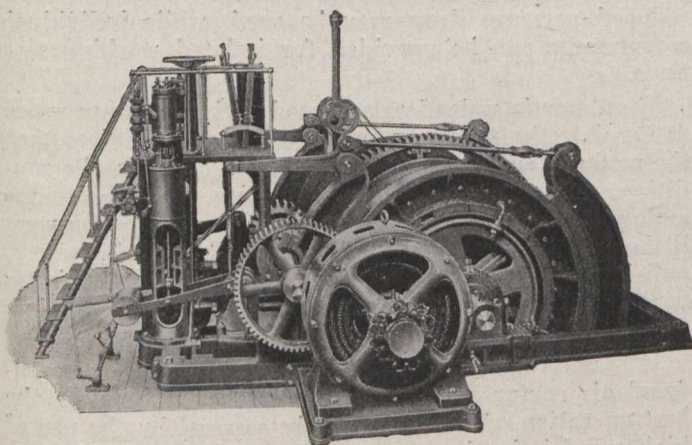


quired constitutes a comparatively negligible demand on the power station, owing to the possession of natural drainage facilities, with a resulting limitation of the pumping units to those required for boiler supply, fire protection, and a few dip pumps operating at low heads.

On the other hand, a large percentage of the mines situated below local water levels are absolutely dependent for continuous operation on the efficacy of their pumps or water hoists, and the cost of their operation has a vital influence on the obtainable margin of profit. The importance of this factor can be fully appreciated when it is realized that in many mines more than ten tons of water have to be elevated to the surface for every ton of coal mined. In addition to this, the pumping outfit must ordinarily have sufficient reserve capacity to cope with excessive demands due to floods, having their source either on the surface or in water bearing ground which is likely to be encountered in extending the workings.

Two facts have contributed to simplify the problem of the main pumping units in coal mines. First, the recent remarkable improvement in the efficiencies of multi-stage centrifugal pumps, which were formerly only applicable to comparatively low head service, but



Electrically Operated Hoist

are now successfully delivering water from sumps located more than one thousand feet below the surface; the best results being obtained when they are driven by motors which are direct connected, thereby avoiding the friction losses of gear drive, the high speeds which are characteristic alike of the electric motor and the centrifugal pump rendering it a simple matter to design a very effective combined unit. Second, the feasibility of providing existing pumps or water hoists, originally designed for steam operation, with motor drive which at once greatly reduces the amount of power required and the expense of attendance necessary, and can safely be made automatic in operation, if desired.

Where motors are geared to reciprocating pumps their use insures the direct application of a larger percentage of the initial power developed than other methods, and many pumping sets of this class are still employed, although the centrifugal type is usually adopted for new installations.

The pumping units of a representative "wet" coal mine can be roughly divided into four classes, i.e., sinking pumps, used in development work, in sumps or for emptying flooded mines; main sump pumps, permanently installed in the mines; auxiliary pumps feeding into a central sump; and portable pumps for temporary service or removing small amounts of water from depressions beyond the reach of the stationary auxiliary

pumps, or for fire fighting. There is also a fifth class which, however, is common to all power station service, and includes those units which provide for boiler feed and general water supply.

The motor-driven sinking pump must, of necessity, be capable of maintaining good efficiencies under fluctuating heads, and in some instances must be capable of operating when entirely submerged. When used in slopes, it is generally mounted on rails or a car to facilitate the movement necessitated by following the receding water level, but if it is serving a shaft it is either mounted on a float so that it will always operate at the surface of the water, or is supported by chains or cables so as to permit of the necessary adjustment. In all cases the power is supplied by flexible cables of sufficient length to meet all variations of the operating level, and as they occupy but little space they leave the shaft or slope practically free from any encumbrances, and as provision need only be made for the discharge pipe and the electrical conductors, they can usually be run in one of the hoisting compartments. Induction motors should preferably be used for sinking pumps, especially if they are liable to be submerged, as this type, due to its simple construction and the absence of moving electric contacts, need not ordinarily be enclosed, but the factor of safety is very greatly increased by using an enclosed motor with waste packed bearings, the use of stuffing-boxes not being essential.

In sinking pumps the load increases inversely as the head against which the pumps are delivering water and, as a rule, the limits can be approximately predetermined and the motors so designed that from the start the efficiency increases with the increasing head. Both alternating and direct current motors with either horizontal or vertical shafts can be readily adapted to all forms of sinking pumps, the type of motor selected depending upon the service required and the character of the electrical energy available.

The main sump pumps are usually of large capacity, and their energy requirements often constitute a large percentage of the generating station output. Where the sump is of sufficient size to store the water normally collected during the day, the cost of this demand on the generating equipment may be minimized by running these pumps at night, in this way tending to equalize the power station load and permit the operation of a mine or colliery with a much smaller capacity in generators than would be required if these large pumping sets were run as a day load.

The adoption of the centrifugal type of sump pump in coal mines is due not only to the improved efficiencies of the modern multi-stage form, but also to the ability of the centrifugal type to handle liquids containing a considerable percentage of solid matter in suspension more successfully than reciprocating pumps. Moreover, its design and practically uniform load when serving sumps permits direct drive by means of high speed motors, preferably of the constant speed polyphase induction type where alternating current is obtainable. As single pumps capable of delivering water to the surface from any depth required in coal mining, at one lift, can now be run with greater economy, both as to first cost, and power consumption, than a number of units of low head and equal capacity, the once common practice of raising the water to the surface in successive lifts to sumps located at different levels has been practically abandoned.

For draining portions of the mine which are below the level of the sumps, a number of comparatively small pumps are ordinarily required, and as the difference in