Status of Cooperative Work on Joint Use of Poles *

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Because of the necessity of reaching the same customers, electric supply and telephone lines commonly use the same streets and highways. In urban communities, the joint use of poles for these two services has been very widely adopted and practises for joint use construction have been established from experience gained in past years. In rural communities, joint use is not always practicable or economical. Joint use involves many engineering and economic problems which have received the careful consideration of the Joint General Committee of the National Electric Light Association and Bell Telephone System.

This paper describes some of the problems which have been encountered in joint use, and briefly outlines the work which is being conducted by the Joint General Committee in connection therewith.

It is concluded that in specific cases proposed for joint use all factors should be studied cooperatively by the companies concerned and that everything practicable should be done to facilitate joint use construction and extend its usefulness.

TELEPHONE and electric light and power services are supplied in the same areas and to customers who are to a large extent common to both utilities. It is therefore necessary that both types of service be carried along the same streets and highways.

Experience has shown that safer and more satisfactory conditions can often be secured if the power and telephone circuits are carried on the same poles. This is due in part to the fact that clearances and climbing space can be more readily maintained where both classes of circuit are carried on the same poles rather than on separate poles on the same side of the street. Where separate lines are placed on opposite sides of the streets and alleys, it is difficult to secure and maintain proper clearances for service wires to buildings where these cross the line of the other utility.

Joint use of poles by the power and telephone companies results in the use of fewer poles on streets and highways and better appearance of aerial lines. It is, therefore, more desirable from the public point of view. It conserves pole timber and in many cases is more economical to both classes of utility than separate lines.

Because of the above mentioned advantages, joint use of poles by power and telephone companies has been widely adopted. No complete data are available as to the extent of such joint use at the present time, but it is estimated that there are at least five million poles jointly used by the power and telephone companies in the United States.

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Both of these classes of utility have been growing rapidly in the past twenty-five years and the development, design, and construction of the physical plant of each has kept pace with the growth in territory and number of customers served.

While earlier types of distribution plant were such that the possibility of contacts between wires of the two utilities and other hazards could be satisfactorily met by proper construction methods, protective devices, etc., later developments have increased the use of types of power distribution circuits regarding which questions frequently arise as to how service can be properly maintained and extended on jointly used poles.

These questions have received and are receiving careful consideration by the Joint General Committee of the National Electric Light Association and Bell Telephone System. This committee has recommended certain principles and practises for the joint use of wood poles which are intended for use as a basis on which electric supply companies and communication companies should work out their mutual problems and has undertaken important research work in connection with these matters through its Joint Subcommittee on Development and Research.

The principles and practises mentioned were presented in a report of the Joint General Committee under date of February 15, 1926, and while it is beyond the scope of this paper to consider these principles in detail, the following recommendations are of interest in that they indicate the way in which this matter is generally being approached:

Each party should:

(a) Be the judge of the quality and requirements of its own service, including the character and design of its own facilities, both now and in the future.

(b) Determine the character of its own circuits and structures to be placed or continued in joint use, and determine the character of the circuits and structures of others with which it will enter into or continue in joint use.

(c) Cooperate with the other party so that in carrying out the foregoing duties, proper consideration will be given to the mutual problems which may arise and so that the parties can jointly determine the best engineering solution in situations where the facilities of both are involved.

It will be observed that while each party retains full responsibility for facing and meeting its own problems, it is recommended that both parties cooperate in working out mutual problems involving the joint use of poles and in finding the best over-all engineering solution in each situation. These are among the most important of the principles

which have been recommended and are the basis upon which practically all cooperative work is being carried forward.

It is the purpose of the following paragraphs to describe what has been done and what is being done by the Joint Subcommittee on Development and Research in connection with the engineering and economic problems which have been encountered in joint use work.

Construction Practises

Joint use construction practises have undergone almost continual change and improvement from the time joint use was first adopted and continued development is to be expected in the future. However, many of the fundamental requirements for securing satisfactory conditions on jointly used poles were recognized at an early date and form the basis for present day practise.

In the matter of relative levels it has been recognized that power wires should as far as practicable be carried in the upper position. In general, they are larger and stronger than the telephone wires. This is inherently so because of the current carrying capacity required. Placing power wires in the upper position on jointly used poles avoids the necessity of telephone linemen climbing through power circuits, the exact nature and characteristics of which they are not always familiar with.

