument, politically and capitally loaded and except for establishing the present position of CATV in Great Britain, as I have tried to do, this need not be further developed by me here.

Leaving the British scene for a moment we can now look at Europe. CATV operation as I mentioned earlier, is very new.

There have been a number of radio relay systems operating for years, but until four years ago, only a few limited attempts were made to distribute television via cables, and these were not a great success generally because of immature technical application, but also we must consider here that television popularity is far behind what it is in the United States and in Great Britain. The variety of programs is limited and the number of homes with a television set are relatively few. Even today homes with television receivers are only 20% - 30% of the total in most large cities.

However, the first successful multi-channel VHF system to be installed in Europe was erected in Namur, Belgium, by Coditel. Today there are three such systems in Belgium. The other two are in Liege and Verviers. The three systems are now distributing to some 10,000 subscribers, (5) five TV programs of four different transmission standards, and up to 32 FM radio programmes, over quite extensive coaxial networks, reaching up to six miles or more. An indication of the channel reception and distribution is given in SLIDE I.

Slide One

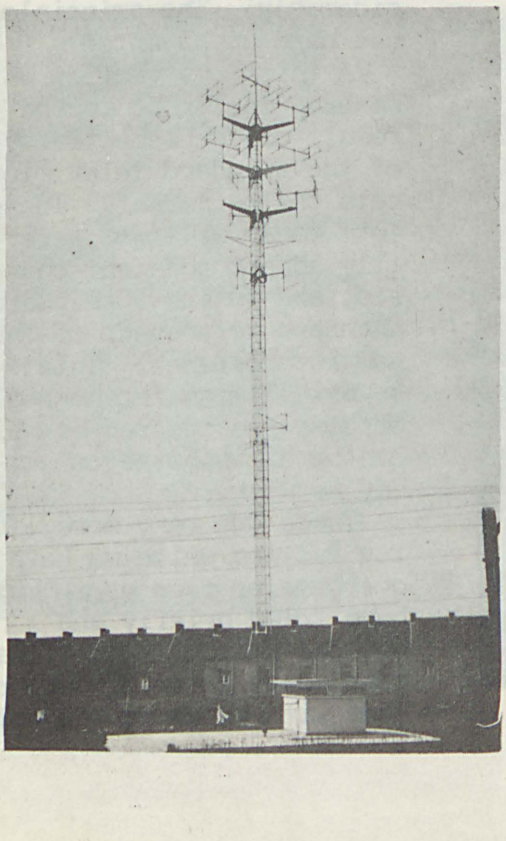
Subscriber's receiver			Stations received by CODITEL		
Television programmes	Channel selector switch position	Standard	Name	Band	Channel
Belgian Fr.	8	Belgian 819 Belgian 625	WAVRE ... or LIEGE	III I	8 3
Belgian Fl.	10	Belgian 625	WAVRE ...	III	10
French * ...	12	Lille 819 ...	LILLE	III	F8A
Dutch	4	Europe CCIR	ROERMOND	III	5
German ...	2	Europe CCIR	AIX or ... ... LANGENBERG	IV III	24 9

* Without any guarantee, according to propagation conditions.

The system, the equipment, and all associated equipment used were entirely developed and supplied by my Company.

Coditel have also installed a small system in Tramelan, Switzerland, and are expanding in that country, and now beginning to install a system in the town of La Chaux de Fonds. This virtually is the CATV operation in Europe and brings us up to date giving the brief background history.

Slide Two



To round off the general overall picture, I must now say a few words with regard to the practical application of CATV operation, because it is completely different from the applications used in your country. It is important to realize that these determining factors demand an entirely different concept.

As I have just shown on SLIDE I, we are faced with a number of different standards - 405, 625,819, line band widths ranging from 4 to 14 mc/s, positive, and negative modulation, AM & FM sound. These variations all add to the complexity of system design.

