PERMISSIBLE COAL-CUTTING EQUIPMENT

APPROVED PRIOR TO JULY 1, 1932

By

L. C. ILSLEY, H. B. BRUNOT, and H. B. FREEMAN
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PERMISSIBLE COAL-CUTTING EQUIPMENT

(Approved prior to July 1, 1932)

BY L. C. ILSLEY, H. B. BRUNOT, and H. B. FREEMAN

EARLY WORK ON EXPLOSION-PROOF MOTORS

In the United States the safety electrical apparatus first developed for use in gassy mines were largely coal-cutting machines, probably because these machines are used at the face of the mine workings where the danger from explosive gas is greatest. During 1910 and 1911 the United States Bureau of Mines conducted a preliminary investigation with five designs of motors; the results were published in Bulletin 46.4

SCHEDULES, APPROVALS, AND APPROVAL PLATES

The Bureau of Mines approves apparatus as permissible for use in gassy and dusty coal mines under the provisions of "permissible" schedules, which establish certain minimum standards of safety and give details of test methods adopted to determine whether these standards have been met and a list of charges for such tests. Any manufacturer has the privilege of submitting his product for test in accordance with the conditions outlined in the schedules. His action is wholly voluntary, as the Federal Government has no control over selection of equipment to be used in mines, such authority being left to the various States. When the product of a manufacturer has met the requirements of the schedule he is permitted to advertise this fact and to attach an approval plate with the Bureau's seal to each machine he makes that is identical in every respect with the equipment tested, inspected, and approved by the Bureau.

Schedule 2, approved by the Secretary of the Interior, October 26, 1911, deals with explosion-proof motors and was the first schedule issued for electrical apparatus. Its requirements were based on the Bureau's preliminary investigations in this field. This schedule has been revised from time to time to conform with information gained from testing a large variety of equipment and to bring the require-

1 Work on manuscript completed September 1932.
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ments in line with new developments in the art. Thus, Schedule 2A was issued November 2, 1915, and Schedule 2B August 16, 1921, each a revision of the preceding schedule. Schedule 2C, issued February 3, 1930, and now in force, combined in one schedule the requirements for approval of storage-battery locomotives and power trucks, junction boxes, and electric motor-driven equipment which had been covered by separate schedules.

The theory and practice followed by the Bureau of Mines in the investigation of electrical equipment made for service in gassy mines have been published as Bulletin 305. Approvals are granted only for complete machines, not for separate motors or other parts, because a safe assembly consists of more than a group of parts of which each in itself may be safely constructed; the wiring between these devices and to the source of power must be adequately protected. The approval plate attached to a machine is the manufacturer's guarantee that his machine is constructed in strict accordance with the specifications on file in the Bureau covering the design tested, inspected, and approved as permissible in accordance with the requirements of the schedule. It is a label that identifies the equipment so that anyone can tell at a glance whether or not it is of the permissible type. Use of the approval plate obligates the manufacturer to see that each machine is constructed according to the drawings and specifications accepted and recorded by the Bureau. Equipment having changes in design which do not have official authorization from the Bureau are not permissible machines and therefore must not bear approval plates.

All approvals are granted with the understanding that the manufacturer will make his machine according to the drawings which he has submitted and which have been considered and recorded in the approval. Therefore, when any change is desired the manufacturer must first obtain the Bureau's authorization and furnish revised specifications showing the changed construction. If the user desires any change in a machine he should have the manufacturer to whom the approval was granted obtain the Bureau's authorization in the form of an extension of the approval for the proposed change.

As the approval plate on a machine evidences compliance with the safety requirements established by the Bureau the user, in fairness to the Bureau and the manufacturer, should not operate such a machine if it has been changed from the design approved without authority or if it has become unsafe through neglect or accident. The machine should be in proper condition, or the approval plate should be removed and destroyed.

ACKNOWLEDGMENTS

Most of the photographs reproduced in this bulletin have been made available by the manufacturers of the various machines.

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1 In accordance with sec. 311 of the Economy Act (H.R. 11267, 72d Cong.) and with the approval of the Acting Secretary of Commerce fees for testing explosion-proof mine equipment were revised, effective August 3, 1932.

GENERAL SAFETY REQUIREMENTS

TRAILING CABLES

All permissible coal-cutting machines use high-grade, rubber-sheathed trailing and butt cables. The manufacturer of the machine generally includes several makes of cable in the specification submitted to the Bureau because the cable is considered a part of the approved outfit; therefore, only cables listed in its specifications can be used legitimately on any particular permissible machine. However, extension of approval for any suitable cable can be obtained without delay. Only changes in cable entrances, cable clamps, etc., present any inconvenience. The Bureau specially recommends the use of cables that comply with certain special test requirements stated in Schedule 2C, but these also must be included in the manufacturer’s specifications on file with the Bureau before they can be used on a permissible machine.

CONNECTION TO POWER SUPPLY

Direct-current machines may be connected to the power supply by a fused trolley tap and rail clamp, or they may be connected to a permissible junction box or a permissible storage-battery power truck. The general practice, except for longwall machines or equivalent outfits, is simply to include a suitable fused trolley tap and rail clamp in the specifications filed with the Bureau, but this does not prohibit connection to a permissible junction box or to an approved power truck. For a-c. shortwall machines three fused taps are generally included in the specifications, although connection to an approved junction box can be made wherever desired. For certain longwall machines and similar outfits (either a-c. or d-c.) that do not include switch-and-fuse protection in the design of the cutting unit the use of a permissible junction box to furnish overload and short-circuit protection is obligatory. Special connection arrangements such as plug-and-socket connections to automatic-control equipment will be considered in the descriptions of the various machines.

FUSES AND OVERLOAD DEVICES

Schedule 2C requires that “the trailing cable of every portable machine shall be protected against overload and short circuit by a fuse or other automatic circuit-interrupting device of suitable capacity in each ungrounded conductor.” This protection may be provided in any suitable manner. The schedule also requires that “every motor shall be protected against overload by an automatic circuit-interrupting device.” The protection for the cable is not considered to fulfill the second requirement, except in certain cases. In general, an interlocked fuse (or fuses) or other overload and short-circuit protection at the machine is included in the design (frequently on the cable-reel truck). Many machines have auxiliary fuses to protect branch circuits or control wiring. The maximum relay settings and the ratings of fuses for a permissible machine are limited by the specifications filed with the Bureau. Fuses or overload-relay settings for larger currents than those on the machine as received from the
manufacturer should never be used; smaller ones may be used if desired. Three-hundred-ampere fuses (for 250-volt service) are the largest supplied for any of the permissible coal-cutting machines, and many have a much smaller maximum allowable fuse rating. The Bureau strongly recommends the use of as small fuses and relay settings as is consistent with satisfactory operation of the machine. The causes of excessive overloads should be removed instead of the size of fuse increased, as such procedure eventually will lead to serious trouble and expense.

