June 28, 1967

The session convened in the Monroe Room at 9:15 a.m., Mr. John R. Penwell presiding.

CHAIRMAN PENWELL: Gentlemen, we will start the ball rolling. Welcome to the final technical session of this 16th Annual Convention. I think we have had an excellent group of technical papers and presentations to date, and today's session certainly promises to be most interesting, rigorous and deep.

Listening to some of the other papers in the past two days, I recalled an experience at Philco in Palo Alto. There was an unseen but pretty well-known prophet named Murphy. He had written some laws which the designers encountered. The first law was that you design an amplifer and it oscillates. The second law was that you design an oscillator and it amplifies. When the poor guy was really in trouble he discovered the third law, which was that things hate people. I think we also find problems of that type.

Todays panelists may or may not come to the podium, at their option. There is plenty of room up here.

The first paper this morning is "How to Evaluate Coaxial Cable for Maximum Ulitization and Longevity". Allen Kushner is Manager of Engineering Services for Times Wire and Cable Company, Division of International Silver Company. He works out of Wallingford, Connecticut. He has a Bachelors Degree in Mechanical Engineering and a Master's in Electrical Engineering. In his nine years with the company he has been responsible for the design, development and evaluation of many of the cable products. Allen Kushner.

HOW TO EVALUATE COAXIAL CABLE FOR MAXIMUM UTILIZATION AND LONGEVITY

ALLEN M. KUSHNER: As technical men, you now have or will have the problem of determining what coaxial cable will give you maximum system revenue. As a cable designer, our company has the same problem. Because of this, over the years we have been constantly pursuing the design which was both economical and would give us longest life. We applied polyethylene jackets to give you longer jacket life. We use foam polyethylene to give you longer distances between amplifiers. We have improved our manufacturing techniques to raise the return loss to 30db to prevent signal loss and ghosting. As we continue in our efforts to improve our design, our material and our method of manufacture, we have developed certain guidelines to aid ourselves in determining the worth of possible improvements. I present these guidelines here because I feel that they can be of value to you in evaluating cable for your systems. Once the factors critical to cable usefulness are understood, cable evaluation is quite simplified.

FACTORS LIMITING CABLE USEFULNESS

There are two primary factors which limit the usefulness of the coaxial cable.

1. Stability of electrical characteristics-when the electrical characteristics of the cable have degraded system performance beyond an acceptable limit.

2. Functional obsolescence-when the electrical characteristics will not allow the system to economically perform a functional different from that for which it was selected.

STABILITY OF ELECTRICAL CHARACTERISTICS

The electrical characteristics which are vital to the system are:

1. Attenuation
2. Shielding
3. Return loss

A sufficient number of papers have been written concerning the effect of moisture on the attenuation in a foam dielectric cable, so that as an industry we appreciate the necessity of preventing moisture from entering. We also seem to agree that a metallic barrier is the only economical method of preventing moisture entry. At the present time all plastics, with the exception of the Teflon family, will allow vapor to enter. Some are better than others, but they all do pass vapor at some rate.

ATTENUATION

Almost all of the trunk and feeder cable used today incorporates foam polyethylene as the dielectric material. The foam consists of tiny, individual air spaces which are formed by a gas which is liberated by the heat of extrusion. Another by-product of the extrusion operation is water vapor which collects in the individual air spaces. Directly off of the extrusion line, attenuation of our foam cores are quite high. When we dry out the moisture, the attenuation drops to the level which is guaranteed. However, it is necessary for us to insure that the cable does not again absorb moisture prior to our placing it in the metallic sheath.

To completely keep moisture from the foam core, the metallic barriers should be complete. However, experience has shown that this is not practical. We know that connectors improperly-installed will leak, and we also know from REA experience that aerial cable will develop at least one hole in the sheath per 1000 feet due to many causes.

The construction must therefore be such that moisture will not propagate thru the cable from the ends or from holes generated in the metallic barrier along its length. There are three paths moisture could take:

1. Between the center conductor and the foam polyethylene.

2. Between the foam polyethylene and the metallic barrier.

3. Through the foam polyethylene.

Moisture can be prevented from traveling along the center conductor, if the foam polyethylene adheres to it tightly. Moisture can be prevented from traveling between the foam polyethylene and outer barriers by tightly compressing the surface of the dielectric. Thus moisture entering from the ends or at holes along its length will not be able to rapidly travel through the cable.

The question then arises, as to how fast the moisture will travel through the foam polyethylene. Actually it travels quite slowly. While it might travel radially through the cable from outer conductor to inner in a matter of months, along the length of the cable this is an insignificant distance. We can easily tolerate one foot of cable with an attenuation twice as high as normal as long as the remaining 2500 feet did not change.

How do you verify that a cable design is moisture tight? The test is simple. Apply 15 psi of Freon pressure into the end of the cable and search along its length, and at the opposite end with a freon detector. Ten feet of a well-designed cable should be sufficient to prevent vapor travel from end to end.

We have also learned that a by-product of a cable which is made pressure tight, as we have described above, will reduce the effects of different coefficients of expansion in the inner and outer conductors.

It is interesting to note that we have had other foam materials with which we could achieve lower losses, increase our output and achieve better return loss figures. However, we are unable to bond this material to the center conductor, and as a result have been unable to make use of it. Another interesting by-product of a cable which will not pass vapor longitudinally is the fact that it reduces dielectric shrinkback should the cable be stretched substantially on installation.

We have considered above the design and manufacture of a cable which would maintain a constant attenuation over a long period of time. We must also be certain that large sections of the tubular outer conductor is not removed by corrosion. This subject will be discussed further on in the paper. The factors which I have stated above appear to have been borne out quite well by field results and laboratory tests. It is our conclusion that a cable from which longitudinal travel of moisture can be prevented, will be able to maintain a constant attenuation for an extended time.

SHIELDING EFFICIENCY

This is a factor which is sometimes overlooked, because of the inherent, excellent shielding offered by our tubluar, outer conductor. This efficiency will be lost if the outer conductor were to open in any way, either from design deficiency, improper manufacture or installation or corrosion. A break in the cable, or improperly-installed connectors, will allow signals to escape or unwanted signals to enter. As we move out of the "on frequency" channels, we should remember we are being exposed to massive interference.

If we move down in frequency toward the AM frequencies we should also remember that the shielding efficiency is a function of shield thickness. We should also not forget that the voltage developed along the outer conductor and between the outer and inner conductors if lightning should strike, are a function of the resistance of the outer conductor.

In situations where a jacket is required to protect the outer conductor, whether it be aerial or underground, we must remember that the jacket becomes as vital as the tubular metal outer conductor. The following must be considered:

a. Jacket thickness.

b. Number of pinholes.

c. Tightness of jacket on tubular outer conductor.

d. Life of jacketing materials.

e. Protection of the jacketing material.

f. Type of metallic outer conductor used.

While the requirement for sufficient jacket thickness is obvious, the requirement for no pinholes is overlooked. Extruded jackets will have pinholes. These must be searched out by application of a high voltage in sensitive testers and removed. We must be certain that the jacketing material will have the proper life expectancy. Let us not forget the work done 15 years ago which determined that only specific polyethylenes, without contaminants but with an optimum percentage of carbon black particles of a stated size and properly dispersed, will protect the jacket from the cracking effects of sunlight and certain chemicals.

UNDERGROUND BURIAL

I think it pertinent at this time to discuss the suitability of jacketed cables for underground burial. This is an area where the technology of our industry is lagging. It is known that if the jacket is damaged during installation or removed by rodents and then exposed to the moist earth, then corrosion of an aluminum outer conductor will proceed at a rapid rate. It is logical to expect that more new systems will be buried to improve the appearance of our expanding towns and cities. We must give serious consideration to the protection of cables from installation damage, damage due to subsequent excavation and damage from rodents and borers.

