water supply or raising the tail-water to an extent sometimes disastrous. Further, it must be realized that surface ice in an open stream converts the waterway into a closed channel, and by the friction imposed by the surface covering transfers the cross-sectional area of maximum velocity to a greater or less depth, according to conditions. The velocity factors in stream gauging under such circumstances must, of course, be correspondingly changed.

Anchor ice most often causes trouble by its rising in masses from the river bottom; even rising and carrying stones and boulders of considerable size which have been embedded in the mass. While anchor ice is first formed by the radiation of heat on a cold, clear night, this will probably be accompanied by the forming of frazil, the anchor ice becoming the nucleus for the accumulation; such active masses are to be included among the operator's greatest trials.

Frazil ice is the most troublesome, but it is only to be expected where the air temperatures are hovering slightly below the freezing point. This is a condition to be met at the beginning and end of the winter season or during a changeable period, and after a short experience with it, its vagaries may be readily anticipated and the necessary precautions taken. The ice crystals formed by exposure to the cold atmosphere grow rapidly and adhere to one another to form lumps and spongy masses, attaching to every cold body they encounter; racks or screens, penstocks, turbines and all essential parts of water power equipment are readily affected by enormous accumulations capable of completely closing down the plant. The great majority of power plants have suffered; the modern plant, however, has become more immune from the effects, now that a full understanding of the problem is possible.

In selecting the site for power works on a river one must bear in mind the chances of ice troubles. Naturally, it is preferable to have large still-water pondage immediately above the water intakes; such a provision assures surface ice, which will obviate the formation of frazil and anchor ice adjacent to the power works. Unruffled water in the river supply for several miles above the pondage may be expected to reasonably free the lower waters of frazil; this condition is usually readily obtained, as in the damming of the river the adjacent rapids or falls are drowned out and the consequent head taken advantage of. The tail race and lower river must be viewed from the standpoint of ice discharge and the river course eased sufficiently to preclude any possibility of ice jams. Floating ice may be discharged from the forebay by booms arranged to deflect the ice to ice overflows and runways, which may carry it to the tail race. Ice which may be carried under the boom or screen house curtain so as to accumulate in front of the intake racks has generally to be poled out to the main ice overflow or to a separate runway adjacent to the screens.

It has been found by experience that the source of trouble from frazil ice is its great adhering power to cold bodies in the water. Iron screen racks are much affected when, in the presence of frazil, their temperature is but a fraction of a degree below the freezing point. The precautions are obvious. The submerging of iron racks below the surface will insure their being at the same temperature as the water and they will not act as conductors of the cold from the air; the top screen section which may extend above the water level may be of wood, which will act as a comparative insulator to the transfer of cold. Iron racks rising above the waterline may be fitted with a housing containing heat supplied by electricity or steam, so that the iron will conduct a small amount of heat throughout its length; the wider application of this is the screen house which is sheltered completely from outside air and may or may not be heated.

Iron penstocks, and turbine cases, have been known to be completely blocked by frazil ice, due to the colder temperature of the iron. The housing in of all water-carrying equipment is essential where frazil is encountered. The covering of surge tanks to protect against excessive freezing where the surface water is undisturbed for a sufficient period, such as may occur with a continued steady load, is essential.

The problem of housing of penstocks has evolved several practical and economic methods, when burying them is not possible nor desirable. The most common and possibly the cheapest arrangement is by means of a continuous wooden sheeting, having two vertical sides and a sloping or peaked roof, all on a simple wooden framing. A better arrangement, and undoubtedly a more desirable method, is by the application of metal lath or wire netting on metal or wooden framing plastered over by cement gun or by hand; the same scheme of covering may be used on surge tanks; these, however, are generally of such magnitude that it is preferable to include them in the architectural featuring, along with the power plant buildings.

The necessary exposure of gates, sluices, stop-log guides and seats, racks, etc., has required, in several cases, the installation of steam-heating plants supplying permanently placed steam piping for maintaining freely working equipment, and in the notable case of the Shawinigan plant, heated air is blown onto the protruding racks and onto the incoming water in the screen house.

LEAD COATING FOR IRON AND STEEL.

A patent has been granted in the United States for a process of coating iron or steel surfaces with a continuous and uniform film of lead. The object of the process is to provide a substitute for zinc and one less costly than tin for a protective coating.

After the iron or steel surface has been cleaned of scale or oxide, it is subjected to a suitable flux, such as zinc chloride, and submerged in a melted bath of lead containing a little cadmium. Ordinary commercial lead possesses but little affinity for iron, but in the presence of metallic cadmium, even in very small quantities, it will amalgamate with the iron surface so as to coat it with a very thin film. In the process, which is the subject of patent, there is used as small an amount as 0.17 per cent. but there can be used as high as 1 per cent. of cadmium. The smallest possible amount is recommended, as cadmium is expensive. Since it tends to oxidize and pass into the flux, causing a loss, the addition of about ½ per cent. of zinc to the lead bath prevents this, as the zinc oxidizes first and passes into the flux in preference to the cadmium. Cadmium, being more positive than iron, its presence in the lead tends to protect the iron the same as zinc. It also is claimed to promote and subsequently maintain the adherence of the film of lead.

Railroads operating 41,988 miles of line in the United States, and having a capitalization of over two billion dollars are now in the hands of receivers. This is said to be a larger number than ever before in the history of the country.