**FLANGE WIDTHS AND CLEARANCES**

To prevent the discharge of flame from joints of explosion-proof compartments wide metal-to-metal contact between the parts is required. Gaskets are not allowed, except for metal-to-glass joints where lead gaskets are commonly used to give a firm seat for the glass. Rubber, putty, and plaster of paris are not acceptable for sealing metal-to-glass joints. The minimum width of metal-to-metal contact at any joint is 1 inch except for metal-to-glass joints having an internal volume of less than 60 cubic inches where a width of three-fourths inch is allowed. In many machines a greater width than 1 inch was found necessary to prevent the discharge of flame due to wide spacing of the bolts or to other features of the design. The requirement for metal-to-metal contact at plane joints is considered to have been fulfilled if the separation does not exceed 0.004 inch for distances less than 6 inches and does not permit discharge of flame in explosion tests. The clearances allowed for special joints, such as tongue-and-groove, cylindrical, or step joints, are determined by explosion tests; the machining tolerances on the specifications are fixed accordingly in each instance.

**DESCRIPTION OF EXPLOSION-PROOF FEATURES OF PERMISSIBLE MACHINES**

Bulletin 78, published in 1920, describes the explosion-proof features and tests of the first four coal-cutting machines approved by the United States Bureau of Mines. The present bulletin, the third in a series covering permissible motor-driven machinery, describes the explosion-proof features of all the coal-cutting machines (including those given in Bulletin 78) approved prior to July 1, 1932.

**APPROVED MACHINES BUILT BY THE GOODMAN MANUFACTURING CO.**

**TYPES 12-CC AND 12-EC, D.-C. SHORTWALL CUTTING MACHINES, APPROVALS 101 AND 101A**

Approvals 101 and 101A, covering 210-volt and 500-volt, types 12-CC and 12-EC, d-c. shortwall cutting machines, were issued to

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the Goodman Manufacturing Co. on May 20, 1916. Approval 101 designates the 210-volt machines and approval 101A, the 500-volt machines. The electrical accessories for these machines comprised the type 23-C motor unit (fig. 1, A) and the reel-truck unit (fig. 1, B) described in Bulletin 78. For completeness, the 23-C motor unit will be described briefly and the reel truck, including the changes in its construction made since the publication of Bulletin 78, in detail because it is part of several other cutting machines to be described.

The type 23-C motor unit includes the motor, controller, and resistance. The motor is rated at 35 hp. for 1 hour without exceeding a temperature rise of 75°C. on the windings or 100°C. on the commutator. One end of the motor shell is cast closed, except for the shaft opening; the commutator end is closed by end plate a. Pipe plug b closes the shaft opening through the plate and is essential to the flammability of the motor. Cover c permits access to the commutator and brush rigging, and covers d and e close the resistance and controller compartments, respectively. All joints between the covers and the various compartments have broad flanges, well-secured with studs or bolts in bottomed holes. Small covers f protect the glass that closes two peepholes in commutator cover c.

The motor bearings are of the sleeve type, and the oil wells at the top and bottom of both bearings are closed by special explosion-proof oil valves, which must be in place and in working order to preserve the safety of the motor. The motor end plate at the commutator end is equipped with pressure-relief devices of the gauze-and-grid type. The discharge opening from these is downward at g (fig. 1, A).

The wiring between the motor, controller, and rheostat compartments is within the machine proper and is thus well-protected. Terminal cover h with a bell mouth and an insulated strain clamp secures the cable and protects the terminal connections. Connection is made to the inside by insulated studs.

The cable-reel unit, which includes the main switch, the fuse protection for the machine, and the reel for the trailing cable (fig. 1, B), is an essential part of the machine. Explosion-proof compartment a contains a fuse mounted on a holder or plug, b, and a two-pole switch. The design is such that the fuse is disconnected from the circuit before the fuse plug can be removed from the explosion-proof compartment and the fuse plug is in place and secured before the fuse can be connected in the circuit. A bayonet-type arrangement which requires turning the plug to release or lock it in place provides this interlocking. Knife-blade-type connections, closed only when the plug is in the locked position, place the fuse in circuit. Handle c operates the switch; it raises the 2 sliding contacts from slip rings attached to the shaft of the reel and at the same time opens 2 contacts between 2 controller-type fingers and stationary contacts on a terminal board at the end of the case. The switch thus opens each side of the circuit in two places; the contacts on the slip rings are adjusted to open first. Connection from the slip rings to the cable on the reel is made by two single-conductor cables which pass through holes drilled in a large-diameter journal on the shaft. The wires have long, close fits in the holes in the
journal, and in addition the insulation for the slip rings obstructs the entrances to the holes from the interior of the compartment. A fiber rod which prevents rotation of the journal bushing relative to the shaft fits a drilled hole similar to those for the cables. This rod must be in place to close the opening into the explosion-proof compartment and to prevent strain on the cables by movement of the journal bushing. Connection from the cable to the motor to the inside of the switch case is made by insulated studs. A terminal cover with a bell-mouth exit and an insulated strain clamp protects the outside terminal connections and secures the cable.

The two halves of the switch compartment meet in a wide, plane, metal-to-metal joint held together by seven bolts with nuts and
lock washers. The bushing carrying the cables to the reel and the other end of the shaft are journalled in brass bushings which fit in semicylindrical seats in the lower half of the case and corresponding seats in bearing caps bolted to the lower and upper halves of the case. The bearing caps thus aid in securing the two halves of the case together. The handle end of the switch shaft is journalled in a bearing plate bolted to the upper and lower halves of the case. The bearing for the other end of the switch shaft does not open to the outside of the compartment. The metal-to-metal joints between the bearing caps, the switch bearing plate, and the two halves of the case must be tight to make the compartment explosion-proof. The cylindrical fit of the fuse plug in its bore in the upper half of the case makes an explosion-proof joint. No bolt holes are drilled through to the inside of the compartment. The top half was equipped with a pressure-relief device of the gauze-and-grid type. A special explosion-proof drain valve at the lowest point of the case must be in place and in working order to preserve the safety of the compartment.

The chief changes in the design of the cable-reel unit follow: The width of the flange has been increased slightly, probably to allow for variations in castings. An insulated stud using tubular terminal lugs held by nuts with lock washers replaced the original insulated stud which employed a set-screw-type connection for the hand cable to the motor. Service has shown that arcs from the switch destroy the gauze-and-grid-type pressure-relief device, which is being removed both from new reel units and from those already in service. A plate is riveted over the recess formerly occupied by the device and the space filled with plaster of paris. An insulating lining is also being placed on the case next to the switch contacts. In addition, 2 more bolts are used on new reel units to hold the 2 halves of the case together.

Extension of approvals 101 and 101A permits the type 312-H automatic reel truck, described under the Goodman Manufacturing Co. type 312-EJ shortwall machine covered by approvals 204 and 204A, to be used with types 12-CC and 12-EC machines. The revised design, described under extension of approvals 204 and 204A, was the form allowed for the present machine.

The Goodman Manufacturing Co. types 12-CC and 12-EC were the second mining machines approved by the Bureau. The type 23-C motor used on these machines is now considered obsolete. The reel-truck unit, however, is still supplied as part of other permissible machines made by the company.


Approvals 105 and 105A, covering types 12-CJ and 12-EJ standard-control, d.-c. shortwall machines, were issued to the Goodman Manufacturing Co. on June 21, 1920. Approvals 106 and 106A, covering types 112-CJ and 112-EJ universal-control, d.-c. shortwall machines, were issued to the company on February 9, 1922. Approvals 105 and 106 designate 210-volt machines and approvals 105A and 106A, 500-volt machines. The chief differences between the standard-control and the universal-control machines are mechanical.
The terms "standard" and "universal" as here used refer to designs in which only one or both rope drums are power-driven, respectively. One description will suffice for both types if the slight differences in the electrical accessories are pointed out.

