PERMISSIBLE COAL-HANDLING EQUIPMENT

Approved from
January, 1926, to December, 1930, inclusive

BY

L. C. Ilsley, E. J. Gleim, and H. B. Brunot
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PERMISSIBLE COAL-HANDLING EQUIPMENT 1

(Approved from January, 1926, to December, 1930, inclusive)

By L. C. ILSLEY, 2 E. J. GLEIM, 2 and H. B. BRUNOT 3

COAL-MINE MECHANIZATION AND EQUIPMENT

The rapidly increasing use of machinery in coal mines for supplanting manual labor in loading and transporting coal from the face has brought about the development of equipment as varied in type and size as the systems of mining that have been tried in the effort to make mechanical loading a success. On the one hand is the small pit-car loader operated by a 1-hp. electric motor; it is light enough to be moved about by one man but aids rather than displaces hand loading. At the other extreme is the heavy self-propelled loading machine operated by a number of motors ranging in capacity from 10 to 25 hp. and more; this type eliminates shoveling by hand. Between these two extremes are various loading and conveying machines, of which some are largely instrumental in reducing or even eliminating the movement of mine cars to and from the face workings.

Some machines throw considerable dust into suspension in the air by their more or less violent handling of the coal. At the same time the advance into the coal beds is more rapid by machinery than is possible with hand loading and consequently may result in liberating more gas in a given period than with slower methods. Moreover the introduction of mechanical loading has led to many departures from the conventional room-and-pillar system of mining. As a result the problem of devising other methods for ventilating and timbering the mined areas satisfactorily has only added to the complexity of the question of safety. Thus, with the increased use of machinery in the mines operators and safety men are realizing that the potential hazards incident to the ignition of gas and coal dust are likewise greater and admit of no neglect in the adoption of proper safety measures. Naturally, therefore, considerable attention is being given to the design of explosion-proof motors, controllers, and other electrical parts for the new machinery. Manufacturers are recognizing the growing demand for machines that have met the requirements of the United States Bureau of Mines and have been approved by the bureau.

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In the investigations leading to approval of loading and conveying machines the bureau is guided by the provisions of Schedule 2C,\(^4\) issued on February 3, 1930. This schedule classifies the various electrical parts according to their liability to sparking and specifies the type of inclosure to be used for each class. As required by the schedule, a part that may produce sparks during normal operation must be inclosed in an explosion-proof casing; that is, an explosion of gas in such a casing must not ignite the gas surrounding the casing or discharge flames from any joints, bearings, or lead entrances. The object of the bureau's investigations is therefore to determine by test and inspection whether or not the inclosures are suitable to the purpose for which designed. The explosion-proof qualities are demonstrated by tests in which gas is exploded within the casings. Other tests are made to check the adequacy of electrical clearances and insulation. In addition to the tests, a detailed inspection of parts, including a careful check against drawings and specifications, is made. These drawings constitute the chief record of the equipment investigated and therefore must be complete in detail to cover adequately the construction to be approved. A description of test equipment and methods followed in conducting these investigations is given in Bureau of Mines Bulletin 305, Inspection and Testing of Mine-Type Electrical Equipment for Permissibility, published in 1929.

After a machine has met the bureau's requirements satisfactorily as set forth in Schedule 2C it is approved and thus receives the "permissible" classification. A permissible loading machine is easily recognized by the approval plate attached to it. This plate bears the official seal of the United States Department of Commerce, Bureau of Mines, and a suitable statement calling attention to the precautions to be observed in keeping the machine in a permissible condition. It also bears the name of the manufacturer and an approval number which identifies the approved design in the bureau's records.

ACKNOWLEDGMENTS

All the photographs reproduced in this bulletin were obtained through the courtesy of the several manufacturers whose products are described herein.

DESCRIPTION OF PERMISSIBLE LOADERS AND CONVEYORS

The following descriptions of permissible loading machines and conveyors now included in the bureau's lists of approved equipment are given to indicate to mine operators not only the types available but also show to some extent the special features employed in designing machines that minimize the hazard of gas and dust ignitions. Furthermore, the authors hope that the descriptions will have some value to manufacturers who may contemplate entering this field of special design.

Units of the coal-handling type that have received the approval of the Bureau of Mines may be divided into three general classes:

1. The conveyor type which is loaded either by hand shovels or

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\(^4\) Schedule 2C supersedes Schedule 2B, which was in force during most of the approval work and is a revision and enlargement of the latter.
by discharge from other conveyors and which conveys the coal 20 to 300 feet for delivery to mine cars or to another conveyor; (2) the type whose chief function is to elevate coal into mine cars and so minimize the manual labor required in loading; and (3) the type that digs, scoops, or picks up the coal and delivers it to the mine cars. For the purposes of this bulletin the machines are grouped under these three classes for discussion.

CONVEYOR-TYPE LOADERS

The first group of conveyor-type loaders includes the small “feeder” or face conveyors and the larger main conveyors. As a rule, the conveyors may be extended or shortened to suit conditions, although some of the small face conveyors are of fixed length. The entire group is particularly adapted for use in places where headroom is an important consideration. Nearly all have direct-current electrical equipment.

BIRD COAL CO. BELT CONVEYOR,
APPROVAL NO. 126

The Bird Coal Co. conveyor, shown in Figure 1, consists of an endless belt 15 inches wide mounted on pulleys in a wooden frame having an over-all length of 20 feet. The over-all height is about 23 inches. The belt is driven through a train of gears by a 5-hp. motor placed under the discharge end of the conveyor. The starting switch a is mounted on the side of the conveyor close to the motor and is connected to it electrically by a short length of No. 10 all-rubber insulated duplex cable. A 220-foot length of the same kind of cable enters the starting switch and terminates at the other end in a fused trolley tap and a rail clamp; this cable connects the
machine to the power circuit. A clamp, \( b \), of insulating material fastened to the conveyor near the switch prevents undue strains from being placed on the cable as it enters the switch.

The conveyor is provided with a small drum, \( c \), on each side of the frame. Both are on a common shaft at the discharge end of the conveyor and are thrown in or out of gear by a keyed pinion which slides in or out of mesh on the driving shaft. A steel plate on which the motor rests has turned-up edges and thus serves as a skid on which the heavy end of the conveyor is moved. The light end of the conveyor rests on two swiveled wheels. By means of a rope anchored to some suitable point, such as a jack pipe, one man can easily handle the conveyor in moving it from place to place by taking two or three turns of the rope around one of the drums.

Approval of this face conveyor was issued to the Bird Coal Co. on June 25, 1926, and approval No. 126 was assigned to it. The permissible machine is built for 250-volt direct-current service.

**PERMISSIBLE FEATURES**

The Bird Coal Co. face conveyor has only two explosion-proof enclosures—the motor and switch. The motor is designated as type M-2 by its manufacturer, the South Fork Foundry & Machine Co. It has an intermittent rating of 5 hp, at 250 volts, direct current. Simple lines have been followed in the construction of this motor. The end bell or bearing bracket at the pinion end has a step flange which centers \( f \) in the motor frame. At the commutator end the bracket is in two parts—a 4-arm bracket holding the bearing itself and a cap fitting over the bracket to close the openings through it. Cap screws with heads drilled for wires to secure them against loosening are used at both ends of the motor to hold the bearing brackets to the frame. A single stuffing box takes a 2-conductor cable into the motor from the starting switch. No special handhole covers are provided for gaining access to the commutator and brushes. When inspection of these parts is necessary the cap previously mentioned can be removed without disturbing the bearing bracket. The commutator and brushes can then be examined through the openings between the arms of the bracket.

The starting equipment is also made by the South Fork Foundry & Machine Co. and is essentially a 2-pole fused quick-break knife switch with duplicate sets of 30-ampere fuses. It is so designed that upon blowing one or both of a set, throwing the switch in the opposite direction inserts the second pair of fuses in circuit. Before fuses can be replaced the six cap screws holding the cover plate must be removed. The cover plate is interlocked with the switch handle to prevent the removal of the plate except when the switch is in the open position, and once the plate is off the switch can not be closed. The explosion-proof casing for the switch consists of a short piece of 7-inch wrought-iron pipe threaded at each end. The cap that screws on the front end carries one bearing for the switch and has two stuffing boxes, one for the cable to the motor and one for the trailing cable. The casting that screws on the other end of the pipe has a circular opening through which the fuses may be reached. Normally, this opening is closed by the cover.
plate which makes a step-flange joint with the casting. Both end castings have feet which permit the switch to be mounted in place. The motor and switch met Bureau of Mines requirements for construction, as specified in Schedule 2B, and satisfactorily withstood the prescribed explosion tests. In addition, the switch was subjected to certain electrical tests and in this respect proved satisfactory.

![Image of Bird Coal Co. chain conveyor]

**Figure 2.—Bird Coal Co. chain conveyor**

No cable reel or hooks for coiling up the trailing cable are provided with the conveyor. A fused trolley tap is provided on the trailing cable for connection to feeder or trolley circuits. The fuse in this tap is rated at 65 amperes.

**BIRD COAL CO. CHAIN CONVEYOR, APPROVAL NO. 129**

The conveyor shown in Figure 2 was the second type to be built by the Bird Coal Co. It consists of a sheet-metal trough in which the coal is moved by flights of 1-inch angle attached to a chain running
down the center. The trough is about 18\(\frac{1}{4}\) inches wide at the top and 14\(\frac{3}{8}\) inches wide at the bottom. The distance between the sprockets (center to center) is 20 feet. The chain is driven by a 5-hp. motor, \(a\), through a train of gears, including a worm. By means of a special coupling this unit can be made to drive as many as four other conveyors not equipped with individual drives; that is, one motor can be made to drive a set of five conveyors emptying into each other successively. This motor is fastened to a steel plate at the discharge end of the conveyor; and instead of being placed underneath, as with the belt type described, it is at the side of the conveyor. The starting switch \(b\) is mounted directly on top of the motor and is connected to it electrically by a short length of No. 10 all-rubber insulated duplex cable, \(c\). The trailing cable \(d\) is 220 feet long and is also a duplex cable with No. 10 conductors and all-rubber insulation. Fastened to the side of the conveyor and near the switch is a clamp, \(e\), of insulating material which holds the trailing cable so that when pulled or jerked it will not be loosened in the stuffing-box entrance to the switch.

This conveyor has no special arrangements for moving about, as were provided for the belt-type conveyor. Obviously, there is not the necessity for shifting a conveyor that can be extended or shortened by the addition or removal of extra lengths.

Approval of the chain-type conveyor was issued to the Bird Coal Co. on July 21, 1926, and approval No. 129 was assigned to it. It was approved for 250-volt direct-current service only.

PERMISSIBLE FEATURES

The motor and switch for this conveyor were both built by the South Fork Foundry & Machine Co. These parts are identical with those used on the belt-type conveyor manufactured by the Bird Coal Co. and therefore need no further description.

The trolley tap supplied with the trailing cable is fitted with a 65-ampere fuse. No provision is made on the conveyor for reeling or coiling up the trailing cable.

THE JEFFREY MANUFACTURING CO. CHAIN CONVEYOR, APPROVALS NO. 133 AND 133A

The Jeffrey type 49–A chain conveyor is also one that may be classed as portable. It is made of 5-foot steel-trough sections that can be bolted together to make a maximum length of 60 feet. The width of the trough is approximately 18 inches, and only 17 inches is required to clear the highest point of any part of the conveyor. The machine as originally approved used a 3-hp, direct-current series motor and was claimed to have a capacity of 60 tons of coal an hour. The optional use of a larger motor has since been authorized and therefore the capacity may be different for machines driven by it.

The motor is mounted at the side of the conveyor near the discharge end. A driving shaft extends from the motor and ends in a bevel gear for driving two chains, between which are fastened the flights that move the coal. A reversing switch built into the motor permits the conveyor to be reversed in direction, as may be desirable for carrying back timbering supplies. The starting equipment,
made by the Jeffrey company, is simply a fused switch mounted on a shelf just back of the motor, and electrical connection between the two is made through a short length of 2-conductor No. 14 gage all-rubber insulated cable. A 300-foot length of the same material serves as a trailing cable for the conveyor. Two fused trolley taps are furnished for making connection to the feeder circuit. The cable is held by a clamp of insulating material near the starting switch so that strains will not be transmitted to the connections inside.

No special provision was made in the construction of this conveyor for moving it about; however, it is not too heavy or too long even when fully extended for several men to move it short distances. When it is necessary to move it greater distances the sections can be unbolted and transported on a truck.

On February 10, 1927, the Jeffrey Manufacturing Co. was issued approvals No. 133 and 133A to cover the 250 and 500 volt direct-current conveyors, respectively.

PERMISSIBLE FEATURES

The motor and switches are the only explosion-proof inclosures used on the Jeffrey 49-A permissible conveyor. The motor, made by the Jeffrey Manufacturing Co., was designated type L-5-K and has an intermittent rating of 3 hp. It has the box-frame style of construction. The pinion end is closed by a gear housing cast integral with the frame. The inclosed gears permit the speed to be reduced to the proper value for driving the conveyor chains. The commutator end of the motor is closed by a deep casting which makes an explosion-proof flange joint with the frame to which it is held by 1⁄2-inch button-head cap screws and lock washers. This casting or bearing housing carries one of the motor bearings and has an asbestos-packed stuffing box which admits the cable from the starting switch. Access to the motor for inspection of brushes and commutator is gained through three circular openings, one at the top of the bearing housing and a smaller one on either side. These openings are threaded for screw-type handhole covers, which are sealed during normal operation with a meter seal and wire. The housing for the reverse switch screws into another opening at the lower end of the bearing housing.

The starting switch is of the interlocking type so that fuses can be renewed without the hazard of exposed live terminals; it is so arranged that the screw cover giving access to the fuses can not be opened until the switch is opened. Once the cover has been opened the interlocking mechanism of the cover hinge interferes with the switch handle and prevents the switch handle from being moved to close the switch. Two fingers wiping on circular segments constitute the switch proper; in other words, it is a double-pole, single-throw, drum-type switch. The fingers and segments are surrounded with heavy insulation of heat-resisting material. When the switch box is open only the two fuses are accessible, and these are separated by an insulating barrier. For 250-volt direct-current conveyors the capacity of fuse required by the approval is 30 amperes; 15-ampere fuses are required for 500-volt conveyors. The trailing cable and the cable between the motor and switch pass through two asbestos-packed stuffing boxes in one wall of the switch inclosure.
The motor and switch as used on permissible conveyors both comply with the requirements of the Bureau of Mines as to construction of explosion-proof inclosures; in addition, they passed the required explosion tests satisfactorily. The switch proved satisfactory under the electrical tests imposed.

As with other machines of this type, the Jeffrey type 49-A conveyor has no provision for coiling up the trailing cable when it is not in use.

The rating of the fuse for each of the two trolley taps is 30 amperes for the 250-volt machine and 15 amperes for the 500-volt machine.

EXTENSION OF APPROVAL

Before receiving approval of its type 49-A conveyor with the L-5-K motor, the Jeffrey Manufacturing Co. signified its intention of applying for an extension of approval which would authorize the use of a larger motor than that called for by the original specifications.

Some months after the approval was issued a 250-volt type L-38 motor was submitted for inspection and test. It was a direct-current series motor with an intermittent rating of 7½ hp. Its construction differs considerably from that of the L-5-K motor. Instead of screw inspection covers it has a single cover of boiler plate held in place with cap screws and lock washers. There are two stuffing boxes, each admitting a single conductor to the motor. These conductors are protected by two rubber air-hose conduits between the motor and starting switch. A reversing switch of the same general design as that originally used is mounted on top of the L-38 motor.

The starting switch for conveyors with this larger motor is the same as that previously described, except that four instead of two asbestos-packed stuffing boxes are used, one for each of the single conductors to the motor and one for each conductor of the trailing cable. The fuses specified for use in this switch box, as well as the fuses for the trolley taps, are rated at 60 amperes. The trailing cable is of the concentric type having No. 8 gage conductors. The cable is spliced to short lengths of No. 8 single-conductor cable, which pass through the stuffing boxes into the switch.

The speed is reduced by means of gears in a housing separate from the motor. The shaft driving the conveyor rotates at 100 r.p.m. With the larger motor the conveyor requires approximately 23 inches to clear the uppermost point. The over-all width is 3 feet.

An extension of approval covering the conveyor with the 250-volt L-38 motor and electrical equipment modified to correspond was issued to the Jeffrey Manufacturing Co. on March 12, 1928. The wording of the approval plate had to be changed to suit the construction of this conveyor.

On August 23, 1929, another extension of approval was granted to authorize the use of an improved design of fused trolley tap.

LORAIN STEEL CO. BELT CONVEYOR, APPROVAL NO. 139

A belt-type conveyor built by the Lorain Steel Co. for use at the face was covered by approval No. 139. Two methods of driving the
belt were used in the construction of this conveyor: One employs a worm gear so that the motor shaft is parallel to the center line of the belt, whereas the other employs back gears and has the motor shaft perpendicular to the center line of the belt. A chain from the back gears to a sprocket on the belt pulley completes the driving mechanism. The first arrangement is the more compact in that the motor is close to the side of the conveyor instead of extending out, as it does in the second conveyor. Two methods for mounting the starting switch are also employed: For the worm-drive conveyor it is mounted at the side of the conveyor on an inverted channel, which is made to extend from the under side of the conveyor; in the second method the switch is fastened to the motor frame. A short length of No. 12 all-rubber insulated duplex cable joins the motor and starting switch electrically in each instance. A 250-foot length of this cable enters the switch and is used to connect the machine to the trolley or feeder circuit. A fused trolley tap and a rail clamp are the means provided at the end of the cable for attaching it to the circuit.

Near the switch in both conveyors is a bell-mouth fitting intended to prevent sharp bends from forming in the cable where it is held by an insulating clamp.

Although the Lorain Steel Co. conveyor comes under the general classification of portable machines, apparently no special provision was made in its construction to facilitate handling when moving it from place to place.

Approval covering a 220-volt direct-current machine was issued to the Lorain Steel Co. on August 19, 1927. Approval No. 139 identifies it in the bureau's lists of permissible equipment.

PERMISSIBLE FEATURES

The only explosion-proof inclosures on the conveyor are the motor and switch. The motor, which has a compound winding, is made by the South Fork Foundry & Machine Co. It is designated as type 2-1/2-M and has a continuous rating of 1 to 2 hp., depending upon the armature speed adopted. The motor frame is a cylindrical steel shell with suitable feet cast on it for holding the motor in position. This shell is threaded internally at both ends. At the commutator end two parts are required to close the motor. One of these is a 4-arm bearing bracket threaded to fit into the motor shell; the threaded portion is longer than that of the motor shell. The second part, a roughly hemispherical cap, screws onto this excess length of thread and completes the inclosure at the commutator end of the motor. When inspection of commutator or brushes is necessary the cap can be unscrewed quickly after a small locking bar that fits into a notch in the outer rim has been released. The pinion end of the motor has a 1-piece bearing bracket for closing the shell. The electrical connection between the motor and starting switch is made with a 2-conductor cable passing through a single asbestos-wick packed stuffing box.

The starting equipment, also made by the South Fork Foundry & Machine Co., closely resembles in external appearance that made by this firm for use on the Bird Coal Co. belt conveyor previously described and is known as the No. 3 switch. The joints and inter-
locking mechanism are the same for both switches, but the one on the Lorain Steel Co. conveyor is a later design. It has two instead of four 30-ampere fuses; that is, both sides of the line are fused, but the switch is of the single-throw type.

Both the motor and switch complied with the bureau’s constructional and test requirements.

**SOUTH FORK FOUNDRY & MACHINE CO. CHAIN CONVEYOR, APPROVAL NO. 151**

Another chain-type conveyor is that built by the South Fork Foundry & Machine Co. (See fig. 3.) Trough a is of sheet steel supported and strengthened by a framework of angle iron. A single chain, b, running down the center of the trough carries the steel flights for moving the coal. Motor c, for driving this chain, is rated at 5 hp. for intermittent duty and is placed directly under the conveyor at the discharge end. Two drive chains with a set of spur gears between them are used to obtain the necessary speed reduction from the motor to the conveyor chain. The drive chains are guarded to prevent clothing being caught between them and their sprockets and to keep out dirt.

To start the motor it is thrown directly across the line by means of a fused switch. The switch is secured to angle irons bolted to the structure that supports the conveyor. It is at the side of the trough, the handle being near the level of the upper edge. A short length of No. 10 2-conductor all-rubber insulated cable joins the motor and switch electrically. The trailing cable is of the same material and is equipped with a fused trolley tap by which it is connected to the trolley or feeder wire. Near the point at which this cable enters the starting switch a clamp of insulating material holds the cable to prevent strains upon the cable connections in the switch.
The ends of the angle irons supporting the motor are turned up slightly, forming skids that aid in shifting the position of the conveyor. As there is no reel, the cable is simply placed in the trough when the conveyor is moved to another place.

The South Fork Foundry & Machine Co. permissible conveyor is built only for 250-volt direct-current service. Approval No. 151 was issued to the company for this machine on May 19, 1928.

PERMISSIBLE FEATURES

The only explosion-proof inclosures on the approved conveyor are the motor and its starting switch. Both are built by the South Fork Foundry & Machine Co. and have been described. The motor is the type M-2 which, as already stated, is rated at 5 hp. for intermittent duty. Its description was given under “Bird Coal Co. belt conveyor, approval No. 126.” The switch is the type No. 3 described in connection with approval No. 139 except that No. 10 cable is used. It is equipped with two 30-ampere fuses. The trolley tap on the trailing cable also has a 30-ampere fuse.

MAVOR & COULSON (LTD.) SHAKER CONVEYOR, APPROVALS NO. 149 AND 194A

Another conveyor-type loader is that built by Mavor & Coulson (Ltd.), Glasgow, Scotland. This, a larger and more complex machine than any of the preceding types, consists of troughing made up of 9-foot sections which are given a reciprocating motion through a crank and connecting rod. The motion is a combination of movements in the horizontal and vertical directions and causes the coal in the trough to travel toward the car to be loaded. By changing the pinion on the motor the number of strokes per minute and the length of throw are varied according to the grade upon which the conveyor is operated, the greater number of strokes and shorter throw being set for the steeper grades against the load. The position of the crank is also varied to shorten the stroke as the grade increases against the load. The quantity of coal that can be handled by this conveyor depends upon the moisture content of the coal. An output ranging from 30 to 60 tons an hour is claimed.

The conveyor may receive coal from other conveyors, loading machines, and hand shovels, or it may even load itself if a “duckbill” shovel is attached to its end. The maximum distance coal can be moved by one of these conveyors is 300 feet, except when a duckbill is used; then the conveyor is shortened to 250 feet.

