CATV DISTRIBUTION PLANNING

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Participants:
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"Problems and Solutions in Buried CATV Plant"

Preston Spradlin
"A Review of Taps for CATV"

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Objectives

Plans and organization are essential elements in any type of construction. This is especially true in building an underground CATV System in any community. Underground plant construction extends into every neighborhood utilizing most every street, alley and occasionally other public and private right-of-ways. Each potential subscriber is personally involved in this construction. His exposure may be a minor delay to work because of trenching operations along his normal route; or he may be exposed to strangers cutting a small trench through the parkway in front of his home causing damage to the flora and fauna. A potential subscriber is more involved in underground construction than aerial construction because our facilities inadvertently trespass his accustomed habits.

There are four objectives to this paper. They are:

1. Highlight the problem areas of organization and planning as it relates to underground CATV construction.

2. Suggest sound methods of solution.

3. Stimulate thinking on the subject matter.

Philosophy

In order to have a successful image in the community and to have a successful business, we believe that the underground system should be built as quickly as possible with the minimum inconvenience to potential subscribers and the city at large. The construction and operation of the plant should provide maximum service at a minimum of cost.

Major Problem Areas

The major problem areas that you are likely to encounter during construction are:

I Escalating construction costs

II Incomplete plans and specifications

III Inadequate organization

IV Part-time supervision

V Subject of Relationships

I. Escalating Cost--How to Minimize

Aerial construction is relatively simple. Hardware and cable are placed between poles A and B, then messenger and cable are installed. They are relatively few variables. By contrast, underground construction has many variables; and these variables drastically affect the per mile cost of the system. The location of the trench, whether it is in the street or in the parkway, affects cost; likewise, soil conditions, rock conditions and whether or not the surface material (asphalt or concrete) will also force the expenditure of more money than anticipated. The situation is further complicated by the varying conditions throughout the community. Therefore, the creation of a defined construction area becomes important for a number of reasons, most important of which is project control. The construction area should have several common denominators, such as: more or less uniform soil conditions, street construction or alley construction or a geographical area in the community lends itself to a definable unit.

In our Newport Beach System, the construction area is defined by the distribution system extending from a system "bridger-converter". In Phase I of the Newport Beach System, there are 23 converter areas. Work is assigned and inventory is controlled by these converter areas. Likewise, our direct sales marketing program is organized on a converter area basis so that system construction, cabling, splicing, proof of performance, house drops, house wiring, sales and customer hook ups can be coordinated on an area by area basis. We have termed this the "batch flow method" of construction. Without utilizing the batch flow method of construction, the assignment of priority tasks or inventory control problems seem to increase.

CATV construction contracts are basically unit contracts. Normally, contractors press to complete as many units per day in order to offset their high overhead and construction costs. A defined area approach forces the contractor to complete one portion of the system before skipping to the next. Some contractors have been known to work through a general area of the community skipping through and completing all the easy construction and then doubling back and gearing up for more difficult construction problems. This situation leaves gaps and voids in the system which can delay energizing the plant and obtaining revenue from subscribers.

Establishing starting and completion dates for each phase of construction, focuses the attention of all parties on priority tasks.

II. Incomplete Plans--Avoid It!

The lack of complete and approved construction plans undoubtedly will become the most costly mistake encountered in building an

underground system. The competitive climate in which CATV franchises are pursued forces the CATV operator to make commitments to the city well ahead of any thoughtful consideration for system design and construction practices. Operators, especially multiple operators, have a tendency to rush the strand mapping, field engineering and design phases in order to initiate construction in accordance with the time requirements of the city franchise; hence, inaccuracies and voids appear and the critical area of system construction plans.

I suggest that you check with the city public works department to determine the type of map which would be most acceptable for the construction and electronic layout. The standard procedure of obtaining city maps and retracing them excluding superfluous detail, was not a good practice for our Newport Beach System. The city public works department determined that they would rather have the same maps used by the utility companies, so that page 17 of the City Water Plans corresponded to sheet #17 of the CATV Plans. Had this request been determined prior to developing the plans, many hours and quite a few dollars could have been saved.

Each sheet of plans should be complete with the name, address and telephone number of the owner along with the official date that the plans were first circulated and used by several contractors, the city and our own company representatives. Without the official date appearing on each sheet of the plans, it is conceivable that your contractors may be building different systems. Each set of plans should be complete with a page devoted to typical construction practices of vaults, cross sections of streets, the location of other underground utilities, complete with a legend and standard specifications which have been approved by the City Department of Public Works.

A key sheet should be submitted to reveal the precise area in the community that the work is to take place.