Figure 2, A, shows the type 40-C motor unit of the form used on the standard-control machines as originally approved. The type 40-C motor is rated at 50 hp. on a 1-hour basis. The three compartments—motor, controller, and resistance—comprising this unit are isolated from each other to prevent an explosion in one compartment from propagating into the others. Tests have shown that propagation of explosions between the various compartments results in greatly increased pressures. The wires between the controller and motor pass through a narrow passage in controller neck a; an
asphaltum compound of high melting point is used to seal completely
the opening into the controller. In later machines plaster of paris
has replaced the asphaltum compound and should be used on earlier
machines if the seals are renewed in the field. The wires between
the motor and the resistance pass through a well which is filled with
an asphaltum compound of high melting point to form a seal. Con-
nection from the power supply to the inside of the explosion-proof
compartment is made by insulated studs at $b$. The outside terminals
are protected by the terminal cover with a bell-mouth cable entrance
and the insulated strain clamp for the cable as shown. Resistance
cover $c$, commutator cover $d$, and controller covers $e$ and $f$ are of cast
steel; they make wide, plane, metal-to-metal joints with the castings.
The opening into the motor for the wires from the controller is closed
by the controller neck, which makes a wide, plane, metal-to-metal
joint with the motor shell. The controller is held by 2 long and 2
short bolts as shown. The bottom cover of the controller is held by
4 hexagon-headed and 2 flat-headed cap screws; the fastenings for
the other covers are plainly visible in figure 2, $A$. None of the holes
for the fastenings go through to the interior of the explosion-proof
compartments. All fastenings are secured by lock washers except
the flat-headed screws, which should be prickpunched to prevent
loosening. A cast end plate, secured by eight $3/4$-inch bolts in
bottomed holes, closes the commutator end of the motor compart-
ment; it makes a wide, plane, metal-to-metal joint with the frame
casting. The motor bearings are of the sleeve type, and the oil wells
at the top and bottom of both bearings are closed by special explo-
sion-proof oil valves, which must be in place and in good order to
preserve the safety of the motor. A pipe plug closes a hole in the
motor end plate in line with the end of the shaft; this plug must also
be in place for safety. The outer ends of the controller reverse drum
and main drum are journaled in holes through cast-brass bearing
bushings $g$ and $h$. The bearings for the other ends of the shafts do
not go through to the outside of the case. The bearing bushings fit
into cylindrical holes bored in the bosses on the end of the controller
case. Lips on the outer ends of the bushings provide additional
length of metal-to-metal joint between the bushings and the case.
The bushing for the main drum is held by 3 and that for the reverse
drum by 2 flat-headed screws. A screw passes through the end of the
case between the two bearing bushings to support the finger board;
this screw must be in place, as omission would leave an opening into
the explosion-proof enclosure.

The cable-reel unit described under approvals 101 and 101A forms
part of types 12-CJ, 12-EJ, 112-CJ, and 112-EJ machines.

EXTENSIONS OF APPROVAL

When the universal-control machine (approvals 106 and 106A)
was approved the approvals of the standard-control machine (ap-
provals 105 and 105A) were extended to allow changes in the design
which made the electrical parts of the two nearly identical. Figure
2, $B$, shows the assembled machine without the cable reel after the
changes were made. The principal changes concerned the controller
and its attachment to the motor frame. The controller case and top
cover were changed to place the joint along the sides in a vertical plane. The joints at the ends of the cover remained horizontal. In other words, the changed top cover was the shape of a channel. Two bolts on each side at a hold the side joints tight, and a bolt at each corner draws the surfaces of the end joints together. The bottom cover and drum-shaft bearings are the same as on the original design. The neck of the controller was made rectangular instead of circular in cross-section, and the passage for the conductors was made to turn through an angle of 90° instead of being straight. The joint between the controller and motor at b was thus made horizontal instead of inclined to the horizontal. The only change in the motor was to make the plane of the joint for attachment of the controller horizontal.

The only difference between the electrical parts of the modified standard machine and the universal-control machine was in the controllers; these differed slightly in the shape and dimensions of the neck which joins them to the motor shell.

Only a few additional changes have been made in the motor shell since its modification to place the joint with the controller in a horizontal plane, and these have not materially affected the permissible features of the machine. The neck leading to the joint with the controller was changed to permit laying the controller back on top of the motor without disconnecting the wires, and the depression or trough in the casting for the wires connecting the armature, resistance, and controller was moved from the resistance side to the opposite side of the motor shell.

The outside terminal connections at the motor unit have been changed from a set-screw-type connection stud to studs taking tubular lugs secured by nuts with lock washers.

Extensions of the approvals have allowed several additional changes in the controller and two new types of controllers as optional equipment. Two of the four bolt lugs were lengthened, and the two short bolts that held the controller to the motor shell were replaced by longer ones. The top of the controller case and the cover for the universal-control machines were lengthened one-eighth inch. The changed cover, however, will fit the controller for the standard-control machine, as no change in the bolt spacing was made. A hole closed by a pipe plug has been placed in the necks of the controllers to facilitate proper sealing of the wires. Care should be taken to have this plug in place and secure.

The general design of the type 70 controller, the first of the two controllers allowed as optional, is similar to that of the original controller. The method of attachment to the motor shell and of sealing the entrance for the wires and the arrangement of the bearings for the controller drums and the screw through the end of the case for supporting the finger board are the same as on the original controller. The top cover is a flat, slightly dished, cast-steel plate (later changed to machine steel) which makes a wide, plane, metal-to-metal joint with the case; 12 flat-headed screws with nuts and lock washers hold the joint tight. The bottom cover is a flat, slightly dished, cast-steel plate which makes a wide, plane, metal-to-metal joint with the case; on the original design six hexagon-headed cap screws in bottomed holes held this cover. Later the number of cap screws was increased
to 12, and machine-steel covers were substituted for those of cast steel. The controller is intended for use on the 500-volt universal- and standard-control machines.

The second of the two controllers allowed as optional equipment is known as the 109 controller. The design differs considerably from the other controllers. The neck for attachment to the motor is absent, and lugs cast on the bottom of the case are used to support the controller. The bottom of the case is cast shut instead of closed by a bolted cover plate. The top cover is a flat, slightly recessed, cast-steel plate, which makes a wide, metal-to-metal joint with the case. Nine 1/2-inch flat-headed cap screws with nuts and lock washers and one flat-headed cap screw in a bottomed hole in the case and secured by a countersunk shakeproof lock washer fasten the cover to the case. The arrangement of the bearings for the controller drums and the screw through the end of the case for supporting the finger board is the same as for the other controllers. The six wires enter the case through a rectangular hole at the point where the neck was on the other controllers. A shallow housing with individual stuffing boxes for the wires is bolted over the opening to close the case. It meets the case in a wide, plane, metal-to-metal joint and is fastened by four bolts in bottomed holes; the bolts are secured by lock washers. A similar lead-entrance housing closes the opening into the motor when this type of controller is used. The wires between the motor and controller lead entrances are protected by a sheet-steel housing.