From the physical aspect of the wiring, our respective problems are worlds apart. In Europe the CATV operator receives a concession from a Local Authority, and tied to this concession are many restrictions with regard to the construction and erection. Street crossing are limited, (and in many places they must be underground), spans via poles or umbrella type wiring which is con-

Slide Three

Designation			Standard					
				Video			Sound	
Programme	Band	Cha. Nr	Band width MHz	Line Nr	Mod.	Freq. MHz	Mod.	Freq. MHz
Belgian Fl.	I	2	7	625	pos.	48,25	A3	46,75
Belgian Fr.		3	7	819 625	pos.	55,25	A3	60,75
Dutch ...	III	5	7	625	neg.	175,25	FM	180,75
French ...	III	F8A	14	819	pos.	185,25	A3	174,10
Luxemburg	III	7	7	625	neg.	189,25	FM	194,75
Belgian Fr.	III	8	7	819 625	pos.	196,25	A3	201,75
German ...	III	9	7	625	neg.	203,25	FM	208,75
Belgian Fl.	III	10	7	625	pos.	210,25	A3	215,75
Belgian Fr.	III	11	7	819 625	pos.	217,25	A3	22,75
German ...	IV	24	7	625	neg.	495,25	FM	500,75
German ...	IV	26	7	625	neg.	511,25	FM	516,75
German ...	IV	29	7	625	neg.	535,25	FM	540,75
German ...	IV	—	7	625	neg.	etc.	FM	—
German ...	V	*	7	625	neg.	*	FM	*

* At least to our knowledge, no receiving tests have been carried out so far on Band V.

Slide Four

sidered general practice in this country is not allowed at all.

The Post Office will not considerer allowing the cables to go on their poles etc. The operator can only then get his cables throughout an area by placing them on private property, and to do this wayleaves are required from each land owner. Wayleaving is considered the most difficult part of installing any network in England and it can be expensive. Only when routes have been wayleaved, can planning be finalized. Absentee land owners is only one of the many problems and headaches involved.

SLIDE 4 shows a typical street wire. The cable is clipped here under the eaves.

SLIDE 5 shows an estate wired in Bath. We see here a typical example of the subscriber feeder technique. The illustration here is of a Teleng tapper unit.

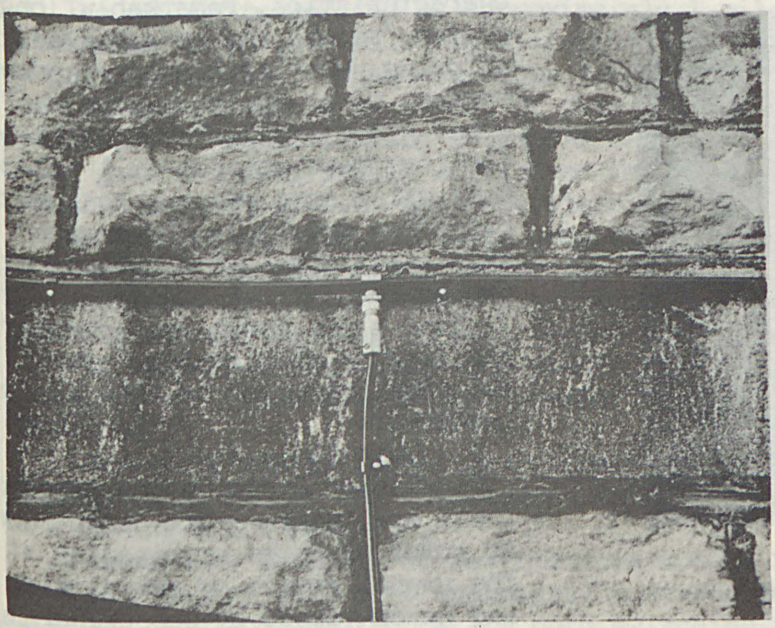
SLIDE 6 is a close up of this unit. As you can see the main distribution cable is not broken at all and because of simple operation, installation time is reduced considerably. The principle use here is patented.