Taking these suggestions to mind does not eliminate all of the conflict. The City Department of Public Works is primarily interested in the location of the trench; therefore, they want simply a trench diagram. Because many utilities are located underground, most cities require that plans should be dimensioned showing the precise location of the proposed CATV facilities. The city, at least our city, was not interested in the electronic layout which reveals the number of cables and electronic devices which are required. In order to eliminate the need for two types of plans, i.e. a set of construction plans and a set of electronic layout plans, I suggest that you bring this to the attention of city officials and negotiate a reasonable compromise.

A civil engineering consultant is a most handy person to have available prior to and during the course of construction. This consultant is able to talk "turkey" with his civil engineering

counterpart in the city government; also, the consultant is able to save many dollars by advising the cable tv operator of streets and alleys which are already severely congested with underground facilities. I recommend the addition of a civil engineer on a consultant basis without qualification.

In many areas of our country, cities are separated by imaginary boundary lines. You may find yourself in a situation in which I found myself. While constructing the system within the city of Newport, crews inadvertently placed several hundred feet of distribution system within the adjacent city of Costa Mesa, California. At first the city manager of Costa Mesa was delighted to hear about my mistake, for he though he had found a way to balance the city budget; however, a very equitable solution resolved the problem.

III. Organization

To connect a subscriber to a CATV System on the day that proof of performance and system acceptance has been completed is the objective of good organization. This organization necessarily includes every function from the time the franchise was accepted to the installing crew connecting a subscriber to the system. "He who has the gold makes the rules" is the guiding principle of the organizational structure. It is the project manager who represents the stockholders who have the gold. The project manager, unequivocally, should have the entire responsibility and commensurate authority over the creation of the underground system. Key personnel in the areas of engineering, finance, marketing and public relations, serve as staff functions to the project manager and the civil engineering consultant should be available to him as needed. There is line authority between the project manager and the superintendents of construction, splicing, house drops, wiring, customer connections and testing and proof of performance.

System construction involves several processes; namely, sign surface removal, trenching, removal of back fill, placing of conduits in vaults, refilling with slay or a natural fill and finally patching. If a contractor has three complete crews performing these functions at different locations within the city, the project manager should have his superintendent follow each crew each day. The construction superintendent is responsible for quality control of his crew. He should be able to make decisions on the spot which will keep the job moving and to insure the project manager that each aspect of the job is being done properly.

When the contractor submits his invoice and worksheets for payment, the construction superintendent will verify the quantity and quality of work accomplished. Upon the superintendent's approval, the invoice is forwarded to the project manager for

payment. The splicing superintendent conducts his operation in the same manner and procedures. If underground house drops and house pre-wiring are handled by contractors for testing and proof of performance, the person in charge of these activities should exert quality control and advise the project manager of any irregularities.

Ideally, construction, splicing, house wiring and house drops should be done by a single prime contractor; however, having two contractors on hand provides some flexibility for the project manager.

Unfortunately, not all underground contractors are equally experienced and/or well-financed. Therefore, it may seem prudent to accept bids for certain defined areas of your system and based upon performance of the contractor, amend the contract to extend the construction into adjacent new areas.

IV. Supervision

The organizational chart reveals that the cable TV operator provide field personnel supervising each phase of construction and that an individual should ideally be provided with each construction or installation crew. This practice results in quality control of the work being performed.

The job of the field supervisor is to make on the site decisions which will implement construction insuring a high quality of work being performed and to advise the project manager of the status of the project daily. With daily status information, the project manager can adjust the work load enabling him to meet the predetermined target date for completion. Anticipating these needs is much less expensive and easier to accomplish than correcting faults and mistakes during construction.

V. Relationships

In order to see a project through a successful completion, there must exist good relationships between and among the city, contractors, utility companies, potential subscribers and your company. Wholesome productive relationships exist for two reasons, (1) character of the individuals involved, and (2) the communication which exists among them. To begin with weekly meetings should be established with representatives from each company involved in the project. At these meetings, the procedures should be established to correct any damaged utility line or subscriber's property with the minimum inconvenience to all. After the project is underway, the meeting time could well be extended to twice each month. Memorandums, with copies to each company representative, aid in informing people of the result of the meeting and in communication.

Operators should be equally concerned with the relationships that exist within their own company. The perpetual conflict between the technical and marketing areas can be resolved by a blanket of complete understanding of the problems involved. Marketing is dedicated to saturate the system with subscribers pressing the technical people to rush their work so that salesmen can keep promises to the potential subscribers. Frequent and regular communication between the marketing and technical personnel tends to alleviate sticky problems.