It appears that a steel tape or strip armor with an outer polyethylene jacket may have to be applied for the worst conditions. Another design approach would be to seal the outer jacket to the tubular outer conductor with a flexible sealing compound. We may have to consider copper as the outer conductor to inhibit corrosion.

RETURN LOSS

The return loss of the cable is not affected by moisture. It could be affected by physical damage during installation or during its life, or by severe corrosion of the outer conductor. In metropolitan areas, we see perhaps, the requirement for making splices at each manhole. At higher frequencies, a nominal cable impedance, different than that of the splice impedance, could build up to a substantial figure. While non-uniform spacing will reduce the problem, a tightly controlled nominal impedance is desirable.

FUNCTIONAL OBSOLESCENCE

As previously stated the economical life of the cable is determined by the stability of the electrical characteristics and by functional obsolescence-when the original electrical characteristics are no longer suitable for the changing function.

INCREASING NEED FOR CHANNELS OR BANDWIDTH

It appears that the most obvious change in function will be the offering of more services. 12 channels for many are already being superseded by 20. This is, of course, a dynamic example of how quickly functional obsolescence can occur, when we consider that in essence 12 channel systems installed one or two years ago may for certain areas be obsolete.

It is easy to appreciate why this is happening. You are making available to each subscriber a total communications media — you can supply sound, video or data. In reasearching ideas for this presentation, I was impressed by the thinking of the system designers. I would like to list some of the possibilities:

1. T.V. between schools and class rooms due to shortage of teachers.

2. The teaching of various types of skills — different channels for different skills required in that area.

3. The teaching of languages.

4. Data transmission in business such as inventory records and work loading.

5. Stock market reports.

6.Civic affairs, congressman direct to constituent — perhaps as far as registering a vote.

7. Automatic reading of water, power and gas meters.

8. Burglar alarms.

9. Fire alarms.

10. Medical electronics.

11. Shopping, ordering and billing.

12. Surveillance.

What this means in terms of cable is that we must assure that the widest possible bandwidth is available to cover such expansion. It appears that it would be economically feasible to expand systems in the foreseeable future to as high as 300 MH_Z.

The return loss is the parameter with which we must concern ourselves when considering broad bandwidths. As you most likely know, the return loss is a function of how the cable is manufactured and how it is handled during shipment. To manufacture a cable which has a good return loss at channels 2 thru 13, may be substantially different from achieving the same return loss from 8 to 300 MH_Z. It has been our experience that this could cause a redesign of the basic manufacturing equipment.

The state of the art is such today that good return loss can be guaranteed over 8 to 300 MH_Z. In addition, though data is not available to definitely prove this, there appears to be an indication that a cable exhibiting a good return loss figure to 300 MH_Z will also be good to above 500 MH_Z.

CONCLUSION

The utilization and longevity of a cable depends on how long it will economically perform the desired function of the system. This depends primarily on how long it can retain its attenuation without significant increase; how long it retains its shielding efficiency; and the bandwidth over which a good return loss is available.

If the criteria of development is correct, the state of the art offers the maximum insurance that the longest economical cable life will be achieved. It is suggested that you use the following criteria to evaluate cable for its life expectancy:

a. Is the cable moisture tight — apply pressure to one end and determine if there is any leakage through the cable.

b. Is the outer conductor susceptible to splitting — flex the cable to determine if it will sustain bending.

c. Lightning protection — check the D.C. resistance of the outer conductor.

d. Corrosion resistance — apply pressure beneath the cable jacket and determine if there are any leaks.

e. Return loss — what is the highest return loss and broadest bandwidth obtainable.

CHAIRMAN PENWELL: Are there any questions?

FROM THE FLOOR: You said something about teflon. Have you used the family name?

MR. KUSHNER: The family name is fluorocarbon. Teflon is the trademark of the DuPont Corporation for the generic family.

FROM THE FLOOR: You said that you have designed cable that you can't get moisture into, and then you build it, and the first thing you do is to take the moisture out of it. I am a little confused.

MR. KUSHNER: When we make our cables, regardless of which way the industry makes it, we take a center conductor and extrude a dielectric over the center conductor. Then we apply some outer conductor around it. There are different outer conductors. In foam polyethylene, when we extruce it, moisture is right inside of it. Fortunately we can drive the moisture out. If we could not, we could not use this material.

FROM THE FLOOR: You drive the moisture out after you put the outer conductor on?

MR. KUSHNER: No; before. Before we put the outer conductor on we drive the moisture out.

FROM THE FLOOR: I can't remember that your 201 cable didn't stick to the outer conductor — did it?

MR. KUSHNER: Hopefully, the 201 did.

FROM THE FLOOR: But not because you were afraid of moisture? The paper you wrote came some time after that.

MR. KUSHNER: The 201 cable stuck to the center conductor. In that cable we had it sticking there for an entirely different reason. We were sticking it to the center conductor to maintain stability of the dielectric. Foams have a characteristic also of shrinking. By adhering it to the center conductor we give the foam dimensional stability. A problem with most plastics is that they will shrink or expand, but if you obtain a bond to some metallic member you give it inherent stability.

MR. DONALD LEVENSON (Wheeling, West Virginia): I have been using the Freon technique for about four years, and I think you might point out that you can also use this technique for finding pinholes in the outer sheath of a cable by putting the entire reel of cable in a polyethylene bag.

If I might make an observation, I have never found a roll of cable yet that you can't get freon through, not ten feet but 2,000 feet. I may be wrong, and there may be some newer cables that are better, but I have always been concerned with this problem. Sometimes from the inner conductor to the polythylene you can separate this. You can find out where it is coming and how it is going through, or between the outer conductor and the polyethylene, and then of course you put the whole thing in a bag and you will find you have holes in the aluminum. Maybe they are microscopic and may not cause trouble.

MR. KUSHNER: My compliments! I wasn't aware that people in the field were using this. We use freon mainly because in our business we make a multitude of cables for Underwater use — a very good technique. I would like to talk to you more about that later.

I would like to say, as another technique, that to find out exactly where we are having problems along the length we use a gas collector which we build to go around the cable, and we run our cables through it. When you come to a leak with our electronic detectors it will sound a horn, so you can stop and investigate and analyze where the problem is and what it costs.

FROM THE FLOOR: You take some freon and blow it and see what you get on the other end. There is nothing more esoteric than that.

MR. KUSHNER: It works on the basis that moisture will propagate because of the pressure difference.

MR. NADEAU (Alcoa): I would like to have you elaborate a little more. You mentioned the steel jacket and the changing of the shield to a different type of metal, or what-have-you. Would you care to elaborate on this?

MR. KUSHNER: Actually, there is not really too much elaboration that I can give you at the moment. I could say as a cable manufacturer that we have seen cases where cables have been installed in the ground and it looks as if the jacket has been damaged either on installation or by subsequent burial. Anybody who has worked with the corrosion characteristics of aluminum I am sure has been the characteristic that the aluminum is corroded extermely rapidly.

It is our conclusion, therefore, that for areas that are going to be subjected to this abuse, we of the industry should recognize this characteristic and do something to protect our cables; and quite honestly, at Times Wire and Cable Compnay we have our thoughts, and we are developing a product.

The problem really is that right at the moment there are other industries that have done work in this area, and they do have ways of slowing down, we will say, gophers. We have no way of stopping gophers. We slow them down. They go through steel and lead and steel tapes. So, what we end up doing is that we come to a compromise.