The electrical equipment on the Mavor & Coulson conveyor consists of two main parts: A shunt-wound motor, $a$, rated at 15 hp. for intermittent duty, and a controller, $b$. (See fig. 4.) In the control casing is a rheostat with a number of taps for bringing the motor up to speed in starting. The controller is bolted to the side of the motor, and the two make a compact unit. As originally submitted for approval this unit did not include a switch by which power to the motor could be interrupted independently of the controller or contain any fuses or overload relays for protection. Upon the bureau’s request these were supplied in the form of a separate junction box previously approved, which serves as a fused switch. A cable in a hose conduit makes electrical connection between the switch and the
motor. Each end of this cable is fitted with a plug interlocked with the casing into which it fits. Neither plug can be withdrawn before the circuits are opened. The cable in the hose conduit has three conductors; two constitute the power circuit, while the third grounds the driving unit to the switch, which in turn must be grounded. A concentric cable brings current from the power circuit to the switch.

A shaker conveyor of this type does not come under the portable classification. The trough sections can be added or detached to suit conditions without moving the drive unit; hence the installation can be made semipermanent. The drive unit may be separated readily from the conveyor proper for transportation to another place. It has a base plate of sheet steel with edges turned up to facilitate dragging, if necessary.

Approval of this machine was issued on March 29, 1928, to the C. H. McCullough Engineering Co., American representative of Mavor & Coulson (Ltd.). The conveyor was approved for 250 and

![Figure 4.—Mavor & Coulson (Ltd.) shaker-conveyor drive unit](image)

500 volt direct-current service, and approvals No. 149 and 149A, respectively, were assigned to identify the machines in the two voltages.

**PERMISSIBLE FEATURES**

The motor is the box-frame type with a rectangular section and is built by Mavor & Coulson. A heavily ribbed plate at each end carries the armature bearings. The joints between the plates and frame consist of flat machined surfaces held together by 10 studs with nuts and lock washers. The frame has three other openings, one of which (not shown in fig. 4) is over the commutator and one on either side of the frame. Steel-plate covers close two of the openings. The connections between the motor and control are made through the third opening, against which a side of the controller is bolted. Three insulated studs protruding from this side of the controller are the means provided for connecting it to the motor. The side
cover plate has a glass peephole, \( c \), three-fourths inch in diameter. The company considered this necessary so that the operator could observe the commutator and brushes without removing the covers to note particularly whether the brushes were sparking.

The drum controller and rheostat made by Mavor & Coulson are housed in a boxlike casing with a single hinged cover which permits access to the parts. Some departures from American practice in the construction of explosion-proof compartments are noteworthy in this controller. One of these is the use of valves for the relief of explosion pressures developed inside the casing. There are two valves for this purpose. Normally they are held closed by springs and, like a safety valve, open when the internal pressure overcomes the resistance of the springs. The opening through each valve is protected by “metallic sponge” whose function is to cool flames that may enter the valve below the danger point so that propagation can not spread beyond to surrounding explosive atmospheres. Another interesting feature is the method used to retain the six cap screws in the cover after they have been loosened to release the cover. Instead of drilling the cover so that the cap screw will slip through readily, the usual procedure in American construction, the holes are threaded part way and enlarged the rest of the distance (next to the casing). The shank or body of the cap screw is smaller in diameter than the threaded portion. Therefore, when the cap screw is released from the casing it is held in the cover by its threads unless turned until the threaded portion comes through the hole tapped for it. The joint between the cover and casing is made up of flat machined surfaces.

The interlock for the plug inserted in the controller is merely a plunger actuated by a cam on the shaft for the controller drum. In addition to this interlock, a pin with a handle is used to prevent the plug from being pulled out accidentally when the controller is in the “Off” position. To prevent loss of the pin, a short length of chain is attached to one end of the handle, while the other end is secured under the head of a cap screw.

The fused switch used with this shaker was made by the Sullivan Machinery Co. Except for some slight modifications in the plug for clamping the cable and securing the hose-conduit end, this switch is the same as the Sullivan permissible junction box.\(^5\) This box contains a quick-break, double-pole, single-throw, knife-blade switch. The fuses are renewable and are contained in plugs that can be removed from the outside of the case only when the switch is open. The interlocking mechanism also locks the switch in the open position. The connection plug is similarly interlocked with the switch. Spring-actuated latches hold both the connection and fuse plugs in position when the switch is open. The connection plug has three sockets matching three studs in the plug receptacle. One of the studs is connected to the switch casing, and thus through its corresponding socket and the conductor fastened to the latter the ground connection is established between the switch and drive unit. The cable, which includes this ground conductor, is a 3-conductor No.

2 cable with all-rubber insulation. This size is specified for both the 250 and 500 volt approved machines.

The trailing cable also has all-rubber insulation but only two No. 2 conductors. It is protected by an Ohio Brass Co. fused trolley tap on the positive side. A rail clamp of the same make is used on the negative conductor. One-hundred-ampere fuse elements are specified for the trolley tap on either voltage. The specifications call for 100-ampere fuses to be used in the switch for 250-volt machines and either 50 or 75 ampere fuses for 500-volt machines.

CONVEYOR SALES CO. (INC.) SHAKE CONVEYOR, APPROVAL NO. 171

The second shaker-type conveyor approved by the Bureau of Mines was that of the Conveyor Sales Co. (Inc.) using electrical equipment built by the Goodman Manufacturing Co. (See fig. 5.) The conveyor itself is made of troughs which come in standard section lengths of 13 feet and move on rollers. The sections are easily joined by connecting bolts or special fasteners. With a duckbill shovel attachment and a swivel trough the conveyor can be made self-loading and can therefore be adapted to driving up rooms and entries. Advertising matter states that this conveyor can be operated on grades up to 8°. It
further states that with a duckbill "it seems reasonably certain that a production of from 200 to 250 tons per 8-hour shift can readily be obtained with this equipment under average conditions with careful organization and management."

The electrical equipment consists of a 12-hp. shunt-wound motor, \( a \), with an automatic starter, \( b \). The starter has two single-pole line contactors which close when "Start" button \( c \) is pressed. Steps of the starting rheostat are controlled by two accelerating relays in bringing the motor up to speed. An overload relay set at 75 amperes affords overload protection. The motor is protected further by a low-voltage relay. The control circuit, which includes the magnet coils for the contactors, is protected by two 2-ampere fuses.

"Stop" button \( d \), when pressed, opens the control circuit and causes the contactors to open the main circuit. The stop and start buttons are side by side on top of the motor frame at the commutator end. Two insulated studs at the same end provide a means of connection between the trailing cable and the main circuit inside. The starter case is bolted to the side of the motor, and the whole makes a compact unit. The motor and the gear mechanism for driving the conveyor are mounted on a "skid" of steel plate, each end of which has a place for attaching a hook or chain when the drive mechanism is moved.

The approval of this shaker conveyor was issued to the Goodman Manufacturing Co. on April 17, 1929. To date the approval covers only 250-volt machines. Approval No. 171 was assigned for this voltage.

**PERMISSIBLE FEATURES**

Two separate explosion-proof casings inclose the motor and its automatic starter. Accessibility was a controlling factor in the design. The motor, designated as type No. 95, has a continuous rating of 12 hp. The magnet frame or motor shell is a heavily ribbed casting, roughly rectangular in section, with two open ends. At one end a cast plate is secured by 12 studs with nuts and lock washers. The joint between the motor shell and the plate consists of wide flat machined surfaces. The plate holds a ball bearing through which the pinion end of the armature shaft extends. A bracket fastened vertically in the other opening of the motor shell carries the second bearing and also supports the brush rigging, but it does not close the opening at the commutator end of the motor shell entirely. The explosion-proof inclosure is completed by a special fabricated cover or door, \( e \), hinged to the shell at one side. The door is composed of a cast frame whose opening is covered by a curved steel plate welded in place. A tongue machined on the inner face of the frame fits into a corresponding groove cut in the edge of the opening in the motor shell. A latch, \( f \), which exerts a clamping action on the side of the door opposite the hinge side, is held in the closed position by a padlock. The commutator or brushes can be inspected easily and quickly by removing the padlock, pushing back the latch, and swinging the door open. The tongue-and-groove joint between the door and motor shell derives its effectiveness from the close-fitting surfaces, the path through which presents four changes in direction to any flame or sparks from the interior. The
push buttons previously mentioned are mounted horizontally in a cast cover seated over a small rectangular opening in the motor shell. The bottom, two sides, and one end of the casing for the automatic starter are of 1/4-inch sheet-steel plates welded together. Strips of steel welded to the casing form stiffening ribs. Two frames are welded to the top for doors or covers. One of these is a cast frame with a groove machined in it to receive a tongue machined on the door, and the other was built of four steel bars welded together. The latter forms the opening to the rheostat compartment, which is a pocket isolated from the remainder of the casing by partitions of steel plate. Five insulating bushings in one of the partitions carry the wires that connect the starter and rheostat. The open end of the starter casing has a cast doorframe, similar to that on top, welded in place.

The cover for the rheostat compartment is simply a steel plate secured by 12 cap screws with lock washers. The other two covers, like the door for the motor, are made of a piece of sheet steel welded to a cast frame and are hinged to the starter casing. Two sides of each cover are constructed as for hinging, but instead of two hinge pins for a cover there is one hinge pin and one locking pin. The latter is held to the cover by a padlock.

Although the parts of the starter are compactly arranged, they are readily accessible for inspection and adjustment. The main contactors are suspended from a horizontal insulating panel which can be pulled forward through the end of the casing. The two accelerating relays are on another panel, while the overload and low-voltage relays are on a third. Both of the latter panels are vertical, and flexible leads permit them to be raised out of the compartment without disconnecting any wires.

EXTENSION OF APPROVAL

Approval No. 171 was extended on August 21, 1930, at the request of the Goodman Manufacturing Co. to replace the automatic starter by a new one. The bottom, sides, and ends of the casing for the new starter are rectangular pieces of 1/4-inch steel plate welded together. Strips of steel welded to this casing form stiffening ribs. The top is open and has a rectangular cast-steel frame welded to it for the door that closes the opening. The door is hinged at its ends and makes a tongue-and-groove joint with the frame welded to the casing. It is also padlocked, as were the small doors on the original starter. Electrically, the new starter is similar to the old one, except that only one accelerating contactor is used and the overload relay is set at 100 instead of 75 amperes. All of the equipment but the rheostat is mounted on small sliding panels which can be lifted out of the casing to permit examination and adjustment of the parts. Flexible leads permit movement of the panels without disconnecting any wires. In the new design all the leads from the motor are brought through a single hole in a small-diameter bushing instead of through individual holes in the larger wooden bushing. As the resistance is in the same compartment with the control equipment the leads to it do not pass into a separate resistance compartment, as in the original starter. Asbestos-covered, varnished-cambric cables are used on the new design between the motor and starter.
Electrical connection between the motor and starter is made by means of eight flexible cables which fit snugly in holes through a maple bushing $3\frac{1}{8}$ inches long. The bushing has a shoulder that seats against the end of a steel tube welded in the side of the starter casing. The motor shell is counterbored to take the steel tube; this arrangement prevents the maple bushing from coming out of the tube when the starter is bolted against the motor.

The two insulated studs previously mentioned are guarded by a cast cover, $g$, which has a clamp to hold the trailing cable so that strains will not be transmitted to connections to the studs. The cover also has a bell-mouth entrance for the cable. The shape of the entrance tends to minimize sharp bends in the cable at the point where it is attached to the machine. The trailing cable specified for use with this machine is No. 4 concentric with all-rubber insulation. A fused trolley tap and a rail clamp, both made by the Goodman Manufacturing Co., connect the cable to the trolley wire and rail, respectively. The fuse specified for the trolley tap has a rating of 100 amperes.

**GELLATLY & CO. (INC.) FACE CONVEYOR, APPROVAL NO. 203**

The Gellatly & Co. 2-hp. mat-type conveyor is shown in Figure 6. This company's type G conveyor, which differs from the mat type only in using a chain-flight conveyor, is also included under this approval. The conveyor is driven by a power unit through a sprocket chain. The power unit consists of a 2-hp. motor, $a$, an across-the-line starter, $b$, and a speed reducer, $c$, all mounted on a common bedplate bolted to the side of the conveyor. A short length of No. 12 2-conductor all-rubber insulated cable protected by a hose conduit connects the starter and motor, and a No. 8 cable of the same type and of suitable length connects the switch to the power supply. A fused trolley tap and rail clamp or other satisfactory means connect the cable to the power supply. An insulated strain clamp secures the cable at the bedplate, and a short length of hose conduit is used to protect it from the starter to this point.

Approval No. 203 for both the type G and the mat-type conveyors was granted September 23, 1930, to Gellatly & Co. (Inc.). The approval covered 230-volt equipment only.

The mat-type conveyor consists of an endless mat of wire mesh running over a driving-sprocket cylinder at the head end and a smooth idler cylinder at the tail end. The loaded mat slides over a flat steel plate between side pieces, $d$, and returns on the under side of the plate. The conveyor is made in 5-foot sections bolted to each other and to the head and tail pieces; it may therefore range from 8 to 30 feet in length. The mat can be shortened or lengthened readily so that the length of the conveyor can be adjusted as desired. The total weight of a 25-foot conveyor is approximately 1,000 pounds; the heaviest single part is the power unit, which weighs about 350 pounds. The height of the head or discharge end is 18 inches; of the tail end, about 7 inches; and of the loading portion, $3\frac{1}{2}$ inches. The maximum width at the head end is 54 inches; at the tail end, $21\frac{1}{2}$ inches; and of the loading portion, $23\frac{1}{2}$ inches. It is claimed that the conveyor can handle 60 tons an hour.
The type G chain-flight conveyor differs from the mat type in the use of a chain with cross flights attached running down the conveyor pans instead of a wire-mesh mat. The over-all dimensions are as follows: The height of the head end is 19½ inches instead of 18; the height and width of the loading portion are 5¾ and 20¼ inches instead of 3½ and 23½, respectively; the tail end is 1 inch
wider and about 2 inches higher than the mat type. The electrical accessories for the two types of conveyors are identical.

PERMISSIBLE FEATURES

The only explosion-proof inclosures on the Gellatly & Co. conveyors are the motor and the starting switch. The former is a Westinghouse 230-volt type RH compound-wound motor rated at 2 hp. for continuous duty or 5 hp. for intermittent duty. The motor frame is a cylinder of rolled-steel plate bored out to take the pole pieces and finished at the ends for the joints with the bearing brackets. The bearing brackets close the ends of the frame and carry the roller bearings for the shaft. A lip turned on the rim of each bracket fits snugly into the bore of the frame, while a shoulder on the rim is pressed against the end of the frame by four tap bolts; a right-angle joint is thus formed. The brush rigging is supported from the front bracket. Two circular holes through the bracket on opposite sides of the shaft permit inspection of the commutator and brushes. A screw cover fits into each hole, and the two covers are sealed in place to prevent removal by unauthorized persons. The connections to the inside of the motor are made by a No. 12 2-conductor round cable passing through an asbestos-packed stuffing box on the front bracket. The stuffing-box nut is extended to slip inside the hose conduit that protects the cable. The hose is then secured by a clamp.

The starting switch is a Westinghouse drum-type across-the-line starter rated at 230 volts direct current, 5-hp. for intermittent duty. The switch gives two breaks in the positive line and one in the negative line. A 40-ampere fuse is provided for the positive side of the line. The starter is so arranged that the fuse can be renewed only when its terminals are dead. The case is a length of steel tubing threaded internally at both ends. A base casting carrying the entire switch mechanism screws into and closes one end of the tube. Two of the mounting feet form part of this casting; the other two are on a supporting ring surrounding the tube near the other end. The fuse is mounted on a plate of insulation at one end of the switch mechanism that prevents access to the live parts when the switch is assembled. A cover screws into and closes the end of the tube opposite the base casting. The operating shaft is journaled in a hole through a boss at the center of the cover. The inner end of the shaft is in the form of an L-shaped key. When the switch is closed the key turns under a plate and prevents the cover from being unscrewed. The cover can also be sealed to prevent its removal by unauthorized persons. The wires enter through two asbestos-packed stuffing boxes in the base casting, one carrying the 2-conductor No. 12 cable from the motor and the other the 2-conductor No. 8 concentric trailing cable. The stuffing-box nuts are arranged to slip inside the hose conduit on the cables, and clamps then secure the conduit in place.

GELLATLY & CO. (INC.) CHAIN CONVEYOR, APPROVAL NO. 205

The Gellatly & Co. 5-hp. type A chain-flight conveyor power unit, shown in Figure 7, is very similar to that described for approval No. 203. Motor a, however, is rated at 5 hp., and the cable connect-
ing the motor and starter b is a 2-conductor concentric No. 8 all-rubber insulated cable. The starter and the trailing cable are the same as that on the power unit covered by approval No. 203.

The conveyor is made in sections about 6 feet long bolted to each other and to the head and tail pieces; it may therefore range from 8½ to 150 feet in length. The height at the head or discharge end is about 22 inches; at the tail end, 10 inches; and of the loading portion, 7 inches. The maximum width at the head end is 47 inches; at the tail end, 20 inches; and of the loading section, about 17 inches. It is claimed that the conveyor can handle 35 tons an hour.

**PERMISSIBLE FEATURES**

The motor and the starting switch are the only explosion-proof inclosures on the type A conveyor. The starting switch is the same as that already described for the conveyors covered by approval No. 203 except for a slight modification to accommodate the different size of cable to the motor.

![Figure 7.—Gellatly & Co. (Inc.) type A conveyor power unit](image)

The motor is a Westinghouse 230-volt type 53-SK, compound-wound motor, rated at 5 hp. for continuous duty. The motor frame is a cylinder of rolled-steel plate bored out to take the pole pieces and finished at the ends for the joints with the bearing brackets that close the ends of the frame and carry the ball bearings for the shaft as well. A lip turned on the rim of the brackets fits snugly into the bore of the frame, while a shoulder on the rim is held against the end of the frame by eight tap bolts; a right-angle joint is thus formed. The brush rigging is supported from the front bracket. Four equally spaced circular holes through the front bracket whose axes are perpendicular to the armature-shaft axis permit inspection of the commutator and brushes. A screw cover fits into each of the inspection openings, and the four covers are sealed in place to prevent removal by unauthorized persons. The wires enter the motor in the form of a No. 8 2-conductor concentric all-rubber insulated cable through an asbestos-packed stuffing box.

Approval No. 205 for the type A conveyor was granted to Gellatly & Co. (Inc.) October 30, 1930. The approval covered 230-volt equipment only.
The Fairmont Mining Machinery Co. face conveyor is one of the chain-flight type. It is driven by a power unit through a universal coupling. The power unit consists of a 3-hp. motor, an across-the-line starter, and a speed reducer. These parts are mounted on a common base attached at the side of the conveyor. The electrical connection between the motor and starter is a short length of 2-conductor No. 12 rubber-clad cable protected by a hose conduit, and that between the starter and the power supply is a trailing cable of the same size and type, ranging in length from 25 to 320 feet. A fused trolley tap with a 60-ampere fuse and rail clamp or other satisfactory means is used to connect the cable to the power supply. An insulated strain clamp secures the cable at the base of the power unit, and a short length of hose conduit is used to protect it from the starter to this point. The power unit can be detached from the conveyor without disturbing any of the electrical connections.

The conveyor is made up of crosspieces or flights fastened between two endless chains. The chains and flights slide over a flat steel plate between sidepieces and return on the under side of the plate. The chains run over and are driven by two sprockets on a shaft at the discharge and run over idler sprockets at the other end. The conveyor is made in sections about 5 feet long bolted to each other and to the head and tail pieces; it may therefore range from 8 to 32 feet in length. The height of the discharge end is about 19 inches, and the width over the power unit is about 4½ feet. The height and width of the loading sections are about 3½ inches and 2 feet, respectively. The speed of the conveyor chain is 100 feet per minute.

PERMISSIBLE FEATURES

The motor and the starter are the only explosion-proof inclosures on this conveyor. The motor is a Westinghouse 230-volt type RH compound-wound motor. It was originally rated at 3 hp. for one hour, but this rating was later changed to 2 hp. for continuous duty or 5 hp. for intermittent duty. The motor design is identical to that described for the Gellatly & Co. (Inc.) conveyor, approval No. 203, and the starter is also the same Westinghouse drum-type across-the-line type as that used on the Gellatly & Co. (Inc.) conveyor, except that a slight change in the lead entrance for the trailing cable is necessary to accommodate the No. 12 cable used on the present conveyor instead of the No. 8. The fuse rating for both conveyors is 40 amperes.

For a description of the permissible features of the motor and starter the reader is referred to the description under approval No. 203 for the Gellatly & Co. (Inc.) 2-hp. conveyor.

Approval No. 209 for the Fairmont Mining Machinery Co. face conveyor was issued to the company on December 2, 1930. The approval covered 230-volt equipment only.

GELLATLY & CO. (INC.) CHAIN CONVEYOR, APPROVAL NO. 212

The Gellatly & Co. type A chain-flight conveyor covered by approval No. 212 is the same as the type A chain-flight conveyor
covered by approval No. 205, except for the power unit, which has a different motor and starter. These are the same as those used with the South Fork Foundry & Machine Co. conveyor covered by approval No. 151.

The trailing cable is a No. 10 2-conductor protected by a 30-ampere fuse in the trolley tap. There is also a 30-ampere fuse in the positive side of the starter.

Figure 8 shows the power unit for the conveyor covered by approval No. 212. No detailed description of the accessories will be given, because these have already been described in detail in connection with other approvals.

Approval No. 212 for the type A conveyor was granted to Gellatly & Co. (Inc.) December 26, 1930. The approval covered 230-volt equipment only.

![Figure 8](image_url)

**Figure 8.—Gellatly & Co. (Inc.) type A conveyor power unit**

**PIT-CAR LOADERS**

Ease of handling is an important factor in the construction of the pit-car loaders included in the next group of machines to be considered. With the exception of the last machine in the group the loaders are not self-propelling, and with the exception of the first and last they are moved from place to place somewhat as 2-wheeled carts are pushed along. The weight of the loader is supported by two flanged wheels of comparatively large diameter on a single axle and by the loading end of the conveyor. The weight is so distributed that the conveyor can be balanced over the wheels when the loading end is lifted. This feature permits the loader to be easily rolled on the rails or on a hard, smooth bottom.

In general construction the approved pit-car loaders resemble each other closely. The loading or receiving end usually is a short section of trough that rests flat, or practically so, on the floor. From this section the conveyor moves up an inclined section rising over the wheels and terminates in a virtually horizontal overhanging section. The length of the overhang varies somewhat among the different manufacturers according to the height and length of cars to be loaded. For some machines it is as much as 8 feet. The over-all length also varies for the several designs, but is usually about 18 feet.
The height of the "pan" or receiving end of the loader is low, so that the least physical effort is expended in lifting the shovels of coal into it from the mine floor. The machine itself is intended to be kept close to the coal, so that the distance the coal is to be shoveled will be the minimum.