Clearances must be provided which give sufficient space below the power wires so that power linemen will not have to come in contact with telephone wires while they are working on power wires. This neutral space must also provide sufficient clearances above the telephone equipment so that telephone linemen may work on the telephone plant without danger of coming in contact with power equipment. Clear climbing space must also be provided so that linemen may climb poles without having to be extremely careful to avoid falls or contacts with circuits from which they may receive physical injuries.

Fig. 1 shows one method for securing satisfactory conditions on a jointly used pole carrying circuits which both the power and telephone groups have recognized as being suitable for joint use.

In the matter of mechanical strength, joint use follows the practise in the construction of separate lines. That is, strength of construction should be provided such as to stand, with reasonable factors of safety, storm conditions which experience indicates are likely to occur from time to time in any particular area.

With regard to the matter of insulation and electrical strength, practises as to the size and type of power insulators have followed developments in the general field of power construction. Wires to street lights

and underground connections to aerial plant require vertically run wires on jointly used poles. The location, insulation and mechanical protection of these have received special consideration to eliminate hazards to workmen.

Sufficient clearances between vertically run circuits of one type and the equipment of another utility on jointly used poles have also been

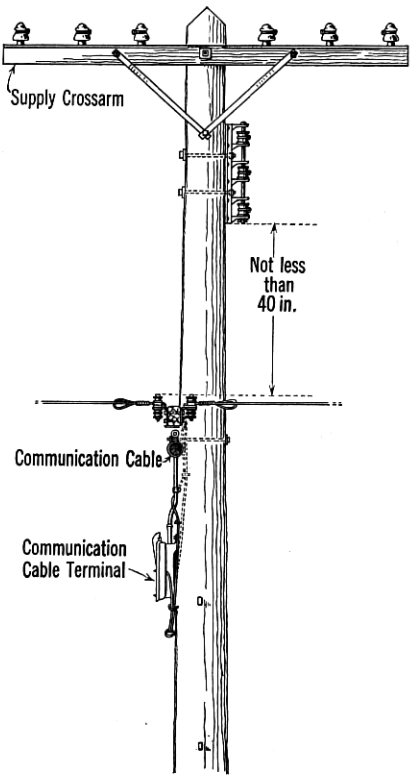

Fig. 1—Typical jointly used pole.

found to be very important from the standpoint of avoiding interruption to power and telephone services.

In the course of electrical storms, lightning may induce high voltages on either supply or communication wires. If the separation between the supply and communication facilities is not adequate at any point, these induced voltages may break down the insulation and arc between the two as illustrated in Fig. 2. Damaged plant may, of course, result from lightning alone. However, when lightning has established an arc between the power and communication circuits the normal voltage of

the supply circuit may maintain the arc. This results in the transfer of power into the telephone plant at voltages which may be well above that for which it is insulated and may cause trouble on both the power and telephone system. This sort of abnormal belongs to the general class that includes insulator flashovers, short circuits on cables, tree grounds and similar power system occurrences that always carry the probability of damage to the power system or service.

While vertically run attachments with improper clearances have played a large part in causing such occurrences, any situation where

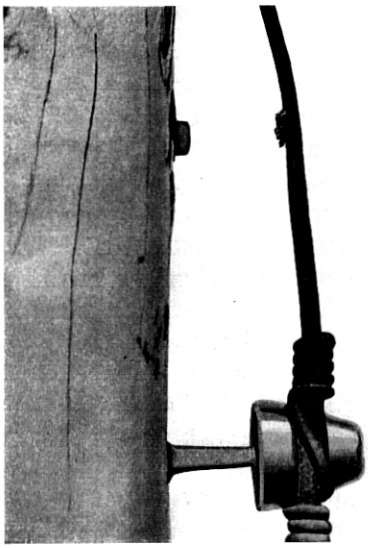

Fig. 2—Frayed insulation showing breakdown of insulation between power and telephone plant.*

insufficient clearance between power and telephone facilities is provided may result in similar trouble.

Emphasis has, therefore, been placed in present day standards on the necessity of maintaining proper clearances as well as strength of construction to prevent this kind of abnormal. Experience has shown that where these clearances are adhered to this type of abnormal is kept to a reasonable minimum.