Summary

Five basic points were presented in this paper. They are:

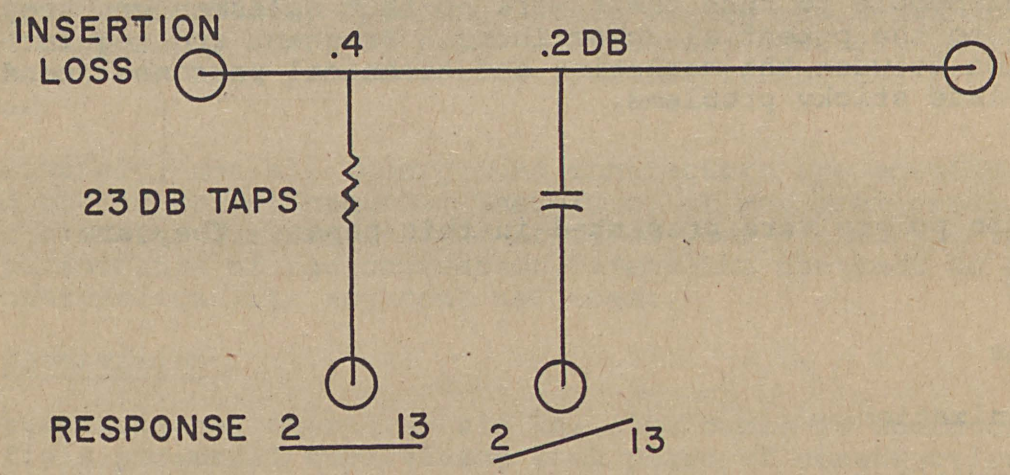
1. Cost
2. Plans
3. Organization
4. Supervision
5. Relationships

It is believed that cost can best be controlled by the batch flow method under the supervision of field personnel responsible to the project manager.

Plans complete in all details are fundamental for a successful project. Operators should work closely with their municipal jurisdiction to establish the ground rules prior to beginning construction. Frequent and regular meetings among all aspects of the construction organization contribute to the understanding of the other fellow's problem.

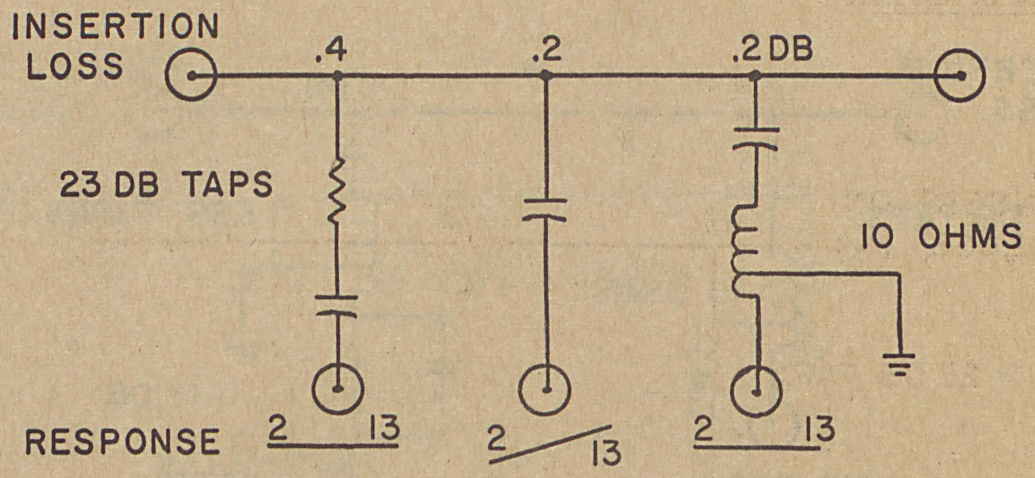
Will there be any risk if operators put into practice all the suggestions in this paper? Yes, there will be. But we wouldn't have America today if Columbus didn't risk a little. Good luck.

PRESTON SPRADLIN



NO BACK MATCH 1

In the very beginning of CATV, two taps were used extensively. First, a resistive tap as shown and followed by the capacitive tap. Each were acceptable in a low bank system (channels 2 to 6). The capacitive tap was more popular because it has less insertion loss and, with its built-in tilt, helped compensate for cable losses. Being a capacitor, it naturally provided AC isolation, although a capacitor could be inserted in series with the resistor. Neither unit was backmatched but this was not too important before the coming of color. For our discussion, we will consider a tap value of 23 dB.