Pit-car loaders reduce the physical effort required of miners in loading coal. Elderly miners who had difficulty in hand loading coal into mine cars can shovel onto these machines with greater ease. In some instances a reduction in the tonnage rate for hand loading has been possible without a decrease in the daily wage because of the greater speed of loading possible with pit-car loaders. It is also claimed that the use of these machines results in greater concentration of workings, with resultant saving in track work, timbering, etc. For example, in one mine two men working in one place load nearly three times as much coal using a pit-car loader as one man working alone without the machine.

In some mines pit-car loaders have been called upon to serve as loading booms for larger conveyors.

The machines generally are provided with a means for raising and lowering the discharge end of the conveyor. This adjustment allows for some variation in the topping of the cars, depending upon the clearance between the top of the car and the roof.

The machines vary considerably in weight, the minimum being about 1,000 pounds and the maximum about 3,000 pounds.

The only electrical equipment on permissible pit-car loaders besides the motor is the controller or starting device. It is at the side of the machine at convenient height. The energy is received through a suitable length of flexible cable, generally 250 to 300 feet long, connected to the starter. No cable reels are used in coiling the cable; instead, each machine has hooks or "horns" upon which the cable can be wound when not in use.

A more detailed description of the characteristic features of the several machines follows.

DUNCAN FOUNDRY & MACHINE WORKS LOADER, APPROVALS NO. 166 AND 166A

As previously stated, the loader of the Duncan Foundry & Machine Works differs in several respects from most of the group in which it is included. Unlike the majority of others this machine is intended to be kept on the mine track when in service; therefore a 4-wheel truck is employed to transport it. Instead of being rigidly fastened to this truck, however, the loader is supported on a double turntable arrangement. (See fig. 9.) One turntable is mounted on the truck and has an extension track along which the second turntable carrying the loader proper can be moved. This construction is designed to permit a certain degree of flexibility in handling which would not otherwise be possible without sacrificing the convenience of keeping the truck wheels on the room tracks. The extension track is provided with supports at the outer end. These are adjustable to allow for unevenness of the floor and enable the extension track to bear the weight of the conveyor at any point. Provision is also made for varying the height of the conveyor over the car being loaded.
The Duncan Foundry & Machine Works loader was approved on March 13, 1929, for 230 volts direct current only. Specifications for the 500-volt equipment were not completed until later; approval therefor was issued on July 11, 1929. Approvals No. 166 and 166A, respectively, cover permissible machines for these two voltages.

The electrical equipment consists of a type BD-33 compound-wound motor, a, and a type CR-4006-W2 overload protective switch or starter, b, both built by the General Electric Co.

The motor has a continuous rating of 1 hp. The frame is a casting, cylindrical in general shape. The bearing brackets are also externally ribbed castings, each held to the frame by eight cap screws with lock washers. The joint between the brackets and the frame is of the step-flange type with a 90° change in direction. The main surfaces are at right angles to the axis of the frame, but each bracket has a short lip turned on it that fits snugly into a bored portion in the frame, thus centering the bracket in the frame and at the same time giving the additional protection of two closely fitting surfaces, which are not all in one plane. The bracket for the com-
mutator-end bearing is somewhat deeper than that at the pinion end. This greater depth provides the necessary room for brush rigging and for two diametrically opposite handholes about 4 inches in diameter. The screw-type covers for these two openings are fastened together with a seal to prevent removal by unauthorized persons.

Two insulated studs on top of the motor frame provide for electrical connection with the interior. The outer ends of these studs are embedded in blocks of insulation, which in turn are shielded by a cast cover fastened to the frame. This cover serves further as a point of attachment for a fitting to which is clamped the hose conduit carrying the 2-conductor cable between the motor and its starter.

The CR–4006–W2 protective switch is a 2-pole contactor actuated by a single magnet coil and a thermal overload relay mounted together on a single frame. No resistance is inserted on starting; therefore the switch may be considered an across-the-line starter. The motor is ordinarily started or stopped by closing or opening an auxiliary or control circuit. The thermal overload relay is below the contactors and is the 2-pole type TC–121 having a capacity of 5 amperes for 230-volt machines and 2½ amperes for 500-volt machines. When the motor is loaded beyond the point for which the relay is set the thermal elements begin to heat, and if the motor is overloaded too long they will be released, thus interrupting the control circuit and causing the contactors to open. The advantage of the thermal overload relay is that overloads of short duration will not cause it to function; therefore the motor will not be shut down unnecessarily. This relay has the inherent disadvantage, however, that it does not give protection against short circuits; this point is discussed later.

The case enclosing the contactors and relay is a boxlike construction made of sheet steel welded together. The cover is a single flat steel plate held to the case by 18 half-inch bolts secured by lock washers and nuts and further sealed by a wire that passes through holes drilled in the ends of the bolts to prevent unauthorized opening. The joint between the cover and the case consists of broad flat surfaces, both of which have a ground finish. The cover is normally vertical. The two contacts in the control circuit are actuated by a strip of insulating material on a shaft through the right side of the case near the bottom. The operating handle on the outside end of the shaft is normally held in a "neutral" position by a spring. To lock the loader the handle is turned to the "stop" position and padlocked. When the overload relay operates it can be reset without opening the starter case, but not until the elements have cooled enough to allow the triggers to catch and hold together two contacts of the control circuit.

The relay can be reset without removing the cover from the switch case by pressing push button c (fig. 9), whose stem extends through the left side of the case.

The cable to the motor passes through a stuffing box in the bottom of the starter case, while the 2-conductor incoming power cable passes through one near the top on the left side of the case. The latter cable is short and ends at a terminal block fastened to the outside of the case just below the stuffing box. The trailing cable
is also secured to the terminal block; this arrangement permits renewal of the trailing cable without disturbing the stuffing box. The metal cover that shields the terminal block also carries a clamp that holds the cable and so prevents strains from being transmitted to the connections at the terminal block. There is another clamp, \( a \), on the supporting framework of the loader. A bell-mouth outlet, \( e \), in the cover relieves the cable of sharp bends at the point of entrance.

The trailing cable specified for use with the Duncan loader may be either No. 12 or No. 10 duplex cable in lengths of 250 to 300 feet. The same size of conductor is used for either voltage for which the machine is approved. The trolley tap, however, should have a 20-ampere fuse for 230-volt loaders and a 10-ampere fuse for 500-volt loaders. Although this fuse should give the short-circuit protection to the motor that is not provided by the thermal overload relay, the Bureau of Mines considers that this protection should be assured by a positive means nearer the motor. This is to be taken care of ultimately by a fuse in the switch case connected in the positive line with the thermal relay. Hooks on the side of the conveyor are provided for coiling the trailing cable when it is not in use.

**BROWN-FAYRO CO. LOADER, APPROVALS NO. 167 AND 167A**

The “Brownie” mine-car loader, the machine built by the Brown-Fayro Co., is a 2-wheeled loader that can be supplied in various lengths and heights to suit the cars and the height of coal bed in the mine where it is to be used. As previously indicated, this loader need not be kept on the track when being operated.

The original electrical equipment on the Brownie loader was a motor and starting switch, both made by the Crocker-Wheeler company. These are used on the loader shown in Figure 10. An extension of approval issued later allows optional use of a switch made by the Brown-Fayro Co.

**PERMISSIBLE FEATURES**

The approval of the Brown-Fayro Co. loader was issued on March 27, 1929, and covered both 230 and 500 volt direct-current machines. The approval numbers corresponding to these voltages are 167 and 167A, respectively.

The compound-wound Crocker-Wheeler motor is designated as size EF and has an intermittent rating of 1 1/2 hp. The magnet frame is roughly cylindrical. Shields for both commutator and pinion ends have lips turned on them that fit into bores in the frame. The ends of the magnet frame are faced off, thus forming a step-flange joint between the shield and frame. The pinion-end shield is held by four \( 3/8 \)-inch cap screws secured by lock washers. The commutator-end shield consists of two parts, a 4-arm bearing bracket and a “shroud” fitted to the bearing bracket. Four \( 3/8 \)-inch studs in the motor frame pass through the rims of both the bracket and the shroud. Nuts and lock washers hold the assembly secure. This arrangement permits removal of the shroud without disturbing the bearing bracket; the brushes and commutator can therefore be observed in their normal positions. The entrance to the motor for electrical connection is by means of an asbestos-packed stuffing box placed centrally between
ends of the frame and at the side. A change in speed with a corresponding continuous rating of 1 1/4 hp. was permitted by extension of the approval.

The Crocker-Wheeler starter $a$ (fig. 10) for the motor on the Brownie loader is simply a 2-hole, single-throw, knife-blade type of switch with quick-break mechanism mounted in an explosion-
proof casing with two fuses, one for each side of the line. The casing has two main parts, a shallow cast-iron box of rectangular section and a deep cover, also of cast iron. The two parts meet in a plane flange joint and are held together by 10 cap screws with lock washers. The switch itself is fastened to the bottom of the box with barriers of insulation between and above the blades to prevent arcs jumping to the case or between the blades. The shaft for operating the switch passes through a bearing, which is half in the box and half in the cover.

There are also four fingers that make contact with the fuses. These are on an insulating base in the bottom of the box. The two fuses are secured to a removable "hub" or plug which fits into the side of the cover. The fuses must be opposite each other horizontally while the plug is being inserted; to make contact between the fingers and the fuse ferrules the plug must be given a quarter turn clockwise. This motion also engages a lug on the cap with a clip on the cover and holds the plug against forces tending to expel or pull it out. The cap or handle end b of this plug is interlocked with the switch handle in such a way that when the plug is in its place it can not be turned for removal if the switch is closed. A segment, c, linked with the switch handle covers the end of the plug when the switch is closed, or if the plug has been removed it covers the opening and prevents returning the plug to its position for service. In this way the plug can not be used as a switch. The fuses specified for 230-volt machines are of 15-ampere capacity. For 500-volt machines 8-ampere fuses must be inserted in the plug clips. Otherwise, there is no change in the starter for the two voltages.

A stuffing box is placed centrally in each end of the switch box. One of these admits the cable from the motor and the other the trailing cable. Both are No. 14 2-conductor all-rubber insulated cables. The one between the motor and switch is inclosed in air-hose conduit. The trailing cable is held to the side of the loader by a clamp, d, of treated wood so that pulling on the cable will not affect the tightness of the packing in the stuffing box. Some minor changes in the position of the switch and in the type of handle and interlocking mechanism were permitted by extensions of the approval.

Instead of separating the individual conductors of the trailing cable for a distance suitable for connecting into the trolley tap and rail clamp, lengths of single-conductor No. 6 all-rubber insulated cable were spliced to the trailing cable to obtain the mechanical strength not possessed by the small conductors of the main cable. The trolley tap contains a 15-ampere fuse for 230-volt loaders and an 8-ampere fuse for 500-volt loaders.

By extension of the approval issued August 14, 1929, the Brown-Fayro Co. was allowed optional use of a switch of its own design in place of the one covered by the original approval. In outward appearance this switch resembles somewhat the one just described. Its cover is held to the box by 12 instead of 10 cap screws and lock washers. The internal construction, however, differs in several features from that of the original switch. The switch itself is also a double-pole, knife-blade type but is closed against the tension of a spring, which gives the quick-break feature when the switch is released. To minimize and confine the arcs between the blades and
their respective clips, “snuf-arc” are used. The “snuf-arc” consists of two parallel plates of insulation, one on either side of a switch clip and pivoted to the clip. The plates are linked to the switch blade and therefore follow the movement of the blade in planes parallel to that in which the blade moves. Thus, the plates tend to prevent arcs and flashes from deviating from the path between the clip and its switch blade. The plates are kept a fixed distance apart by a small block of insulation to which they are fastened. As the plates move with the opening of the switch, this block describes a circular arc close to the tip of the clip and introduces a barrier between the blade and its clip to interrupt an arc that might otherwise continue between the blade and clip. In addition to the “snuf-arcs” the box is lined with 1/16-inch transite around the switch, and the cover has a sheet of 1/16-inch asbestos cemented in place over the switch to prevent arcs from jumping to the case.

Normally, the switch is held in the closed or “on” position by a latch actuated by a magnet coil. When the voltage gets too low the coil releases the latch, and the switch is tripped open. Two methods are provided for regular stopping of the motor—to use the switch handle or to press the button marked “Stop—Reset” in the switchbox cover. This opens the circuit to the magnet or holding coil, and the switch is opened by the spring connected to it. The push button is connected to a thermal overload relay that also opens the magnet-coil circuit when the load has exceeded normal for too long a time. The switch can be held in by hand. In case of a short circuit in the motor or abusive overloading the thermal relay alone would not protect the motor; therefore a fuse is placed in the same side of the line as the relay. For 230-volt equipment an 8-ampere relay and a 30-ampere fuse are required, while for 500-volt machines a 4-ampere relay and a 15-ampere fuse are required. Aside from the difference in fuse and relay capacity, the switch is the same for either voltage except that a current-limiting resistor is used to protect the holding coil on 500 volts.

THE NORTHERN CONVEYOR & MANUFACTURING CO. LOADER, APPROVALS NO. 168 AND 168A

Among the first manufacturers to apply for approval of a pit-car loader was The Northern Conveyor & Manufacturing Co. Its machine was of conventional design and was equipped with a motor built by the Continental Electric Co. and a starter made by the Union Electric Manufacturing Co. The 500-volt permissible loader is shown in Figure 11.

PERMISSIBLE FEATURES

On April 5, 1929, approval No. 168 covering a 250-volt model 50-B loader was issued to The Northern Conveyor & Manufacturing Co. Approval of a 500-volt machine was requested later, and this was granted on September 27, 1929, after the bureau had completed an investigation of a starter suitable for 500-volt service.

The Continental motor is designated as type DF-23 and has a continuous rating of 1 hp. at 1,750 r. p. m. A shunt motor is used for the 230-volt loader and a compound-wound motor for the 500-volt
loaders. The frame for the DF-23 motor is roughly cylindrical. There are two bearing brackets, each held to the frame by six cap screws and lock washers. These brackets make a step-flange joint with the frame, a lip being turned on them to fit snugly inside a bore of the magnet frame. The bracket at the commutator end is the deeper of the two and has two tapped holes 3¾ inches in diameter horizontally opposite each other. The holes are for brush renewals or commutator inspection. The screw covers that fit these holes are sealed in place when the motor is properly assembled for service. A single asbestos-packed stuffing box admits a 3-conductor cable to the motor at the side of the frame near the commutator end. A Continental Electric Co. type DF-26 1½-hp. continuous-duty compound-wound motor has been approved as optional by an extension of the original approvals. The construction of this motor is similar to the type DF-23. The same end bells are used on the two types.

The starter used on model 50-B loader is made by the Union Electric Manufacturing Co. and is referred to as a type V nonreversing starter. In the original design one step of resistance was incor-
pitated, as it was held to be necessary for proper starting of the motor. Later, however, it was found that the resistor could be dispensed with; accordingly, it has been omitted from starters of recent construction.

The explosion-proof inclosure for the type V starter has two main parts: (1) A casing or “tank,” a (fig. 11), made of pipe threaded at one end and closed at the other end by a circular piece of boiler plate welded in place; and (2) a cast-iron “head” or cover, b, into which the tank screws. A piece of 8-inch wrought-iron pipe is used in the construction of the casing for the 250-volt starter. Because of the need for greater electrical clearance the casing for the 500-volt starter is made from 10-inch steel pipe. The assembled starter is supported from a side plate on the machine by the head. To inspect the starter, the padlock that locks through a lug on the head matching with one on the tank must be removed and the tank must be unscrewed and lowered.

All the parts that comprise the starter are attached to the head. A shaft through the center of the head carries the segments of a drum switch for which three positions are marked—“Off,” “Start,” and “Run.” Below the drum switch is an insulating panel, on one side of which is a 2-pole contactor and on the other side an overload relay with an inverse time element designed to carry momentary overloads and starting current without tripping. For the 250-volt loader a single magnet coil operates the double-pole contactor. For the 500-volt machine there are contactors, each with its own coil. When the motor is overloaded or the voltage is too low the contactors open both sides of the line and shut down the motor. In either instance the switch handle must be returned to the “Off” position before the magnet coils will be energized to close the contactors. When in use the resistor is in series with the armature at the “Start” position of the switch and is short-circuited at the “On” position.

In addition to the switch shaft, there are two asbestos-packed stuffing boxes in the head. One of these is for the incoming line which consists of a 2-conductor rubber-clad No. 12 cable; the other is for a 3-conductor No. 14 rubber-clad cable running to the motor. These same sizes of conductors are used for both the 250 and 500 volt machines. The cable between the motor and starter on these loaders is inclosed in air-hose conduit c. The incoming line or trailing cable passes under the conveyor to the side opposite the starter and is held there by a fiber strain clamp. Between this point and the starter a conduit of air hose incloses the cable. As additional protection for the wiring inverted channels d of No. 16 gage steel are placed over the two pieces of hose conduit.

A 250-foot length of trailing cable equipped with fused trolley tap and rail clamp is specified for the model 50-B loaders in both voltages. A 10-ampere fuse in the trolley tap is required for both 250 and 500 volt machines.

FAIRFIELD ENGINEERING CO. LOADER, APPROVALS NO. 173 AND 173A

The Fairfield pit-car loader shown in Figure 12 employs the same electrical equipment as was used on the Brownie loader, namely, a size EF 1½-hp. Crocker-Wheeler motor, a, and a Crocker-Wheeler starter, b. The construction of these two parts was given in detail.
for the previous loader; further description is therefore unnecessary. As will be seen from comparison of these two machines, the mounting of the starter is different. On the Fairfield loader it is underneath the conveyor instead of at the side of the machine; the motor is higher than in the Brownie loader.

Approvals No. 173 and 173A were issued to the Fairfield Engineering Co. on April 30, 1929, to cover both the 230 and 500 volt designs, respectively.

The fuses in the switch are rated at 15 amperes for 230-volt machines and at 8 amperes for 500-volt machines. Fuses of this same rating are used in the trolley taps for the two voltages. Trailing cable e for either voltage has two No. 14 conductors and is of the all-rubber insulated type. It is equipped with trolley tap d and rail clamp e.

An extension of approval that allows a change in speed, giving a rating of 1 ¼ hp. to the motor for continuous duty, has been made, as in the case of the Brown-Fayro Co. loader. An extension of approval that allows a change of position of mounting for the motor and switch, placing the switch on the side frame, has also been granted. The motor was turned 90° and a worm drive used.

BERTRAND P. TRACY CO. LOADER, APPROVAL NO. 174

The second manufacturer to employ the General Electric type BD-33 compound-wound motor for driving a pit-car loader was the Bertrand P. Tracy Co. The starter, however, is made by the Ohio Brass Co. As may be seen in Figure 13, the general construction of the loader closely resembles that of the three preceding machines. For details of the motor con-
struction the reader is referred to the description of the pit-car loader built by the Duncan Foundry & Machine Works.

Approval of the Tracy pit-car loader was issued on May 22, 1929. To date the loader is built for 230-volt service only; it is identified by approval No. 174.

**PERMISSIBLE FEATURES**

Ohio Brass Co. starter $a$, as used on this loader, consists of a Moore safety switch in a cast-aluminum inclosure whose base is a short cylinder $6\frac{1}{2}$ inches in diameter, closed at one end and threaded internally. It has three lugs for bolts to mount the starter. The switch case, also a cylinder threaded externally, screws into the base. The main joint in the inclosure is therefore threaded. There are two asbestos-packed stuffing boxes diametrically opposite each other in the case for two 2-conductor all-rubber insulated cables, one to the "line" and the other to the motor. The shaft for operating the switch extends through a boss cast on top of the case and terminates in a small composition knob or handle, $b$ (fig. 13), for which the three positions, "Set" (or "Reset"), "On," and "Off," are indicated on the case. When the switch is wired up and mounted on the loader it can not be opened unless the mounting bolts are removed or the cables cut. Access to the interior of the starter is prevented further by a sealed wire that passes through a sealing lug on the base and through both the packing nuts in the case.

The switch proper has two poles, each of which has two breaks. It consists of four stationary and four movable contacts. The latter are held in a rotating disk under spring pressure and are joined in
pairs by flexible conductors. When the switch handle is turned to the “On” position a spring attached to the disk is placed in tension and the disk is held by a latch on the armature of an electromagnet, which has two windings on a common core. One of these is always in series with the positive side of the load; and the other, which might be termed a shunt coil, has one end permanently connected to the positive line. Connection to the negative line is established when a bimetallic strip in the negative side of the circuit becomes heated enough by motor overload to make contact with the coil terminal. When the coil is energized the armature is attracted to the core. The disk is thus unlatched, and the spring returns it to the “Off” position. The series coil gives protection against short circuits in that the heavy current in it induces magnetic flux of enough intensity to attract the latch armature and so results in opening the switch. When the switch handle is turned to the “Off” position the latch is released mechanically. The disk does not move when the switch handle is moved between the “On” and the “Set” positions. Before it will latch, however, the switch handle must be turned to the “Set” position; then two of the contacts are raised so that the circuit through them is not completed until they are lowered by turning the handle to the “On” position.

The connecting cable between the switch and motor has two No. 14 conductors and is in a rubber-hose conduit, c. Trailing cable d also has two No. 14 conductors and is specified in lengths of 20 to 300 feet. Sharp bends at the point at which the cable enters the starter are prevented by a short piece of rubber hose. A clamp of fiber next to the starter grips the hose tightly enough to hold the cable and so relieves the internal connections of strains resulting from pulls on the cable.

A fused trolley tap, containing a 30-ampere fuse, and a rail clamp furnish the means for connecting the trailing cable to the power circuit. Six-foot lengths of single-conductor No. 6 all-rubber insulated cables spliced to the main cable supply the necessary mechanical strength where the conductors enter the trolley tap and rail clamp.

CHICAGO AUTOMATIC CONVEYOR CO. LOADER, APPROVALS NO. 175 AND 175A

The fifth in the group of pit-car loaders is known as the model 70 “Red Devil” (fig. 14), built by the Chicago Automatic Conveyor Co. The electrical equipment consists of a type 70-C motor, a, and a No. 21575 fused starting switch, b, both made by the Goodman Manufacturing Co. At first the machine with this equipment was built only for 500-volt service; approval No. 175A was issued to the Chicago Automatic Conveyor Co. on June 24, 1929, to identify the machine. Shortly afterwards there was a demand for loaders operating on a lower voltage; accordingly approval No. 175 was issued to the company on July 26, 1929, to identify the 250-volt machine.

PERMISSIBLE FEATURES

Motor.—The 70-C motor is series wound and is understood to have a rating of 1 hp. It has a cast frame, roughly square in section, with two removable end plates, each of which holds a bearing for the
armature shaft. The ends of the frame itself are faced at right angles to the armature shaft and also bored parallel with the shaft. Each end plate has a lip that extends one-fourth inch into the bore and a machined surface that is held against the end of the frame by eight cap screws with lock washers. The end plate for the commutator end of the motor has a single asbestos-packed stuffing-box
type of lead entrance for the 2-conductor cable running to the starting switch. In the top of the motor near the commutator end are two openings threaded to take 3½-inch handhole covers. These covers are near enough together to be locked in place by means of a single padlock.