The type 312–H automatic reel truck described in connection with the Goodman Manufacturing Co. type 312–EJ shortwall machine, approvals 204 and 204A and extensions thereto, has been authorized by extension of approvals 105, 105A, 106, and 106A.


Approvals 107 and 107A, covering types 12–CC and 12–EC standard-control shortwall machines, were issued to the Goodman Manufacturing Co. on February 9, 1922. Approvals 108 and 108A, covering types 112–CC and 112–EC universal-control, d-c. shortwall machines, were issued to the company on February 9, 1922. Approvals 107 and 108 designate the 210-volt machines and approvals 107A and 108A, the 500-volt machines.

The type 23–E motor used on the machines covered by these four approvals is rated at 35 hp. on a 1-hour basis. The motor unit closely resembles the 40–C unit, described in connection with approvals 105 to 106A, after the standard-control machine had been modified to conform with the universal-control machine. In other words, the 23–E motor unit resembled the 40–C motor unit with the horizontal joint between the motor and controller—not the original standard-control machine with the joint inclined to the horizontal. The controllers are identical, and the same modifications in the controllers have been made. The two optional controllers have also been added to the 23–E motor unit.

Only a few noteworthy changes have been made in the motor by extensions of approvals: A commutator end plate, equipped with a
ball bearing instead of a sleeve bearing, has been added, the outside terminal connections at the motor unit have been changed from a set-screw-type connection stud to studs taking tubular lugs secured by nuts with lock washers, and the cast commutator cover has been replaced by a machine-steel cover.

The same cable reel described in connection with approvals 101 and 101A is a part of types 12–CC, 12–EC, 112–CC, and 112–EC machines.

The equipment covered by approvals 107 and 107A supersedes the old “standard” equipment, which included the type 23–C motor and was covered by approvals 101 and 101A.

The type 312–H automatic reel truck described under the Goodman Manufacturing Co. type 312–EJ shortwall machine, approvals 204 and 204A and extensions thereto, has been added by extension of approvals 107, 107A, 108, and 108A.

**TYPES 212–EJ AND 212–CJ, D–C. SHORTWALL CUTTING MACHINES, APPROVALS 113 AND 113A**

Approvals 113 and 113A, covering types 212–EJ and 212–CJ standard-control, low-vein shortwall cutting machines, were issued to the Goodman Manufacturing Co. on November 4, 1924. Approval 113 designates the 210-volt machines and approval 113A, the 500-volt machines. Figure 3 shows the machine without the cable-reel unit, which is the same as that described under approvals 101 and 101A.

The motor for these machines is the type 56–C, rated at 50 hp. The motor, controller, and resistance compartments are in one casting and are isolated from each other by dividing walls. The wires between them pass through individual holes fitted with insulating bushings. To guard against propagation of explosion from one compartment to another, the holes are long, and the wires fit closely in them. The two incoming power conductors pass through a well or cup sealed with plaster of paris and then enter the end of the motor compartment through holes with insulating bushings. The incoming cable passes through a bell-mouth entrance and is held by insulated strain clamp a. Connection between the conductors of the cable and the 2 wires entering the motor is made by 2 sleeve connectors held in a terminal block; the wires are held by set screws. Circular loom is used on the wires between the terminal block and the entrance to the motor; these wires are mechanically protected, partly by the framework of the machine and partly by a special sheet-metal cover. Plate-steel cover b closes the controller compartment. The cover and casting meet in a plane joint with wide metal-to-metal surfaces held in contact by studs with nuts and lock washers (fig. 3); the holes for the studs are bottomed where necessary to prevent them from cutting to the inside of the compartment. The feed-control shaft is operated through a pinion by handle c and the chain-clutch shaft, by handle e; they pass through both ends of the controller compartment. The controller drum and the reverse drum are operated by handles d and f, respectively.

The reverse-drum and control-drum shafts are concentric with each other, the control-drum shaft being journaled in the hollow reverse drum and the reverse-drum shaft being journaled in bearing plate or
Figure 3.—Goodman types 212-EJ and 212-CJ shortwall machine.
bushing $g$. A cylindrical portion of this bushing fits a hole bored through a boss on the end of the controller compartment. A lip on the outer end of the bushing rests against the end of the boss and is held by three flat-headed screws in bottomed holes. The second bearing for the reverse drum is inside the controller compartment. The rear end of the control drum, however, is journaled in a cup-shaped bushing of insulating material with a brass liner for the bearing surface. The bushing closes a hole through the end of the controller compartment. Steel-plate cover $h$, held by studs with nuts and lock washers, closes the inspection opening over the commutator. Wide, plane, metal-to-metal surfaces form the joint between the casting and cover. The opening into the resistance compartment is also closed by a steel-plate cover which meets the casting in a wide, plane, metal-to-metal joint held by studs with nuts and lock washers. Commutator end plate $i$ is held by four large studs with nuts and lock washers. A cylindrical lip on the plate fits into a bored hole in the motor shell, and the face of the plate meets the end of the shell. A step joint with wide metal-to-metal surfaces in contact is thus formed. The pinion-end bearing housing fits a hole bored in the end of the motor shell, and the wide, cylindrical metal surfaces form a flametight joint between the parts. A key riveted to the motor shell prevents the bearing housing from revolving and closes the opening through the keyway into the explosion-proof compartment. Ball bearings are used at both ends of the motor, and long, close running fits of the shaft through baffles back of the bearings prevent discharge of flame at these points.

**EXTENSIONS OF APPROVAL**

The changes in the original reel-truck unit have been discussed in connection with approvals 101 and 101A covering types 12–CC and 12–EC machines.

Several other interesting changes have been made. The set-screw connector between the incoming cable and the wires from the lead entrance to the motor has been replaced by a clasp connector. The studs and nuts holding the resistance cover have been changed; thin nuts are used to allow clearance on 36-inch-gage track. A slightly recessed machine-steel controller cover has been substituted for the plate-steel cover.

The type 312–H automatic-reel truck described under the Goodman Manufacturing Co. type 312–EJ shortwall machine, approvals 204 and 204A and extensions thereto, was added by extension of approvals 113 and 113A.

**TYPES 112–CK3 AND 112–EK3, A.-C. SHORTWALL CUTTING MACHINES, APPROVALS 114 AND 114A**

Approvals 114 and 114A, covering types 112–CK3 and 112–EK3 universal-control cutting machines, were issued to the Goodman Manufacturing Co. on February 7, 1925. Approval 114 designates the 220-volt machines and approval 114A, the 440-volt machines. The permissible features are the same for both types and voltages; no further distinction will therefore be made in the description of these machines.
Figure 4 shows a machine essentially the same as that discussed. It differs only in that the motor has a higher horsepower rating than the machines covered by approvals 114 and 114A; it will be discussed later. Figure 4, however, will illustrate either machine if the slight differences in details between the motors are pointed out.