A third restriction which we have in Europe is the result of the selectivity of the standard television sets on the market. These sets today will not generally accept adjacent channels, and we must use guard channels to prevent co-channel interference. This severly limits the number of possible programmes which can be distributed on any VHF network.

There are many more limiting factors which we have to overcome or face up to but I have tried briefly and I hope not too sketchily to illustrate only a few of our problems with which you do not

Slide Five

Slide Six



have to contend in your operation.

And now "Looking Ahead". What is in store for Europe? Well, of course there are more television and radio programmes coming, color, Pay T.V.!!

I have to qualify here that my remarks with regard to the future are based on my personal views and the views of my Company, and I wish to portray our appreciation of the situation and our approach to find the correct solutions.

A CATV system erected today in Europe must be capable of distributing the following, if it is to be fully utilized:

1. At least 9 off air TV broadcast programmes.
2. 30 + FM radio programmes
3. Pay T.V. programmes

It also must cover a large area, say 100,000 to 150,000 houses from one aerial site and be commercially acceptable and reliable in providing the service.

With regard to I there are areas now where six T.V. programmes are required to be distributed. The schedule now planned for new stations to be opened will increase this to 9 channels in certain areas on the Continent in the next few years alone.

Re. 2, this number of FM radio programmes is now available in many areas.

Re. 3, if Pay TV is going to succeed, and a great many in this country are putting their shirts on it succeeding, it is only natural that it be one of several services on a CATV system.

Our reasoning goes something like this:-

1. Pay TV can be transmitted over the air or distributed via cable. Transmission over the air is highly unlikely because there is hardly enough air space to handle the other services already planned. Actually this is one of my strongest reasons for believing that CATV operation will soon be a necessity. There is already a world tendency for telecommunications to go back to wire, and I am sure that statistics will show that more and more cable is being laid each year. In Europe especially the situation is that there are many Countries in a restricted area, all with their respective services. Interference now is quite a problem, and I shudder to think what it will be like in a few years time.

2. Distribution via cable is the natural environment for Pay TV because of the security and the control it offers.

3. Television off air broadcasting in Europe is such that CATV systems will be in most cities within the next 15 years.

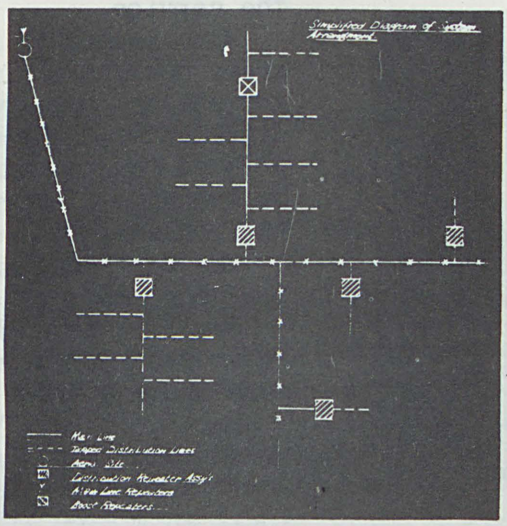
4. A Pay TV operation via cable requirement is that only large areas of the population can support such a service.

5. Our conclusion is that a system is required where both services can share the same facilities, thereby carrying only a proportion of the fixed overheads.

Someone, somewhere, has said that the problem must first be recognized and then a goal set, before any achievement can be made. I think we have done this.

We have now a system which will meet the above requirements which we call System D. This system employs principally a special design of "distributed" type repeater of low gain, with exceptionally good noise and cross modulation characteristics, which enables the very wide frequency spectrum of 8-225 MC/S to be fully utilized.