There is a cable construction whose price is reasonable enough so that you can install it, and it will give you sufficient protection for a reasonable life expectancy. I suggest really that our industry take a very good look at these cables that will be installed in areas where they are likely to encounter such damage.

MR. S. W. PAI: I wonder if you have any data on the cross tap problem of two cables. Suppose you have two cables stranded tightly together for many, many miles. Cable A carries from Channel 2 to Channel 13 and cable B also carries another Channel 2 to Channel 13. Do you have any data at this time concerning these problems?

MR. KUSHNER: Yes, we do, except that data on shielding is extremely difficult to give you unless you really relate exactly how you have tested it. We get into ground circuits and the exact setup of the test equipment.

There has been a lot of literature that has been collected on this. Do you have in mind aluminum sheath cable?

MR. PAI: Yes; say 412 or half-inch, and so on.

MR. KUSHNER: And this is at frequencies from 50 MH and on up?

MR. PAI: Yes.

MR. KUSHNER: We don't have data, let's say, on a long length of line stretched parallel or close to another line. We have laboratory tests. Our laboratory tests indicate that if there are no breaks in the aluminum sheath cable, at about 50 MH you need not really concern yourself with the cable. The area of concern is the connectors.

You will find that the leakage from the connectors, depending upon the type of connector, is the area where you are getting your leakage, and that really depends upon the particular connector, because I would say probably no two connectors are within 20 db of each other. So, I think it becomes a question of evaluating the connector, and on that we really have no data.

MR. McCURRY (Cook Electric Company): What kind of design life are you looking into as far as the underground cable of the future is concerned? It it five, ten twenty, forty years?

MR. KUSHNER: Sir, we just look for the longest we can get, really. To put a time limit on it is impossible.

MEMBER: Aren't you just saying it upside down — that the functions he is after are practically skip-continuous and very irregular, in such a way that you can't collect any data? When you say you don't have it for each type of wire, this has been one of my problems. As a matter of fact, we have spoken on the phone about it. You don't have it for almost any wire.

Having it for one wire, given the way it is tied together, for instance, you don't have it for another wire; you don't have it whether they are tied this way or that way. In other words, the function itself. There is no usable function at all. You have to find out for each wire under each situation, given the length of wire also, and of course the discontinuity you mentioned, the connectors. There is nothing you can do in so far as function relationships are concerned, no general statement you can make.

MR. KUSHNER: I think there is probably one statement you could make.

In a flexible cable, where we were perhaps ten years ago, there was a very definite pick-up from the two cables if they were side by side. There were other problems in the system. We probably weren't aware of it, or it was a situation that really didn't hurt us. But going to semi-flexible cables, we have improved our isolation per cable better than 60 db. That is from each cable. So, we are 60 db plus 60 db, and that is 120 db therefore we have a order of magnitude of difference.

MEMBER: Would you touch on something for me that is rather elementary? This matter of periodic discontinuities that are causing your return loss to go down — to be lowered. Is this such a serious problem when compared to the components that we insert in the cable — splices, amplifiers, that have a termininating or output impedance that is considerably inferior to the cable itself?

It seems like your cable is so much better than the equipment, that asking for a return loss of 30 db is rather gilding the lily, so to speak.

MR. KUSHNER: There are three points I would like to make in that connection: No. 1, we have to think of the characteristic of obsolescence. Maybe ten years downstream our system will be so much better that the cable will be the poorest point. That is one thing to consider.

No. 2, the total system performance is equal to the sum of all its parts. Perhaps in all honesty the cable is so much better that what is the difference between 30 db and 26 db? It doesn't add that much to the sum. That may be valid.

No. 3, I think the real question is: What are you going to pay for it? If you have to pay twice as much to go 3 or 4 db return loss, you won't pay it. What really happens today — and I think this is what we apply when we buy any component — is that we buy the best there is if the price is reasonable. There really is no set answer. Right today — two years ago, if you bought the best there was, perhaps you only got two years out of it; but if you hadn't bought the best there was maybe you would have gotten less.

MEMBER: I wonder if this might be related to ghosting, smearing, and things like that.

MR. KUSHNER: Very definitely.

MEMBER: Connectors and periodic connectors every 250 feet, probably would contribute more to that as a problem than just little periodic discontinuities in the cable itself?

MR. KUSHNER: No doubt about it. As a particular component in your system today, the cable, as far as return loss is concerned, is the best you have; but it does add to the total picture. How much it does lose is a question.

There is something else here we should not forget, when we are talking about an individual system. You have to be aware of cascades. If you cascade a system to the limit you can get yourself into a situation, even with 30 db cable, where you might have a problem.

There is a characteristic about cable that we should be aware of. I think the return loss characteristic of cable is something we don't have a really good feel for. In other fields we talk about transfer function. Return loss is something we can measure because it is easy to measure it. We can all buy the equipment for $1,000 or $2,000 to measure return loss. People going into the metropolitan areas are measuring return loss on every piece of cable, and they are really concerned.

What we are really looking for is not the return loss characteristic, but it is something else we can't measure. We are looking for attenuation spikes of less than .1 db. Our equipment is not sensitive enough to measure it. What happens is that in cascaded systems, if you have a spike at the same frequency, you can still end up with 30 db with a noticeable attenuation of signal or noticeable reflection.

If you could get 40 db cable, I would say, get it. The problem is, we also have to be careful that as our components get better we are going to be seeing other things that we never saw before — things we never really expected would hurt us. I must admit that buying the best return loss is a marketing axiom, but I think on an engineering basis it makes sense. If it doesn't cost too much, that is.

MR. FRED SCHMIDT: In the construction of the cable, the dressing of the cable, what is the effect of putting in a right angle bend? We know if it is bent too hard it will give a suck-out. How much will cable deviate by putting these right angle bends that are silos into a cable?

MR. KUSHNER: In general there are recommended bend radii which we list. If you will go with those recommended bend radii you will not see any reflections; in fact, as a sort of rule of thumb, if the cable isn't wrinkled it won't bother you. The reflection at that point is usually less than 1 per cent if it isn't wrinkled.

MEMBER: What about the usual flooding compounds under the jacket for burial for underground cables, and as it is used by Gordon Electric for the Bell Telephone in Canada?

MR. KUSHNER: With regard to the flooding compound, my feeling is that flooding compounds have two purposes. The first purpose is to do away with the air spaces so that you will not get water accumulation. The second purpose is to cover the metallic surfaces so they will not corrode. The flooding compound should be tenacious so that it will truly stick to it. In that case it does a very find job.

I think we should be careful if we think that flooding compounds are going to prevent the passage of vapor. They will not. So, depending upon the purpose for which they are put into the cable, in general they do perform a function. I think there is a very serious question as to whether they perform a function with regard to the passage of vapor.

MEMBER: Measurements were made showing that flexible foam cables exhibited an attenuation increase due to humidity. I had the impression it then tended to level off. Have you found that since you made these measurements this is true, or does the thing keep on going up?

MR. KUSHNER: In general, what appears to happen is that the attenuation of the cable is a function of the relative humidity level to which it is subjected, with one exception: If you allow the foam to come in contact with water it will go so far in some cases as to absorb the water like a sponge.

MEMBER: You mean that foam 59/U could go up worse than RG 59?

MR. KUSHNER: Yes. In the worst case it could. Thank you very much. (Applause)

CHAIRMAN PENWELL: Thank you very much, Allen.

We don't have a projector yet, and S. W. Pai's paper has some slides. Is Brian Jones in the room? Do you have slides with your paper? (Yes) Oh, boy! I think the projector is on its way.

