CONDITIONS FOR CONTINUOUS SERVICE OVER LINES OPERATED IN PARALLEL.

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In order to maintain a continuous service, nearly all of the more important transmission systems have installed two or more pole lines, each carrying one or more circuits. As a rule the circuits are operated in parallel but are so arranged that at least one of them may be entirely disconnected without interrupting the delivery of energy.

Two sets of conditions are met with in practice: first, normal operating conditions; secondly, accidental conditions. It is possible by design to provide for the first, and, in the main, for the second. The normal operating conditions include inspection, repairs, and additions to the circuits. But little work can be done on high-pressure circuits while in service, and it follows that adequate switching devices must be provided such that any circuit may be disconnected without an interruption of the service.

Both the air-break type of switch and the oil-switch are now available for pressures to 60 000 volts, and may be installed in various ways to obtain the desired results. They may be operated either automatically or manually. There are in use several systems of switching transmission circuits in parallel. Some arrangements provide for connecting only the low-pressure side of the transformers; others only the high-pressure side, and still others provide for the connecting of both the high- and the low-pressure sides in multiple. An arrangement of connections for two transmission circuits in parallel is shown in the accompanying diagram.

This system may be elaborated by adding group-switches on one or both sides of the transformers. If more than two circuits, or more than two banks of transformers be employed, various devices are resorted to for providing the required flexibility. Practice in this last connection has taken the direction of sectionalized bus-bars, with some form of group switching. In addition to the switching devices at either end, it is desirable on long lines to install sectionalizing and paralleling switches so arranged that a section of a transmission circuit may be entirely isolated and the remainder continue in parallel with the other circuits. The switches for this purpose are usually mounted on the poles and are operated manually. It is probable that the practice of sectionalizing long transmission lines will be extended in future and that improved switching apparatus will be employed for this purpose.

In addition to normal operation, the accidental conditions which may arise and affect the continuity of the service should be anticipated and provided for. These conditions, whatever may be their primary cause, usually result in an open circuit, a short circuit, or a grounding of the conductors. Whenever one of these occurs it is essential that the entire circuit, or at least the defective section, be immediately isolated from the other circuits of the system. This may be accomplished either by automatic devices or by the attendants. The automatic methods, on account of the time-element involved, are undoubtedly superior, but the apparatus should be of thoroughly reliable construction and should be tested frequently if the best results are to be obtained. The best practice calls for circuit switches controlled automatically by means of time-limit overload relays at the generating end, and similar switches controlled by time-limit reverse-current relays at the receiving end. These devices properly installed will effectually isolate a transmission circuit in case of trouble, but other conditions must also be considered if the service is to be uninterrupted. Whenever a parallel circuit is disconnected it disturbs the entire system and especially affects the electrical pressure. A long transmission circuit represents a considerable capacity, inductance, and resistance, and when this is removed or placed in parallel to other circuits, it becomes necessary to readjust the pressure. This is usually done by the attendants at the generating station but a reliable automatic device would be of value for this purpose if designed to meet all the requirements of transmission service.

A considerable change in pressure at the receiving end of the line may result in an interruption if induction motors or synchronous apparatus be operated by the current. The greater the number of circuits in parallel, the smaller the amount of disturbance produced by removing a single circuit. Many of the better high-pressure transmissions depend, however, upon two lines of one circuit each, and in case of accidental difficulty with one of the circuits the entire load is carried temporarily on the other line. By a proper design this may be successfully accomplished, and even in the case where one of the circuits is suddenly isolated by automatic devices the variation of pressure may be kept within such limits that there will be no interference with the service.

The reliability of high-pressure and long-distance transmission has been thoroughly demonstrated, and it has been shown by actual results that a continuous service can be maintained for indefinite periods by the use of multiple lines and proper appliances.