CANADIAN HYDRAULIC POWER PROBLEMS.

ONE of the Canadian papers read and discussed at the International Engineering Congress in San Francisco, in September, dealt with the radical advances made in Canada in the past twenty years in the field of hydraulic power development. Lack of space prevents a comprehensive review of this valuable paper. Its author, Lieut.-Col. C. H. Mitchell, C.E., now on active service in Flanders, has presented a concise general consideration of the whole field, and in a manner that merits careful study and that invites closer and more detailed investigation. Chiefly worthy of mention are the sections of the paper covering water storage, progress in hydraulic engineering, and the problem of dealing with ice conditions. We make the following abstracts of Col. Mitchell's paper, relating to the first and third of these, with the intention of presenting in an early issue an extended reference to the second.

Water Storage.—Storage of water for power purposes by no means presents a new problem, but the application to the immense power projects now existing or under way demands a systematic conservation of water quite beyond the requirements of the past and introduces many new phases into the question.

The seasonal changes in river flow are very pronounced, as the winter discharge is, in general, retarded by freezing and in the late summer the combined effect of low precipitation, excessive evaporation and depletion of natural storage again creates low water; the lesser flow of the two periods definitely determining the economic value of the water power. The enormous flood flows following the winter seasons are available for but a very short period, but if properly conserved and further augmented by the storage of the surplus of the subsequent rains, the minimum flow can be materially increased and the value of the benefited power developments correspondingly raised.

The condition is general in Canada, that hydro-electric developments have approached or exceeded the unregulated capacities of their respective rivers, and while very few extensive storage systems are as yet constructed, the activity of industrial expansion now demands that the power developments must anticipate the very near future and fully provide for the securing of maximum available outputs and that every advantage be taken for complete conservation and storage. It is remarkable that practically all Canadian rivers are naturally provided with excellent storage possibilities.

Pondage, differentiated from storage as being the day-to-day storage of water immediately available at the turbines, is an essential in Canadian water powers as providing an insurance against ice, which is a factor commanding the full respect of the engineer. The river flow due to the controlled discharge from remote storage reservoirs may not correspond to the variation in power demand during the day, thus, further necessitating pondage as an important component in the economic regulation.

The investigation of storage and pondage requirements must fairly establish the load factor of the power supply imposed on the system, the load distribution over the twenty-four hours, and, further, the seasonal variation of load as dictated by the nature of the market. The study of the unexploited field demands an approximation of loads, whose character may be assumed by comparison with other existing loads, and it is essential that the inherent load factors applicable to the respective types of loads be fully recognized.

It must be appreciated that effective storage requires relatively large acres of land for flooding purposes and such lands, by growth of population and by the establishment of permanent improvement, increase in value at a rapid rate; at the present time, however, it transpires that the majority of the Canadian storage schemes now under way involve remote forested Crown lands readily adaptable for storage purposes. The multitude of interests involved in extensive storage developments makes the accomplishment of storage, in most cases, quite beyond the capabilities of the power developing companies and requires concerted action in the obtaining of the necessary rights. In Canada, the respective Government, Dominion or Provincial, which has jurisdiction over water powers, acts as the intermediary, and this has been a very substantial factor in the notable success of the power situation throughout the country.

The author then describes a number of Canadian storage developments, in service or projected. These include the Northeast and Indian Rivers scheme in Nova Scotia, the Saguenay River and St. Maurice River projects in Quebec, the contemplated storage scheme on the Winnipeg River, the Bow River and Athabaska River storage possibilities in Alberta and the Stave Lake and Coquitlam Lake systems in British Columbia.

Ice Conditions.—As before stated, ice conditions have been a serious factor against the continuous operation of hydraulic plants.

The ice problem is one which has engaged the hydraulic engineer throughout the whole history of development of Canadian water power plants. The low temperatures of winter are responsible for the diminution of run-off, the reduction of river areas and the entire freezing up of small streams. The retention of the greater portion of the winter's precipitation leads to spring flood flows of magnitude many times greater than the normal discharge, while the breaking up of surface ice in spring readily becomes a menace to be guarded against in protecting constructed works. The accommodating to small winter water supply is an economic problem, and the controlling of floating ice and of flood water is a problem of routine operation. The great difficulties, however, in the handling of water under winter conditions are due to the slight changes in the temperature of the water, when varying but a small fraction of a degree about the freezing point. It must be realized that the temperature of the water, even in the most severe weather, does not appreciably vary from the freezing point; indeed, it is only by the most delicate thermometers that the variation can be detected, but within a small range of temperature the most distracting troubles may arise.

There are three kinds of ice which are generally recognized: First, surface ice or sheet ice, which forms on still or comparatively still water; second, anchor ice which forms and grows on the beds of rivers which are not protected with surface ice; and third, frazil ice, which forms in the agitated water of rapids, falls and high velocity channels and accumulates in great masses in adjacent undisturbed water.

Surface ice may or may not be harmful. The chief trouble is experienced by the total freezing up of small streams and the diminution of the cross-sectional areas of the rivers. The ice floes and broken sections, when loosed in spring, are frequently troublesome through the forming of jams in the water channels, thus cutting off