The starting switch, a 2-pole, single-throw, knife-blade switch with auxiliary blades for obtaining a quick break upon opening, is inclosed in an explosion-proof compartment, b. The motor is protected by a 10-ampere fuse of the cartridge type for both the 250 and 500 volt machines. A partition in the switch casing completely isolates the fuse from the switch compartment. The electrical connections between the two compartments are made by means of two single-conductor cables fitting tightly in individual holes through a wooden plug in the partition. A 2-conductor cable protected by a short length of air-hose conduit leaves the fuse compartment through an asbestos-packed stuffing box and connects with the motor. The trailing cable, which is of the duplex type containing two No. 12 conductors, connects with two insulated studs in the end of the switch compartment. It is furnished in 200 and 300 foot lengths; the same size of conductor is used for both voltages. The two conductors of the trailing cable are fitted with an Ohio Brass Co. trolley tap and a rail clamp, respectively. The trolley tap is fitted with a 10-ampere fuse for both 250 and 500 volt service. As the starter has only one fuse, it is important that the trailing cable be connected so that this fuse will be in the positive side of the line.

A separate cover is used for each of the two compartments of the starting switch. The one for the switch compartment is bolted to the casing, forming a joint of flat machined surfaces. The switch-operating shaft extends through a special bearing in this cover. The cover for the fuse compartment is hinged at the end farthest from the switch and makes a tongue-and-groove joint with the casing. The other end of the cover is held down when in operating condition by a hinged cover lever, c. The lever and the switch handle d interfere with each other's movements in such a way that the lever can not be raised to release the cover for opening unless the switch handle is in the "Off" position, and once the cover has been opened the switch can not be closed. Thus, the terminals in the fuse compartment are dead while the cover is open. An extension of the approvals allows the motor to be turned 90° from the position shown in the figure to permit a chain drive.

THE NORTHERN CONVEYOR & MANUFACTURING CO. LOADER, APPROVAL NO. 178

The second pit-car loader for which the Northern Conveyor & Manufacturing Co. was granted approval is of special design and differs in several respects from the first machine approved. The motor differs in size and position, and provision is made for operating a 40-foot auxiliary belt conveyor through a flexible drive that can be coupled to the loader. The belt conveyor is not permanently attached to the loading boom, but as occasion demands it can be used as an extension to the boom.
So far, the permissible design has been built only for 230-volt service. Approval No. 178, issued October 5, 1929, designates the approved machine.

PERMISSIBLE FEATURES

The motor used on this loader was built by the Continental Electric Co. and has a frame designated as DF-325. It has a compound winding and a continuous rating of 2 hp. at 1,750 r. p. m. The construction of this motor as regards joints, bearings, and lead entrance is the same as that of the 1-hp. Continental motor described in connection with the first permissible loader built by the Northern Conveyor & Manufacturing Co. The dimensions of the 2-hp. motor, however, are greater than those of the 1-hp. motor, and two more cap screws are used at each end for holding the bearing bracket to the frame. As with the first motor, two handhole covers of the screw type are provided for brush openings at the commutator end. These covers are of the same thread diameter as was used for the 1-hp. motor, and they are sealed shut to prevent tampering. A 3-conductor cable connects motor and starter.

The starter is of the same design as was used with the 1-hp. motor and is built by the Union Electric Manufacturing Co. At first a resistor that gives one step of resistance in starting was used in the starter; later an extension of approval allowed use of the starter without the resistor.

The cable between the motor and starter is inclosed in a rubber air-hose conduit, which in turn is covered with a guard fabricated from 16-gage sheet steel. From the starter to a clamp upon the side of the conveyor the trailing cable is similarly inclosed and guarded. Two horns on this side of the conveyor are provided for coiling the trailing cable, which is a 2-conductor No. 12 rubber-sheathed cable. A 3-foot length of No. 6 single-conductor rubber-sheathed cable is spliced to each of the No. 12 conductors. The No. 6 cables terminate in a fused trolley tap and a rail clamp, respectively. A 20-ampere fuse is specified for the trolley tap.

MANCHA STORAGE BATTERY LOCOMOTIVE CO. LOADER. APPROVALS

NO. 179 AND 179A

The next in the group of pit-car loaders is the type AH "Coal-getter" built by the Mancha Storage Battery Locomotive Co. In general outline this machine closely resembles most of those described previously. Square seamless tubes fastened between two chains comprise the conveying mechanism proper. The motor, which is underneath the conveyor trough, is shielded further by side plates which serve to keep coal and dirt from entering the drive mechanism from the sides.

The first Mancha loader to be approved had 500-volt direct-current electrical equipment. Approval No. 179A was issued for this machine on October 19, 1929. Shortly afterward drawings and specifications covering a 230-volt direct-current loader were submitted, and this machine was approved on November 26, 1929. Approval No. 179 was assigned. The permissible loader is shown in Figure 15.
The motor used to drive the Mancha Coalgetter is manufactured by the Continental Electric Co. Like that used on the preceding machine, it has a DF-325 frame. Its rating, however, is 1½ hp. at 1,150 r. p. m. It is compound wound. The construction of the
motor is the same as that described in connection with The Northern Conveyor & Manufacturing Co. special type of loader. The starter $a$ is that made by the Union Electric Manufacturing Co. already described. For the 250-volt loader a step of starting resistance is incorporated in the starter, but for the 500-volt loader the starting resistor is omitted. The 3-conductor cable between the motor and starter is inclosed in a rubber air-hose conduit, $b$. A piece of this conduit nearly 3 feet long is used to protect the trailing cable starting from the point at which it enters the starter. Both stuffing boxes in the top of the starter are shielded by an overhanging plate welded to the side of the conveyor frame.

A 300-foot length of trailing cable, $c$, is used with this loader. A fused trolley tap and a rail clamp permit connection to be made to the feeder circuit. For 230-volt machines a 15-ampere fuse is used in the trolley tap and for 500-volt service a 10-ampere fuse is used.

BERTRAND P. TRACY CO. LOADER, APPROVALS NO. 187 AND 187A

On March 19, 1930, the Bertrand P. Tracy Co. was issued an approval covering its second design of pit-car loader. This machine was built for 250-volt service. On October 17, 1930, the machine with a different motor was approved for 500-volt service. Except for some slight changes, the second loader is essentially the same mechanically as the first design approved. Electrically, however, the second loader is considerably changed, in that a different starter and different motors are used. The approval numbers assigned to it are 187 for 250-volt service and 187A for 500-volt service.

PERMISSIBLE FEATURES

The 250-volt motor is made by the General Electric Co. It is a compound motor known as type BD–226 and has a continuous rating of 1 hp. The magnet frame is octagonal in section with two end shields, each held by four cap screws with lock washers. The joint between the shields and the frame is the step type; that is, each piece has two flat machined surfaces in different planes joined by a cylindrical surface three-sixteenths inch in height.

Ball bearings are used at each end of the motor. They fit in a container or “cartridge,” which has a cylindrical surface fitting in a bored opening in the end shield.

The end shield at the commutator end is much deeper than the one at the pinion end of the motor. It has two oval inspection openings, one on either side of the armature shaft horizontally. The long axis of these openings is vertical. A steel plate one-half inch thick serves as a cover for each opening. The explosion-proof joint between the covers and end shield is made up of plane surfaces held in contact by five cap screws secured with lock washers.

The lead entrance to the motor is in the side of the magnet frame. An asbestos-packed stuffing box admits a 2-conductor No. 14 cable.

The 500-volt motor is the Continental type DF–23 described in connection with the third loader, approvals No. 108 and 168A.

The starting or control equipment, made by the Bertrand P. Tracy Co., consists of two manually operated contactors with blow-out coils, an overload relay, and a fuse, all mounted in a cast-iron box. The
contacts are opened and closed by means of a shaft extending through the right side of the box and terminating in a knurled knob which is used for the switch handle. A toggle arrangement holds the contactors in the closed position; they can be tripped open either by a slight twist of the knob or by an overload, causing the relay to function and release the toggle. A spring turns the shaft to the neutral position if it is not prevented by holding the knurled knob. When the shaft is held in the closed position the overload relay is prevented from tripping the contactors open. A 10-ampere fuse at 250 volts or a 5-ampere fuse at 500 volts is provided to protect the motor should a deliberate attempt be made to operate it continuously when over-loaded or short-circuited. Both the fuse and overload relay are connected in the positive side of the circuit. The relay is set for instantaneous operation at 11.8 amperes for 250 volts and 5.6 amperes for 500 volts.

The cover for the switch box is held by 18 bolts with nuts and lock washers. Surfaces machined flat make up the joint between the box and the cover.

The 2-conductor cable between the motor and starter enters the latter through an asbestos-packed stuffing box on the right side. A rubber hose is used as a conduit for this cable. The trailing cable enters the left side of the starter through another asbestos-packed stuffing box. A short piece of hose at this point prevents sharp bends from being made in the cable, and the clamp that holds the hose also grips the cable by compression on the hose; in this way strains are not transmitted to the connections in the starter.

A duplex all-rubber insulated trailing cable with No. 14 conductors is furnished with this design of Tracy pit-car loader, the maximum length specified being 300 feet. For connection to the power circuit one conductor of the cable is fitted with a trolley tap containing a 15-ampere fuse for both 250 and 500 volt service. The other conductor is fitted with a rail clamp.

**THE JEFFREY MANUFACTURING CO. TYPE 38-D LOADER, APPROVALS NO. 200 AND 200A**

The Jeffrey Manufacturing Co. type 38-D pit-car loader is shown in Figure 16. This machine differs from most of the other pit-car loaders in that it is a self-propelling, alternating-current machine kept on the track when in service. It is about 20½ feet long and 40 inches wide, not including the wheels. The width over the wheels ranges from 38 to 54 inches, depending upon the gage. The complete machine weighs about 3,200 pounds and travels about 1.7 miles an hour. The conveyor chain and propelling drive are operated through clutches. The machine is pivoted on a self-propelling truck so that it can be swung about 35° to the right or left of the center line of the track.

The electrical equipment consists of a type E, 43-N frame, 3-hp., 3-phase, squirrel-cage motor, built by the Louis Allis Co., and a type 26-B reversing starting box, built by the Jeffrey Manufacturing Co.

The Jeffrey type 38-D pit-car loader was approved by the bureau on August 28, 1930; approvals No. 200 and 200A were assigned to the 220 and the 440 volt machines, respectively.
The motor is a Louis Allis Co. type E, 43–N frame, 3-hp., 3-phase, externally ventilated, squirrel-cage induction motor. The stator laminations are held between two steel rings fitting inside the ends of a cylinder formed of sheet steel bent around and welded to the rings.

The ends of the cylindrical shell are closed by cast end plates carrying the ball bearings. The end plates are bored to fit over the outside of the projecting ends of the steel rings which are accurately machined. In this way the end plates and bearings are accurately centered, and the closely fitting cylindrical surfaces (plus some additional flat surface at right angles to the shaft) form the explosion-
proof joints between the end plates and the shell. The end plates are
held by eight tie bolts extending from end to end of the motor out-
side the shell. The bolts pass through holes in lugs on the end plates
and are secured by nuts and lock washers at each end.

The shaft projects at both ends of the motor, one end carrying the
sprocket and the other the cooling fan. The fan is inclosed in a cast
shroud fastened to the motor and communicating with a narrow an-
nular space between the cylindrical motor shell and a cylinder of
thin sheet steel slightly larger in diameter than the motor shell. The
air from the fan is thus forced over the surface of the motor shell,
thereby cooling it. A 3-conductor No. 14 rubber-sheathed cable passes
through an asbestos-packed stuffing box. The stuffing box is at the
end of a short tube welded to the motor shell to carry the cable
through the air space surrounding the motor.

Starting box.—The class 26-B alternating-current starting box is a
reversing, across-the-line starter including fuse protection for each
line. The cover a screws into the case and closes the circular opening
into the compartment. Interference between the bar b, which con-
nects the switch levers, and the hinge piece c prevents the cover from
being opened when the switch is closed or the switch being closed
when the cover is open. An interlock rod sliding in guides on the
outside of the case prevents the reverse switch from being operated
except when the main switch is open. The switch is 3-pole. The live
parts in it are covered by insulation barriers and are therefore not
accessible immediately when the cover of the compartment is opened.
Twenty-ampere fuses are used for 220 volts and 10-ampere fuses for
440 volts. These are readily accessible and can be renewed easily
without hazard, as the fuse terminals are dead when the cover is
open. Two 3-conductor No. 8 rubber-sheathed “superservice”
cables enter the compartment through asbestos-packed stuffing boxes.

The cable to the motor is protected by hose conduit and is spliced
at the motor to the motor cable by clasp-type connectors adequately
insulated and secured in wooden clamp blocks. The connections
are covered by a sheet-metal connection box, d, which is also a place
for attachment of the hose conduit.

The trailing cable is a No. 8 3-conductor superservice cord
300 feet long. It is cleated in place and is secured by insulated
strain clamp e. The excess cable is coiled on two hooks, as the speed
of the machine is slow and no cable reel is needed. These hooks are
not shown in Figure 16. Three trolley taps with 30-ampere fuses for
220 volts and 15-ampere fuses for 440 volts are used for connecting
the cable to the power supply.

SELF-LOADING LOADERS

The third and last group of machines to be considered comprises
those that gather or pick up the coal before discharging it into
cars or other means of transportation. The only similarity in the
machines of this group is that they are intended to displace hand
shoveling completely. Consequently, they vary widely in the meth-
ods adopted for achieving the objective.
The Jeffrey Manufacturing Co. type 43-A Shortwaloader falls in the group of self-loading machines. As its name implies, it combines the work of a short-wall mining machine with that of a loading machine. In Figure 17 α is a chain cutter bar used to undercut the coal. During this process the two cutter bars β are turned back out of the way; after the coal has been shot down, however, they are swung into position above the cutter bar proper, where their action is to loosen the coal and pull it into the elevating conveyor at the right side of the machine. The conveyor discharges into a second conveyor, which in turn empties the coal onto another conveyor.
separate from the loader. The last conveyor obviates the necessity for the use of track and cars in the place being loaded out.

Electrically, the machine consists of (1) a type MM–147–C, 50-hp. direct-current motor, \( c \), which drives the conveyors and cutter bars; (2) a rheostat, \( d \), mounted on the left side of the motor; (3) a class 21 starting box on the right side of the machine opposite the rheostat (not shown in fig. 17); and (4) a 2-pole fused switch. Energy for the machine is received through a trailing cable. One end of the cable enters the fused switch, and the other is equipped with a fused trolley tap and a rail clamp for making connection to the power circuit. There is no cable reel for handling the trailing cable.

This loader is not self-propelling but is equipped with rope drum and sheaves, by means of which it is moved while both cutting and loading. It is intended to be kept at the face until the room or place has been worked out to avoid unnecessary moving of the machine. In entry driving it has been claimed that the machine has established a cutting record of 25 to 35 feet per 8-hour day.

The Jeffrey Shortwaloader was approved by the bureau on January 8, 1926. Approvals No. 122 and 122A were assigned to cover the 250 and the 500 volt machines, respectively.

**PERMISSIBLE FEATURES**

The type MM–147–C motor is compound wound. It has a solid frame, the commutator end of which is cast shut except for a small hole bored to take a bearing housing. The pinion end of the frame is open. A cast plate held by 11 cap screws and forming a flat joint with the frame closes the opening in the frame. This plate carries a bearing housing. Two 6-inch-diameter screw covers in the top of the frame give access to the commutator and brushes. Normally these covers are sealed when the machine is in operation. Electrical connections with the motor are made through five single-conductor cables, each in an individual, asbestos-packed stuffing box, the boxes arranged in a single row in the commutator end of the frame.

The controller or starting box for the type 43–A machine is of the same general design as the class 21 starting box used on the Jeffrey mining machines. The casing inclosing this controller consists of three main parts, two of which are castings bolted together with one flat joint between. These two parts form the four sides and front of the controller. The back of the controller is a piece of boiler plate which supports the whole in a vertical position at the side of the elevating conveyor. A steel block welded to the boiler plate with nine asbestos-packed stuffing boxes in three rows constitutes the lead entrance.

Rheostat \( d \) used on this loader consists of three stacks of cast-iron grid resistors mounted in a cast-iron box having a boiler-plate lid. This lid makes a flat joint with the box and is held to the latter by 18 cap screws with lock washers. The lead entrance to this compartment consists of four asbestos-packed stuffing boxes, each taking a single-conductor cable.

The fused switch used on the 43–A loader consists of a 2-pole, knife-blade switch and a single 300-ampere cartridge fuse for 250-volt machines and a 150-ampere fuse for 500-volt machines in a cast-iron inclosure. The fuse is mounted between the two switch
blades and is surrounded on the four sides and back with heavy insulation. The enclosure is made up of two main parts, a box and a hinged cover. The cover is interlocked with the switch in such a way that the switch must be opened before the cover can be opened, and once the cover is opened the switch can not be closed. The cover is so designed that when fully closed it must be moved to the side in a direction parallel to the hinge axis before it can be swung open on its hinge, because of the special method of holding the cover instead of employing cap screws or bolts. One of the cover edges, which are at right angles to the hinge axis, slides into a slightly tapered groove about five-eighths inch deep in the side of the box; at the same time an edge at the opposite side of the box slides into a corresponding groove in the side of the cover, effectually holding it to the box against the outward force of possible explosions of gas inside. To make the fastening more secure, each of the other two edges of the cover is held by two overhanging lugs. The edge of the cover is cut away so that when the cover is moved far enough to the side it will clear the overhanging lugs when it is swung open or shut. Unless turned to the “Off” position, the switch lever at the side of the box obstructs the path of the cover when slid to the side and thus prevents it from turning on its hinge.

The switch-operating mechanism consists of two pairs of levers, an internal and external lever, at each of two opposite sides of the box. The two levers of each pair are pinned together, and the external levers are joined by a piece of iron pipe held in place by a threaded rod through its center with a nut and lock washer on each end. This pipe serves as the handle for operating the switch; as it swings about an axis parallel to the cover hinge it crosses over the cover. Thus, when the cover is open it holds the handle in the open position. Four insulated studs in one end of the switch casing are provided for the electrical connections. The sides of the casing are extended; these and a steel-plate cover form a connection box around the insulated studs. The cables between the switch and controller pass through the cover plate, and the incoming leads pass through the side of the connection box. The switch is mounted on the same side of the machine as is the controller. Between the switch and controller are a clutch lever and two hand wheels, which are used to control the rate of feed and the rope drums that govern the movement of the machine.

The wiring between compartments is carried in air-hose conduits.

The rubber-sheathed trailing cable is supplied in 300-foot lengths. The trolley tap for the 250-volt machine is fitted with a 300-ampere fuse, while a 150-ampere fuse is used for the 500-volt machines. No. 3 concentric cable is used for both voltages.

THE JEFFREY MANUFACTURING CO. CONVEYOR LOADER, APPROVALS NO. 123 AND 123A

A method of handling coal entirely different from that of the Jeffrey Shortwalaloader is employed with the type 44–B conveyor loader built by this same manufacturer. The latter machine is styled a self-loading conveyor and is designed for long-wall practice in which the faces are 100 feet or more long. The conveyor portion
consists of 10 1/2-foot sections, furnished with a form of universal coupling for joining them to make the desired length. As may be seen by reference to Figure 18, these couplings permit the conveyor to adjust itself readily to the contour of the bottom on which it may rest and to the contour of the face. The flights that move the coal are secured to a chain at one end only. This end is hinged, and after the flight reaches the discharge point of the conveyor a guide raises it to an upright position; in this position it returns to the other end of the machine under a sheet-steel cover.

![Figure 18.—The Jeffrey Manufacturing Co. conveyor loader](image)

The flights are purposely built low, so that they can be placed partly under the kerf in low coal beds before the coal is shot down. For higher beds the conveyor is placed so that the coal when blasted will fall into the conveyor but not beyond it. The coal covering the conveyor loader is discharged into a sectional conveyor on the entry and the remaining loose coal is picked up by crowding the loader over into the pile with winch devices, of which there is one at each joint. The loader is not self-propelling. Eyes secured to the side of the driving unit permit attachment of rope or chain for dragging the loader.

It is claimed that this machine can load a 100-foot face of 42-inch coal two and even three times in a single 8-hour shift.
The driving unit for the approved Jeffrey conveyor loader is at the discharge end. The electrical parts of this unit include: (1) A type MM-147A direct-current motor, (2) a controller, (3) a rheostat, and (4) a 2-pole fused switch.

Approval of the type 44-B conveyor loader was issued to The Jeffrey Manufacturing Co. on January 15, 1926. Approvals No. 123 and 123A were assigned to the 250 and 500 volt machines, respectively.

**PERMISSIBLE FEATURES**

Except for the addition of two insulated studs at the commutator end of the frame, the type MM-147A motor is almost identical with the type MM-147-C motor used on the Jeffrey 43-A Shortwaloader previously described. It is a 50-hp, compound-wound motor. Part of this motor, as used on the conveyor loader, may be seen at a in Figures 18 and 19. The two insulated studs are covered by housing b in Figure 19 and are used in making connection between the motor and fused switch c in Figure 19. The wires connecting the two compartments are covered by a hose conduit, which may be seen coming out of housing b in Figure 19.

Except for the entrance of the cables from the motor and the method of mounting, the fused switch is the same as that already described in connection with the Shortwaloader. A sheet-metal cover, shown removed in Figure 19, incloses the switch during normal operation of the loader. A small opening in the cover is provided for opening or closing the switch.

Controller compartment d in Figure 19 and e in Figure 18 is another class 21 starting box. The casing has the two castings previously mentioned, but the back is not closed solidly by a plate, as was the controller used on the Shortwaloader; instead, the open back is bolted over the open top of the rheostat compartment (not shown in fig. 19). The electrical connections between the controller and rheostat are carried through the open space between them.

The rheostat is bolted against the commutator end of the motor frame. An opening in the rheostat casing fits over the five stuffing boxes in the motor. All the wiring between the motor, controller, and rheostat is therefore wholly within explosion-proof inclosures. The only conduit on the machine is that running from the motor to the switch.

The trailing cable specified for this machine is a No. 3 concentric rubber-sheathed cable 300 feet long. The same size of conductor is used for both 250 and 500 volt service. The clamp for holding the trailing cable to the machine is shown at e, Figure 19. The trolley tap for connecting the cable to the power circuit contains a 300-ampere fuse for 250-volt circuits and a 150-ampere fuse for 500-volt circuits.

No cable reel is provided with the machine.