Slide Seven



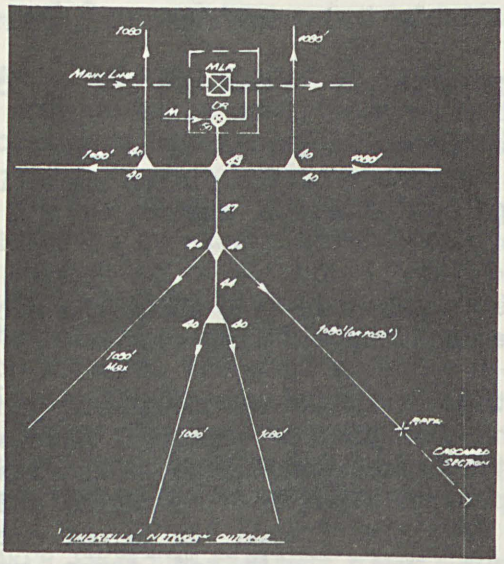
Without the restriction and operational difficulties which would normally occur with multi-channel operation employing more normal type of 'distributed' circuit type repeaters. Because of these outstanding repeater characteristics, remarkably long system 'reach' can be achieved, allowing very large multi-channel systems to be built up. On the other hand, smaller systems employing these methods will possess still more reserve against cascading troubles, and ensure simple policing and maintenance procedures.

This slide shows the schematic diagram of planning. Two principal types of cabling are involved:-

1. Main Lines
2. Tapped Distribution Lines

These are 'semi virgin' point to point circuits originating at the signal source or aerial site and never tapped by subscriber connections, but teed into branching or distribution repeaters

Slide Eight



to generate spurs for further main line network extensions, or for tapped distribution lines. These are lines to which subscribers connections are made. To obtain the optimum repeater cascading performance, the main lines are operated at a max. signal level of 30 dbmV, with min. of 17 dbmV which gives a required repeater gain of 13 db. It can be shown that a gain of this order represents the optimum for repeater cascadeability.

The tapped distribution lines (No. 2) are all generated from distribution repeater assemblies, with a launch level of up to 50 dbmV.

From this high level the maximum use of cable splitting is used to provide the largest possible 'coverage' network without further repeaters. (This may cover up to 300 houses). Normally, to extend beyond this coverage the main line network is used or extended to a further distribution repeater assembly teed to the main line network, but when advantageous limited extension to any 'arm' of the distribution network can, if the noise and Xmod limitations of -43 db are not exceeded, be achieved by use of standard repeaters used as boosters.

The AGC units located at approximately 1 mile intervals are control units for inclusion at intervals, in distribution main, or trunk lines to mitigate variations of level caused by cable temperature and repeater mains supply etc. The (patented) method employed, of obtaining the required control bias, avoids difficult VHF amplification in excess of that necessary for signal amplification only, giving a mosy stable unit, free from uncertainties inherent with amplified signal frequency or D.C. amplifier techniques.

The ALC unit, here, for wide band distribution systems, operates from a control or pilot carrier placed above 200 Mc/s. The gain of the unit throughout the amplifier operating spectrum is varied in relation to the level of the controlling carrier, giving partial signal level control on a wide band system.

The unit is intended for use with a succeeding repeater unit Type 228 from the output of which the control carrier is extracted by means of a tee unit (provided)

CATV operators in Europe are of course looking forward to easement of many restrictions, and to the advancement in development of techniques which will make living a lot easier.

Examples of easement of restrictions are as follows:

1. Standardization of transmission standards. There is evidence of this already. England and France are both switching to 625 line standard of a type.

2. Improved selectivity of TV sets. Set manufacturers are placing sets on the market now with improved electricity and when this higher standard is made universal, adjacent channels can be used.

3. Provisions made by the planners of new towns for the erection of a CATV sytem. Many new towns are being built in Europe and especially in England. A CATV system is being considered as a public utility service to go in a house along with the electricity, telephone, gas, and water. Conduits can be provided for under street crossings, cavities made available in houses for flush mounted wall outlet units, etc.

Every operator looks forward to cheaper systems, which are easier to install and require little or no maintenance.

Components now becoming available are improving the position daily, and of course transistors are in the limelight. A number of transistor amplifiers are on the British market used in limited application and of course, we all encourage further advance.