NO BACK MATCH

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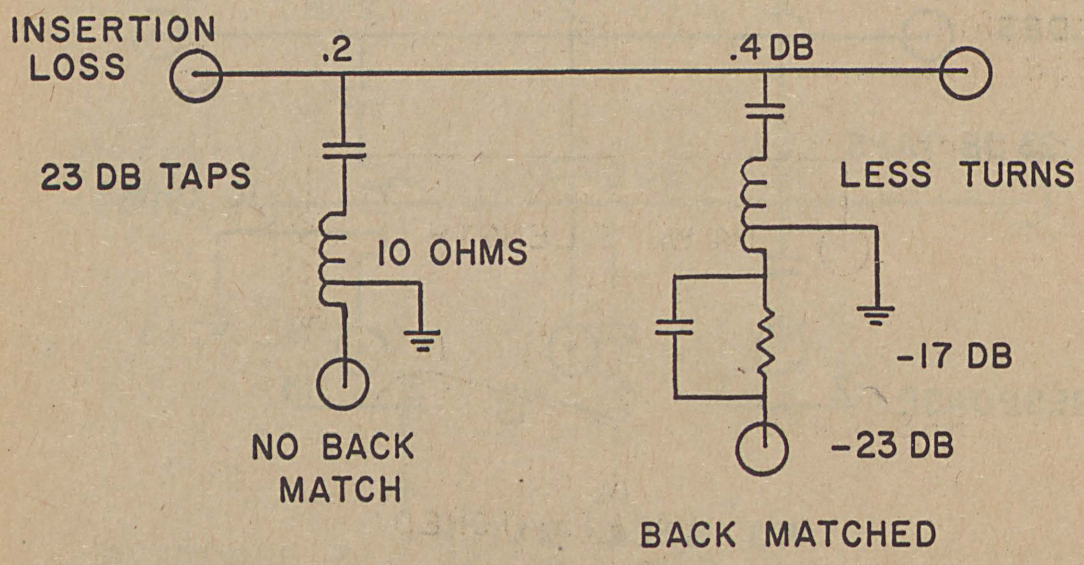
The next type of tap to come into popular use with the event of all-band systems was the transformer tap as shown. It featured low insertion loss and flat response. The capacitive tap was unacceptable in all band systems because of its extreme tilt and resulting low tap loss at Channel 13. The big disadvantage of the transformer tap was that it too wasn't back-matched.

In some color situations, it was necessary to use a pad preceding the TV set transformer to keep down standing waves.



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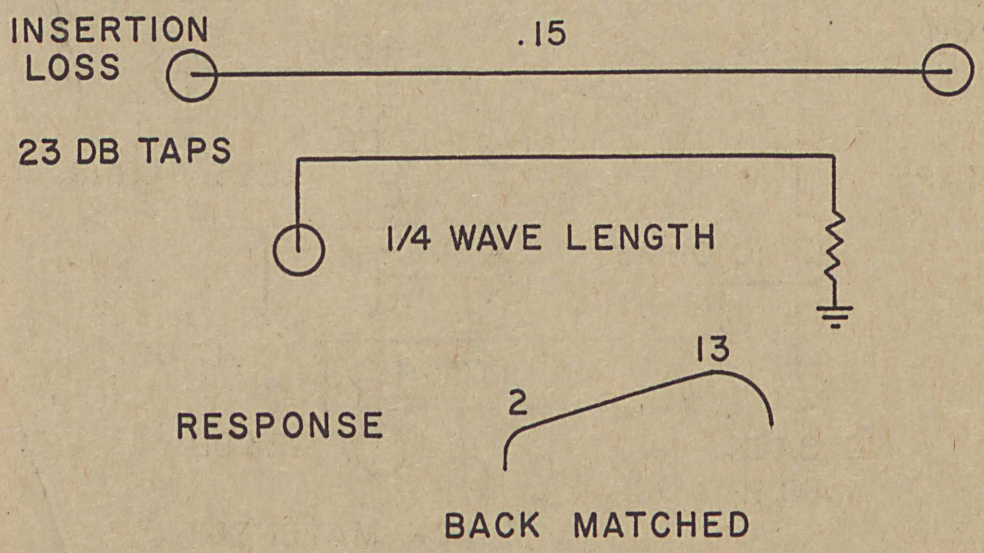
A modification of the transformer tap made it a back-matched unit but brought about a strong disadvantage, which was more insertion loss. The first transformer tap shown has a back-match impedance of approximately 10 ohms, depending on frequency. To back-match this, a resistor was merely inserted in series with the output lead to match it. A small shunt capacitor was used to compensate for high frequencies. This resistor resulted in an additional 6 dB loss to the tap. In order to keep our tap value at 23 dB, we must use less turns on the transformer so that our junction point (Series resistor & transformer) is -17 dB -6 dB through the resistor which = -23 dB at output. This change in the transformer brought about more insertion loss to the thru line or .4 dB. This approximately equals the resistor tap insertion loss, but it has the additional feature of being back-matched. To this point we have not mentioned VSWR (return loss,) - but we can expect that more insertion loss will result in lower return losses, which brings us to our next consideration.