**MYERS-WHALEY CO. LOADING MACHINE, APPROVALS NO. 127 AND 127A**

The first approved machines that employed the shoveling principle of lifting the coal and placing it in conveyors for discharge into mine cars were the Myers-Whaley direct-current loaders. Three dif-
ferent sizes and three different models are made, but the electrical equipment is practically the same for all of them. Each machine is self-propelling. There are two conveyors, one that receives the coal from the scoop or shovel and one that discharges it into the mine cars. One motor, through suitable gear reductions and clutches, op-

erates the conveyors, the shovel, and the traveling movements of the loader.

In the model first approved two standard sizes—a No. 4 shown in Figure 20 and a No. 3 special—are built. The over-all length of the No. 4 machine is 25 feet, and the minimum operating height above the rail is 5½ feet. A capacity of 1 ton a minute is guaranteed. The No. 3 special is 1 foot shorter than the No. 4 machine and can
operate in a 4-foot space between the rail and roof. Its capacity is three-fourths ton a minute. A crew including the machine operator, car coupler, and helper can load 200 to 300 tons a shift. This model has a scoop, $a$, that digs or crowds under the coal, lifts it, and then by tipping backward empties it into a transfer section that acts as a back for the scoop. This section moves forward and up with the scoop during the digging motion and later separates from it, continuing to tip backward as at $b$ until the coal has been transferred or discharged from it into the conveyor back of it. Once the motor is started and the clutch thrown in the same cycle continues independent of the operator in charge of the loader. It is common practice, however, for the operator to assist in the digging motion by moving the entire machine forward with the scoop and returning it as the scoop returns, much as a man moves his body forward and back again in ordinary hand shoveling.

The second approved model is designated as a "single-motion shovel." It has no transfer section, and the forward motion of the entire machine is depended upon to fill the scoop. The latter is hinged at the back and by means of a crank and connecting rod on each side is tilted so that the coal slides into the front conveyor. The operator can hold the shovel tilted until the coal is carried away. This model is made in the No. 3 and 4 sizes. The former is about 26 feet long, requires an operating height of at least 48 inches from rail to roof, and is claimed to have an average capacity of 50 to 60 tons an hour. The No. 4 size is about 30 feet long, requires an operating height of at least 60 inches between the rail
and roof, and is claimed to have an average capacity of 60 to 80 tons an hour of actual shoveling.

The third model, also made in the No. 3 and 4 sizes, is known as the "automatic double-cramp shovel." The No. 3 automatic shovel is about 26½ feet long and requires an operating height of at least 48 inches above the rail. The No. 4 size is about 29 feet long and requires a headroom of at least 4½ feet above the rail. The automatic shovel is claimed to have an average capacity of more than 2 tons a minute and a maximum of more than 4 tons. This model also has no transfer section, but a special double crank and the connecting rods on each side impart a motion to the scoop similar to that of the first model; that is, the scoop moves forward to be filled and then tips up and back to discharge upon the front conveyor. This shoveling action proceeds at the rate of 40 to 50 strokes a minute. The forward and return motion of the entire machine is unnecessary in loading out the coal.

The two conveyors on the Myers-Whaley loaders are of the belt type. Steel reinforcing bars closely spaced on the belts protect them against undue wear. The rear or loading boom can be moved through an angle of 20° on either side of the center line of the machine, and the front conveyor has a lateral movement of 45° on either side of the center line. A seat, c, is provided for the operator on a small platform.

The first 250-volt model in the No. 4 and No. 3 special sizes was approved by the Bureau of Mines on July 16, 1926, and the 500-volt model on September 23, 1927. The approval numbers assigned to correspond to these two voltages were 127 and 127A. The single-motion shovel with explosion-proof electrical equipment was authorized by the bureau under an extension of approval issued on March 30, 1928. The automatic double-cramp shovel with explosion-proof parts was authorized under an extension of approval issued November 12, 1929.

Motor.—The motor is made by the General Electric Co. and is a modification of the one used on the Sullivan Machinery Co. type CE-7 permissible, short-wall mining machine. It has a rating of 30 hp. on a 1-hour basis and has a compound winding. It is the only ventilated motor on permissible loading machines. The openings through which air circulates are protected against discharge of flames from gas burning within the motor by means of thin sheet-metal plates closely spaced. These plate "protective devices," as they are termed, are illustrated and described in Bureau of Mines Bulletin 78, Approved Explosion-Proof Coal-Cutting Equipment, published in 1920. There is one protective device in each of the two motor heads. The head at the commutator end has eight small ventilating openings or ports, and the one at the pinion end has two larger ones.

Broad, flat, machined surfaces constitute the main joints between the heads and motor frame. At one point, however, the lip that is turned on the pinion-end head to center it in the frame is depended upon to give the necessary total breadth of joint. Only six cap screws are used to hold each of the heads to the motor frame. Some of these screws are rather widely separated. Closer spacing of the screws was not necessary to prevent the motor from failing during explosion tests because the release offered by the protective devices
prevents building up of high explosion pressures and also because the exceptionally rigid construction of the heads does not permit much springing open between the broad joints.

An oblong cast plate on top of the motor frame at the commutator end covers an inspection opening. This plate and the motor frame have flat machined surfaces in contact. The joint is made tight by six studs with nuts and lock washers.

A plate over an opening in the rear or pinion-end head has three asbestos-packed stuffing boxes, each serving as an entrance for a single-conductor cable.

Control unit.—Control unit \( d \) for the Myers-Whaley loaders contains the controller proper, a rheostat, headlight fuses, a small resistor (when a single headlight is used on 500-volt machines), a main switch, and main fuses.

The casing for these parts is a heavy box casting about 7 inches deep, 17 inches high, and \( 27\frac{1}{2} \) inches long, internal dimensions. A heavy cast cover with two inspection openings closes the large open side of the casing. The joint between the cover and casing consists of wide, flat, machined surfaces held in contact by 4 studs and 16 bolts with castellated nuts and cotter pins or wires. The inspection openings are so placed that fuses can be renewed through one and the controller adjusted through the other. The covers for these openings are each held by eight studs with castellated nuts and cotter pins or wire.

Electrical connections between the control unit and motor of the machine are made by means of three insulated studs in one end of the casing. Two other studs provide for the connection of the incoming lines from reel \( e \). All terminal connections to the studs are imbedded in insulating blocks that also hold ferrules to which conduits are fastened. At the opposite end of the casing are one or two stuffing-box lead entrances, depending on the number of headlights \( f \) mounted on the machine.

In the control unit the two incoming lines go direct to a drum switch. There are four positions for the drum; one cuts off all power to the machine, including the headlights, and the other three are for main fuses—that is, for each of these positions there is a cartridge fuse in both sides of the line. This arrangement permits three changes of fuses to be made without opening the control case, simply by turning the handle of the drum switch. After one or both fuses of each set are blown the case must be opened and fuses renewed before operation of the loader can be continued. For 250-volt machines 150-ampere fuses are used, and for 500-volt machines 70-ampere fuses are used.

Two fuses protect the headlight circuits, but there is no switch for controlling the headlights independently of the main switch. On 500-volt loaders alternative methods of connecting the headlights are offered. If there in only one headlight a resistor in series with it is placed in the control unit; but if two headlights are desired they are connected in series, and the resistor is omitted.

Next to the drum switch and spaced about centrally in the control unit is the rheostat for bringing the motor up to speed. Beside the rheostat is the controller. It is nonreversing and is operated by means of an oil cylinder on top of the control-unit casing.
As originally approved, Myers-Whaley loaders were equipped with hand-operated cable reels. (See e, fig. 20.) Later, however, an extension of approval authorized the use of a clutch-operated, power-driven cable reel with a spooling device. Both types of reels are the same electrically; that is, there is a slip-ring housing at each end. Each conductor of the trailing cable is connected to an inclosed ring that turns with the reel. A cap that completes the slip-ring inclosure carries another ring that has three springs back of it for maintaining contact pressure between the two rings. A cable entering each cap through an asbestos-packed stuffing box connects the ring with the controller. The joint between the cap and the remainder of the housing consists of two cylindrical surfaces, one fitting closely within the other. The reel is built in sizes to accommodate 250 or 400 foot lengths of No. 4 parallel duplex cable as specified. The cable terminates in a fused trolley tap and rail clamp for connection to the mine circuits. An extension of approval, authorized as an alternate arrangement, is the use of a 250-ampere connection plug to enable operation of the loader from a permissible storage-battery power truck. For this purpose a 250-foot length of No. 3 parallel duplex cable is used.

An extension of approval was issued authorizing the use of a trolley pole as a support for the trolley tap when "tramming." This makes for safety in that it frees one hand for better control of the machine and at the same time eliminates a shock hazard and protects the eyes from flashes.

Headlight on Myers-Whaley loaders is of Westinghouse manufacture. It consists of a cylindrical boxlike cast-iron body, into which a cover holding a glass one-half inch thick is screwed. The glass is held between lead gaskets by means of a ring fastened to the back of the cover by six screws. A seal prevents unauthorized persons from removing the cover. The lead entrance for the 2-conductor cable to this headlight as used on these loaders is made by the Myers-Whaley Co. It is a special fitting screwed into a tapped hole in the side and sealed with plaster of Paris, but later it was replaced by an asbestos-packed stuffing box for the 2-conductor cable.

At first, all wiring on the approved loaders was carried in flexible metallic conduit, but an extension of approval authorized the use of rubber air-hose conduit and the stuffing-box type of lead entrance in place of insulated stud connections.

JOY MANUFACTURING CO. LOADING MACHINE, APPROVALS NO. 132 AND 132A

The Joy Manufacturing Co. type 5-BU loader is described as a "combined digging and loading machine." It is shown in Figure 21. In the operation of the 5-BU loader the inclined head or apron a is forced under the pile of loose coal and the two pick-pointed arms b dig into the coal, loosening it further and pulling it toward the center and onto the front conveyor. This conveyor delivers the coal into a hopper, whence it is taken by the second conveyor c for discharge into the mine cars. Oil-actuated pistons or jacks under both conveyors provide for raising or lowering them to suit conditions. The rear conveyor is swung horizontally by wire ropes attached to pistons in
cylinders at the side and near the upper end of the front conveyor. One of the cylinders is shown at \( d \).

The 5-BU loader is self-propelling, normally moving on two caterpillar treads during the loading of coal. When the mine track gage is 42 inches or more two axles are extended so that track wheels may be mounted on them. The machine can thus be made to move at a greater speed when some distance is to be traveled. For the narrower gages the calks on the treads are spaced to correspond to the track gage and thus act as wheel flanges to keep the treads on the track.

The over-all length of the Joy loader is about 25 feet and the height about 56 inches. It is claimed to have a capacity of 2 tons of coal a minute.

A single motor resting in the chassis under the upper end of the front conveyor drives the conveyors, tractors, gathering arms, and an oil pump through suitable gearing and clutches.

The movements and operation of the machine are controlled from the right side. A reversing controller, \( e \), with a rheostat in the back governs the speed of the motor. A headlight, \( f \), mounted above the controller is connected to the main circuit inside the latter. At the left of the
controller are the valves in the pipe lines to the several jacks that regulate the movement and position of the conveyors and the steering and clutch levers.

Forward and backward movement of the loader is controlled through two corresponding hydraulically operated clutches instead of by changing the direction of rotation of the motor armature. The reverse switch is not used in normal operation of the loader, and the motor is reversed only in an emergency, as when something catches in the conveyors. Then the usual procedure is to reverse the direction of the conveyor motion.

The machine receives energy through a trailing cable connected to two insulated studs in the right side of the controller. No cable reel is furnished with this loader; the cable must therefore be dragged when the machine is moved away from the point of connection to the power circuit and must be coiled by hand in some convenient place on one of the conveyors when the machine is moved in the opposite direction. In actual practice with a 2-man crew the one who sees that the loads are properly trimmed also takes care of the cable, keeping it out of the way of the loader and moving cars.

The 250-volt Joy type 5–BU loader was approved on December 29, 1926, and was assigned approval No. 132. A 500-volt machine with explosion-proof equipment was built later and was approved on March 22, 1927. It is identified by approval No. 132A.

PERMISSIBLE FEATURES

Motor.—The first motor used on Joy permissible loaders was the type CCM, size 35–K, built by the Crocker-Wheeler Electric Manufacturing Co. It had an intermittent rating of 35 hp. and a compound winding. The frame section at right angles to the shaft was approximately 22 inches square and the motor length was 28 inches. There was a circular opening at each end, over which an end shield with a single-row roller bearing was secured with four cap screws. Each shield had a lip which not only centered it properly but also served as part of a step flange. The armature shaft extended through each to take a pinion gear.

There were two rectangular vertical openings in the frame on opposite sides of the commutator. A ribbed, cast cover plate of bronze was used to close each of these openings. The joints between the plates and the frame consisted of plane machined surfaces held in contact by \( \frac{1}{8} \)-inch cap screws with wire through their heads to prevent loosening. The construction of these plates was intended to assist in dissipating heat developed in the motor.

For ordinary inspection of the commutator or adjustment of the brushes two 6%-inch circular openings were provided—one above the commutator and one at the side. Normally, the openings were closed with bronze screw covers secured with chains and padlocks to prevent removal by unauthorized persons.

Five asbestos-packed stuffing boxes, each having a single-conductor cable, served as lead entrances to the motor. These were put on a 45° slope on top of the frame at the commutator end. A special cast housing or conduit box bolted over these lead entrances was used for attaching an end of the conduit going to the controller.
The 35-K motor was later superseded by a 35-KT motor under authority of an extension of approval. This motor does not have the two ribbed plates at the side, but it has a third screw cover underneath the commutator. The chain and padlock for securing the cover were discarded in favor of wires and seals. Some alterations were also made in the bearings, notably the addition of drain holes and special parts to prevent the entrance of oil into the motor and at one end the substitution of a double-row for a single-row roller bearing.

**Controller.**—Two makes of controllers have been authorized for use on the Joy 5-BU loader. As originally approved the machine used a controller manufactured by the Ward-Leonard Electric Co. This controller has two main parts: (1) A boxlike casing that houses the controller proper and (2) a smaller casing that incloses the rheostat. The control mechanism consists of a reverse switch and the usual type of drum controller for inserting or “cutting out” resistance. It also includes a single-pole magnetic contactor and a magnetic time-limit overload relay. On top of the controller casing two small levers marked “Start” and “Stop,” respectively, are used to close and open the control circuit just as push buttons are now used on electrical-control apparatus. In starting the motor the start lever must be held to the left while the controller handle is moved through the various accelerating points. On the first point the magnetic contactor closes and will remain closed only so long as the start lever is held, until the full-speed position of the controller handle is reached. If the contactor opens for any reason, the controller must be returned to the first point before the former can be closed, as previously stated. The motor may be stopped in either of two ways: The controller handle may be moved back at least one point or the “Stop” lever may be pushed to the left. Either action will break the control circuit and cause the contactor to drop open.

The shaft of the controller drum extends through a plain bearing in the center of a circular plate which is held to the top of the controller casing by six cap screws with tie wire. This plate covers a circular bored opening large enough to permit the drum to be lifted out for examination or repair. A flat machined surface, together with a lip fitting snugly in the bore, makes a flame-tight joint.

The Ward-Leonard rheostat consists of a ribbon resistor tightly packed in quartz sand in the smaller inclosure bolted to the back of the main controller housing. The joint between the two inclosures is made up of flat machined surfaces, and the wall between the rheostat and controller compartments is an insulating panel that carries studs for making connection from the resistor element to the controller fingers.

The use of the Clark controller on the 5-BU loader was authorized by extension of approval issued on May 22, 1928. This controller has the same outside dimensions as the Ward-Leonard controller, but it is of the “full automatic” type and therefore differs from the latter in internal construction. There are start and stop levers and a reverse switch on top of this controller like those on the Ward-Leonard controller, but there is no controller handle. When the start lever is pressed to the left two magnetic contactors close; if the lever is held in this position two other contactors will close in timed sequence, thus giving 3-point acceleration. Alloy ribbons edge
wound on porcelain constitute the resistor elements, packed in sand as before. There is a time-limit overload relay in each of the two main lines of the incoming circuit.

On the Clark controller a screw cover is used in place of the circular plate over the controller drum. Both controllers have two screw covers for inspection openings in the left side of the casing. These are fastened with a chain and padlock or seals. Each controller also has an 18-inch-diameter opening in front, giving ready access to the interior. This opening is likewise closed by a screw cover during normal operation and may be locked either with a padlock or seal to prevent unauthorized tampering with the controllers.

The main lead entrances for these controllers are seven insulated studs in the right side of the casing. Two of these studs embedded in treated wooden blocks serve as the point of connection for the trailing cable. The other five studs similarly incased in wood are the means of connection between the motor and controller. The cables between the latter two compartments are incased in rubber air-hose conduit for mechanical protection. A piece of such conduit also protects the trailing cable where it passes along the chassis and for several feet beyond the bumper of the machine.

The Joy 5–BU loader uses a type F headlight manufactured by the Mancha Storage Battery Locomotive Co. This headlight has a cylindrical body closed at one end by a screw cover containing one asbestos-packed stuffing box, through which a 2-conductor cable passes. A plano-convex lens is held in a frame that screws on the other end of the body and completes the explosion-proof inclosure.

A sliding bar fitting into a notch in both the cover and lens frame, and held in position by padlock, locks all the parts at once.

The headlight circuit taps onto the main circuit in the controller and is protected by two 3-ampere fuses both for 250 and 500 volts. A 250-volt headlight, however, is used on the 500-volt machine; a resistor must therefore be used to limit the current to the lamp. The circuit is carried in hose conduit between the headlight and controller and enters the latter through an asbestos-packed stuffing box in the left side.

A 300-foot length of trailing cable is used with the Joy loader. No. 2 cable is used for 250 volts and No. 3 special parallel-duplex cable for 500 volts. A fused trolley tap containing a 200-ampere fuse is supplied with 250-volt machines for connecting to the feeder or trolley circuit. A 150-ampere fuse is used for 500-volt machines. A rail clamp is also supplied for connecting the negative conductor in the trailing cable to the rail.

SULLIVAN MACHINERY CO. COAL LOADER, APPROVALS NO. 135 AND 135A

The Sullivan Machinery Co. coal loader, Figure 22, uses a different method of attacking the coal from that of any machine already described. The procedure in loading is substantially as follows: Scoop a, containing a conveyor with flights b, is forced under the loose coal until caterpillar treads c, on which the machine is mounted, start to slip. During this process arm d, which terminates in long revolving bits, is in the raised position indicated. The coal that does not fall of its own weight is then brought into the scoop con-
veyor by lowering arm \( d \) while the bits are revolving counterclockwise. After the loose coal has been secured the loader is moved forward with arm \( d \) in the lowered position and the bits again revolving counterclockwise until a small amount of coal has been taken out at the bottom. The bits are then made to revolve in the opposite direction, and the standing coal is loosened by raising the arm to
its upper limit. The next step is to reverse the bits once more and bring the arm down to gather the loosened coal into the scoop.

Secondary conveyor e, which receives the coal from the scoop conveyor, is adjustable as to height, the range being about 4 feet at the discharge end. A hand crank is used when the conveyor is raised or lowered. The secondary conveyor is also pivoted and is swung by power to keep it over the mine car during loading periods.

The Sullivan coal loader weighs about 7 tons, and its over-all length is nearly 24 feet. It is designed to be used where the coal bed is 5 feet or more thick. The capacity of this machine is given as 300 tons per 8-hour shift. A traveling speed of 150 feet per minute is attained with the caterpillar treads.

This loader was approved by the Bureau of Mines on May 11, 1927. Approvals No. 135 and 135A cover the 250 and 500 volt machines, respectively.

PERMISSIBLE FEATURES

The electrical equipment on the Sullivan loader consists in part of a 30-hp. motor, controller, and rheostat. The two latter are inclosed in explosion-proof compartments in a gear box casting bolted to the motor, thus making one rigid power unit. There is also a double-pole, main-line switch and a fuse in a separate explosion-proof compartment.

A 250-foot length of trailing cable, terminating in a fused trolley tap and rail clamp, is supplied with this loader. The machine has no reel upon which to wind the cable.

It is understood that the loader is undergoing both electrical and mechanical changes. Therefore no detailed description of the explosion-proof features will be attempted here.

GOODMAN MANUFACTURING CO. ENTRYLOADER, APPROVALS NO. 138 AND 138A

Figure 23 shows a loading machine called the type 136-EC Entryloader by its builder, the Goodman Manufacturing Co. This machine differs from the others in the group in that the major portion containing the electrical parts remains at the entry while the room or panel is loaded out. A bottomless scoop or scraper, a, is operated to and from the face and point of discharge by means of three wire ropes. Head rope b, attached to the front of the scraper by chains, is used in pulling the scraper toward the loader. The second or tail rope is fastened to the rear of the scraper and returns it to the face. The third rope is so arranged that the scraper can be taken across the room or entry at an angle with the main path or drag way traveled in reaching the loading point. The Entryloader is therefore in effect a hoist for winding and unwinding these ropes on drums controlled through friction clutches by suitable operating levers on the machine.

The scraper has a capacity of three-fourths ton and can be moved from the face to the discharge point at the rate of about 300 feet per minute. The total capacity of the machine per shift therefore varies as the distance over which the scraper travels.
This machine is self-propelling and remains on its trucks at all times. The self-propelling feature, however, is not used in the loading of coal but is simply a means provided for minimizing the time and labor required in changing the set-up from one point to another. Scraper \( a \) is drawn up into the chute, chute extension \( c \) is placed in the chute, and extension arm \( d \), with the sheave for the head rope, is retracted when the machine is moved.

The electrical equipment necessary for rotating the drums and for moving the entire machine is a compact unit protected overhead by the steel plates forming the chute from which the scraper discharges the coal into the mine cars.

In the actual operation of the loader the man who controls movement of the ropes attached to the scraper usually depends upon signals given by the men at the face.

Only a short length of trailing cable is furnished with the Goodman permissible Entryloader, because the machine stands at the entry where a trolley wire or feeder circuit is close at hand to supply current; hence, a cable reel is not attached to this machine.

The type 136-EC Entryloader was approved by the Bureau of Mines on August 5, 1927. It is built for two voltages, 210 and 500 volts; the approval numbers are 138 and 138A, respectively.

**PERMISSIBLE FEATURES**

The electrical equipment on the Goodman permissible Entryloader consists of a controller, motor, rheostat, main switch, and fuse. The first three are joined side by side in one casting in the order named; the other two are separate units adjacent to the motor unit.

