

contribute to some other desired advance. For example, when there was presented by the American Company the problem of automatically insuring that no two toll circuits, which needed an intervening repeater, should be connected by the intervening operator without a repeater, other recent developments were looked to for contributions. By utilizing some of the apparatus and methods recently developed for machine switching, suitable circuits and equipment were devised. Toll lines may now be equipped automatically to select, from a bank of repeaters, an idle repeater whenever they are connected to other toll lines of such transmission equivalents that a repeater is required.

In many of their problems the development groups of systems and apparatus are closely related. What a system will do is largely determined by the apparatus but the requirements imposed upon the apparatus are determined by the desired or projected system. Relays, for example, must operate for certain minimum or limiting currents which are dependent upon the circuits of which they are a part and upon the voltage range of the power supply at central offices.

When such limits are determined the problem of design becomes one for the apparatus development group. But such problems are continuous so that there is always going on a continuous program of fundamental investigations and designs. What is true of relays is also true of all the other pieces of equipment which enter into the telephone plant whether desk sets, plugs and jacks, repeating coils or condensers.

In each case fundamental studies are always in progress. Materials are investigated not only to determine new possibilities but to be informed of variations which may occur in materials already in use. New methods of measurement and investigation are developed and general relationships are established between such factors as: the operating power requirements, the size, the materials, the manufacturing conditions, factory adjustment and its