on a reasonably generous policy toward the investor. The situation has changed radically in the last five years. Even the big and successful companies have to pay high for the capital they need for necessary improvements. All the costs have increased at a startling rate, and unless they are met by a modest rise in the price of the product sold progress must necessarily be checked.

Short-Circuit Currents in Networks

IN THE early days of electric light and power transmission the problem before the designers and constructors was to furnish the generators which could supply the load called for. In recent times, however, the amount of power that can be furnished by a large central station is so great that some safeguard has to be established against accidental short circuits in the system. If no check were established, a severe short circuit might not only develop an enormous amount of energy locally liberated but the mechanical stresses upon the generators and plant might easily become excessive. Sound generators have occasionally been wrecked from mechanical injuries due to stresses from a short circuit.

The protective devices which have been installed during recent years—permanent reactors, overload switches and time relays—are capable of checking the rush of current and energy into a short circuit when the conditions can be assigned in a simple and definite way. In the case, however, of a complex network of high-voltage conductors, such as exists in many large cities, the conditions under which a short circuit can occur are so complicated that it may be very difficult to predetermine whether the safeguards installed are adequate.

An interesting experimental method of ascertaining the electrical severity of a short circuit at any point of a given high-voltage system, supplied by any number of generators in parallel, is described this week by W. R. Woodward. It virtually consists in constructing an artificial line or system on an experimental switchboard supplied with a 110-volt generator. The switchboard artificial system can be short-circuited at any desired point, and the currents in the system or at the generators can be measured by inserting an ammeter at the corresponding points. A current of 1 amp. on the model may mean a current of 1,000 amp. in the actual system, the ratio being determined partly by the voltage supplied to the model and partly by the scale of resistances used in its construction.

An interesting feature of the artificial-line system is that, in the ordinary method of its use, resistances in the model represent reactances in the actual system. The resistance distribution in the actual system is ignored in the model. Consequently, if a short-circuit on the model involves a certain amount of current and power, with reactance only inserted, the added effects of resistance will tend to reduce somewhat the currents in the actual systems. The currents in the model are to that extent limiting currents. This procedure greatly simplifies the construction of the model, because if the latter had to be supplied with both resistance and reactance to match the actual system in all parts, the construction would become much more expensive, while the increased precision would ordinarily be of little service from a practical standpoint.

The switchboard artificial system also has the advantage that it lends itself to the modeling of any given city system with relatively little delay.

Another Stride in Railroad Electrification

THE 207 miles between Tacoma and Othello, Wash., added to the 440 miles previously electrified between Avery, Idaho, and Harlow, Mont., makes 647 miles of track belonging to the Chicago, Milwaukee & St. Paul Railway over which trains are now propelled by electricity. When the connecting link of 212 miles from Othello to Avery shall have been electrified, a straight run of 859 miles will be in operation. Here are both fulfillment and prophecy—fulfillment of a notable undertaking and prophecy of the day when water-power development will cause electric energy to supersede steam for traction purposes in many states—or even of the time when with the onward march of electricity locomotion by this means will be nation-wide.

Pond-Level Control Very Important in Low-head Plants

IRREGULAR flow has always been a problem confronting the hydraulic engineer, and particularly along the Atlantic seaboard, where the run-off is apt to be rapid and the available heads relatively small enough to make variation of pond level a serious factor. In the Rockies and on the Pacific Coast, where several hundred feet of head is the rule, the pond level as such causes very little variation of head and the main problem is to retain all the water possible. In the eastern part of the country, however, the hydraulic works must be so managed as to keep the level on the whole as high as possible, with due provision for taking care sometimes of enormous amounts of surplus water which cannot be saved in the area impounded and is likely to do much damage unless discharged into the stream. In last week's issue Earl Stafford analyzed the various schemes for accomplishing these ends, beginning with the old-fashioned flashboard and proceeding to the recent types of automatic swinging gates.

The flashboard is, of course, able to change the level by only a structurally fixed amount of a very few feet. Discharge of water in time of flood is accomplished by removing the flashboard; but the control of head thus obtained is very imperfect, for, with the original form of flashboard, it is merely a case of a dam with or without the boards. These work passably well, however, in big storage areas with small variations in head. The hinged flashboards pivoted on the lower edge and held up by props which can be removed readily when necessary form a further step in design but still represent only the crudest sort of regulation of the pond level. One step further along comes the sliding gate, effective but requiring hand regulation and in cold climates likely to get blocked by ice. Various forms of pivoted gates show some improvement over the sliding device, being more easily managed and less easily put out of action. Of late there has been a strong tendency to install swinging-leaf automatic gates hinged and counterbalanced so that the water pressure itself determines the angle at which the gate stands. These are now used up to large sizes, 8 feet or 10 feet (2.4 m. or 3 m.) high and 50 feet (15 m.) or more long, and when carefully balanced they seem to be exceptionally successful in holding a steady level in normal circumstances and meeting flood conditions successfully. Something of the detail of the installation costs and practical operation in saving water with these gates is given in Mr. Stafford's paper. Incidentally he deals with the methods for meeting ever-present ice problems in Northern plants