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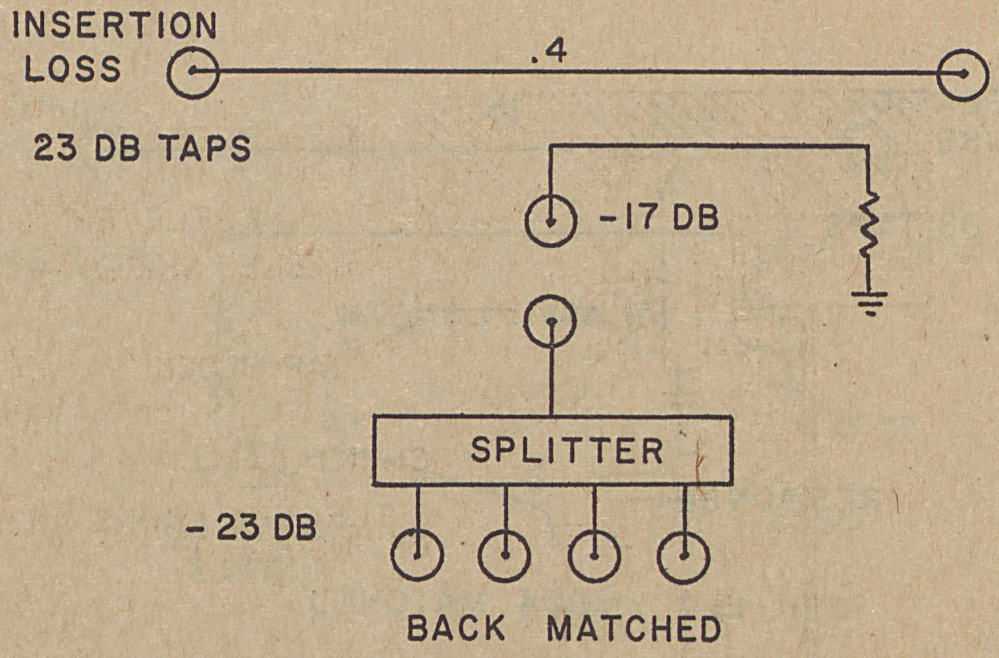
Directional Coupler

The Directional Coupler - or in-line tap - has come into extreme popularity because it provides several advantages over the previous units. (1) Low insertion loss (2) A flat to slightly tilted response (dependent on design) (3) Directivity (4) Back-match without series resistors resulting in less insertion losses. You might say it is the ultimate to date. It does have the disadvantage that the cable must be cut at each tap with resulting additional costs in labor and the increased cost of the basic unit - it also gives us additional possible trouble points due to the connectors involved.

The directional coupler can also provide a better VSWR (return loss) if properly designed than the pressure tap because it goes in series with the coaxial cable and a certain amount of compensation can be done to maintain this match, while the pressure tap can only parallel the center conductor and as the insertion loss increases the return loss goes down.



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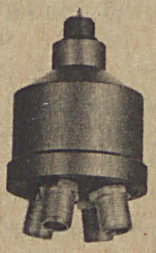
The type of tap shown is the strip line version utilizing a 1/4 wave length principle.

The directional coupler can also provide 4 outlets with only the expected increase of insertion loss - many units give an option of single, -2, or 4 outputs.



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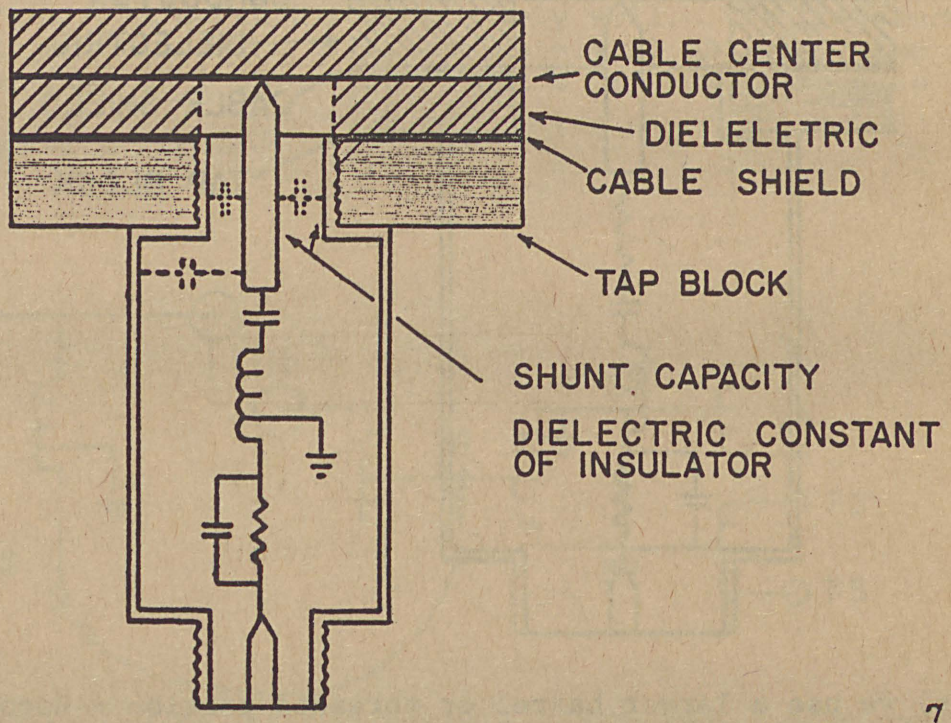
What we will attempt to do is design a multi-tap with as many features of the directional coupler as possible, yet stay with the old school - of not buying a thousand-foot reel of cable, hang it in the air, and then cut it into 8-10 pieces. In short - in existing systems, we like the pressure tap principle.

