THE USE OF GROUP-SWITCHES IN LARGE POWER-PLANTS.

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In a number of large electric generating plants recently designed in America, the feeder circuits are divided into a plurality of groups, and a switch designated a "group-switch" is connected into the circuit between the main bus-bars and each group of feeders. Obviously, no switch should be added to an organization of switch gear already very complicated and expensive, unless practical usefulness fully justifies its adoption. As this subject has never been discussed by the INSTITUTE, the writer avails himself of the opportunity presented by the invitation of the Chairman of your Transmission Committee to introduce it.

In considering a subject such as this, accurate generalization is difficult if not impossible. Probably no one who knows what engineering means would affirm without qualification either that he approves the use of group-switches or that he does not approve their use. There are few hard and fast rules in engineering. If such matters as the use or non-use of group-switches could be settled once for all, and for all plants regardless of size, function, or attendant conditions, the purchasing agent would soon succeed the engineer, the pharmacist would take the place of the physician, and the capitalist investing his money in electric power development and use would have no occasion to seek among technical advisers for sound judgment resting upon broad experience, and exercised in full knowledge of the existing state of the art, as well as recognition of its general direction and

tendency. Instead of attempting a generalization, therefore, we may consider more profitably the arguments for and against the group-switch in the case of a typical plant, and then glance at some of the modifications of function and circumstance which in the case of other plants would affect our conclusions. The group-switch first appeared in the plant of the New York Street Railway Company at 96th Street, but as the writer had nothing whatever to do with the design of that plant, he selects for consideration the plant of the Manhattan Railway Company.

In this plant two complete sets of main bus-bars are used. Switches are provided by means of which each of these sets may be divided into two independent sets of bus-bars to each of which four alternators and four groups of feeders may be connected. Eight group-switches are provided, through each of which current is supplied to a set of auxiliary bus-bars, to which in turn the individual feeders are connected through their respective switches. One of the eight feeder-groups is used to supply power to auxiliaries in the power-house. The other seven groups supply power, respectively, to the seven sub-stations which receive power from this central source. All switches in the high-pressure alternating-current circuits are of the motor-operated oil type.

The arguments in favor of the group-switch as used in the plant of the Manhattan Railway Company are:

1—It affords an additional means of opening a feeder-switch that may fail to open its circuit, when operated for that purpose. The advantages of the group-switch in respect to this function to-day appear materially less than they did five years ago, for the reason that the power-operated oil-switch within the period named has demonstrated a high degree of reliability. However, it cannot be assumed that the feeder-switch is invariably reliable, and, therefore, judgment of the weight of the argument in favor of the group-switch, based upon its use as a reserve for the feeder-switch, becomes a question of judgment of the chances of failure of the feeder-switch on the one hand and the seriousness of total interruption of power supply on the other.

2—It affords means of reducing aggregate load upon the power-house in case of necessity, more rapidly and otherwise less objectionably than the usual method of cutting off individual feeders. It will sometimes happen in the operation of a power-plant that it becomes necessary suddenly to shut down one of the generating units. If the load carried at the time be such

that the shutting down of the generator implies reduction of the external load, this can be accomplished most conveniently by operating one or two group-switches.

3—Where duplicate main bus-bars are used it facilitates transfer of load from one set to the other, in case it becomes necessary suddenly in operation to make such transfer. As bus-bars and connections are now installed in our best plants, this necessity does not arise frequently; nevertheless it is liable to occur, and obviously half a dozen group-switches may be used to effect the transfer in much less time than would be required were five or six times that number of individual feeder-switches used.

4—The grouping of the external feeder-circuits in group units bearing a simple fixed relation to the generator units establishes a symmetry and proportion most useful to the operator, particularly in times of emergency. In the case of the plant under consideration, at times of full load, the power passing through each group-switch is substantially equal to the output of one generating unit. This relation of course does not exist under partial loads, but under such loads it is not difficult usually to keep in service generating capacity exceeding the load by a margin sufficient to make it possible to shut down one generator without cutting off feeders; and in cases where this margin of capacity is not kept in service it is, nevertheless, a more speedy and certain operation to cut off the necessary number of groups of feeders than it would be to cut off a proportionate number of individual feeders.

The arguments against the group-switch are:

1—It introduces additional apparatus and, therefore, in itself increases the risk of interruption due to failure in switch insulation, etc. The successful operation of many plants, particularly in America, has been interfered with by the introduction of too much switch gear and too many safety devices, automatic and other; these additions in themselves being responsible in some cases for more trouble than they prevent; and it is to be noted that the group-switch implies the auxiliary bus-bar. Here again it is unwise to dogmatize, for as the result of additional experience the judgment of to-day may be reversed five years from now. As an expression of personal opinion, however, I may say that if the group-switch and the auxiliary bus-bars be reasonably well insulated and installed, the interruptions originating in this additional apparatus should be almost negligible in the case of such a plant as that which we are considering.

2—The group-switch and its bus-bars imply, of course, an increase in cost of the plant. In case of the Manhattan plant this increase is about 10% of the cost of the switch gear and measuring apparatus, and about four-tenths of one per cent of the cost of the plant. To put it another way, the cost of the group-switches and bus-bars for the plant approximates \$20 000, and the annual cost, assuming this to be 10% of the investment cost, is \$2000, which is about two-tenths of one per cent of the annual cost of operating the entire plant, including substations.

In the plants in which the feeder unit equals or exceeds the dynamo unit of power, the group-switch, of course, disappears. In this case, however, it may still be advisable to use two feeder-switches in series in order to avoid the necessity of shutting down the entire plant in case of the failure of a single feeder-switch.

Obviously, also, there is no reason for attempting to use group-switches in cases where the total number of feeders is small.

For plants comparable in magnitude to the plant of the Manhattan Railway Company, using a very considerable number of feeders, the group-switch is important and its use generally advisable.