The motor is designated as type 23-F and has a 1-hour rating of 35 hp. and a compound field winding.
The magnet frame or motor shell has two major openings. One of these is over the commutator and has a flat, malleable-iron cover held by 10 cap screws with lock washers. The joint between the cover and the frame consists simply of two plane surfaces in contact. The other opening is also in the commutator end of the frame and is the one through which the armature is removed. The end plate for this opening is a ribbed-steel casting fastened to the frame with 16 cap screws with lock washers. The joint between the end plate and motor shell is made up principally of plane surfaces. Two short lips turned on the end plate fit into a bore in the end of the motor shell; as the end plate has one of the armature bearings the lips center the bearing with the motor shell. The two armature bearings are of the simple sleeve type in which a cast-brass bushing is employed for the bearing surface.

Three special drain valves are permanently fastened to the under side of the motor for draining accumulations of oil or water. Under normal atmospheric pressure the valves are held open by a spring and so enable excess water or oil to drain away. In the event of an explosion within the compartment, however, the sudden development of pressure closes the valves against the spring pressure and prevents the escape of flames. Each of the oil reservoirs under the bearings also has a drain valve.

There are no open passageways between the motor compartment and the two compartments immediately adjacent. The wall between the motor and rheostat has four fiber tubes 2½ inches long held in reamed holes by prick punching the metal around them at each end. Each tube has a single-conductor cable fitting closely in it for making connection with the rheostat. Similarly, the wall between the motor and controller has eight tubes for insulating eight single-conductor cables taken through the wall.

The rheostat for the 210-volt machine is made of cast-alloy grids, and that for 500-volt machines of a wire-alloy grid. A single opening as large as the entire side of the rheostat compartment gives ready access to the rheostat and connections inside. The compartment is closed by a flat, malleable-iron cover held by 14 cap screws with lock washers. Here again the joint between cover and casing is made up of flat machined surfaces. The rheostat compartment is provided with a drain valve.

The controller compartment is divided into two sections. The larger houses the main and reverse cylinders of the drum controller, while the smaller serves as a junction box where connections are made between the cables from the three compartments.

The bottom and top of the larger section are closed with malleable-iron covers. The top cover is held by 10 cap screws and the bottom cover by 9 cap screws and 1 stud. Lock washers secure all the fastenings. The joints between the covers and case are flat machined surfaces. The bottom cover has a drain plug welded permanently in place.

An opening between the two sections allows the cables to pass between. Opposite this opening is another that gives access to the cables from the outside. A rectangular cover plate held by six cap screws with lock washers is used to close the opening. The smaller
section is cast with one side open. A casing that houses the single main fuse closes this opening and is held in place by six cap screws with lock washers. Connections to the fuse are made by means of two insulated studs in the fuse casing wall that serves as a partition between the two compartments.

The main switch for the Entryloader is fastened to a bracket attached to the main frame of the machine and is under the fuse. A rod connected to the switch handle is arranged to interfere with the plug containing the fuse in such a way that the plug can not be removed under load, that is, while the switch handle is in the closed position. If the switch should be closed after the plug has been withdrawn the interlock mechanism prevents insertion of the plug in its normal position. Consequently the fuse plug can not be used as a switch—a service it was not designed to perform.

The fuse plug is made so that fuses may be removed quickly and easily. A 150-ampere fuse is specified for 210-volt machines and a 100-ampere fuse for 500-volt machines. The fuse compartment is a cylindrical chamber, one end of which is closed by a screw cover. The explosion-proof inclosure is completed by the cap or handle end of the fuse plug. This cap has a cylindrical surface that fits closely in a bore in the fuse chamber. A circular lip extends over approximately one-third of the circumference of the cap, and when the cap is inserted its full distance it can be turned on its axis. This action turns the lip into a groove and thus locks the fuse plug against expulsion in case gas should be ignited in the chamber.

The main switch is a 2-pole design with two quick-break blades for each pole. It is operated by means of a handle on a shaft extending through bushings in two opposite walls of the switch housing. The end of the shaft that does not carry the handle is fitted with the mechanism that actuates the interlock rod. The inclosure for the switch is a boxlike steel casing with a single flat, rectangular cover fastened with eight cap screws and lock washers. This cover has a flat machined surface in contact with the flat machined surface around the edge of the opening in the casing. These surfaces comprise the principal explosion-proof joint in this compartment. Each of the two pairs of clips for the switch blades terminates in a stud that passes through the rear wall of the switch casing. These studs, of course, are insulated from the casing. One of each pair is longer than the other, so that connection can be made with two insulated studs through the bottom of the junction-box portion of the controller compartment. Connection between the switch and the incoming line is made through two insulated studs in the upper side of the switch casing. A casting that fastens over the insulated studs is made to serve a twofold purpose: (1) As a guard against accidental contact with live terminals and (2) as a bell mouth and clamp for the trailing cable.

The trailing cable specified for the Goodman 210-volt Entryloader is an all-rubber, insulated, concentric cable with No. 3 conductors. The same type of cable is specified for the 500-volt machine, but the conductors are No. 4 size. The length originally specified was 75 feet but later was reduced to 40 feet. These cables are furnished with a fused trolley tap and a rail clamp for connecting the
loader to the power circuit. The capacity of the trolley tap fuse at first was 175 and 125 amperes for 210 and 500 volts, respectively, but later was reduced to 150 and 100 amperes, respectively, for the two voltages.

GOODMAN MANUFACTURING CO. TYPE 48–E POWER SHOVEL, APPROVAL NO. 150

The Goodman type 48–E electrohydraulic power shovel more closely resembles a miner in handling his shovel than any of the machines thus far considered. The common mechanical method of transferring coal from the point of collection to the mine car is to transport it by conveyors. With the Goodman power shovel, however, a large scoop picks up the coal, lifts it, swings it over the car, and empties it without intermediate handling.

The loader illustrated in Figure 27 is the type 148–E covered by a later approval, but in method of operation it is essentially the same as the type 48–E shovel. The chief difference in mechanical features between the two shovels is the use of a telescoping boom on the 148–E shovel, making it 5 feet shorter than the other. The projection of the boom to the rear of the 48–E machine is eliminated by the telescoping boom on the 148–E machine. On the latter the motor is larger, and the motor, controller, and rheostat and junction box are somewhat different in design from those on the 48–E shovel. Also, one less headlight is used than on the 48–E machine.

In the operation of the Goodman power shovel scoop a on boom b is lowered to the position illustrated and at the same time thrust forward until filled with coal. It is then raised and swung while being retracted or extended still farther, as may be necessary, to reach the car being filled. The coal is discharged from the scoop by an ejector plate which pushes the coal out. During these operations the loader is held securely in position by a vertical hydraulic jack, c, which is extended to the roof; the loading mechanism swings around this jack as a pivot.

A seat, d, is provided for the operator with levers e conveniently placed for controlling all loading movements. When the loader is to be moved to another place jack c is lowered, and the machine is propelled on its caterpillar treads f. Two levers at the rear of the machine control the direction of travel, and the forward or reverse travel is governed by the direction of armature rotation in the motor. The maximum traveling speed is 1.7 miles an hour.

The propelling and swinging movements of this loader are accomplished through mechanical gearing, but the movements of the scoop are all controlled by hydraulic means. Pressure is maintained by a triplex water pump kept running continuously by a 15-hp. electric motor.

The 48–E power shovel is equipped with four headlights—one large (type R) and three small ones (type S)—all of which are mounted to swing with the shovel. The large headlight gives general illumination of the area in front of the shovel. Two of the small headlights are arranged so that they tilt up and down with the scoop, keeping it illuminated as it is raised or lowered. The fourth headlight or pilot lamp is mounted so that it throws its light back of the shovel.
A height of about 6 feet is required for satisfactory operation of this loader. The over-all length is 17 feet and the width 67 inches. The scoop holds one-half ton of coal.

A trailing cable, by which the loader obtains current for its electrical equipment, enters the back of the machine at the right side. No reel is supplied for winding up the cable.

Approval of the 48-E power shovel with 250-volt explosion-proof electrical equipment was issued by the Bureau of Mines to the Goodman Manufacturing Co. on May 11, 1928. Approval No. 150 was assigned to designate the permissible loader.

PERMISSIBLE FEATURES

The electrical equipment of the Goodman type 48-E power shovel consists of a motor, controller, rheostat, junction box, switch-and-fuse, and the four headlights previously mentioned.

Motor.—A type 55-F series-wound, direct-current motor drives the pump for the hydraulically controlled movements and also furnishes the power for the movements controlled through gears and clutches. The motor shell or frame is oblong in the section at right angles to the armature shaft. Numerous ribs add considerable radiating surface to the outside of the shell. This shell is cast with both ends open; an "end plate" carries a ball bearing for each end of the armature shaft. Each plate has two circular arcs machined to fit corresponding curved surfaces in the shell. In this way the plates are fixed in position, and the armature is centered accurately. The explosion-proof joint between each of the plates and the shell consists of flat machined surfaces held in contact by 12 studs with nuts and lock washers.

The commutator-end plate has the brush rigging fastened to it. An oblong opening in the top of the motor shell permits access to the brushes and inspection of the commutator. An oblong opening in the lower edge of the commutator-end plate permits connection to be made inside the motor to cables entering it from adjacent compartments. A 1/4-inch steel plate covers each opening. The cover over the commutator is the larger of the two and is held by eight studs with nuts and lock washers. The other cover has six studs to hold it.

Four wires enter the bottom of the motor shell through a 1 1/2-inch hole. The motor rests upon a combination rheostat and junction-box compartment, whose top has a machined surface in contact with the machined surface on the under side of the motor shell. The lead entrance hole in the motor shell coincides with one in the junction box. The latter hole, however, has a treated maple bushing or plug with four holes for the cables, which fit snugly in their respective holes.

Rheostat junction-box unit.—As previously stated, a junction or connection box and the rheostat compartment are combined in one irregularly shaped casing with a dividing wall between. Each section has one main opening provided with a rectangular flat cover held by six cap screws with lock washers. The cables from the several compartments on the machine pass through the junction box, where splices and turns are made. A wooden plug with five holes is fastened in the wall between the rheostat and junction box and serves as a passageway for the cables between the two compartments. Nine conductors extend from the junction box to the controller in a 1 1/2-inch rigid-
iron conduit whose inner surface is enameled. This conduit terminates in a fitting that is bolted over a hole in the side of the junction-box case. There is no plug in this hole. The length of the conduit and the space occupied by the cables are such that flame will not propagate through should an explosion occur in the junction box. Similarly, four cables are taken through a 1-inch iron conduit between the junction box and the switch-and-fuse compartment. Two of these supply current to three of the headlights. The headlight circuit passes through the wall of the junction box in the form of two insulated studs. A rubber-hose conduit carries the headlight leads from the junction box to the large headlight, and from this point a branch circuit, also in hose conduit, carries the current to the two headlights over the scoop.

The rheostat for the Goodman 48-E power shovel is made up of six resistance tubes compactly assembled and is designed for starting duty only. Later an extension of the approval authorized eight.

Switch-and-fuse compartment.—The switch-and-fuse compartment for this loader is essentially the same as that described in connection with the pit-car loader made by the Chicago Automatic Conveyor Co. (See p. 36.) One difference is that there are three fuses for the power shovel instead of one—one 75-ampere fuse in the positive line protecting the main circuit of the machine and two 10-ampere fuses protecting both sides of the headlight circuit. Another difference is that there are two insulated studs in the wall of the fuse compartment for connection of the circuit to the pilot lamp. Furthermore, four cables from the junction box enter the fuse compartment through a special fitting for the 1-inch conduit between the two compartments instead of one cable entering through a stuffing box, as on the pit-car loader.

Controller.—The controller used on the 48-E power shovel is designated as 50-K and is a reversing type. The explosion-proof enclosure for the main and reverse drums consists in the main of a cast-steel case with a steel plate for a cover. The latter is secured to the case by means of 12 cap screws, two of which screw into bottomed holes in the case. The remaining 10 extend through both the cover and the external flange of the case and are secured by nuts with lock washers.

A bushing pressed into a hole through one end of the case serves as a bearing for the shaft of the main drum. The opening in the bushing does not extend through it. The corresponding bearing for the shaft of the reverse drum is wholly within the case, as this shaft is somewhat shorter than the first. The bearings for the handle ends of the shafts are both in brass bushings. The openings in the case to admit these bushing are large enough to allow the respective drums to be inserted or withdrawn through the openings. The reverse-drum bushing is held to the case by two flat-head machine screws, and the main drum bushing is held by three flat-head screws. The heads of these screws are prickpunched in the bushings to prevent their loosening. The flame-tight joint between each bushing and the case is made up of cylindrical surfaces parallel to the shaft axis and flat surfaces at right angles to the axis.

Nine cables enter the 50-K controller from the junction box through a neck formed in the back of the case. This neck is threaded
externally to take a special cylindrical nut that serves the double purpose of holding the conduit between the two compartments and forming an explosion-proof joint.

**Type R headlight.**—The type R headlight is roughly hemispherical. It has a double-spring mounting to offset the effects of vibrations of the loader upon the filament of the 50-watt lamp and to diminish the chances of damage to the headlight from blows.

The lens for the headlight is a circular piece of glass three-fourths inch thick and is held between two lead gaskets in a circular frame or cover by a ring that screws into the rim of the cover. One circular bar with six radial bars cast as part of the cover protects the lens against breakage by flying objects. The explosion-proof joint between the case of the headlight and the cover is made by a cylindrical surface of the latter fitting closely in the bored front opening in the former and flat surfaces at right angles to the cylindrical surfaces. Six cap screws with lock washers hold the lens frame to the headlight case.

Two insulated studs in the back of the case make electrical connection between the interior and exterior of the headlight. A conduit box cast integral with the case guards the external live terminals of the studs and provides two points of connection for rubber-hose conduits—one for the supply circuit and the other for the circuit to the two type S headlights. A 1/8-inch rectangular steel plate held by four small screws permits ready access to the terminals and connections in the conduit box.

**Type S headlights.**—The type S headlights are slightly smaller than the type R and there are a number of constructional differences between the two types. A section through the type S headlight parallel to the front is oblong, with the longer side horizontal. The back surface is cylindrical and takes a polished sheet-aluminum reflector. The front of the type S headlight is circular, the largest diameter being about equal to the long side of the case.

The lens frame is threaded to screw into the case and is locked in place by means of a padlock through a drilled lug on the frame which matches with one on the case. The lens is a circular piece of 3/8-inch glass held in the lens frame by a clamping ring. There is a lead gasket on either side of the glass. The gaskets, lens, and clamping ring are inserted from the outside rather than from the inside, as on the type R headlight. To prevent the ring from loosening, a headless set screw is inserted radially through the frame and into the ring.

The lead entrance to this headlight is much the same as that previously described, in that two insulated studs and a conduit box in the back of the case are used. Two screws instead of four hold the plate that closes the opening into the conduit box.

Right and left models of the type S headlight are mounted behind the scoop. The two models differ in that the conduit box and lamp socket are at the one side of the case in the former, whereas in the latter model they are at the other side of the case. Both models have two places for attaching the conduit fittings that hold the hose conduit to the conduit box. A plate is fastened to the conduit box in place of one of the conduit fittings when only one hose is attached to
the headlight. Both models also have a spring suspension like that employed with the type R headlight.

Trailing cable and accessories.—A No. 4 concentric cable connects the Goodman 48–E power shovel with the power supply. The approval of this machine covers optional use of the product of any one of four cable manufacturers. A fused trolley tap is furnished with the trailing cable. The loader has no cable reel on which to wind or pay out the cable when traveling from place to place. Swinging of the machine during loading necessitates a certain amount of dragging of the cable, because the place where the cable enters the switch also swings with the machine.

BETHLEHEM STEEL CO. FACE LOADER, APPROVAL NO. 155

Two types of loading machines built by the Bethlehem Steel Co. have been approved by the United States Bureau of Mines. The first of these, termed a "face loader," is a low-type self-propelled machine that normally travels on caterpillar tractor treads. (See fig. 24.) It is so designed that wheels may be readily attached for moving it on the mine tracks.

The loading mechanism comprises two main sections—a gathering or digging arm, a, and a discharge or delivery section, b. The former is raised and lowered by a hydraulic jack, c. It is also swung around vertical axis x–y by hydraulic means, the maximum angle being 120°. Rooms 20 feet wide can therefore be loaded out with this machine. The discharge section is raised and lowered by hydraulic jack d; this section does not swing. An endless chain, on which are secured flights e, runs the entire length of the machine and is the means for transporting the coal from one end to the other. The chain is reversible, according to the direction in which the digging arm is moving; that is, when the arm swings from right to left the chain on the left side of the loader moves toward the discharge end, and on the return swing of the arm the chain on the right side moves toward the discharge end. In the actual loading of coal, therefore, the loader is advanced toward the face after each sweep of the arm across the room or entry until all loose coal has been removed.

As yet the Bureau of Mines has no data as to the capacity, speed of travel, and weight of the Bethlehem face loader.

A single motor rated at 25 hp. for intermittent duty delivers all the mechanical power required to operate this loader. The tractor treads and the loading chain are connected to the motor by clutches. The tractor drive permits two traveling speeds, forward and reverse.

Current for the motor is received through a trailing cable, a fused trolley tap and rail clamp being used to make the connection between the cable and the feeder or trolley circuit. No mechanical arrangement is provided for reeling and unreeling the cable.

In lieu of headlights four Super-Wheat permissible storage-battery hand lamps fastened in steel boxes to the digging arm and the delivery boom furnish light at the face and for the car being loaded.

This loader with 250-volt direct-current equipment was approved by the Bureau of Mines on August 2, 1928. Approval No. 155 identifies this machine in the bureau’s records.
PERMISSIBLE FEATURES

The electrical parts considered by the bureau in connection with the investigation of the Bethlehem face loader were the motor, the combination controller-rheostat unit, and a fused switch.

Motor.—The motor on this loader is known as size 12KL, type SM series wound, and is built by the Crocker-Wheeler Electric Manufacturing Co. The magnet frame of this motor is a box-shaped
steel casting approximately 24 inches long, 13 inches high, and 19½ inches wide in outside dimensions. A circular opening bored in each end allows removal of the armature from either end. The front shield, which closes the opening at the commutator end of the motor frame, houses a roller bearing for the shaft and also carries the brush rigging. The rear shield, which closes the other end of the frame, also includes a roller bearing. Both shields are held to the frame by four cap screws with lock washers, and both make the same kind of joint with the frame. A lip turned on the shield fits the bored opening in the frame, and a flat surface at right angles to the axis of the armature seats against a corresponding flat surface on the end of the frame. Both ends of the armature shaft extend beyond the bearing to take a pinion.

The commutator end of the motor frame has four inspection openings; one is in each side of the frame and the other two are underneath the commutator. A screw cover fits into each opening, and a lock wire with a meter seal is employed to prevent unauthorized removal of these covers.

A single 4-conductor cable, which enters the top of the motor through an asbestos-packed stuffing box, is the means for making electrical connection with the motor.

Controller-rheostat unit.—The controller and rheostat for the Bethlehem face loader are mounted end to end in a long, narrow, steel casing lined with sheet asbestos. The casing is cast with an opening that extends its full length and width, through which the parts are assembled and mounted. The shallow cover for this opening is a cast frame over which a steel plate has been welded. It is fastened to the casing by 46 studs with nuts and lock washers, bringing flat machined surfaces together to form a flame-tight joint. One end of the casing is also cast open. The inclosure is completed at this point by a casting held by 10 studs with nuts and lock washers. The one controller shaft passes through a brass bushing pressed into the cover, and an asbestos-packed stuffing box is fastened in each of two other openings in the cover—one for a 2-conductor incoming cable from the switch and the other for the 4-conductor cable to the motor.

The rheostat is composed of a flat ribbon resistor wound on porcelain forms. The controller has no reverse drum. The main drum is so designed that one side of a neutral point corresponds to one direction of armature rotation, while the other side gives reversal of the armature.

Fused switch.—The main switch, also used on the second loader (see d, fig. 25), which controls the current from the power circuit, is an interlocking type; that is, the circuit must be opened before the two 100-ampere cartridge fuses are accessible for renewal. In this particular design the cover is interlocked with the switch as follows:

A screw cover, which must be removed to reach the fuses, has a bearing in its center through which the switch-operating rod slides in and out. When the switch is closed a square shoulder on switch handle f fits into a notch in the outer end of the bearing hub, thereby locking the screw cover and preventing its being turned on its threads. After the switch-operating rod has been pulled out to open the switch a locking screw, g, must be fully loosened with the
fingers by its knurled head before the cover can be unscrewed. This screw not only locks the cover to the case so that the notch comes in the proper position relative to the switch handle but also performs the important function of interfering in such a way that the switch can not be closed while the screw is out. At the same time, the switch must be opened before the cover can be loosened because the switch handle must be pulled out to give clearance for backing out the screw. The screw cover is not removed from the handle, but when it is freed from the case both it and the rod drop down to a position that permits the fuses to be reached.

The switch itself is a double-pole, single-throw, knife-blade type. A spring connection between it and the handle gives the quick-break feature. The switch clips are inclosed in a transite arc chamber.

The explosion-proof casing for the switch and fuses is a cast-steel box 16 inches long and almost square in cross section, the height and width being approximately 8 inches. The opening for the screw cover is in one end of the box. An opening in the top of the box, through which assembly and repairs to the internal mechanism are made, is closed by a rectangular steel-plate cover held by 14 studs with nuts and lock washers. The joint between the cover and box is made up of flat machined surfaces in contact.

There are two asbestos-packed stuffing-box lead entrances to the switch box. One admits the trailing cable, and the other admits a No. 4 concentric cable for connection to the controller-rheostat unit. The trailing cable is a No. 4 concentric all-rubber insulated cable. The trolley tap has a 150-ampere fuse.

Bethlehem Steel Co. Car Filler, Approval No. 156

The second of the Bethlehem Steel Co. loading machines to be approved by the Bureau of Mines is called a “car filler.” A part of this machine, which combines the functions of a shaker conveyor and a mine-car loader, is shown in Figure 25. It drives a conveyor made up of 2-wheeled shaker-trough sections which can be extended to 250 feet in length. It also drives a chain conveyor, \( a \), which transfers the coal from the shaker conveyor into the car.

The operating and control mechanisms are mounted on a 4-wheel self-propelling truck for movement along the mine tracks. The single 22-hp. motor \( b \) furnishes power for all mechanical operations of this machine and also drives a pump for developing the pressure required by the several hydraulically actuated movements, such as elevation of the discharge conveyor. Controller-rheostat unit \( c \) and fused switch \( d \) complete the electrical equipment. One of four Super-Wheat permissible electric hand lamps mounted similarly to those on the Bethlehem face loader is seen at \( e \) resting on its holder.

Trailing cable \( h \) supplied with the machine is 300 feet long and is the concentric, all-rubber insulated type. No. 4 conductors are used. A rail clamp and a trolley tap containing a 150-ampere fuse are furnished with the trailing cable for connecting it to the circuit from which current is to be drawn.

Approval No. 156, covering the 250-volt car filler, was issued to the Bethlehem Steel Co. on August 2, 1928.
PERMISSIBLE FEATURES

It is reported that the Bethlehem car filler is no longer being built; therefore only a brief general description of the parts is given.