The tap units discussed are circuits built into a pressure tap which has several factors we must consider.



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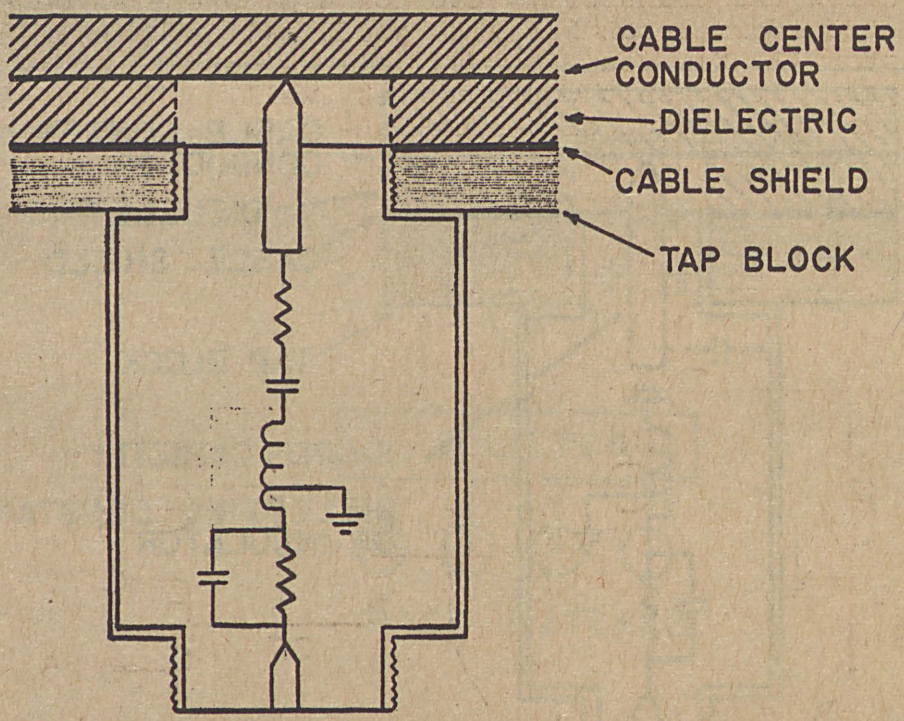
The cut-away view of the pressure tap shown is typical and must receive several considerations in its design. The most important being the design of the Stinger and its associated components. The parallel areas of the pin making contact with the center conductor, and the threaded barrel that screws into the block form a small capacitor which adds to the insertion loss of the unit. So the less capacitance, the less the insertion loss. To lower the capacitance we can use an insulating material with a low dielectric constant, shorten the pin or enlarge the threaded barrel which will increase the distance.