The motor, type 35-C, is a three-phase, 60-cycle, squirrel-cage induction motor rated at 35 hp. The controller, type 70-J, is bolted to the stator frame of the motor. No resistance is used, as a Y-delta scheme is employed for starting the motor. The wires from the motor to the controller compartment pass through two holes lined with insulating bushings in the wall between the two compartments. Four wires pass through each bushing, and the close fit of the wires in the long bushings obstructs propagation of explosions between the two compartments. Care must be taken to see that wires of the proper size are used and that the insulating bushings are in place. Connection to the cable supplying power is made by insulated studs through the stator wall under terminal cover a (fig. 4), which has a bell-mouth entrance to protect the cable and an insulated strain clamp to guard the electrical connections against pulls on the cable. Special terminal lugs with D-shaped holes to fit a flat surface machined along the stud and so prevent their turning are used. The motor and controller form one unit without any outside wiring between them. The terminal connections at the motor are the only exposed live parts on this unit.

The joint between the controller case and the stator frame must be explosion-proof, as the wall of the stator closes the rear of the controller compartment. The controller casting meets the stator frame in a plane joint with wide metal surfaces held in contact by 10 cap screws secured by lock washers and screwed into bottomed holes in the stator frame. The front of the controller is closed by a slightly dished cast-steel cover, which meets the case in a plane-flange joint with wide metal-to-metal surfaces held in contact by 10 bolts with nuts and lock washers. The handle ends of both the main- and the reverse-drum shafts are journaled in holes drilled through bosses on the end of the case; the other ends are journaled in bottomed holes in two bearing plates or bushings, which fit into large holes bored through bosses on the end of the case. The holes are large enough to allow removal of the drums through them. The cylindrical fit of the bushings in the holes forms a flammertight joint with the case. Three flat-headed machine screws secure one bushing, and two flat-headed screws secure the other; the screws are in bottomed holes. A special screw passes through the handle end of the case to support the finger board; a cotter pin is used to prevent the screw from loosening. The screw must be in place to close the hole to the interior of the explosion-proof compartment.

The pinion end of the stator frame is closed by a cast-steel end plate. A circular turned lip projecting from the inner side of the plate fits the bored opening in the stator frame; the inner surface of the plate rests against the machined surface of the end of the stator frame. A step joint with wide metal surfaces in contact is thus formed between the end plate and stator frame. Four bolts with nuts and lock washers and three cap screws screwed into bottomed holes in the stator frame and secured by lock washers hold the end plate.
The housing for the ball bearing fits a hole bored through the center of the end plate, and the wide, cylindrical, metal surfaces form a flametight joint between the parts. A key fastened in its keyway in the end plate by rivets prevents the housing from revolving and closes the opening through the keyway into the motor. A gear case formed partly by the end plate and partly by an additional casting further obstructs the joint around the bearing housing. The other end of the stator frame is closed by a cast-steel end plate or ball-bearing housing. A narrow circular lip on the inner surface of the plate fits into a bored hole in the end of the stator frame; the surface of the plate rests against the flat machined surface of the stator frame. A step joint with wide metal surfaces in contact is thus formed. Three bolts with nuts and three cap screws in bottomed holes in the stator frame hold the end plate; lock washers prevent the fastenings from loosening. Four small screws in bottomed holes in the end plate hold the retaining cap for the bearing.

The close running fit of the shaft through baffles on the bearing housings at both ends of the motor is relied on principally to prevent the discharge of flame along the shaft.

The cable-reel unit includes the main switch-and-fuse protection for the machine and the reel for the trailing cable. The unit occupies the rear of the truck. Explosion-proof compartment b (fig. 4) contains the main switch and three isolated fuse compartments c. The fuses are mounted on holders or plugs; the design is such that a fuse is first disconnected from the circuit before the plug can be removed from the explosion-proof compartment. As each plug is isolated from both the switch compartment and the other plugs, the removal of a plug does not leave an opening into the explosion-proof compartments for the switch or the other plugs. Moreover, the fuse plug is in place and secured before the fuse can be connected in the circuit. A bayonet arrangement which requires turning the plug to release or lock it in place provides this interlocking. Wiping contacts, which are closed only when the plug is in the locked position, place the fuse in circuit. The switch is operated by handle d, which raises the 3 sliding contacts from slip rings attached to the shaft of the reel and at the same time opens 3 contacts between 3 controller-type fingers and stationary contacts on a terminal board at the end of the case. The switch thus opens each phase in two places. Connection from the slip rings to the cable on the reel is made by 3 single-conductor cables which pass through holes drilled in a large-diameter journal on the shaft. The wires fit closely in long holes through the journal, and the insulation for the slip rings obstructs the entrance to the holes from the interior of the compartment. A fiber rod which prevents rotation of the journal bushing relative to the shaft fits a drilled hole similar to those for the cables. This rod must be in place to close the hole into the explosion-proof compartment and to prevent strain on the cables by movement of the journal bushing. Connection to the cable from the motor is made by insulated studs through the side of the switch compartment. A terminal cover, e, with a bell-mouth exit and an insulated strain clamp protects the outside terminal connections and secures the cable.

The two halves of the switch compartment meet in a wide, plane, metal-to-metal joint and are held together by 8 bolts with nuts and 1 cap screw in a bottomed hole in the lower half of the case.
The fastenings are secured by lock washers. The journal bushing carrying the cables to the reel and the other end of the reel shaft are journaled in brass bushings which fit in semicylindrical seats in the lower half of the case and corresponding seats in bearing caps bolted to the lower and upper halves of the case; each cap is held by 2 bolts with nuts through lugs on the sides of its lower seat and 2 cap screws in bottomed holes in the side of the upper half of the case. The fastenings are secured by lock washers. Dowels prevent endwise motion of the bearing bushings. The bearing caps aid in holding the halves of the case together. The handle of the switch is journaled in a bearing plate bolted to the case by 5 cap screws in bottomed holes, 2 in the upper and 3 in the lower half of the case. The bearing for the other end of the shaft is journaled in a bottomed hole in the lower half of the case. The wide metal-to-metal joints between the bearing caps, the switch bearing plate, and the two halves of the case must be tight to keep the compartment explosion-proof. Cast-iron plate j closes the fuse section of the compartment. Wide, plane, metal surfaces form the joint between the case and plate; and 2 bolts with nuts and 2 cap screws in bottomed holes in the bottom half of the case and 5 bolts with nuts and 1 cap screw in a bottomed hole in the upper half of the case hold the plate. All fastenings are secured by lock washers. Three holes through the plate and three corresponding holes through the case are closed by the fuse units. The joints are formed by the long, cylindrical fit of turned surfaces on the fuse units in the holes through the case and plate. Each fuse unit consists of a cylindrical metal shell closed at one end by a brass cap screwed in its end and secured by a set screw which cannot be removed without removing the entire unit from the switch case. The other end is closed by the plug carrying the fuse element. The cylindrical fit between the metal end of the plug and the cylindrical case makes a flammertight joint. Connection to the contacts inside the fuse case is made by insulated studs with terminal lugs held by nuts. Special terminal lugs with D-shaped holes to fit a flat surface machined along the stud and so prevent their turning are used. Lock washers secure the nuts. The terminal connections and wiring to the fuses are entirely inside the switch compartment. A special explosion-proof drain valve at the lowest point of the switch case must be in place and in working order to preserve the safety of the compartment.