**Motor.**—The motor on this loader is built by the Crocker-Wheeler Co. It is compound wound, with an intermittent rating of 22 hp. and is designated as type CCM, size 12KL. The explosion-proof construction of this motor is virtually the same as that of the motor described in connection with the face loader, except that the armature shaft does not extend through the shield at the commutator end.

**Controller-rheostat unit.**—The casing for the controller and rheostat is in two parts and is lined with sheet asbestos. A ribbon-type resistor is in the lower part, and the controller is mounted in the upper part. The electrical connections with this unit are made through three asbestos-packed stuffing boxes. The two parts of the casing have flat machined surfaces held in contact by 32 bolts.

**Fused switch.**—The same design of fused switch is used on both of the Bethlehem loaders. For a description of this switch the reader is referred to page 68.

**OLDROYD MACHINE CO. TYPE L-2 LOADING MACHINE, APPROVAL NO. 182**

The Oldroyd Machine Co. type L-2 loading machine is unlike the usual design in which one motor supplies all the power required for the various movements of a loader in that it has 13 motors, no one of which takes care of more than one movement. Therefore, investigation of the Oldroyd Machine Co. type L-2 loader for permissibility was the most extensive of the kind ever undertaken by the Bureau of Mines because it involved consideration of 40 explosion-proof compartments with intricate wiring between.

The Oldroyd type L-2 permissible loader shown in Figure 26 has three main conveyor sections: (1) A front boom or section, a, including a "dipper" that picks up the coal and moves it onto the front conveyor immediately behind it; (2) an intermediate or transfer section, b, that receives the coal from the first section; and (3) a rear section or boom, c, that takes the coal from the intermediate section and discharges it into the mine car to be filled. Two 4-wheel articulated trucks under the intermediate section support the weight of the entire machine and through the two 7½-hp. motors on each truck furnish the traction required both in attacking the coal and in moving from place to place.

Two men are required to operate the machine. One stands on a narrow platform or running board, d, and controls the major movements of the machine. The second man walks alongside the machine within easy reach of the three switches e and among other things sees that the cars are properly loaded. One switch governs the raising and lowering of the rear conveyor, another controls the swing of this conveyor, and the third switch stops and starts all three conveyors simultaneously while an empty car is brought to replace the loaded one. The second man also keeps the rear conveyor and the trailing cable clear of obstructions when the loader is traveling.

The dipper on the front section consists of a cylinder with two rows of bits or teeth spaced 180° apart. When the dipper is ad-
vanced into loose coal the bits on the revolving cylinder push the coal upward and over from underneath. A hinged apron over the cylinder raises and drops as each row of bits approaches. The raising motion of the apron throws the coal on it toward the conveyor. The cylinder is revolved by two chains, $f$, with toothlike projections that assist in clearing a path for the dipper as it advances. A 20-hp. motor, $g$, on each side drives the chains. Two large screws, $h$, driven by a 7½-hp. motor raise and lower the dipper, and another 7½-hp. motor swings the front section. The combined lifting and propelling motions of this loader and the action of the dipper exert a force powerful enough to dislodge large lumps of coal from a standing shot. The dipper swings on either side of the machine and can clean up a room or entry 24 feet wide when the tracks are placed in the center.

The Oldroyd L-2 permissible loader weighs approximately 30 tons and its over-all length is 57 feet, but in spite of its great weight and length it possesses a high degree of flexibility and speed of movement. It can travel 2 to 6 miles an hour and can easily turn on sharp curves. The loader can fill a 5-ton mine car in 30 to 50 seconds, and the company claims an output of 500 tons per 8-hour shift in 6-foot coal.

This loader has four head-lights. One is underneath the rear conveyor near the intermediate conveyor and lights the track and the car being loaded. A second headlight is similarly placed underneath the front conveyor and lights the track when the dipper is
raised for traveling. The two other headlights, one of which is shown at \( i \), are placed on the sides of the front conveyor just back of the dipper motors. These light up the dipper and the coal that is being removed.

Overtravel in the swing and propelling movements of the Oldroyd loader is checked or retarded by means of six magnetic brakes. Four of these also hold the loader in position against the reaction to the thrust of the dipper. The magnet coils are connected in the various circuits so that the brakes are applied by a spring when the controllers are in the “off” position, that is, when no current is flowing through the motor armatures. The brakes are released magnetically when current flows through the motor armatures. Each of the four propelling motors and each swing motor on the front and rear conveyor sections is equipped with a brake.

Current for operating this loader is received through a trailing cable, for which a hand-operated cable reel is provided.

Approval No. 182 covering the 250-volt machine was issued to the Oldroyd Machine Co. on December 9, 1929.

PERMISSIBLE FEATURES

The electrical equipment used on the Oldroyd type L–2 permissible loader may be summarized as follows:

**Front-section equipment:**
- 2 Westinghouse type 63–SK motors for driving the dipper, each having a \( \frac{3}{4} \)-hour rating of 20 hp.
- 1 Westinghouse type 33–SK motor for raising or lowering the conveyor, having a \( \frac{3}{4} \)-hour rating of 71/2 hp.
- 1 Westinghouse type 33–SK motor for swinging the conveyor, having a \( \frac{3}{4} \)-hour rating of 71/2 hp.
- 1 Westinghouse type 33–SK motor for driving the conveyor, having a \( \frac{3}{4} \)-hour rating of 71/2 hp.
- 1 Oldroyd magnetic brake for the swing motor.
- 3 Westinghouse type S headlights.

**Intermediate-section equipment:**
- 1 Westinghouse type 33–SK motor for driving the conveyor, having a \( \frac{3}{4} \)-hour rating of 71/2 hp.
- 4 Westinghouse type 33–SK motors for propelling the loader, each having a \( \frac{3}{4} \)-hour rating of 71/2 hp.
- 4 Oldroyd magnetic brakes for the propelling motors.
- 3 Westinghouse drum controllers.
- 5 Westinghouse contactor and “protective-panel” compartments.
- 4 Westinghouse rheostat compartments.
- 1 Westinghouse modified type TC–122A switch.

**Rear-section equipment:**
- 3 Westinghouse modified type TC–122A switches.
- 1 Westinghouse type S headlight.
- 1 Westinghouse type RH motor for raising or lowering the conveyor, having a continuous rating of 2 hp.
- 1 Westinghouse type 33–SK motor for swinging the conveyor, having a \( \frac{3}{4} \)-hour rating of 71/2 hp.
- 1 Westinghouse type 33–SK motor for driving the conveyor, having a \( \frac{3}{4} \)-hour rating of 71/2 hp.
- 1 Oldroyd magnetic brake for the swing motor.
- 1 Oldroyd cable reel equipped with No. 2 or No. 0 concentric, all-rubber insulated trailing cable.
- 1 trolley tap containing a 200-ampere 250-volt fuse.
- 1 rail hook.
Motors.—The 13 motors used on this loader have a total rating of 117 hp. They may be divided into three groups for consideration according to type: 2 type 63-SK, 10 type 33-SK, and 1 type RH.

Type 63-SK motor.—The two type 63-SK motors are compound wound, and each has two interpoles. Except for variations necessary to make the lead entrances come in the correct position when mounting the motors on the right and left sides of the front conveyor, there are no other differences in construction of the two motors.

The motor frame is a cylinder of rolled-steel plate bored out to take the pole pieces and finished at the ends for the joints with the bearing brackets. The front bearing bracket is a bowl-like iron casting which fits over the commutator. A lip turned on its rim fits snugly in the bore of the frame, while a shoulder on the rim is pressed against the end of the frame by eight tap bolts; a right-angle joint is thus formed. The brush rigging is supported from the front bracket. Four equally spaced circular holes whose axes are perpendicular to the armature-shaft axis permit inspection of the commutator and adjustment or renewal of brushes through the bracket. A screw cover fits into each of the inspection openings, and the four covers are sealed in place so that only authorized persons may remove them. The wires to the motor also enter through the front bracket. For this purpose there are two asbestos-packed stuffing boxes.

The rear bearing bracket, a shallow semisteel casting, fits the frame and is held in the same manner as the front bracket. Four bolts holding the gear case to the end of the motor probably add to the security of the rear bracket.

Type 33-SK motor.—In general construction the type 33-SK motor closely resembles the 63-SK motor, although it is slightly smaller. The type of joint between the bearing brackets and the frame, the type of frame, and the number, size, and position of inspection openings are alike in both the type 63-SK and the 33-SK motors. The 33-SK motor also has the same number of tap bolts as the 63-SK for holding the bearing brackets to the frame.

There are five modifications in the 33-SK motor as applied to the Oldroyd loader, which vary according to the duty and place of mounting the motor; that is, changes in the number and position of lead entrances and extensions on castings for fastening the motor in place were made to obtain the most satisfactory arrangement of wiring and mechanical details. However, so far as actual explosion-proof construction is concerned there is little difference in the motors.

Seven of the type 33-SK motors have series windings; of these, four are propelling motors, one is used to raise and lower the front conveyor, and one is used on each of the front and rear sections for swinging the section. All have a single asbestos-packed stuffing-box lead entrance in the rear bracket for a 4-conductor cable. The three remaining type 33-SK motors have a compound winding. Each of these drives one of the conveyors, and each has two asbestos-packed stuffing boxes for lead entrances. All of the 33-SK motors have single-row ball bearings.

Type RH motor.—As previously stated, the type RH motor raises and lowers the rear conveyor to suit the height of car being loaded. It is a roller-bearing motor with a series winding.
The motor frame is also a cylinder of rolled-steel plate. Like the other motors already described, it has cast bearing brackets that make step joints with the frame. Because of its relatively small diameter the RH motor requires only four tap bolts with lock washers to hold the brackets to the frame. The brush rigging for this motor is secured to the inside of the front bearing bracket, which has two instead of four inspection openings with sealed screw covers. The inspection openings are diametrically opposite each other on a horizontal axis. A single asbestos-packed stuffing box underneath one of the inspection openings permits electrical connections between the motor and its controller.

Control equipment.—The control equipment for the 13 motors on the Oldroyd L-2 loading machine comprises 3 reversing drum controllers, 2 controller and 3 protective panel compartments, 4 master switches, and 4 rheostats.

The three drum controllers, j, k, and l, with their handles on top, are on the operator’s side of the machine; in order they are the dipper controller, the front-boom controller, and the propelling controller. The dipper controller has two drums; one controls the two dipper motors and has four points in each direction. The other is for reversing all three conveyors and is not used in the normal loading operations of the machine. The front-boom controller has two 4-point reversing drums; the left drum controls raising and lowering of the dipper and its conveyor, and the other operates the motor that swings the front conveyor right or left as required. The propelling controller has two 4-point drums geared together and operated by a single handle. These control the four motors that move the entire loader along the track. This controller also includes a drum switch that permits connecting the sets of motors on the two trucks in series or parallel with each other.

On their last points both the dipper and propelling controllers actuate magnetic contactors placed in explosion-proof inclosures so that the heavy currents are not broken by the drums. Each of the three controllers has a push button connected in the circuits with the contactor magnet coils. Should a drum become stuck in a running position the corresponding push button can be used to open the contactors.

Electrical apparatus for the protection of most of the various circuits is arranged on three panels, and the assemblies are termed “protective panels.” The circuits are separated in such a way that the failure of one does not cause the remaining operations of the machine to cease. Thus failure of the dipper motors would not stop the conveyors, or failure of the conveyor motors would not stop the propelling motors.

The protective panel for the dipper has two contactors—one for each of the two sides of the branch circuit feeding the dipper motors. It includes three overload relays for protection of the two dipper motors and the front conveyor motor. Each side of the circuit to the contactor magnet coils is protected by a 10-ampere fuse. In addition, a no-voltage relay protects the motors by opening the contactors if the potential on the line feeding the loader should drop below a predetermined value.
Similarly, the protective panel for the front and rear booms has two contactors that open and close the circuit feeding the raise and swing motors on both the front and rear booms. Each of the raise and swing motors on the front and rear booms has an overload relay for protection of these motors. The magnet-coil circuit for the two contactors has a 10-ampere fuse in each side, and a no-voltage relay is included in the apparatus.

The third protective panel, known as the “propelling protective panel,” has a set of two contactors which control the branch circuit for the four propelling motors. Here again, the magnet-coil circuit is protected by two 10-ampere fuses. There is also a separate overload relay for the positive line to each of the four motors. A no-voltage relay is included in the equipment.

The boom and propelling protective panels are mounted in boxes m and n under the controllers on the operator’s side of the machine.

Eleven of the thirteen motors are controlled by the three controllers. The other two are controlled by the second member of the crew through master switches, one of which governs raising and lowering of the rear boom while the second governs swinging of this boom. The third switch enables the helper of the crew to stop and start the conveyors at will as cars are loaded, removed, and replaced by empty ones.

The automatic control equipment operated by the first two switches just mentioned consists of two panels, each in a separate explosion-proof compartment. A “conveyor controller panel” gives one step of resistance in starting the three conveyor motors. The master switch closes two main contactors on this panel, thus completing the branch circuit feeding the three conveyor motors. A third contactor automatically cuts out the starting resistance at the proper time. The conveyor controller panel also includes an overload relay for each of the motors driving the center and rear conveyors. As already stated, the overload relay for the front conveyor is mounted on the dipper protective panel. Two 10-ampere control fuses and a no-voltage relay complete the equipment on the conveyor panel.

The other panel is known as the rear-boom controller panel. The apparatus on this panel includes two sets of two contactors, which control the right and left swinging of the rear conveyor with one step of starting resistance. Two other sets of contactors on this panel control the raising and lowering of the rear conveyor.

The four rheostat boxes, one of which is shown at o, Figure 26, contain resistors made up of edge-wound ribbon resistance alloy on porcelain or composition tubes. Rheostat box 1 contains two separate rheostats, one for the dipper motors and one for the swing motor on the front conveyor. Box 2 also contains two rheostats—one for the raise motor of the front conveyor and the other for the three motors operating the conveyors. Boxes 3 and 4 each have a single rheostat for armature resistance in the circuit for the propelling motors.

The remaining piece of control equipment is the fourth master switch near the right side of the propelling controller. If the no-voltage release or the overload relay should operate for either of the raise and swing motors on either the front and rear conveyors the
circuits to these motors can not be reestablished except by use of this reset master switch. If these motors are stopped by the emergency push button the master switch must be used to start them again.

Construction of controller inclosures.—The three reversing drum controllers are not alike in explosion-proof construction, although the differences in their casings are slight. For example, the dipper controller has nine asbestos-packed stuffing boxes for the multiple-conductor cables entering it, while the propelling controller has eight and the front boom controller has six. All of these lead entrances are at the back of the controller casings. The main part of the controller inclosure is an internally ribbed semisteel, box-shaped casting, the front of which is approximately square. The depth of this box is about equal to half the length of a side of the square. A circular opening in front, 18 inches in diameter, permits access for inspection, adjustment, or repairs to the internal mechanism. The cover for the opening is a dished aluminum-alloy casting, heavily ribbed internally and externally for stiffness. Because of the special construction of the cover only four 1-inch studs with nuts and lock washers are necessary to fasten it to the case. First, the stiffening ribs along the straight line between the holes for the studs tend to prevent bending of the cover under pressure of an internal explosion.

In addition, a double tongue-and-groove joint between the cover and case insures retention of flames within the case should the gas within become ignited. This joint consists of a circular tongue three-eighths inch wide on the cover fitting a groove in the case, while a 3/8-inch tongue on the case fits into a groove next to the inner circumference of the tongue on the cover. Next to the groove in the cover is a lip extending three-eighths inch into the case, which has a ledge at the end of the lip. A flat machined surface between the tongue and the outer edge of the cover rests on a machined surface on the case. This rather complicated joint provides six changes in direction for any flame that attempts to escape.

In the top of each of the three controller cases are two circular openings 4 3/4 inches in diameter. A plate with a circular lip fits closely in each opening. Pressed into the plates for the propelling controller is a brass or bronze bushing through which the controller drum shafts pass. The plates for the other two controllers have reamed holes for the shafts.

Construction of inclosures for protective and controller panels.—As previously stated, there are five compartments or inclosures for the protective and controller panels. Two semisteel castings, a box and a cover, comprise the casing for each of these panels. The over-all outside dimensions of the box casting are as follows: Length, 29 1/2 inches; width, 15 3/4 inches; depth, 10 7/16 inches. Ribs are cast externally on the back of the box and also half-way up the side walls. For the remaining distance along the side walls the ribs are internal. This construction brings the side walls closer together at the back of the box than those near the opening. The cover casting is flat on the side bolted to the box but is ribbed on the other side for stiffening. The joint between the box and cover consists of flat machined surfaces held together by sixteen 3/4-inch tap bolts with lock washers.
The cables for making connection with the panels pass through asbestos-packed stuffing boxes in the walls of the box. The number, size, and position of the stuffing boxes vary on the different boxes both on account of their position on the loader and because of the different apparatus they contain.

**Construction of rheostat inclosures.**—The four inclosures for the six rheostats used on the Oldroyd loader are of substantial construction and consist of shallow semisteel boxes ribbed internally at the back, with semisteel covers ribbed inside and out. The cover is held to the box by sixteen ¾-inch tap bolts with lock washers to prevent loosening. The joint between the cover and box is made up of plane machined surfaces in contact with each other.

Aside from the variations in the make-up of the rheostats themselves the only other differences in the inclosures are in the arrangement of lead entrances. Asbestos-packed stuffing boxes in the back of the boxes admit the cables that connect to the rheostats. Thus there are four different combinations, according to the number and position of stuffing boxes employed.

**Construction of TC-122A master-switch inclosures.**—The four master switches are inclosed in circular semisteel cast boxes with an outwardly dished circular cover of bronze or brass. The opening in the box is equal in diameter to the inside of the box and is threaded part way to take the cover, which screws into place until the protruding rim seats against the edge of the opening, making a flame-tight joint. A meter seal with its wire threaded through small holes in extensions on the box and the cover is the means provided for preventing unauthorized opening of the switch inclosure.

A ½-inch-diameter shaft passing through a reamed hole 1 inch long in the center of the cover furnishes the means for operating the switch mechanism inside. The operating handle fastened to the shaft rests against a collar on the outside, which in turn rests against the cover. A shoulder on the shaft is held against the inside of the cover. Thus two changes in direction in the path of any possible escaping products of combustion are introduced.

The appearance of the four master-switch inclosures is the same externally, except that one has two instead of one asbestos-packed lead entrances in the curved wall of the box.

**Construction of headlights.**—The Westinghouse type S headlights as used on this loader differ only slightly from those described in connection with the Myers-Whaley loaders. (See p. 51 for description.) This difference is merely in the lead entrance. The stuffing boxes for the latter machines are made by the Myers-Whaley Co. and are somewhat different in design from the stuffing boxes made by the Westinghouse Electric & Manufacturing Co. for the Oldroyd machine. On the Oldroyd machines the lead entrance may be on the right or left according to the position of the headlight. Two branch circuits for the four headlights originate at the propelling protective panel. One branch goes to the headlight under the rear boom. The other branch goes to one of the three headlights on the front boom, the second being tapped from the first and the third being tapped from the second headlight. This arrangement necessitates the use of two stuffing boxes on two of the headlights. There are no switches to cut off the headlights from the other circuits.
Construction of brake-magnet compartments.—The solenoid for the brake magnets is inclosed in a cylindrical steel case approximately 11 inches in length and 6 inches in diameter, outside dimensions. Except for a small space at the ends the solenoid almost completely fills its case. One end of the case is counterbored one-fourth inch larger in diameter to take a brass cover. The cover is held in place by the steel core of the coil, the core passing through a central hole in the other end of the case and being threaded for a nut, which secures the entire assembly. The joint between the cover and case is formed by a \( \frac{1}{8} \) -inch shoulder of the counterbore and cylindrical surfaces 1 inch long fitting closely together. At the other end the core fits snugly in the case for \( 1\frac{1}{8} \) inches to make a flame-tight joint.

A cylindrical connection box with a sealed screw cover extends from the side of the magnet case. In this box the connections between the coil and the outside wiring are made. The cable from the outside circuits enters the connection box through an asbestos-packed stuffing box, the axis of which parallels the axis of the magnet core.

The magnet armature is hinged to the case in such a manner that it rests at an angle with the plane of the brass cover when no current is flowing in the magnet coil. The plane of the armature coincides with that of the end of the case when the armature is pulled completely into place.

Construction of cable-reel compartment.—The slip rings, the means of connection between the trailing cable rotating on the reel and the stationary wiring of the machine, are housed within the drum of the cable reel. This housing is a cylindrical casting with a full-diameter opening at one end for inspection and assembly of the parts and a smaller opening in the opposite end for the hollow shaft supporting the reel. The slip rings are secured concentrically on the inner end of the hub for the shaft, while the brush rigging is fastened on insulated studs screwed into the back of the drum.

The large opening into the housing is threaded internally to take a screw cover plate, which has five parallel ribs as stiffening. When the plate is in place a rim that extends beyond the threads rests upon the finished end of the drum, forming a tight seal against passage of flame. A padlock protects the cover against unauthorized opening. The hub in the drum is \( 7\frac{1}{4} \) inches long and has a bronze bearing bushing for the shaft. In addition to the comparatively long joint between the shaft and bushing, the former has a shoulder which fits against the outer end of the bushing and so increases the length of path from the interior of the drum to the exterior.

The trailing cable enters the drum through an asbestos-packed stuffing box in a depression in the curved surface of the drum. The cable from the machine to the rings within the reel passes through the hollow shaft, which does not rotate. On the inner end of the shaft an asbestos-packed stuffing box closes the passageway around the cable.

The cable reel will hold 400 feet of No. 2 cable; an extension of the approval, however, allowed modification of the reel suitable for 300 feet of No. 0 cable.

Wiring.—The wiring from compartment to compartment on the Oldroyd permissible loader is carried entirely in air-hose conduit.
As the compartments are of necessity somewhat scattered over the machine and as allowance had to be made for movement of parts without damage to the conduits, the problem of wiring this loader was found to be difficult.

In the foregoing descriptions of the various inclosures it has been pointed out that asbestos-packed stuffing boxes are used exclusively for cable entrances. Many of these are in special fittings which not only carry the stuffing box but also clamp the end of the hose conduit. In other instances the nut that forces the packing down into the stuffing box is arranged to hold the end of the conduit. Sealing wires are used to prevent the fittings and packing nuts from turning.

GOODMAN MANUFACTURING CO. TYPE 148–E POWER SHOVEL, APPROVAL NO. 186

In its arrangement and method of operation the Goodman type 148–E electrohydraulic power shovel is essentially the same as the type 48–E machine already described. The chief mechanical difference between the two is in the use of a telescoping boom on the type 148–E machine, resulting in a decrease of 5 feet in over-all length and eliminating the projection of the boom at the rear of the machine. Two instead of three type S headlights are used on the type 148–E machine. (See fig. 27.) One of these, e, is mounted on the motor; the other (not shown in fig. 27) is at the rear of the machine. The motor $k$, rated at 22 hp., is larger than that on the 48–E shovel, and controller $i$ and the junction and rheostat boxes are different from those on the type 48–E machine.