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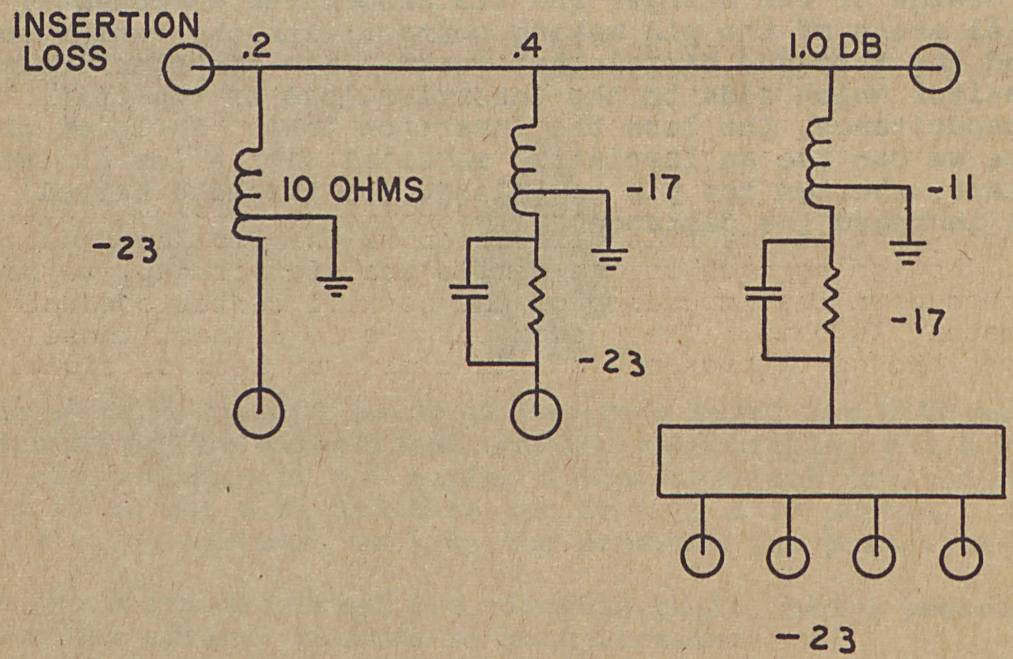
First, we use a larger barrel or threaded portion - Second, we use a low dielectric constant material and Third, we insert a small resistor in the immediate lead shortening the pin - all these factors lessen the capacitance, lower the insertion loss and improve the return loss.



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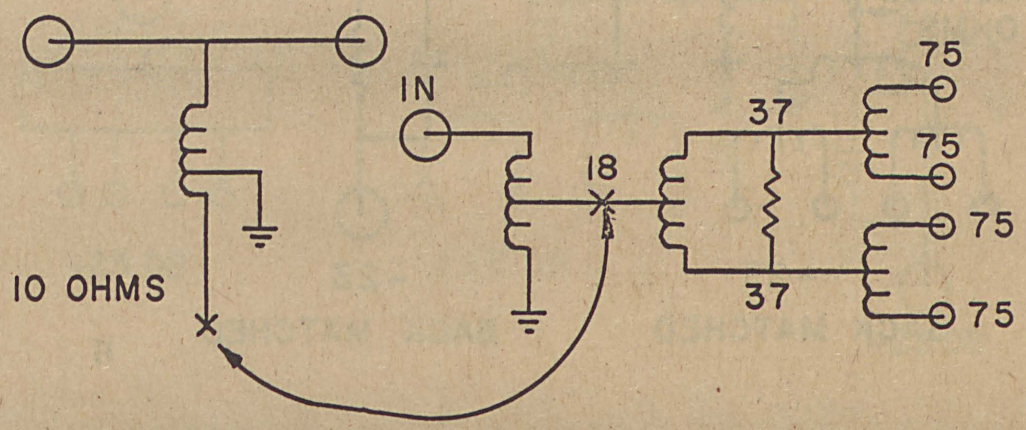
Let's now review the transformer tap for a minute - as we said before, the transformer can be quite good. (1) We back-match it with a resistor (2) Now you might say all we need to do is add a 4-way splitter - It doesn't work out very well. The transformer must be changed to a value of approximately 11 dB, resulting in an insertion loss of 1 dB or none - Let's try something else -