EXTENSIONS OF APPROVAL

Extensions of approval cover several minor changes in design. The only one that will be mentioned is the change from a set-screw-type stud to one with a tubular-lug-type terminal to connect the cable from the motor at the switch compartment.

TYPES 112-CL3 AND 112-EL3, A-C. SHORTWALL CUTTING MACHINES, APPROVALS 115 AND 115A

Approvals 115 and 115A, covering types 112-CL3 and 112-EL3 universal-control, a-c. cutting machines, were issued to the Goodman Manufacturing Co. on February 7, 1925. Approval 115 designates the 220-volt machines and approval 115A, the 440-volt machines.
The permissible features are the same for both types and voltages; no further distinction will therefore be made in the description of these machines.

Figure 4 shows the assembled machine. The motor, type 59-C, is a 3-phase, 60-cycle, squirrel-cage induction motor rated at 50 hp. No resistance is used, as a Y-delta scheme is employed for starting the motor. The cable reel and the controller are the same as those described under the types 112-CK3 and 112-EK3 machines covered by approvals 114 and 114A. In fact, the present machines differ from types 112-CK3 and 112-EK3 only in that the motor has a higher horsepower rating. Therefore, the previous description will serve for the present machines; the following differences between the motors, however, should be noted. The type 59-C motor is about 5 inches longer but of about the same height and width as the type 35-C. The end plate at the gear end is held by two 1/2-inch square-headed bolts with nuts and five 3/4-inch hexagon-headed cap screws in bottomed holes in the stator frame. The other end plate is held by four 3/4-inch square-headed bolts with nuts and two 3/4-inch hexagon-headed cap screws in bottomed holes in the stator frame. The general design is similar to that of the type 35-C motor.

EXTENSIONS OF APPROVAL

The same changes have been made in types 112-CL3 and 112-EL3 machines by extensions of approval as in types 112-CK3 and 112-EK3 machines.

TYPES 124-EJ, 124-EJ-82, AND 324-EJ, D.-C. SLABBING MACHINES, APPROVALS 118 AND 118A

Approvals 118 and 118A, covering 210-volt and 500-volt, type 124-EJ slabling machines, respectively, were issued to the Goodman Manufacturing Co. on March 12, 1925. Figure 5 is an assembled view. Approval 118A was extended on October 12, 1927, to cover the 500-volt, 124-EJ-82 slabling machine. On May 11, 1929, approvals 118 and 118A were extended to cover the type 324-EJ slabling machine.

The machine is self-propelling and remains on the track at all times. Type 56-D, 50-hp. motor \( a \), with the cutter-bar mechanism attached, is carried by a turret mounted to turn about a vertical axis on the front of the truck. The motor and cutter bar can be raised or lowered on guides \( b \) by racks to permit adjustment of the cutter bar to various heights.

The type 56-D motor drives the cutter chain and furnishes power for adjusting the cutter-bar height. A type 77, 10-hp. motor, \( c \), mounted on the rear platform of the truck rotates the turret about its vertical axis and furnishes power for propelling the machine. The remaining electrical accessories are mounted on the rear platform of the truck; they include two controllers \( d \) (type 60-U for 500-volt service or type 60-T for 210-volt service), resistance compartment \( e \), containing the resistance units for both motors, switch-and-fuse compartment \( f \), and reel \( g \) for the trailing cable. The wiring to the type 56-D motor is carried in hose conduit \( h \); all other
Figure 5.—Goodman type 124-EC slabbing machine.
wiring between the parts is either in rigid metal conduit or enclosed in junction-box compartments.

The type 56-D motor is compound-wound and rated at 50 hp. The magnet frame is closed at the commutator end by end plate \( i \), held by four 1-inch studs in bottomed holes; lock washers secure the nuts. A lip or spigot on the surface of the plate fits a bore in the end of the magnet frame, and the inner surface of the plate bears against the flat, machined surface on the end of the frame. A step joint having wide metal surfaces in contact is thus formed to prevent discharge of flame. A cap held by three screws in bottomed holes in the end plate covers the opening to the ball bearing. The long, close, running fit of the shaft through baffles on the inside of the bearing, however, furnishes the chief protection against discharge of flame along the shaft.

A flat, cast-steel plate, \( j \), held by twelve 5/8-inch studs riveted to secure them permanently in the magnet frame, closes the inspection opening to the brush rigging and commutator (fig. 5). Omission of a stud would leave a hole to the inside of the motor. Lock washers secure the nuts. Wide, flat metal surfaces form the joint between the plate and magnet frame.

The pinion end of the magnet frame is cast closed, except for a bored hole for the ball-bearing housing. The wide, cylindrical, metal surfaces form the flametight joint between the parts. A key riveted to the magnet frame prevents the bearing housing from revolving and closes the opening through the keyway into the explosion-proof compartment.

The electrical circuits enter the motor shell by insulated studs under terminal cover \( k \). Special terminal lugs with D-shaped holes to fit a flat surface machined along the stud and so prevent turning are used. The hose conduit is held by clamping blocks fastened under the terminal cover by 2 machine bolts screwed into bottomed holes in the magnet frame. The 2 studs and 2 cap screws holding the terminal cover also screw into bottomed holes. The terminal cover is sometimes arranged for entrance of the hose at the opposite end from that shown in figure 5. The unused entrance is closed by a steel plate held by 2 cap screws. All fastenings for the terminal cover are secured by lock washers.

The type 77 motor is compound-wound and rated at 100 hp. for 1 hour without exceeding a temperature rise of 75° C. The magnet frame is closed at the commutator end by cast-steel end plate \( l \), held by four 3/4-inch studs with nuts and lock washers. The studs are riveted permanently in place in the magnet frame, as omission of a stud would leave a hole to the inside of the motor. A lip on the surface of the plate fits a bore in the end of the magnet frame, and the inner surface of the plate bears against the flat, machined surface on the end of the frame. A step joint with wide, metal surfaces in contact is thus formed between the parts. A cap held by three screws in bottomed holes in the end plate closes the opening to the ball bearing.

The pinion end of the magnet frame is cast closed, except for a bored hole for the ball-bearing housing. A shoulder on the inner end of the housing bears against the inner side of the magnet frame and with the cylindrical surfaces forms a step joint between the
parts. A housing nut screwed into the housing holds the ball bearing in place. A short key prevents the housing from turning, but the keyway does not extend through to the inside of the motor. Two handhole covers are secured by padlocks, screw into the magnet frame over the commutator and brushes.

The electrical circuits enter the magnet frame by insulated studs under terminal cover. Special terminal lugs with D-shaped holes to fit a flat surface machined along the stud and so prevent turning are used. Figure 5 shows the rigid conduit coming into the right side of the terminal cover. The fastenings for the terminal cover and conduit screw into bottomed holes in the magnet frame.

The two controllers are essentially the same as the type 60 controller used on the types 112-CJ and 112-EJ universal-control machine described in connection with approvals 106 and 106A. An angle plate bolted to the entrance of the neck supports this end of the controller. The neck is filled with plaster of paris to seal the lead entrance. Wooden blocks just inside the angle plate, with holes for the wires, are used to space them properly as they leave the controller.