This might be the time to go into the "Underground Construction" program, so if Mark Wolfe, Ted Hughett and Sam Booth will come up, we will introduce this panel. Each of the panel members will bery likely make a short statement about underground, and then we will turn it around.

I understand Vern Collidge could not attend, and Walt Roberts is going to sub for him. He was probably looking forward to coming on a little later. I think we had better proceed with the three panel members.

Ted Hughett, on my left, is with Alarm Corporation, on the Monterey peninsula in California. He attended Monterey Peninsula College. He has been with Alarm Corporation for the past eight years, and he is presently Executive Vice President of the company. He is on the Electronics Advisory Committee for the Monterey Peninsula College.

At my right, Mark Wolfe attended Cornel University and graduated in Electrical Engineering. He is a member of IEEE. He has had 34 years of engineering experience in wire and cable. Presently he is the Chief Engineer, Communications Division, Anaconda Wire & Cable, Sycamore, Illinois.

I am sorry I don't have further information on Sam Booth. He is with Sarasota Cablevision.

After the printed papers there was omitted from the program another paper, on "CATV Coaxial Cables Standardization?" by Sidney A. Mills, from Ameco Cable, Inc., Phoenix, Arixona. This will follow the last of the papers this morning. We are sorry his paper was omitted from the printed program.

At this time we will start with Ted Hughett. Do you have any comments on underground construction? You ought to have a lot of them.

MR. TED HUGHETT: Thank you, John.

Having to put a CATV system underground gives most technicians and engineers a very uneasy feeling both from a maintenance and construction point of view.

Alarm Corporation, over 16 years ago, found there was a need for a CATV system in a unique little town in California called Carmel. Because of the character of the town, the city fathers decided that they system must go underground, much to our dismay. In Carmel there are no sidewalk areas and no accessible utility easements. This left only the blacktop streets to bury the cables in; so we developed methods and equipment to bury cables 6 to 8 inches underground. This was so that we could get back at the cables for tapping and repair purposes. This type of construction I do not recommend unless it is absolutely necessary.

Today's need for ever better pictures and more efficient and economical methods has brought about substantial improvements in both equipment and methods. There are basically two ways of putting cables underground. One is the direct burial method and the other is the ducting or subshielding, as we call it.

Generally speaking, we do not recommend direct burial, per se. It is our opinion that it is too earily damaged or cut and is very costly to repair or replace. In our system, being as shallow as we are, we are cut on the average of once a day, 365 days a year. So, we have gone to a system of, when possible, particularly in new subdivisions, ducting or sub-shielding. We use polyethylene duct because it gives us added protection. We go to depths of 24 to 30 inches, and it gives us permanent raceways. This I feel is the big factor — the permanent raceway system.

If you have problems with cables you at least have a permanent hole in the ground. You don't have to dig up sidewalks, years, tear down fences, and get your customers very angry at you.

The costs of going underground are more than going overhead; but this is offset, I feel, by the nomakeready charge and no pole rental fees. So, generally, underground does have some advantages if done correctly.

You are also not as subject to damage from storms, falling trees, and things of this nature.

In new subdivisions we use methods of joint trenching. This is where the trenching cost is shared or split by anywhere from two to four utilities. Also, in new subdivisions we will put the raceway system in and not commit the cables or the amplifiers at this time because in a great many cases subdivisions will go in and there won't be a house built in there for a year.

We have devised some methods of sealing ducts and cables. We have used shrink tubing; we have used tape; we have used practically everything that comes out. You can't seal them.

The duct sizes that we have standardized on for trunk and distribution combinations — we will use a 2 inch duct. For distribution we will use 1-1/2 inches. This gives us plenty of leeway to get back in and out. We space pull points no farther apart than 250 feet. This facilitates the repair and maintenance, and reduces the time that you may have to have your customers off the air due to a bad or damaged cable. You can pull in pretty quickly 250 feet of cable, and you can isolate your problems down to 250 feet reasonably rapidly. We feel it is much more economical to do it this way.

I think I will leave it at this for the moment, because I know there will probably be a great many questions. Underground varies widely across the country. In California we have some unique situations, and I imagine there are many areas that have as bad, if not worse problems; so I will stop at this point, and say thank you. (Applause)

CHAIRMAN PENWELL: Thank you, Ted, I think we will defer questions until the panelists have all commented. Don't get frightened by Ted's early experience; we might have some more cheering news.

Sam Booth, from Sarasota Cablevision.

MR. SAM BOOTH: Thank you.

Unfortunately, I am not an engineer, and a lot of these problems didn't worry me when we first started in with underground cable. We have about 200 miles of cable buried underground in Sarasota, and it is all direct burial.

We have found recently that General Cable is making an armored cable that has a double shield on it with a floating, flooding compound in it, and in between the double shields are stainless steel spirals; and we are standardizing on that for all of our trunk cable. In areas where we use in-line taps (and they are very few) we are going to use that.

We have taken shovels and axes and abused this cable as best we could, and find it is very difficult to get through to the second — it is not a polyethylene but sort of a coarser material than the normal polyethylene. We feel this flooding compound gets away from the pinholes and other things that you do encounter.

Our decision to go underground is usually based upon one of several factors, one being the unavailability of poles or restrictions of the subdivider, or else the desire to cooperate with Mrs. Johnson's beautification program. Although considerable types of cable have been buried, we still have to use some ingenuity and inventiveness to develop the necessary hardware. This is one of the biggest problems we have found, because, as Ted said, in each area you have problems of a different nature.

We do believe that underground is a superior way to put in a cable system, although you do have a different set of problems, and the fact that so little of it has been done scares almost everybody when they think about it.

You do get away from the annual pole rental, and you don't have the problems of temperature changes. We have made studies and have found that at about 18 inches in Florida we have only a 3 or 4 degree temperature swing in any period of time.

An underground system does create some good public relations systems for you because you are not polluting the air with cables.

We have also found that, in construction of an underground system, labor costs are considerably less because you are not involved in unions, and you don't have people climbing poles, and the high rates you have to pay. We believe in direct burial. There have been mechanized ways of ploughing cable in to speed the mechanization and reduce the cost.

To be perfectly truthful with you, the reason we went underground was because we couldn't get any pole contracts. There were several other franchises outstanding at the time we were trying to build, and it was a matter of us building or somebody else.

When we first started burying we were trenching, and this is going at it the hard way. You go down somebody's lawn in Sarasota, Florida. About 50 per cent of our people are retirees, and most of them have just moved there, into new subdivisions, and have just put $1,000 into a new lawn, and if you take a Caterpillar tractor down their front lawn you will have a problem.

We knew that the ideal way to do it would be to plough it in, but all of the ploughing equipment we had seen was a tractor with a reel on the front of it and the cable going back over it. It meant that every time you came to a street crossing or a driveway you would have to cut the cable and splice it — and of course we all know what splices do.

About the third or fourth day we were underway a representative of the Ditch Witch people came around and showed us how to put the cable in. Set the reel at the point you begin, and pull the cable. They have a vibratory plough and you can go down somebody's yard and they will be hard put to come out and find where you put the cable in because it is just a very thin slice through the lawn, less than 1 inch wide. After a good rain the grass has grown back and there is no complaint.

We have used this method very successfully. Originally we were burying about 30 inches, but we found that was a little too deep; so we standardized at a minimum of 18 inches and a maximum of 24 inches.

We have very little difficulty with out trunk or distribution. House drops are the things we have problems with. We have had cases where the power company set a new pole right in the middle of the trunk; but those cases are few and far between, and we have given all the utilities copies of our "as built" so they at least have a hunting license and know we are somewhere in that vicinity.