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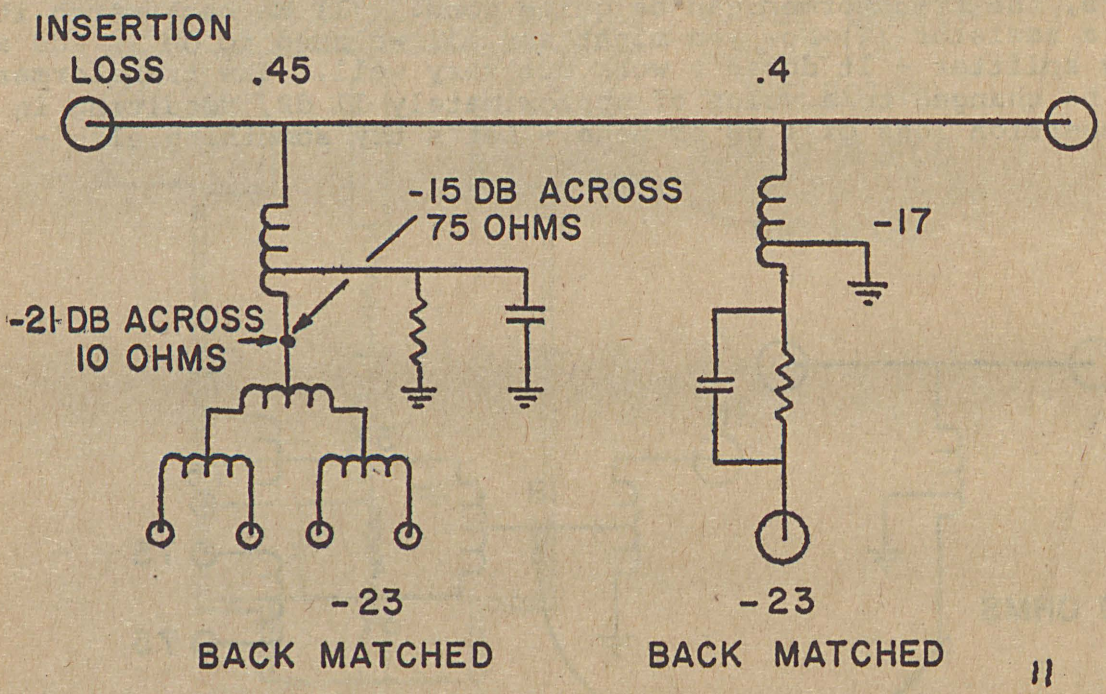
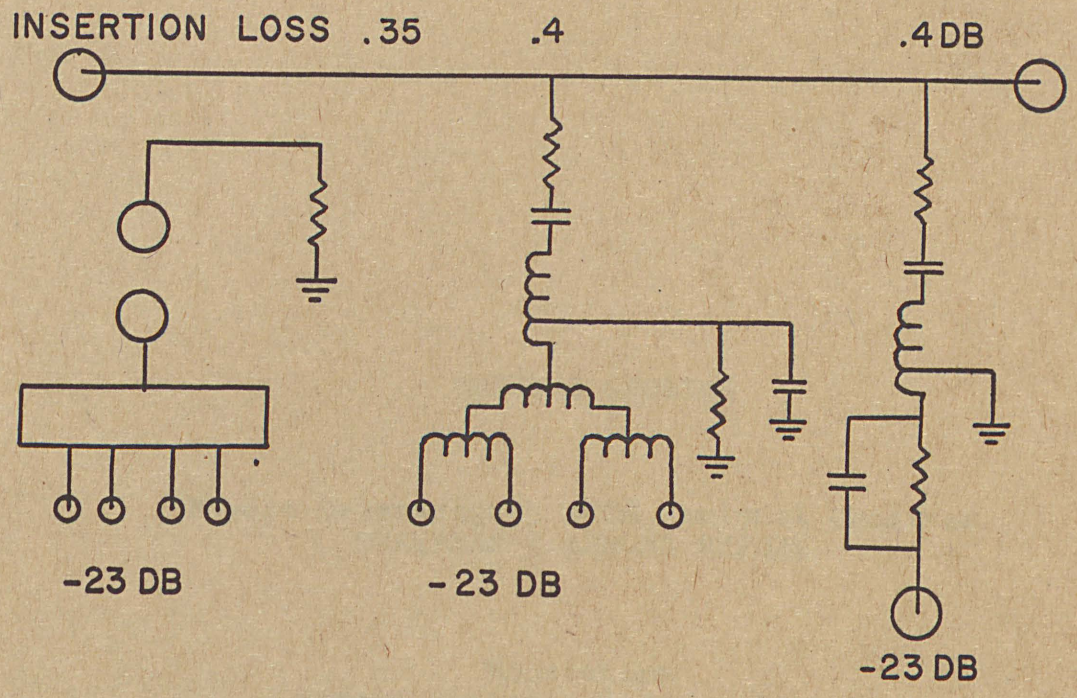
Here is shown a 75 ohm 4-way splitter. The input is 75 ohms and the first coil steps the impedance down to approximately 18 ohms (it varies with frequency). The second coil steps it up to 37 ohms and the next pair of coils brings the impedance up to 75 ohms with an overall theoretical loss of 6.5 dB - capacitors (not shown) are used on the coil junctions to compensate for frequency. The important junction for this discussion is the impedance point of 18 ohms. Now going back to the simple transformer tap, we see the coil steps down the impedance of the coaxial center conductor to approximately 10 ohms. The answer then is to connect these two junctions and get a back-match with a minimum loss of signal.



Here we show the second portion of the 4-way splitter matched to the 10 ohm point on the transformer tap. The transformer coil was adjusted to provide a -15 dB across 75 ohms, but if we could read it at 10 ohms it would be a -21 dB junction - The impedance is then stepped up to 75 ohms across four outputs with only 2 dB of loss. The unit with 4 outputs then compares favorably with the single tap.



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We can now favorably compare the four-way multi-tap with the directional (in-line tap) especially in the values over 20 dB. It is made in 16-20-25-30 & 35 dB values. The VSWR can compare to a directional coupler in all values over 16 dB value.