

trip—are commonly used. The retention of steam locomotives for this work involves interruptions due to the necessary coaling and renewal of the boiler water, and renders impossible that continuity of service which is essential in order to obtain the most economical operation of the coal handling plant.

The standard modern mine locomotive motor equipment consists of two direct current units connected to the driving axles through a single reduction gear, although three motors are sometimes used with three pairs of driving wheels, in which case the centre pair are flangeless in order to permit the turning of curves of short radius. There are also a limited number of single motor locomotives still in use, although they are being very generally superseded by the two-motor type.

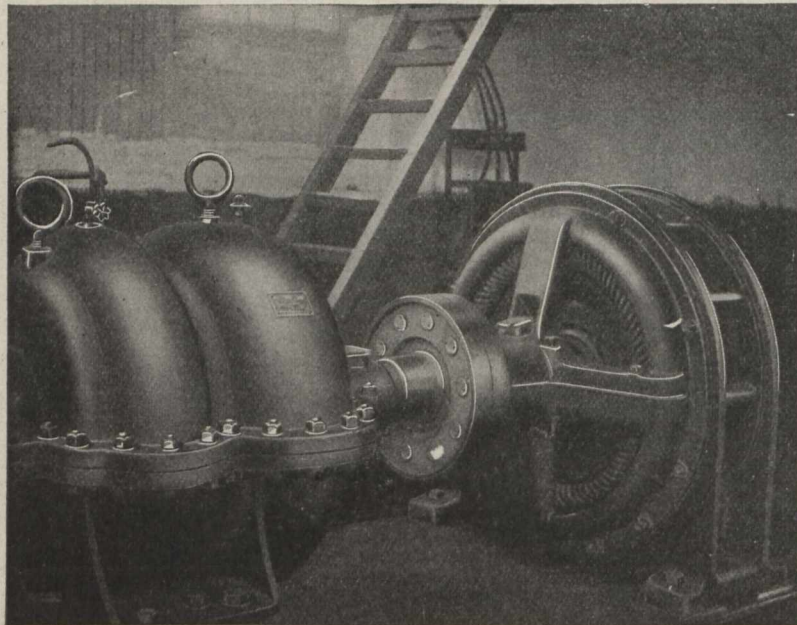
Mine Hoists.

For haulage in slope mines or in drift or shaft mines where the different levels are connected by slopes of considerable length, the locomotive cannot be used and recourse is had to various forms of rope haulage with permanent hoisting drums located either on the surface or in chambers underground. In particular instances

The power losses represented by the drop in voltage in the electric conductors is practically negligible for the distances usually in coal mine transmission when compared with the condensation losses in steam piping or the pressure losses in air lines over the same distances.

With steam hoists the exhaust steam practically prohibits any extended use underground, while the exhaust from the air operated type introduces a factor that may have an adverse effect on the mine ventilating system.

The motor driven hoist is the simplest and most compact form, inasmuch as the motor can usually be mounted on a common base with the hoisting drum and arranged to drive it directly through gears, thereby forming an entirely self-contained unit and effecting an economy in weight and in the amount of space required for its installation, which is often of appreciable importance when the hoists are located in the mine. Owing to the superior speed control of the electric type it has greater flexibility in operation and its extreme simplicity not only minimizes the cost of repairs, but obviates the



Electrically Operated Pump

the use of endless chain haul or conveyor belts or buckets may be advisable. Among the advantages claimed for electric hoists are:

The power is uniformly applied throughout the operating cycle as there is no reciprocating motion or intervening connecting rods or cranks with their varying torque at different positions, and the power demand is limited to the time during which the hoist is in actual operation. This feature minimizes the amount of power consumed. Under space conditions it is possible to employ a system of regenerative braking, the weight of the descending carrier driving the motor as a generator, and thereby feeding back an appreciable amount of current into the distribution system.

The intermittent service of hoists involves a necessity for certain precautions in resuming the operation of steam hoists after they have been shut down which are entirely absent when the electric type is used. If water collects in the cylinder of a steam hoist it must be thoroughly drained before starting the hoist to avoid the danger of blowing out the cylinder head, and in cold weather this is frequently complicated by the formation of ice in both the cylinder and pipe line.

necessity for the service of an engineer in running it, as the average worker is competent to receive the limited amount of instruction necessary and can be safely entrusted with its operation. Emergency demands on the ability of the operator are, as a rule, reduced by providing safety devices in the form of signal lamps, bells, or automatic cutouts, and for conditions such as those imposed by the use of motors for driving the type of water hoist commonly found in the anthracite fields, the hoisting equipment can be made entirely automatic in operation.

Owing to the wider range of speed control which is obtained in hoists driven by direct current motors, this type is very largely used, but in many of the later installations polyphase induction motors having a resistance connected in the rotor have been applied to this service with entire success, and simple and thoroughly reliable controllers can readily be provided to secure the variations in speed required for coal mine hoisting.

Mine Pumps.

The relative importance of the pumping equipment in different coal mines is dependent upon the geological conditions encountered. In many mines the service re-