Resistance compartment consists of a base casting and a cylindrical shell or cover made of a semisteel, cast top plate and a cylinder of 12-gage steel plate with a cast-brass flange ring at its bottom. The cylinder is riveted to the top plate and to the flange ring; the longitudinal joint in it is also riveted. All riveted joints are brazed as well. The joint between the base casting and the flange ring of the cover is of tongue-and-groove type; that is, a tongue on the base fits into a corresponding groove machined in the flange ring. The wide metal surfaces in contact make the joint flame-tight. The cover is held by three long rods which screw into bottomed holes in the base casting and extend through holes in bosses on the top plate. Nuts screwed on the end of the rods and secured by cotter pins hold the cover (see fig. 5). The close fit of the rods through the top plate prevents discharge of flame. The resistance elements are of pancake type. The resistance assembly is held by two rods screwed into bottomed holes in the bottom casting. The top ends of the rods fit into bottomed holes in the underside of the cover plate to hold them in alinement. The wires enter the compartment through a well sealed with a compound of high melting point formed in the bottom casting.

Main switch and fuse with cable reel form a unit similar in general design to other reel units already described. Explosion-proof switch-and-fuse compartment contains the main switch and the main fuse mounted on a holder or plug. The design is such that the fuse is first disconnected from the circuit before the plug can be removed from the explosion-proof case, and the fuse plug is in place and secured before the fuse can be connected in the circuit. A bayonet arrangement which requires turning the plug to release or lock it in place provides this interlocking. Wiping contacts, closed only when the plug is in the locked position, place the fuse in circuit. Although the fuse plug is not supposed to be used as a switch to open the circuit, insulation linings of the case and insulation barriers around the contacts are provided to guard against grounding or short-circuiting, should the circuit be accidentally opened while
carrying current. The switch is operated by handle $p$, which raises the two sliding contacts from slip rings attached to the shaft of the reel and at the same time opens two contacts between two controller-type fingers and stationary contacts on a terminal board at the end of the case. Thus, the switch opens each side of the circuit in two places. An insulating lining in the top half of the case prevents arcs from the switch from jumping to the case. Connection from the slip rings to the cable on the reel is made by two single-conductor cables passing through holes drilled in a large-diameter journal on the shaft. The wires fit closely in long holes in the journal, and the insulation for the slip rings obstructs the entrance to the holes from the interior of the compartment. A fiber rod which prevents relative movement of the parts fits a drilled hole similar to those for the cables. This rod must be in place to close the hole into the explosion-proof compartment and to prevent strain on the cables. Connection from the switch and fuse to the circuits on the machine is made by two insulated studs under terminal cover $q$. The rigid metal conduit for the wires enters the terminal through a bell mouth and is held by the clamp as shown in figure 5.

The two halves of the compartment meet in a wide, plane, metal-to-metal joint and are held together by 9 bolts with nuts and lock washers. The large-diameter journal carrying the cables to the reel and the other end of the reel shaft are journaled in brass bushings which fit in semicylindrical seats in the lower half of the case and corresponding seats in bearing caps bolted to the lower and upper halves of the case; each cap is held by 2 bolts with nuts through lugs on the sides of its lower seat and by 2 cap screws in bottomed holes in the side of the upper half of the case. The bearing caps aid in holding the halves of the case together. The fastenings are secured by lock washers. Dowels prevent endwise motion of the bearing bushings. The handle of the switch is journaled in a bearing plate bolted to the case by 5 cap screws in bottomed holes, 2 in the upper and 3 in the lower half of the case. The bearing for the other end of the shaft is journaled in a bottomed hole in the lower half of the case. The wide, metal-to-metal joints between the bearing caps, the switch bearing plate, and the two halves of the case must be tight to make the compartment explosion-proof. A bearing plate for the fuse plug fits a hole bored through the side of the bottom half of the case. The wide, metal surfaces in contact between the parts form a tight step joint. Two studs permanently riveted in place in the case hold this bearing plate. The nuts are secured by lock washers. The cap on the fuse plug fits a hole bored through the bearing plate, and the wide, cylindrical surfaces in contact make a flamelight joint. The other end of the fuse plug is journaled in an insulated bearing in a bottomed hole in the case. A special explosion-proof drain valve at the lowest point of the case must be in place and in working order to preserve the safety of the compartment.

The wiring between the controllers and the resistance is enclosed in junction boxes to protect the wiring and provide a suitable place for connections between the wires from the various accessories. Because of the method of sealing the lead entrances to the resistance and controller compartments, wires must be spliced to allow them to
be removed with reasonable convenience. The junction boxes are lined with five-ply waterproof laminated fir to minimize the chances of grounding from defective wiring. The splices in the wires are made with Westinghouse knuckle-joint connectors; these are insulated as follows: 1 wrap 3/4-inch varnished cambric one half lapped (2 thicknesses), 1 wrap rubber insulating tape one half lapped (2 thicknesses), and 1 wrap friction tape one half lapped (2 thicknesses). A 6-inch length of varnished-cambric tubing is placed over the joint after it has been taped. The hose conduit carrying the wires to the turret motor is held by wooden clamp blocks just outside the point at which it enters the upper junction box. The rigid conduit carrying the wires from the switch-and-fuse unit and the rigid conduit carrying the wires to the type 77 motor enter the junction box behind the resistance unit. Nuts screwed on the ends of the conduits hold them to the wall of the junction box.

EXTENSIONS OF APPROVAL

Extensions of approval have allowed several important changes in design and several options. The terminals at the switch and fuse were changed from a set-screw type to studs with tubular lugs. A hole closed by a pipe plug, prickpunched to prevent loosening, has been placed in the controller neck to facilitate proper sealing of the wires; care should be taken to have the plug in place. A simpler arrangement of the conduit to the switch-and-fuse unit was made by changing terminal cover q (fig. 5) to place the entrance for the conduit in the opposite direction. The conduit is carried to the other end of the switch, thus eliminating the U-bend. At the same time a better clamp was provided for the end of the conduit, and the end of the platform of the truck was extended to the rear past the end of the switch compartment. The controllers were raised to give better access to the cover of the lower controller. This change made necessary some alterations in the junction boxes.

An auxiliary fuse unit has been added in the positive side of the circuit to the small motor. The case is a cylindrical casting open at both ends. One end is closed by a plate or cap which screws into the case; a small set screw prevents it from loosening. The other end of the case is closed by the end of a plug that carries the fuse element. Wide, cylindrical, metal surfaces make the joint between the plug and case flamelight. The design is such that the fuse is first automatically disconnected from the circuit before the plug can be removed from the explosion-proof case. Also, the plug must be in place and secured before the fuse can be connected in the circuit. An arrangement that requires turning the plug to release or lock it in place provides this interlocking. Wiping contacts which are closed only by turning the plug to the locked position place the fuse in circuit. The locking ring is held in the neck of the fuse case by four small set screws prickpunched to prevent loosening. Although the fuse plug is not primarily intended to be used as a switch, insulating linings for the case and insulation barriers are provided to guard against grounding or short-circuiting should the circuit be opened by turning the plug. Also, a spring-actuated mechanism incorporated in the design of the plug gives a quick make or break when the circuit is closed or opened by turn-
ing the fuse plug. The fuse rating is limited to 75 amperes for 210 volts and 40 amperes for 500 volts. Connections to the contacts inside the fuse case are made by insulated studs with terminal lugs held by nuts. Special terminal lugs with D-shaped holes to fit a flat surface machined along the stud and so prevent their turning are used. Lock washers prevent the terminal nuts from loosening. The fuse is mounted below the neck of the lower controller, and the terminals are enclosed by the truck frame and the lower junction box.