We were fortunate that in Naples, Florida, a system down there has been buried for five or six years, and Dick Cox and Quain Fletcher of Gulf

Toast TV of Naples were kind to us and explained many of their problems to us. We were able to take steps to avoid some of the problems they had encountered.

From our point of view, putting in the trunk and the distribution is not a real problem. With these Ditch Witch machines or Davis machine we have had a four-man crew put in a half-mile system or better in a day's time at a cost that we think is comparable to what it would cost us for overhead.

The problems we get into are getting from the cable into the house. This is a problem we share in common with the utilities. I am talking about some of the electric people. General Telephone operates in that area. A large per cent of their system distribution is underground. They have a pole and they have a house drop running there, and it is very unsightly. It seems to me to defeat the purpose of underground. If you are going to go part of the way you might as well go all the way.

We have recently come across a machine, a Pied Piper, that is made by Sod Master of Minneapolis. They have taken what was a sod cutting machine and reversed the vibrator, and you can plough in short lengths of 412 with it. It is ideal for putting in house drops. We have tried various ways of putting in house drops, and we finally standardized on a little machine used for putting in lawn irrigation systems. It cuts a trench about an inch wide and 6 inches deep, but it has been so dry in Florida that the soil would all blow away, and we caught hell because of the trencher running to the house. We are thinking seriously about buying some of these Pied Pipers and putting it right in. It makes no trench at all, and it works out very nicely.

We have fought the dampness problem. That is one of the biggest problems with underground, especially in an area that gets as wet as Florida. The other day we had 10 inches of rain in two hours.

We really didn't have as many problems. We have had sleepless nights thinking we would have problems. We have tried heat-shrinkables, and we have tried Gayco and various other things. The other day we were looking at a reel of Times cable and we noticed some sort of gunk on the end of it. We called Larry and he got us a sample of it. It is an adhesive made by Raybestos-Manhattan. It comes in a solid form. We heat it, and we have started using that entirely for all of our waterproofing. We use it on connectors and splices and all our house drops. We find it is the most satisfactory material we have been able to get for waterproofing. You can apply it. It is hot, and as soon as it comes in contact with the metal it hardens. It does not harden to the point where it cracks. If you want to work on the splice you can take a knife and peel it off. You can throw it back in the pot and heat it again and use it again.

At the time we formulated our plans for the system we made a decision not to go into in-lying taps. We use pressure taps. We use a football type of tap or block that Wiking makes, and the waterproofing of those was a problem. First we started using Gayco and we used rubber tape and put plastic tape on top of it, but the moisture got through to it. Then we tried a butyl type of caulking compound, and it never got hard enough to really work with, although it was very satisfactory. We finally got this adhesive which we are now using, and we are trying to develop some sort of mold that we can use to pour this around the pressure tap and have it all done in one neat little job. We haven't achieved that yet.

The problem is in areas where you have to cross a street, or a state highway, and you are not permitted to cut a ditch into it. In some areas we sought permission to take a concrete saw and cut a half-inch cut through the street about 12 inches deep. We convinced the county this was an expansion joint for their road system, but in some areas we haven't got that message across yet.

We have tried using a hydraulic press to push pipes under roads. We have tried water jetting and air jetting, and the highway departments have stopped this practice because it isn't good for the road system.

We are currently trying to use an auger that hooks onto the side of one of the tractors. Davis actually has a little machine that fits on there. This is one of the big problems.

Basically, from our point of view, underground is not too much more trouble than overhead. We have four systems in Florida; two are underground and two are overhead. We really haven't been in operation long enough to get an honest comparative cost.

Our experience in building in Sarasota underground has taught us a lot of things, and we are improving some of the other systems. We do feel that the manufacturers are recognizing the fact that underground is here to stay and there is going to be more and more of it. I am sure you have noticed in some of the exhibits that instead of having everything for strand mounting they now have right-angle connectors and you can mount them in a vertical instead of a horizontal position; so, this will make life a lot easier for everybody.

I am sure you will have some questions later, and I will be very glad to answer them. (Applause)

CHAIRMAN PENWELL: Thank you, Sam.

E. Mark Wolf, from Anaconda Wire.

MR. E. MARK WOLF: I think we sometimes get into trouble when we talk about underground systems, because we fail to point out in the beginning that each system has got to be engineered. We sound (as I think I may sound in my brief remarks this morning) as though we can make general rules and they apply to everyone's problem.

You have heard from two gentlemen this morning who certainly have problems that don't fit the average case. There are many options available in cable construction and installation techniques. They all have their price. The practical engineer gets into this to determine what is the best choice for you.

Underground installation of cable is not new, and the history and progress of underground power and telephone cables is one of the more interesting chapters in the field of cable engineering. It covers a span of at least forty years, perhaps even more than that. In this time period we have seen costs go down and reliability improve to the point where today there are an increasing number of telephone and power companies that are promoting underground systems on the basis that they are more reliable and more economical.

Seomone asked earlier, what was meant by long life? That certainly is one of the things we are concerned with when we go underground. There is no positive answer to that, as Allen Kushner said; but most of the utility people we talk with -- power companies and telephone companies -- want the time span to be at least twenty years. So, if that helps you put a number on it, there it is.

Our present situation is that underground installation is generally more economical and more reliable. It was not always this way. Both high cost and poor reliability were almost trademarks of underground installations some years back. The learning curve has really been steep, particularly in the past twelve to fifteen years when we have seen very radical changes in both construction of the cable and in installation techniques. There are a few of these that are worth mentioning.

I feel that in the field of cable construction we have developed a truly new technology in the selection and use of non-metallic coverings to protect the cable cores from underground environment. In the last decade or two polyethylene has been a consistent front runner as a covering material for a number of very good reasons; but early applications of polyethylene as a covering gave very disappointing results, and there were many unexplained cable failures in the early days.

Out of this came a long and comprehensive investigation that was participated in by raw material suppliers, cable manufacturers, power companies and telephone companies; this went on over a span of quite a few years. Two really important facts came out of the investigation -- many more, but I will just mention two:

We learned from this experience that the molecular structure of the polyethylene is more important to its proper performance underground. Today we have very sensitive tests for the environmental adequacy of polyethylene. We know we must use a high molecular weight polyethylene in this environment. The old problems of environmental stress cracking are no longer problems; we can almost forget them.

The other factor that emerged from this investigation was that these coverings must be properly applied if they are to act as an impervious barrier between the soil environment and the cable core. Consider cable with a metallic outer conductor or shield, covered by some kind of polyethylene jacket. To prevent the polyethylene jacket from acting as an osmotic membrane and permitting the transmission of moisture vapor, it just has to be in complete and intimate contact with the underlying aluminum or copper. There is more than one way of doing this. One of the best means for achieving this condition is the use of an adhesive bond between the polyethylene and the underlying aluminum shield. Today I feel it is well within our capabilities in industry to manufacture cables which are both economical and trustworthy and which will give long and reliable service when directly buried.

So much on changes in cable construction we have seen.

At the same time this was happening, I believe we have seen equally remarkable advances in the technology of cable installation. Early installations gave a great deal of trouble due to a variety of causes related to installation techniques. Buried plant construction was in those days very costly. Cables quite frequently were damaged by insects, by rodents, by frost heaving, accidental dig-ins, rocks, and rough handling during installation. I am sure you have all heard of these.

Today -- and again I am speaking not of the special conditions that exist but generally what I guess you could call average areas -- if there is such a thing -- these problems have been largely solved by the development of a wide variety of special equipment for underground installation. Most (certainly not all) of these past difficulties from insects and rodents and frost heaving and accidental dig-ins have been overcome by making available equipment to let you get 3 feet below grade with the cable.