The Joint General Committee is giving careful consideration to the matter of construction standards on jointly used poles. Pending the development of complete specifications covering recommended prac-

* In order to obtain a satisfactory photograph of the points of arc the vertical drop has been straightened out so that the clearance shown is much greater than existed at the time of the arc.

tises under various conditions, they have recommended the National Electrical Safety Code to be used as a guide to practise.

Protective Devices

Both telephone and supply circuits are equipped with protective devices which are fundamentally the same in principle. They may be divided into two general classes:

1. Those which provide protection from abnormal voltages consisting of protector blocks in the telephone plant and lightning arresters in the supply system.
2. Those which provide protection from abnormal currents consisting of heat coils and fuses in the telephone plant and fuses and circuit breakers in the supply systems.

These protective devices are a secondary defense against abnormal conditions which it is impracticable to avoid either by design or through adherence to construction standards.

Even when all practicable precautions with regard to clearances, strength of construction and insulation have been taken, accidental breaks occur in both power and telephone wires. In some cases there are direct contacts between such wires. Higher than normal potentials are also introduced into the telephone and power circuits by lightning and other causes.

It is because of the limitations of protective devices and other protective measures that joint use with certain types of circuits has been in question. Considerable differences of opinion exist between engineers as to the degree of hazard involved in joint use between telephone plant and power circuits of various types, voltages, and connected power. The problem has increased in importance as the use of higher distribution voltages and greater generating capacity have been employed.

This matter is under investigation by the Joint Subcommittee on Development and Research. Studies are now in progress in one rural area and in one suburban area to determine the over-all advantages and disadvantages of the use of higher distribution voltages and of joint use with these voltages under present conditions.

The first experimental work done by the Joint Subcommittee in connection with these problems was a detailed study of the characteristics of various types of fuses. This study covered all of the well known commercial types of telephone fuses and a number of experimental models. The operating characteristics of these fuses were obtained at voltages of 2300, 4000, 7500 and 13,200. The current range was from 16 to 1000 amperes. These tests were carried on in a

laboratory where 20,000 kv-a. of generating capacity was available. The tests showed the dependability that could be placed upon the various fuses for interrupting voltages of the range from 2300 to 13,200 volts. They showed under what conditions the fuses could be depended upon and the ranges where the available type of fuses could not be depended upon for safe operation.

A number of the experimental models showed considerable promise of improvement over existing models, and this work will be carried further to determine what improvements can be made in the operating characteristics of fuses.

The next phase of the problem taken up included a study of the operating characteristics of various types of overvoltage protectors suitable for use on communication circuits. The experimental work covered breakdown with direct current, 60-cycle alternating current and a complete study with a cathode ray oscillograph of the behavior under steep wave fronts for carbon block protectors, neon and vacuum tubes.

These tests showed that the carbon block protector has a breakdown point with all types of applied wave fronts which is sufficiently fast and low to protect the insulation that is now used in the communication plant, as shown by similar tests on condenser and cable paper. The shortcomings of these blocks lie in their tendency to permanently ground the circuit when carrying current for any appreciable length of time.

The tests with steep wave fronts were carried to a rate of rise of 36,500 volts per microsecond, and it was determined by tests of propagation of steep wave front voltages through telephone cable that it was practically impossible to subject the plant to voltages with any faster rate of rise than those used in the protector tests.

The problem of adequate protection of the telephone plant in joint use, obviously, cannot be solved by the development of the telephone protective devices alone. The protective devices in the power system are equally important.

One of the important functions of the power system protective devices is that of clearing power system faults in a reasonable time interval. Obviously, telephone protective equipment cannot be expected to prevent damage to telephone plant in case of contact between the wire circuits of the two utilities when power system protective devices fail to operate and the physical contact of the circuits is maintained over an indefinite period of time.

One problem in the development and research work is the fixing of the part that the protective devices on each system must play in abnor-

mal conditions. It is necessary that the over-all protective equipment be adequate and that the burden of overcoming weaknesses in the protective equipment of one system be not thrown on the protective equipment of the other. There are inherent limitations in both classes of protective equipment that must be defined.

Therefore, the next step in this investigation is a determination of the over-all characteristics of power circuit and telephone circuit protection under typical conditions of contact between the two plants.

While protective devices are an important element in connection with joint use involving certain types of power circuits employing the higher distribution voltages, there are also other important considerations. The general insulation of the telephone plant must also be considered, especially in connection with drop loops attached to and entering subscribers' premises. These matters are also being studied by the Joint Subcommittee.