Approval of the 148–E power shovel with 250-volt explosion-proof electrical equipment was issued by the Bureau of Mines to the Goodman Manufacturing Co. on March 15, 1930. Approval No. 186 identifies the permissible loader.

PERMISSIBLE FEATURES

The electrical equipment of the Goodman type 148–E power shovel consists of a motor, controller, rheostat, junction box, switch and fuse, and three headlights.

Motor.—A type 94–A compound-wound, direct-current motor drives the pump for the hydraulically controlled movements and also furnishes the power for the movements controlled by gears and clutches. The motor shell is oblong in section at right angles to the armature shaft and is cast with both ends open. Numerous ribs on three of the sides add considerable cooling surface to the outside of the shell. An “end plate” which carries the ball bearing closes the pinion end. The two ends of this plate are segments of a circle in contour and are accurately machined to fit corresponding curved surfaces bored in the end of the shell. In this way the plate is placed accurately. The explosion-proof joint between the end plate and the shell consists of flat machined surfaces held in contact by 12 studs with nuts and lock washers. The fit between the curved ends of the plate and the bore in the shell adds somewhat to the explosion-proof qualities of the joint. A spider, accurately placed by machined surfaces and keys, carries the bearing and brush rigging at the commutator end. A solid cover consisting of a cast rectangular frame, over which is
welded a sheet-steel plate, closes the commutator end of the shell. The explosion-proof joint between this cover and the shell is a tongue and groove; that is, a tongue machined on the cast frame fits into a corresponding groove machined around the opening in the end of the motor frame. The cover is held by removable hinge pins at each end that slip into holes in a number of interleaving lugs on the case and cover. The hinge pins are secured by padlocks to prevent tampering. The cover is quickly and easily removed to permit access
to the brushes, bearing, and connections at the commutator end of the
motor.

Five wires from the junction-box compartment enter the bottom
of the motor shell through an oval hole that coincides with a cor-
responding hole in the combined rheostat and junction-box casting
upon which the motor rests. A treated maple bushing or plug with
five holes for the wires fits snugly into and closes the latter hole.
The joint between the motor and combined rheostat and junction-box
casting consists of flat machined surfaces on the two castings.

**Rheostat junction-box unit.**—A junction or connection box and the
rheostat compartment are combined in one irregularly shaped casting
with a dividing wall between. The main opening in each of the two
sections is provided with a rectangular flat cover held by six cap
screws with lock washers. The top edge of one of these covers is
visible below the motor in Figure 27. The cables from the several
compartments on the machine pass through the junction box where
splices and turns are made. A 3-hole wooden plug fastened in the
wall between the rheostat and junction box serves as a passageway
for the cables leading into the rheostat compartment. The five con-
ductors from the controller and one main lead and two headlight
leads from the switch and fuse enter the junction box through a
special bronze fitting held by four cap screws over a hole through
the side of the junction box. The other end of the special fitting is
in the shape of a cylindrical conduit box or auxiliary junction box.
The ends of the cylindrical portion are closed by two flat plates held
by three bolts extending through both plates. The conduit from the
switch and fuse screws into a threaded hole in one of the plates, and
the conduit to the controller screws into a boss on the cylindrical
surface of the fitting. One lead from the switch and fuse to the
controller passes directly through the auxiliary junction box instead
of going to the main junction box.

The joints in the conduit system are designed to be explosion proof.
The length of the conduits and the space occupied by the cables are
such that flame will not propagate through them should an explosion
occur in the junction box.

The headlight circuit for two of the headlights passes through the
wall of the junction box in the form of two insulated studs. A
rubber-hose conduit carries the headlight leads from the junction
box to one headlight; from this point a branch circuit in a conduit
of copper tube, \(i\), goes to the large type R headlight \(r\).

The rheostat for the Goodman 148-E power shovel is made up
of eight resistance tubes compactly assembled and is designed for
starting duty only.

**Switch and fuse.**—The switch-and-fuse compartment on the type
148-E power shovel is virtually the same as that on the type 48-E
machine, except that a 100-amper 250-volt fuse is used on the former
instead of the 75-amper fuse. This accessory (not shown in fig. 27)
is mounted on the right side at the rear of the machine.

**Controller.**—Controller \(i\) (see fig. 27) used on the 148-E power
shovel is the type 107. It is a drum controller of the reversing type.
The explosion-proof inclosure consists of a rectangular cast-steel case
with a hinged, cast-steel cover. The joint between the cover and case
is a tongue and groove; a tongue machined on the cover fits snugly
into a corresponding groove machined around the opening in the case. The cover is held by a hinge pin on each side that passes through holes in a number of interleaving lugs on the case and cover. One hinge pin is permanently fixed, while the other is removable but is secured by a padlock to prevent tampering.

A bushing pressed into a hole through one end of the case serves as one bearing for the shaft of the reverse drum. The opening in the bushing does not extend all the way through it. The corresponding bearing for the shaft of the main drum is wholly within the case. The handle ends of the shafts are journaled in holes through two bushing plates that fit holes bored through the case large enough in diameter to allow the respective drums to be inserted or withdrawn through them. Each of the bushing plates is held by three flathead machine screws prickedpunched to prevent loosening. The flament joints between the bushing plates and the case consist of cylindrical surfaces parallel to the shaft axis and flat surfaces at right angles to the axis.

Six cables enter the controller through a hole in a boss on one side. The cables are carried in rigid conduit L, which terminates in a flange plate screwed on its end. The flange plate is bolted against the machined surface of the controller-lead entrance boss by three cap screws. The length of the conduit and the space occupied by the cables are such that flame will not propagate through it to the junction box should an explosion occur.

Headlights.—The headlights are of the same design as those on the 48-E power shovel already described. Some slight differences are introduced by the use of copper-tube conduit instead of hose to protect the wires to the type R headlight.

Trailing cable and accessories.—A No. 4 concentric rubber-sheathed cable connects the Goodman 148-E power shovel with the power supply. Approval of this machine covers optional use of the product of any one of four cable manufacturers. A trolley tap containing a 100-ampere fuse is furnished with the trailing cable. The loader has no cable reel on which to wind or pay out the cable when the machine is moved from place to place. The swinging of the machine during loading operations necessitates a certain amount of dragging of the cable, because the place where the cable enters the switch also swings with every swing of the machine.

THE JEFFREY MANUFACTURING CO. TYPE 44-C LOADING MACHINE,
APPROVALS NO. 194 AND 194A

The Jeffrey Manufacturing Co. type 44-C loading machine is made up of two main sections—a conveyor section similar in general aspect to a chain-flight pit-car loader mounted on a 4-wheel self-propelled truck and a loading section attached to the front of the conveyor section. Figure 28 shows the machine arranged for traveling. When the machine is loading coal, the 4-wheel pony truck under the loading section is removed and the front part of the loading section is lowered onto the bottom. The machine originally approved differed somewhat from the one shown in that the two starting boxes were arranged crosswise of the machine and no headlight was used. It is understood that only two of the original form were made.
In operation the machine is pulled forward or "umped" into the loose coal to a depth of 7 to 8 feet by a wire rope operated by power-driven drum \(a\). The loading section is then swung by the wire rope attached at \(b\) and passing to the power-driven drum through a snatch block secured to a jack pipe. The endless chain to which are attached flights \(c\) gathers the coal and conveys it to the rear of the loading section, where it is discharged onto the conveyor at \(d\). The loading chain is reversible to permit operation when the loading section is being swung in either direction, the chain moving toward the discharge end on the side advancing into the coal pile. The loading section is swung across the room or entry in both directions until all the loose coal has been removed, the chain being reversed at the end of each sweep. After cleaning up a place the loading section is raised by means of the wire rope and power-driven drum, and the pony truck is put in place. The machine is then ready to propel itself to another room.

The machine is 42 inches high and about 54 inches wide and weighs 3½ tons; the over-all length is about 33 feet. However, as the conveyor swivels on its self-propelling truck and the loading section swivels on the pony truck the machine readily travels around curves into the working places. Four-foot coal is required for operation of the machine.
A loading rate of a ton a minute, or 150 to 160 tons in an 8-hour shift, under favorable conditions is claimed for the machine.

A 7½-hp. motor mounted under the conveyor of the conveyor section drives the chain-flight conveyor and the power drum $a$ and provides power for traveling. It is operated by one of the reversing starters $e$. Clutches connect and disconnect the motor from the various drives. The loading chain is driven by a similar 7½-hp. motor through appropriate gearing. The loading motor is operated by the second reversing starter. A headlight, $f$, mounted on the loading section lights the face during loading operations and in front of the machine when traveling. A headlight switch and fuse is mounted at $g$ between the two motor starters. The headlight and headlight switch and fuse were not on the machine as originally approved but were added under an extension of the approval.

Current for operating the machine is received through a trailing cable; a fused trolley tap and a rail clamp connect the cable to the supply circuit. When not in use the cable is coiled on the hooks or horns at $h$.

This loader with either 250 or 500 volt direct-current equipment was approved by the Bureau of Mines on June 6, 1930. Approvals No. 194 and 194A identify the 250 and 500 volt machines, respectively.

**Permissible Features**

The electrical equipment of the Jeffrey type 44-C loading machine consists of 2 compound-wound 7½-hp. motors, 2 reversing starting boxes, 1 headlight, and 1 headlight switch-and-fuse unit.

**Motors.—**The two motors, type L-279-A on the conveyor section and type L-279-B on the loading section, are of nearly the same design. The only difference is that the outer face of the pinion-end plates on the form B motor is shaped to form part of a gear box. The magnet frames of the motors are box-shaped steel castings whose outside dimensions are about 11 by 15 by 20 inches. Hand-hole cover $i$ screws into a tapped hole at the commutator end and is secured by a seal to prevent tampering. A circular hole is bored in the pinion end of the frame large enough to allow removal of the armature. The corresponding hole in the commutator end is only large enough to accommodate the ball bearing. A lip turned on the pinion-end plate fits the bored opening in the frame, and a flat surface at right angles to the axis of the armature seats against a corresponding flat surface on the end of the frame. The end plate is held by four studs with nuts and lock washers. The bearing cap at the commutator end is held by three studs with nuts and lock washers. The studs pass through the frame and are riveted permanently to the inside-bearing baffle plate.

Four single-conductor cables enter the motor through asbestos-packed stuffing boxes and connect with the four conductors of a 4-conductor No. 8 rubber-sheathed cable by clasp-type connectors. The connectors are adequately insulated and held by wooden clamps. Sheet-metal plate $j$ covers the lead entrance. A clamp under this cover holds the hose conduit $k$, which protects the 4-conductor cable. Similar terminal arrangements are used at the motor on the conveyor section of the machine.
Starting boxes.—The two class 26–A starting boxes are identical in design. Cover l screws into the case and closes the circular opening into the compartment. Interference between tiebar m (which connects the switch levers) and the hinge piece prevents the cover from being opened with the switch closed or the switch from being closed with the cover open. An interlock rod sliding in guides on the outside of the case prevents the reverse switch from being operated except when the main switch is open. The switch has an auxiliary contact that provides a step of resistance in starting. The resistance elements are wound to form blow-out coils for the switch.

Sixty-ampere fuses for 250 volts and 30-ampere fuses for 500 volts in the starting boxes provide overload and short-circuit protection. The fuses can readily be renewed, as the fuse clips are dead when the starting-box covers are open. A 2-conductor and a 4-conductor No. 8 rubber-sheathed cable enter each starting box at the bottom through asbestos-packed stuffing boxes. The 4-conductor cables go to the motors through hose conduits k and n, and the 2-conductor cables are connected to the trailing cable by clasp-type connectors adequately insulated and held by wooden clamps under a sheet-metal cover to the left of the starting boxes.

Headlights.—The class 19–B headlight consists of a cylindrical steel shell closed at one end by a steel plate welded in place. The lens holder is screwed on the other end. A 2-conductor No. 16 rubber-sheathed cable enters the closed end through an asbestos-packed stuffing box. The glass is about 1 inch thick, is flat, and is ground at the edge to fit a spherical seat machined in the lens holder. A lead-faced retaining ring screwed against the glass from the rear holds it firmly in place in its seat. A small rivet prevents the retaining ring from loosening. A seal prevents removal of the lens holder by unauthorized persons. Two bulbs are used in series for 500 volts, while only one bulb is used for 250 volts.

Headlight switch and fuse.—The headlight switch and fuse consists of a small cast box containing a double-pole cut-out with two 5-ampere cartridge fuses and a double-pole snap switch. The top screws into the lower part of the case and is sealed to prevent tampering. A short rod for operating the snap switch is journaled in a hole drilled through the top. Two 2-conductor No. 16 rubber-sheathed cables enter through asbestos-packed stuffing boxes in the bottom of the box.

GOODMAN MANUFACTURING CO. TYPE 636–AK3 ENTRYLOADER, APPROVALS NO. 196 AND 196A

Figure 29 shows the Goodman Manufacturing Co. type 636–AK3 alternating-current Entryloader. The operation of this machine in loading is the same as that of the type 136—EC Entryloader previously described. The present machine, however, is not self-propelled, and the loading incline must be provided as a separate part. In other words, only the power unit and three rope drums used in the Goodman system of scraper loading are included in the unit.

The scraper used with the machine has a capacity of 0.8 ton of coal and can be removed from the face to the discharge point at the rate of about 300 feet per minute. The return speed is 600 feet
per minute. The total capacity of the machine per shift may therefore vary according to the distance over which the scraper travels.

The over-all dimensions of the machine are: Height, 34 inches; width, 46 inches; and length, 112 inches. The machine weighs 6,500 pounds without the ropes.

The electrical equipment for driving the rope drums is a compact unit mounted on the end of the same frames with the drums. Only a short length of trailing cable is furnished because the machine stands at the entry close to the feeder circuit. Inasmuch as the cable is short and the machine is stationary, no cable reel is used.
The 440-volt, type 636-AK3, alternating-current Entryloader was approved by the Bureau of Mines on July 26, 1930. The 220-volt machine was approved on September 29, 1930. Approval No. 196A was assigned to the 440-volt machine and approval No. 196 to the 220-volt machine.

PERMISSIBLE FEATURES

The electrical equipment on the Goodman permissible-type 636-AK3 Entryloader consists of a controller, a motor, and a relay-contactor box. The controller is bolted on top of the motor shell, and the relay-contactor box is bolted to the side of the controller at the top and to the motor shell at the bottom. The wires pass between the relay-contactor box and the motor and controller by means of two short metal bushings or tubes welded to the relay-contactor box and machined to slip into holes drilled through corresponding bosses on the controller and motor cases. The tubes are so long and fit so tightly in the holes that they are flame tight. The metal tubes are lined with fiber tubes to protect the wires that pass through them. (There is no opening for wires direct from the controller to the motor.) No special provision is made to prevent explosions from propagating through the openings for the wires between the compartments.

Motor.—The motor, type 35-C, is a 3-phase, 60-cycle, squirrel-cage motor, rated at 35 hp. on a 1-hour basis. The motor frame is a cylinder with open ends. Numerous ribs around the shell add considerable cooling surface to the outside of the shell. Each of the two end plates carries a ball bearing for an end of the armature shaft. A lip turned on each plate fits a bore in the end of the motor shell. In this way the plates are fixed in position, and the rotor is accurately centered. The explosion-proof joints between each of the plates and the shell consist of the cylindrical fit between the lip and the shell and flat machined surfaces at right angles to the shaft held in contact by 12 cap screws with lock washers. The wires enter through a hole in the side of the shell, as previously described.

Controller.—The controller, type 111, is a drum-type Y-delta controller with a separate interlocked reversing drum. The handle ends of the drum shafts are journaled in holes bored through bosses on the end of the rectangular cast case. The bearing for the other end of the main drum shaft is a bottomed hole in a brass bearing plate which fits into a hole bored through the case large enough to permit removal of the drum. The bearing plate is held by three cap screws with lock washers. The cylindrical fit of this bearing plate in the hole through the case forms most of the explosion-proof joint between it and the case. The second bearing for the reverse drum is entirely within the controller case. Cover a, Figure 29, is a cast rectangular frame over which is welded a sheet-steel plate. The explosion-proof joint between the cover and the case is a tongue and groove; that is, a tongue machined on the cast frame fits a corresponding groove machined around the opening in the case. The cover is held by hinge pins which slip into holes in the interleaving lugs on the case and cover. One hinge pin is permanently riveted in place, while the other is secured by padlock b to prevent unauthorized opening of the controller.
Relay-contactor box.—Relay-contactor box \(c\), Figure 29, is of welded construction and is built up of steel plate, except for the cast frame for the cover opening. The cover is of the same construction and is secured in the same way as was that of the controller just described. The trailing cable enters the compartment through an asbestos-packed stuffing box. A combined bell-mouth and insulated strain clamp is provided to protect and hold the cable. The tube carrying the wires to the motor can be seen at \(d\); that for the wires to the controller is not shown in the figure. The compartment contains a 3-pole magnetic contactor, three magnetic-overload relays, a push button operated by the auxiliary metal pushrod \(e\), and a 2-pole snap switch operated by auxiliary handle and rod \(f\). Fuses are also provided for the control circuit. To close the contactor the controller must be in the “Off” position and the snap switch closed; then by closing the push button the contactor is closed. Once closed, the contactor opens only when tripped by an overload or when the snap switch is opened.

The trailing cable is a 40-foot length of 3-conductor No. 3 “super-service” Rome cable. It is furnished with three fused trolley taps with 100-ampere fuses for 440 volts and 200-ampere fuses for 220 volts. The setting of the overload relays in the contactor-relay case is 60 amperes for 440 volts and 120 amperes for 220 volts.

PERMISSIBLE COAL LOADERS

The accompanying table lists the main features of the three classes of loading machines described.

COAL-HANDLING EQUIPMENT AS CONSIDERED BY THE SAFETY ENGINEER

In considering the relation of the loading machine to the general problem of safety in a gassy mine a number of factors must be weighed before conclusions can be drawn. Chief among these are the type of machine and the system of mining.

WORKING POSITION AND MOVEMENT

The working position of the loader and the frequency of its movement depend upon the type of machine. For example, the driving mechanism of the scraper loader and the shaker conveyor can be placed at or near an entry swept by intake air. In other words, the motor and other electrical parts can be kept away from the face workings where gas is being liberated. Thus they introduce no electrical hazard immediately at the face.

Moreover, the two types of machines mentioned can be installed in a semipermanent manner. As these loaders do not have to be moved every day the place can be timbered so thoroughly that there is little likelihood of damage to the machine from falls of roof, and accordingly the wiring to the machine can be carefully installed so as not to be subject to damage.

On the other hand, some types of loading machines are intended to work close to the face. They move under their own power and can move in and out of a room or place several times a day as con-
ditions require. Care must therefore be exercised during the movement of the machine to prevent it from knocking out props, from running into men or other machines, and from running over its own cables or the cables of any other equipment in the vicinity. The frequency of these movements determines the degree of hazard introduced. Some of these loaders are not equipped with a cable reel; therefore when the loader is traveling one of the crew must carry the trailing cable to protect it. This is not a safe practice, particularly if pressure exceeds 250 volts.

Unless the loader discharges into a conveyor, cars must be brought to the loader to transport the coal from the face. Therefore, locomotives of one type or another must also enter the place where the loader is in operation. Thus, the problem of guarding the trailing cable of the loading machine against being run over by cars and locomotives is introduced. There is also the problem of coal dust raised by the machine not only in gathering the coal but also in discharging it into the cars being loaded.

With the rapidly increasing use of pit-car loaders motors of too small capacity were often used for driving them. The desire to build a light-weight, inexpensive machine was partly responsible for this. However, ignorant and careless use of these machines also contributed to the failure of motors and starters. Abuse of any machine complicates the safety problem. Forcing a loader to operate under loads for which it was not designed leads to overfusing or setting overload relays too high. In consequence, the hazard of overheated motors, starters, and wiring is introduced.

All the various types of loading machines are not suited equally well to every system of mining; accordingly, when a mine is being laid out for mechanical loading the choice of machine is governed by the system to which it is best adapted. Possibly, therefore, a system that affords the greatest safety can be selected.

Along with the system of mining, the speed of mining and the degree of concentration must be considered. Some mines are now being worked two or three shifts a day instead of one; this “speeding up” of production brings up new problems that require the attention of the safety engineer. If mining proceeds at a faster rate, more gas will be released and the problem of ventilation must therefore receive more careful consideration. Although the faster rate may mean shorter exposure of men and machines to hazards at the face this advantage may be partly offset by increased hazards from the electrical equipment. If this equipment is operated three shifts a day instead of one, more frequent inspection and overhaul will be required to keep the machines in safe operating condition. Operation at this rate, however, is not conducive to close supervision of machines, and unless the management fully realizes its responsibilities neglect is almost sure to be the result with a corresponding reduction in the factor of safety for the installation as a whole.

Regardless of the type of loader or the system of mining, the permissible machine merits the careful consideration of every safety engineer. In the first place, the manufacturer has endeavored to develop a sturdy design—one that will withstand not only the severe duty required of the loading machine but one that will also withstand
explosions of gas which might accumulate in the various inclosures for the electrical parts. Such construction has been found to require less attention to maintain and promotes more continuous service. Hence, the permissible machine may possess an economical as well as a safety advantage over the machine that does not have explosion-proof parts.

Furthermore, the conveyor or shovel that carries an approval plate must have the highest quality of trailing cable and suitable short-circuit protection to comply with the Bureau of Mines requirements. These are two features that the bureau regards as particularly important. Cables that are dragged through water and over rough, sharp edges of rails, ties, rock, and coal, that are subjected to tension, corrosion and heating, and that at times are run over by cars and locomotives can not be of too high quality when safety from gas and dust ignition is involved. Because of the severe treatment to which cables are subjected, all those used with permissible loaders are protected against overload. In general, this protection is a fuse placed within a trolley tap which serves two purposes: (1) It affords an insulating handle by which the cable can be attached to the power circuit without danger of shock, and (2) the handle holds and guards the fuse so that no matter where the cable is attached it is always protected.

The quality of cables has improved considerably in the past two years. Several makes of cables that have met the performance tests given by Schedule 2C are now available. The use of these cables is especially recommended by the Bureau of Mines where sizes and types suitable to the loading machine are available. Their use will undoubtedly tend to decrease the hazard from trailing cables.

That the interest in mechanical loading has been widespread can be seen from the fact that the 34 permissible loaders were built by 21 different manufacturers in five years. It is also noteworthy that 8 of the 10 pit-car loaders were all approved within five months during 1929.