Vibrating ploughs are available, and they do a good job of surrounding the cable with rock-free dirt where rocky terrain is a problem. Cable ploughs now are designed to really reduce to a minimum the possibility of damage during installation.

There isn't enough time here, of course, to even attempt to present our collective engineering knowledge in this field; but these highlights perhaps will illustrate that the background and knowledge does exist in cable fields other than CATV. It really doesn't matter whether the cable to be buried is CATV cable, power cable or telephone cable. One basic problem is common to all, and that is to protect the cable core from the underground environment. The means for accomplishing this economically and reliably exist, and I don't feel we should run scared when faced with installing an underground system.

As I mentioned, there are many options available to fit the particular conditions you have. I think the knowledge exists and the background is here, and I think you can find a way to do it to suit your particular situation.

Thank you. (Applause)

CHAIRMAN PENWELL: Our last panelist is Walt Roberts, Director of Research for Superior Cable Corporation. He is substituting for Vern Coolidge, who was on the program.

Walt has over eleven years with Superior, and has been involved in development of high-frequency coaxial cables. He spent three years in the Army during the Korean conflict. He received his Bachelor of Science degree in Mathematics and Chemistry in 1956, and completed work on his masters in Physics in 1958. Walt Roberts.

MR. WALTER ROBERTS: In my remarks, rather than attempt to repeat anything said before, I thought I might take Mr. Wolfe's remarks and pick a few aspects as far as cable itself is concerned, and touch on those very briefly.

As he pointed out, the cable sheath of the coaxial cable, when it is buried, bears the burden of protecting the core. The remainder of the cable, the construction and design, is pretty obvious. It has a function to perform, no different from the aerial cable. Once it is buried it is then susceptible to moisture, water, damage, and so on; so it becomes the burden of the sheath to offer this protection.

I thought I might mention a few susceptibilities that may or may not be unique with buried construction, but some of the various means of losing stability of the cable, and some of the more obvious means for trying to protect against this.

Attenuation stability obviously is the name of the game here. You install a cable with a certain loss (or you are anticipating a certain loss), and if the system is to function properly this loss has to remain constant, within limits.

The two major sources of changes in loss that we know of -- and there may be others that some day will come out -- are: (1) Changes in the dielectric loss; (2) changes in loss contributed by the shield. If major changes in loss occur in the center conductor, this is an indication of a disaster of great proportion, and I think the subject of that particular length of cable comes to a close right there.

Moisture vapor as such can and does affect the dielectric losses of a foam dielectric (one of the two major materials used) and does not require the presence of physical water in the core, meaning liquid water, to do its damage.

Solid polyethylene, used as a dielectric, is not susceptible to moisture vapor as such; and although it is at first glance less economical to use, in some cases it offers a more economical approach in cable design.

The cable obviously has to be larger in order to achieve the same loss as a cable using foam polyethylene as a dielectric. This penalty may or may not be outweighed by the cost or burden of additional protection schemes for foam polyethylene, which obviously has to be protected.

Moisture vapor will certainly permeate nonmetallic sheaths such as polyethylene, and I think polyethylene is probably the material if we are considering plastic materials for a sheath. If no other barriers are present, it will permeate into the core, the losses will go up to some saturated value. Perhaps you could design a system on the basis of this; but then I think you would have to consider the loss of the cable as being that saturated value. Now compare economics with cables such as the solid dielectric, which may have started out a little larger but now you find the relative losses can turn around and actually reverse. So, I don't think this is a way to go about presenting the system. Assuming this, we will have to offer protection.

Mark mentioned the seal required to prevent water movement. This seal also would have, and does have, an influence on the water vapor or moisture vapor that permeates through the core. Picture this cable lying there with the polyethylene sheath, and the polyethylene being the vapor barrier -- a permeable barrier -- moisture can pass through. If you have space between the polyethylene and the shield -- and this is not necessarily a hole you can stick your hand in, but just space -- the moisture then can travel in parallel, you might say, and from this parallel attack can slip around the sheath, and if there is an opening it can surround and attack the core again in parallel.

If you fill this space either by sealing the polyethylene to the tape or by filling it with a flooding material, you accomplish the same purpose. You

What the CATV industry needs is a good weekly Newsmagazine.

The CATV industry has a good weekly Newsmagazine!

the new CATV Weekly magazine

In response to industry-wide demand, a bold new CATV news publication has been launched to serve you! The **CATV Weekly** (formerly **Cable Television Review**) has moved from newsletter to sparkling new magazine format. Greatly expanded coverage of all the latest CATV news plus timely feature stories are yours on a weekly basis. With more than double the number of pages per week, we've beefed up our editorial and Washington staffs to assure **unexcelled** CATV news and pictorial coverage!

WE'RE SERIOUS ABOUT THIS

We're convinced of the need for CATV reporting **without** broadcaster bias. We feel that the CATV industry should have **all** the news reported as it happens during these critical and decisive days.

CATV Weekly offers two exclusive services provided by no other weekly publication: 100% **factual** reporting of all important CATV news — and 100% pro-CATV editorial support. **CATV Weekly** also includes last minute news on system franchises and construction, plus personnel changes, transactions, and expanded industry financial reports.

This industry needs a strong weekly news magazine. Keep up-to-date about CATV news that can effect your profit picture . . . and help us to inform national, regional, and local government and other groups about the status and progress of the CATV industry. Subscribe for your copy of **CATV Weekly** today.

NEW SUBSCRIPTION RATE

A one-year subscription to **CATV Weekly** — 52 issues of solid CATV news — is yours for the newly **reduced rate of *$33.*** And — with your subscription you get **complimentary** copies of the **CATV Directory of Equipment and Services** ($4.95) and the **CATV Systems Directory** ($6.95) when published. Take advantage of this outstanding value now!

Gentlemen: Please begin my subscription to the all-new **CATV Weekly** news magazine immediately. I understand that this also entitles me to a free copy of the **CATV Directory of Equipment and Services** and the **CATV Systems Directory** when published.

NAME ______________________ TYPE OF BUSINESS

FIRM ______________________ ______________

ADDRESS ______________________ ☐ **One year $33**

CITY/STATE/ZIP ______________________ ☐ **Two years $60**

CATV PUBLICATIONS, INC.

207 N. E. 38th St. • OKLAHOMA CITY, OKLA. 73105

If you are already a Cable Television Review subscriber, take this opportunity to extend your subscription for a full year at this new low rate.

confine this space to a simple path that is in near proximity to the overlap, (if it is an overlaped shield). Likewise on the inside if you have it filled or bonded, you can confine the path now to a path emanating or spreading from that entrance point.

Obviously, a welded or swedged aluminum sheath, has no known path. There you are depending on maintaining the integrity of the sheath.

At this point, then, disregarding man-made damage, we have viewed cable construction of two classes: (1) where you have a dielectric that is not susceptible to the presence of moisture. In the case of solid polyethylene you can ignore it and shrug your shoulders. (2) In the case of foam polyethylene you definitely have to maintain integrity by some barrier type or protective means.

I think this has been mentioned in an earlier presentation. Water, as a result of man-made damage, can enter the cable; and even if the core were not susceptible to its effects -- if there is space for it to move, it won't move far before a junction of some sort, a connector or tapoff or something -- it will now become defective because of the water that gained entrance somewhere else and moved along the cable. So, protection from moisture, whichever technique is used to protect the sheath in either case blocks the water from migration along the length of the cable.