All of these problems, as is the case of others being studied by the Joint General Committee, are being approached on the basis of determining the best over-all engineering solution such that both systems can provide their services in the most convenient and economical manner.

Inductive Coordination

In the early history of joint use, noise induction problems involving street lighting circuits appeared. Other interesting problems were encountered such, for example, as the accidental grounding of one corner of an isolated delta power system with its resulting unbalanced voltage inductive effects on open-wire telephone circuits, which type of telephone construction then predominated.

As these problems arose they received careful study and with the development and extended use of telephone cables and the use of improved operating methods in power and telephone distribution generally, inductive coordination of power and telephone distribution systems in the urban communities became less troublesome and did not for a time receive any large amount of consideration.

However, during recent years the introduction and extended use of various types of multi-grounded distribution systems described in the paper by Messrs. Harrison and Silver and the existence of certain types of signaling on local telephone circuits, have contributed toward making important the consideration of noise inductive effects in connection with joint use. This matter is discussed more fully in the paper by Messrs. Harrison and Silver.

The technical factors involved in inductive coordination problems under joint use conditions are complicated. The details regarding

these factors and the results of the extensive studies of these matters by the Joint Subcommittee on Development and Research are described in the paper by Messrs. Wills and Blackwell.

The various operating problems which have arisen almost since the birth of the power and telephone industries and the investigations conducted by the Joint Subcommittee on Development and Research indicate the importance of giving careful consideration to the inductive coordination features of joint use and of including this factor in studies of the relative advantages and disadvantages of joint use as compared with separate lines. This factor should, of course, be considered from both its technical and economic aspects.

Much can be accomplished in the inductive coordination of the two distributing systems by cooperative advance planning. In urban areas where the telephone circuits are largely in cable, there is about a two to one ratio in the inductive effects between a joint line and separate lines across the street. In rural areas where the telephone circuits are largely open wire, the ratio of the inductive effects on joint lines as compared with separate lines across the highway, is much greater, other things being equal.

In urban areas the power and telephone companies can through cooperative planning frequently arrange to establish important power feeders and telephone circuits on separate streets and thereby avoid large inductive effects and permit more extensive joint use of branch lines. A careful review of the equipment used on the power and telephone circuits and the introduction of operating practises designed to limit the inductive susceptiveness of the telephone circuits and the inductive influence of power circuits, form an important part of advance planning and cooperation.

As described in the paper by Messrs. Wills and Blackwell, these latter factors include such items as limitation of the odd triple frequency series arising in Y-connected generators feeding directly on the line and in single-phase service transformers. Suitable limitations of the unbalances existing among the loads connected between the three-phase conductors and the neutral, limit the ground return components.

Grounding of aerial telephone cable sheaths to provide for increased shielding and the use of central office and station equipment providing a higher degree of balance with respect to ground are helpful.

The matter of joint use may involve both rural and urban communities. It is more generally associated with the latter because of the severe limitations in physical space available for utility use. In the case of rural lines where the telephone circuits are largely in open wire

and the exposures between particular circuits are likely to be long, joint use is not always practicable. In these cases locations for separate lines are usually available.

Furthermore, joint use in rural areas is not always economical from a purely construction standpoint due to the fact that relatively longer spans can often be used on the power lines and both utilites are able in many instances to use shorter and lighter poles than would be practicable in joint use. Joint use with telephone toll circuits or power transmission lines has not, in general, been found desirable. Types of construction vary so widely and service requirements and inductive effects are such that it becomes uneconomical to carry out such construction.

Conclusions

Joint use of poles by power and telephone companies has many advantages, both from the standpoint of the public and from the standpoint of the wire using companies. This is especially true in built-up communities.

Important problems brought about by developments in practises, particularly in the use of high voltage distribution, remain to be solved.

Careful adherence to generally accepted practises with regard to clearances, strength of construction, insulation and inductive coordination is necessary in order that the advantages of joint use can be secured.

In considering specific cases proposed for joint use, it is advisable that all of these factors be studied cooperatively by the companies concerned, to the end that good service, safety and economy by both classes of utility may be promoted.

It is important that everything practicable should be done to facilitate joint use construction and extend its usefulness. The Joint General Committee of the National Electric Light Association and Bell Telephone System is continuing its efforts in this connection.