lines, reducing boundary disputes and the customary litigation of mining countries to a minimum.

In conclusion, the impressions formed during the summer's work may be summed up in the statement that the prospects are better than ever before. One mine has already proved to be a splendidly paying property, and several others are apparently on the point of becoming so. The number of properties on which promising finds of gold have been made has greatly increased, and the area of known gold bearing rock has been considerably widened. Many of the properties located will no doubt prove of little value, as is the case in every mining region of the world; others will not turn out to be extensive enough to justify an independent mill, though they may be worked at a profit when within reach of a customs' mill; but it may be looked on as certain that a considerable number of the locations taken up will eventually prove to be paying mines.

MINE DRAINAGE.

By Hans C. Behr, Mechanical Engineer.*

Mines worked through shafts are subject to flooding by penetrating water-bearing ground. Even if not encountered at first, water is liable to be struck at any time, and appliances should therefore always be in readiness to handle it. For moderate inflow the water can generally be hoisted in bailing-tanks without encroaching too much on the time required for other hoisting operations. When, however, a large permanent flow is struck, the entire hoisting capacity may be required for bailing until a suitable pumping-plant can be installed.

In deciding upon the capacity of a proposed pumping-plant, it is necessary to ascertain as nearly as possible the maximum quantities of water that may be encountered at different levels. In well-opened mines this can generally be done without difficulty; not so in sinking a shaft in new ground. But, if other mines are adjacent, a record of their water production is a very good guide.

The pumping-plant should be able to handle a much larger quantity of water than any recorded maximum, so that a considerable increase can be taken care of without resorting to bailing. Bailing arrangements should, however, also to be in readiness to meet at once any extraordinary increase that may occur at any time.

The water is generally found in a mine at various levels, and, where economy rather than simplicity is the object, any considerable quantity of water should be collected and led to pumps at the levels where it issues, and not be permitted to first find its way to the bottom, from where it would have to be raised the entire height to the surface, thereby increasing the cost of pumping in proportion to the increased lift for that part of the water.

In many mines, the quantity of water varies, not only as new bodies are tapped or opened ones drained, but also with the seasons of the year; and observations extending over at least a year should therefore be available for fixing on the capacity of a pumping plant. In the Kennedy Mine, Amador County, California, the water production varies from 75,000 gallons per day during the dry season to 150,000 gallons during the wet season, and is handled by bailing-tanks.

The generally variable nature of water inflow necessitates a corresponding variation in the work of the water-raising apparatus. Bailing adapts itself most readily to such variation, as it gives equal though low mechanical efficiency for a very wide range of capacity. With pumps the case is different, since the number or length of strokes can only be varied economically within certain limits.

Mine pumping plants should be designed and constructed with the aim of obtaining the greatest possible security against breakdowns, and at the same time admitting of rapidly making repairs and replacing worn parts. If possible, the pumping-plant should also be so designed that it will give the highest mechanical efficiency for that rate of flow which prevails most of the time and furnishes the largest proportion of all the water. Large excess over this, if known to be of short duration, can be taken care of by bailing-tanks or cheaper and less efficient emergency-pumps. A sudden influx of large quantities of water can be handled by bailing with powerful direct-acting hoisting engines, which bring the tanks to the surface rapidly. Often a mechanically less efficient plant may, owing to other conditions, prove to be commercially the most efficient.

Timbered shafts are universally used in the west. They are generally arranged with three compartments—two for hoisting, and one for the pumps. The latter should be partitioned off from the hoisting compartment, so that it can be made to serve as upcast to ventilate the bottom of the shaft, because the pump-shaft is usually warmer than the hoisting compartments, due either to steam pipes for operating direct-acting pumps, or to the warm water in the column-pipes.

Where the mine has two separate shafts connected below, so that one serves as upcast shaft, the pumps should, if possible, be placed in the latter.

The kind of pumps, source of power, and the means of transmitting this to the pumps underground, depend on surrounding conditions, and only a careful study of these can decide the proper kind of plant to be adopted.

PRELIMINARY REMARKS ON MINING PUMPS.

Water-Raising Machines used in Mining. The pumps used in pumping out mines are chiefly reciprocating. Centrifugal pumps find some application for low lifts, and generally in open workings. Of other water-raising appliances used, the bailing tank is the principal one, and finds a wide range of application. Pulsometers are used as a low-lift auxiliary to pumps, etc. The same is true of ejectors. It is also occasionally possible to employ siphons for raising water over an eminence.

Reciprocating pumps may be divided into plunger, piston and bucket (or lift) pumps.

The oldest pump used in mines is the draw-lift pump, with a valved bucket working in the barrel. The modern forms of this type of pump are much used for sinking where the pumps are operated by rods. They are not suitable for working against heads of over 200 ft. The pump-barrels and bucket-packing also are exposed to great wear, particularly when the water carries sand. The bucket cannot be packed while the pump is running. Nevertheless, their use in mining is very extensive. In the Cornish system they are generally arranged so that the bucket can be hauled up through the column-pipe for repairs.

Plunger, or force, pumps are suitable for much higher lifts. Vertical, single-acting plungers are the typical form of the modern pumprod system. In these the plunger-packing can be taken up while the pump is running, and, as the packing is located at the highest part of the pump-barrel, away from the course of the water, little sand or grit is liable to reach it. The pump can, therefore, run quite a long time before repairs are required at that point.

Horizontal, double-acting plungers are generally used for high-pressure, direct-driven pumps. These are arranged either with or without cranks and flywheels. In the former case they are called direct-acting pumps; in the latter, rotative pumps. Flywheel, or double-crank pumps of this class, with mechanically actuated valves designed by Riedler, have been used continuously for single lifts of 1,300 ft.

Piston pumps are suitable only for lower pressures. The piston-packing and cylinder are subject to wear, while the pump must be stopped and the piston taken out to pack it.

Centrifugal pumps are, as generally constructed, only suit able for low lifts, but are capable of handling large volumes of water. As they have no valves, the water may contain large quantities of sand and gravel without impairing the efficiency of the pumps while they last. The capacity of centrifugal pumps can only be varied economically within very narrow limits, as they require to be run at a certain speed to pump against a given head.

Injectors, pulsometers, etc., are not economical water-raising machines, and can only be considered as temporary appliances or as substitutes for better apparatus during its repair. The steam used to operate them acts so that a large proportion of its energy is wasted by being applied to heat the water which they deliver.

Conditions Affecting the Working of Pumps. The operation of pumps is influenced by many conditions: the height above sea-level;

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