SPEAKER FROM THE FLOOR: I would like to ask you, sir, about the picture quality, relative quality, between your system and our 525 line system.

MR. EVANS: On the picture quality, the British have done a very good job on the 405 line standard and is, I think, the best picture quality I have seen in the world. My experience is limited to the States and Europe. Regarding the 405 line standard - of course I, as a CATV operator like the 4 megacyles and I have wondered just why Britain has changed to 625. The French 819 is not exceptionally good. I would say that the standard of quality in the United States, mostly from the studio techniques available in the States, is much better than the normal 625 that we are getting on the Continent today.

SPEAKER FROM THE FLOOR: Do you use video at all or is it completely RF or do you have a mixture:

MR. EVANS: No, we use completely RF. The HF system, as I explained does demodulate the carrier to video and then remodulate a HF carrier. RF is still used.

SPEAKER FROM THE FLOOR: What sort of agreement did you make with the property owners when you attach to their homes?

MR. EVANS: Well, we have a very comprehensive contract that we make with the owner of each property with regard to liability. Of course the CATV operator is liable for any damage that is done on the property. To make this legal we do pay to the property owner a shilling a year. This is usually paid. However, there are different techniques which are used. It is ridiculous to make a check out for 14 cents a year and many times there are agreements by the various CATV operators to give this money to charity in a lump sum or do some local function for charity.

SPEAKER FROM THE FLOOR: Could you tell us something about the pattern of charges that are made?

MR. EVANS: Yes, the - Well any CATV operator is going to get as much money as he can for the services which he is providing. Four or five years ago it was standard in Britain to charge an installation fee of approximately 5 pounds, working that out quickly that is about 14 dollars and something, with a weekly charge of 2 shillings and 6 pence to 3 shillings a week. A shilling is 14 cents so three shillings would be 42 cents, a week. In more recent years we have had an awful lot of competition by the various CATV operators and there have been a limited number of what has been considered good concessions, so in order to obtain these concessions the competition has been vicious resulting in reduction of the rates to the taxpayers of a particular local authority. The installation fee has fallen off completely and most systems are working on a charge of 3 to 4 shillings a week only. There are of course the normal terms of payment of paying annually or half yearly or quarterly with appropriate deductions in the - of the amounts.

SPEAKER FROM THE FLOOR: I believe I heard in your talk that you even now go back down to strip amplifiers with their individual AGC, I wonder if you would comment of the technical reason for that, and what you accomplish by it.

MR. EVANS: We do, at approximately every mile on trunk lines only, break up the signals, to single channel strips for control We have not found and we have used a lot of ALC units, wide band units. We have not found that this gives us the sufficient control of what has to be made up on the line due to temperature and main power variations. On the AGC strips we are, you must look forward, if we go over say 9 channels we must look forward to a lot of difficulty in the combining and splitting which does have to be done every mile and which is very, very expensive. Of course, we are trying to develop ALC units or wide band techniques along with perhaps equalizers which will give us the control which is required on these networks.

SPEAKER FROM THE FLOOR: I was interested in the problem ..(Unable to hear speaker)

MR. EVANS: No, that is not necessary assuming that your combined split units are all right.

On the ALC units which we are using now at every half mile, we are putting the carrier frequency above 200 megacycles because we know that we can get a better control starting at the high end of the band rather than having the generated signal, let's say at 75 megacycles which I understand is common in the States, but we are still using both types.

SPEAKER FROM THE FLOOR: (Unable to hear speaker)

MR. EVANS: We are trying to. Any other questions? Thank you very much. (Applause)

MR. W. K. HEADLEY: Thank you very much, Jack, for giving us a most absorbing look into things over your way, both as they are now and as they appear to be in the future.

We have come out very well on our time and I just want to say, Jack, we appreciate tremendously your coming here to this session this morning and it is a very great pleasure for all of us to have you here at our convention.