These are two separate and distinct problems that can arise. We have found a lot of confusion both on our part and on the part of those trying to interpret problems in the field, as to which was really the culprit, whether it was moisture vapor in the sense we are speaking of it or whether it was simply water.

Physical damage to a sheath, whether it is due to foreign workman damage, rodent damage or perhaps a pinhole puncture of a sheath as a result of a surge of lightning -- all of these obviously now lay the core of the metallic sheath open to corrosion if such can occur.

After spending a few minutes this morning reviewing a book on Underground Corrosion, published by the National Bureau of Standards, it would appear that you are always susceptible to corrosion. I picked up a few numbers, not to try to impress you with numbers but just to indicate the range of corrosion that you might experience depending on locality. This brings out one point: if you are considering buried construction in a particular locality, corrosion in that locality involves a unique set of circumstances and it must be scrutinized and examined from that viewpoint. This book, if it is of interest to anyone, very likely will not have answers for your own problem, but I have found it an excellent reference. It shows maps and distributions of various soil types and areas in the country, and gives you a starting point for considering corrosion in your own locality or in a locality under consideration.

The name of the book is Underground Corrosion, by Melvin Romanoff, NBS Circular 579. It costs $5 or $6, and is at least 200 or 300 pages long. It lists page after page of corrosion data taken at various NBS test sites; there must be 75 or 100 listed in it. They are spotted geographically all over the United States.

Just as an example, one of the listings on copper corrosion in these tables, listed in terms of ounces per square foot per year corrosion rate: There are ranges from one test site in California, a dry loam type soil, of .03 ounces per square foot per year, to another extreme of .13, which was in decomposed peat soil in Wisconsin at a test site. This is no condemnation of Wisconsin but just a particular site that was used.

Here is a ratio of at least 5 to 1 in corrosion rate. Something that is a little easier to picture, an ounce per square foot is equivalent to 1-1/2 mil penetration in copper. We are talking about a ten-year period here, assuming the metal has been exposed to corrosion, of something of the order of .5 mil to 2.5 or 3 mil.

The data in this book are pretty sparse as far as aluminum is concerned. I found one set of data for a ten-year study on commercial aluminum where samples 1/16 inch, in five or six different test sites, all had pitted to a depth of 60 mil or so -- almost completely through. In one case apparently the plates had decomposed or somebody stole them. The range was about a 5 to 1 ratio. As I recall the most severe corrosion on aluminum, occurred in a highly alkaline soil condition.

I mention these numbers just by way of illustration. Regardless of protection scheme of the cable design, corrosion will occur to varying degrees, but can be improved by proper metal selection.

Copper in general, the telephone industry has assumed, would be the most corrosion-resistant material, certainly by comparison with aluminum. Yet I can point out personal cases where we found chemical corrosion by hydrogen sulfide. This does not require a hole in the sheath. It can permeate through the polyethylene like a dose of salts. In the southern part of Florida we have found cases in the telephone construction business of just such examples, where the gas permeated through the sheath with no openings. In the laboratory we duplicated this in a matter of minutes, not months. Naturally the gas will attack the copper as soon as it passes through. Since the free gas attacks it as fast as it gets in, you maintain a partial pressure difference until the copper is reacted.

Again this illustrates that there is no one answer. There is at least one case here where copper will not be suitable and I am sure there are others.

This is a rather rambling dissertation on susceptibilities. I am still pointing to one common cry in design, in that stability of this cable is the criterion around which all design points rotate and toward which they all focus.

We as manufacturers certainly want to be able to offer a cable that will meet your needs, and feel that certainly a mutual exchange here of what we think is a proper design for your needs can only be improved upon through mutual exchange and feedback from your own operating viewpoint.

Rest assured (and I think I speak for all manufacturers) that we are certainly standing by to try to offer you, to the best of our ability, a cable that will perform. As Mark pointed out, we have had long years of experience in other areas, and specifically years in the telephone business, from which we feel we can apply practical design considerations.

Thank you. (Applause)

CHAIRMAN PENWELL: Thank you, Walt.

We have heard some very experienced cable operators, one on the West Coast and one on the East Coast, and we have a formidable array of experts in cable. For perhaps seven or eight minutes we will turn the microphone around and let you shoot questions at our speakers.

MR. ALLEN (Arizona): I would like to ask a question of the entire panel, since apparently it is impossible to keep moisture or water out of the duct. I would like to ask whether it is worthwhile to duct rather than to be prepared to replace the cable as soon as it goes to pot; whether it is necessary to put it in duct; and if you are going to put it in duct, whether it is valuable to have the polyethylene jacketing on the cable, or bare copper. What is the preference?

MR. WOLFE: In answer to your question, the answer inevitably has to involve a certain amount of opinion. I think in using duct installation you would be very foolish not to anticipate the fact that there is going to be water in the duct at some time; and therefore the cable that you put in it has got to be suitable for underground use, suitable for direct burial, with one exception, and that is that the mechanical protection that is often needed for rocky terrain and direct burial is not going to be required.

Other than that, the cable has got to be a cable that will operate under water, because at some time or other, as you said, that duct is going to get wet. Don't fool yourself on that.

MR. JOHN FOOD: I direct this to Ted or any other member. I wonder about the plastic pipe without the cable in it. Do you find that it is possible that due to frost, heaving or snow, it gets kinked?

Another question: Does the plastic pipe snake so that when you pull the cable through it is hard to direct it through?

CHAIRMAN PENWELL: I think you hurt his feelings. He is from Carmel. (Laughter)

MR. HUGHETT: As far as the frosting is concerned, you are way out of my area. I live on the West Coast. The crushing or snaking -- we have buried quite a few different types of conduits, ducts and raceways. We are presently using a coiled type of duct, a duct that comes in a coil, a polyethylene. We have done the majority of our systems in duct trenching where we are laid in with power and telephone. We have not had any great problem in the snaking or looping in the trenches.

When the tranches are joined they are about 12 inches wide and 30 inches deep. When we do it ourselves we use a 4 inch wide trench so that snaking is not a great problem.

Do you mean when the cable goes bad?

MR. HOOD: You mentioned something about subdivisions where you placed this pipe, and you didn't pull the cable until later.

MR. HUGHETT: That is correct. This has been very successful. We use a two-man construction crew in both phases, and it is very fast; in fact, we walk circles around the power and the telephone companies. Our crews have to shift jobs because of this.

The pulling in and out factor, in answer to this other gentleman's question, brought up the factor of why you use duct. As long as you have a permanent hole in the ground, or semi-permanent hole, you are not going to have to disturb the areas of sidewalks, customers' properties, and so on. We also use a 3/4 inch ducting into the house to keep away from this, and the speed with which you can do this means that your reliability factor is much higher and you are not off the air as long.

VOICE: Are you working from a pedestal -- the drop line from the house to the distribution line?

MR. HUGHETT: Correct; a common pedestal or a vault. We have used pedestals, vaults, different methods of surface, housings, practically every type that is made.

VOICE: What about vaults? Do you find they fill up with water? Getting back to frost again, if we had a vault and it was not drained properly there might be a big cake of ice.

MR. HUGHETT: As far as freezing and frost areas are concerned, I don't know, except that we do know that rodents, gophers, backfill these vaults. They literally do. They push dirt into them. Moisture comes up from underneath. The vaults, we use only as pull points. We have used them as tap points but found this not to be too successful. We use them as pull points, and then we will attempt to encapsulate, in one way or another, any device. If it is a connector we will try to sling-tube it or cover it or put it in one type or another. A vault is another form of a permanent hole in the ground.

VOICE: We have 300 miles of dielectric cables in one system, and we do seal it.

VOICE: Is it possible that the difference between your experience and Mr. Sarasota's is that when you went deeper you got out of trouble?

Another thing I am curious about is what percentage of the breaks that you had would have broken conduit. You say you had a great deal of breakage; then you changed to conduits. You also went lower when you changed to conduits. The question is: Would the conduit have been broken by the breaks you had? And of course the other question is, Is it the depth and not the conduit that saved you a lot of trouble?

MR. HUGHETT: I think it was a combination of all these factors. The breaks I am talking about -- well, somehow they seem to hunt for the cables. Anybody who digs in the ground seems to find the cables, but the ducts are stronger than the cables.

VOICE: Not as far as a bulldozer is concerned?

MR. HUGHETT: Bulldozers won't stop it; but again we are primarily cut by plumbers, by the power company, by the telephone company; and they don't use bulldozers in built-up areas as a general rule. True, in new subdivisions we have had systems put in and had them torn out before they were ever activated.

VOICE: You have no percentage?

MR. HUGHETT: No, we don't have a percentage, except that it is just something you have to learn to live with and try to work out on your own local basis. Educate the people as to where you are. Try to educate the people who work in the field to be cognizant of where you are, and to be careful.

MR. BOOTH: With this new type of cable that General has, it is stronger than the conduit because it is a stainless steel jacket. It is double jacketed. It has a flooding compound. I would prefer to see it instead of in the conduit, where you are using a polyethylene or water tubing or something like that.

MR. HUGHETT: It is a duct that is manufactured.

MR. BOOTH: Is it like Hercules makes?

MR. HUGHETT: The corrugated? Both corrugated and smooth wall. We will go as far as to put direct burial cables in ducts.

VOICE: The problem we have had with trunk cutting is that we would have had it if it had been in a transit pipe or any kind of pipe. Somebody digs around, and wham!

CHAIRMAN PENWELL: We will allow one more question and then we will have to move along.

VOICE: Rather than asking a question, we have had a problem at one time that we have solved rather uniquely, and it may be of interest. It was a problem of how to get a cable into somebody else's conduit when you have permission, and the possibility of damage when you have to pull it at one time.

Between 1,000 and 1,100 feet we had to put up a $10,000 cash bond that we would not damage it. We brought specialists in from big cities who are supposedly knowledgeable in this business. They got paid by the day, and after two or three days they took their money and left.

We tried all of the techniques that the industry has. You may be interested in how we finally accomplished the job. Would you like me to tell you? I'll tell you what we did.

We were in Wheeling, West Virginia. We built a pliofilm parachute, and we put an industrial vacuum cleaner at the far end of the conduit. The objective here is that as you get closer to the power source you are pulling more string behind you, and therefore this is the way you want to work it. By the way, this conduit had two turns in it. That is why the device is a rocket to shoot through, and they hit a turn and they expell all their energy.

It was very important that we accomplish it. It was the only way we could serve this one area, by building this pliofilm parachute and nylon thread. We could barely feel the air at the side we were working on. With this big vacuum cleaner at the other end we managed to draw the parachute through more than 1,000 feet. Once we got the little thread through we ended up getting the heavier through.

This was transit duct. It was dirty. Mr. Wolfe will have to tell me the compound they used to use about a generation ago on the outside of the cables, like a fiber material. All these other devices, as soon as they started rubbing against this, would lose their energy. We were thinking of skyrockets. You are familiar with the devices they use -- a carbon dioxide pellet device. They would get 100 to 300 feet maybe, but that was all.

Then we tried shooting from both ends, hoping they would twist together. (Laughter) We stood there for close to a week. We had to solve the problem. That was the important thing. We did manage it.

When I talk about an industrial vacuum cleaner I am talking about a device that has a large volume of air. You have got to get the air going through. The air at the manhole we started with was so slight that you had to put your ear against it to even be able to hear any airflow. You could just detect it. I guess we had a religious service the morning before, with all faiths present. It did work.

CHAIRMAN PENWELL: If CATV can continue to innovate like that, we're not dead.

Gentlemen, I want to thank you very much for your time. Perhaps if there are further questions you might try to buttonhole the speakers out in the hall. We have to move along. We are back on schedule now. For the benefit of those who came in late, we didn't have a projector when we started the session, and the second and third presentations require a projector.

Our next speaker, Mr. Pai, has been with CATV and Craftsman Electronics Products for the past three years. Mr. Pai will speak on "Analysis of the Directional Tap in System Design". Mr. Pai.

(Mr. Pai read his paper, marked No. 2.) (Applause)

ANALYSIS OF THE DIRECTIONAL TAP IN SYSTEM DESIGN

by
S. W. Pai

For years, the technique of tapping off signal from CATV feederline to the customer's set has mainly relied on the pressure tap. Although the design and construction of the pressure tap has been constantly improved -- such as, from capacitive tap to backmatch tap. However, the inherited problem both in the circuit design and mechanical construction of the pressure tap limit its performance in today's sophisticated system, especially since the information carried by the CATV system and the length of the feederline are constantly increasing, coupled with the increased demand for better color signal by the customers. Therefore, a better method of tapping off the feederline must be devised; and the directional tap is the most feasible answer at the present time. The advantage of the directional tap vs. pressure tap is, of course, obvious; and also the characteristics of the directional tap probably are well known by this time in the field of CATV. Unfortunately, even today, the advantages of the directional tap have not been fully utilized by many of the system designers. It is the purpose of this paper to present some of the advantages of the sloped directional tap and the distinct characteristics of the directional tap as a feederline tap off device. Figure 1 is a layout of a typical CATV feederline:

The length of the feederline is approximately 900 feet of .412 aluminum cable with nine directional taps spaced approximately 120 feet apart. The feederline is connected to one of four outputs of the bridging amplifier which provides an output of 40 DB on hi channel and 35 DB on low channel. Let's also assume 150 feet of RG59/U is the average length for the house drop. The DB value in the block designates the in-to-tap attenuation value of each particular directional tap. The top figure is for hi channel and the lower figure is for low channel when the signal is tapped off from the first directional tap through a 150 feet of RG-59/U to the customer's television set. Of course, the signal at the input of the set would be approximately 40 - (30 + 9) = 1 DB for hi channel and 35 - (30 + 4.5) = .5 DB for low channel; the signal for the second set is 3 DB for hi channel and 3.5 DB for low channel; and, the third set is zero (0) DB for hi channel and 1.5 DB for low channel. Because of the difference of the cable attenuation vs. frequency at the input of the forth directional tap, hi channel is 33 DB and the low channel is 31.5 DB. Therefore, in order to provide uniform signal level at the set, a sloped in-to-tap attenuation should be introduced to this particular tap. This would provide 2 DB at the hi channel and 1 DB at the low channel for the television set. When the signal travels further down the feederline, as you can see, the level difference between hi channel and low channel increases. When it reaches the end of the feederline, coupled with the RG-59/U house drop, the difference of the signal level between hi channel and low channel is almost intolerable. Therefore, more slope is needed. At the last directional tap, the in-to-tap attenuation is 10 DB for hi channel and 18 DB for low channel. The level at the television set is 1.5 DB for hi channel and 2.5 for low channel. Now, it is evident if a tap off device does not provide a certain amount of slope, especially when the tap locations are approaching the end of the feederline, a uniform signal level cannot be obtained at the customer's set by economical means with a non-sloped tap. Consequently, this would cause undesirable picture quality and an unsatisfied customer.

From the previous illustration, we can easily say the sloped directional tap has the following advantages:

1. Provides uniform signal level at the input of the television set.
2. More taps can be installed with minimum signal loss.