The magnet frame of the type 56-D turret motor has been increased one half inch in length, the fastenings for the commutator end plate have been changed from four 1-inch studs to eight ¾-inch studs, the cylindrical part of the joint between the end plate and magnet frame has been made one eighth inch wider, and another inspection opening opposite the original one has been added. The studs for the end plate are permanently riveted in place in the magnet frame to guard against holes into the motor. The cover for the added inspection opening is ½-inch flat steel plate. The wide, flat, metal surfaces in contact between the cover and magnet frame make a tight joint. Twelve ½-inch studs permanently riveted in place in the magnet frame hold the cover, and the nuts are secured by lock washers.

Type 82, a small motor of somewhat larger capacity than the type 77 motor, was allowed as optional; machines that use it must be designated type 124-EJ-82 slacking machines. The type 82 motor has a considerably higher 1-hour rating than the type 77 motor. The magnet frame is closed at the commutator end by a cast-steel end plate carrying the ball bearing and held by eight 5/8-inch hexagon-headed cap screws. The holes for the screws are bottomed in the magnet frame, and lock washers are used to prevent the screws from loosening. Wide, flat, metal surfaces form the joint between the plate and the magnet frame except at four places, where short lips which center the plate add to the width of joint and form step joints for short distances. Two handhole covers screw into holes through the end plate and are secured by padlocks. A cap or nut screws into the end plate to hold the bearing. As the oil drain leads back of this cap it cannot be considered to make a flame-tight joint with the plate. The close running fit of the shaft through the end plate inside the ball bearing furnishes the chief protection against discharge of flame. The brush rigging is held to the end plate by two studs permanently riveted in place to guard against holes through the plate into the motor.

The pinion end of the magnet frame is cast closed, except for a bored hole for the ball-bearing housing. A shoulder on the inner end of the housing bears against the inner side of the magnet frame and with the cylindrical surfaces forms a step joint between the parts. A housing nut secured by a small screw in a bottomed hole in the magnet frame screws into the end of the housing; a shoulder on the nut bears against the outside of the magnet frame and holds the parts in place. A key prevents the housing from rotating. Although the shoulder on the housing closes the inner end of the keyway care should be taken to have the key in place. The electrical circuits enter the magnet frame by insulated studs. A terminal cover of sheet
steel held by four 3/8-inch screws in bottomed holes in the magnet frame protects the outside connections. The rigid conduit is secured to an angle plate that closes an opening in the terminal cover and is secured to the magnet frame independently of the cover fastenings by two 3/8-inch screws in bottomed holes. Special terminal lugs with D-shaped holes to fit a flat surface machined along the stud and so prevent turning are used.

To improve the clearances for brush holders, etc., the no. 77 motor was superseded by the no. 77-B motor, the over-all height of which was 3/4 inch and the inside width and height 1/4 inch greater. The bore for the end plate was also increased by 15/8 inches over that of the type 77 motor. Connection to the 77-B motor is made by a five-conductor rubber-clad cable entering the magnet frame through an asbestos-packed stuffing box formed in a cast elbow fitting bolted over a hole through the side of the magnet frame by three 5/8-inch cap screws; the screws are in bottomed holes and are secured by lock washers. Wide, flat, metal surfaces in contact between the fitting and the magnet frame make a tight joint. A special clamp holds the conduit to the stuffing-box nut. The commutator end of the motor is closed by a cast-steel end plate held by eight 3/4-inch studs in bottomed holes in the magnet frame; the nuts are secured by lock washers. A lip on the surface of the plate fits a bore in the end of the magnet frame, and the inner surface of the plate bears against the flat, machined surface on the end of the magnet frame. A step joint with wide metal surfaces in contact is thus formed between the parts. A cap held by three screws in bottomed holes in the end plate closes the opening to the ball bearing and holds the bearing in place. The arrangement of the handhole and the pinion end of the motor is the same as on the no. 77 motor.

Approvals 118 and 118A were extended May 11, 1929, to permit option of the type 324-EJ slabbing machine. This machine differs from the type 124-EJ slabbing machine only in mechanical features relating to the mounting of the cutter bar. The permissible features are unchanged, except that the bottom inspection cover on the 56-D motor is fastened permanently in place by flat-headed machine screws riveted over inside the magnet frame.

The auxiliary fuse was moved to a position between the main switch-and-fuse case and the small motor; this change involved rearrangement of the junction box and conduit.

To permit "trammung" the machine without holding the trolley tap in the hand an extension of approval was issued authorizing arrangements for temporary connection of the trolley tap to a trolley pole while the machine is being trammed.

An extension of approval has been granted to permit the use of the no. 109 controller already described in connection with approvals 105 and 105A for the Goodman Co. types 12-CJ and 12-EJ machines.

**TYPES 224-EJ, 224-BJ, AND 424-BJ, D-C, SLABBING MACHINES, APPROVALS 172 AND 172A**

Approvals 172 and 172A, covering 250-volt and 500-volt, type 224-EJ slabbing machines, respectively, were issued to the Goodman Manufacturing Co. on April 30, 1929. An extension of approval issued May 13, 1930, allowed type 224-BJ and extension of approval
issued August 11, 1930, allowed type 424–BJ slabbing machines as optional. Figure 6 shows the type 224–EJ slabbing machine.

The machine is designed to operate in lower coal than the type 124–EJ slabbing machine but is similar in the lay-out and location of its accessories. All the accessories except the small 77–B motor are of different design from those on the type 124–EJ machine.

The machine is self-propelling and remains on the track at all times. The 50-hp., type 85–A motor \(a\), with the cutter-bar mechanism, is carried by a turret mounted so as to turn about a vertical axis on the front of the machine. The motor and cutter bar can be raised or lowered by racks \(b\) to adjust the cutter bar to various heights. The type 85–A motor drives the cutter chain and supplies power for adjusting its height. A type 77–B motor, \(c\), on the rear platform of the machine rotates the turret and furnishes power for propelling the machine. The remaining electrical accessories are mounted on the rear platform of the truck with the 77–B motor; they include 100–U controller \(d\), rheostat \(e\), and switch, fuse, and cable-reel unit \(f\). The wiring to the 85–A motor is carried in hose conduit \(g\); that to the 77–B motor and that from the switch-and-fuse unit are in rigid metal conduits terminating at the junction box between the resistance and controller compartments.

The type 85–A motor is compound-wound and rated at 50 hp. on a 1-hour basis. The magnet frame is closed at the commutator end by a cast-steel end plate which carries the ball bearing for the shaft. The plate is held by twelve \(\frac{5}{8}\)-inch studs in bottomed holes in the magnet frame; the nuts are secured by lock washers. Wide, flat, machined metal surfaces form the joint between the parts, except at two places where short lips which center the plate make step joints for short distances at the top and bottom. The retaining cap for the ball bearing is held by three cap screws in bottomed holes in the end plate. Four studs permanently riveted in place secure the brush rigging to the end plate. There are 2 inspection openings, 1 on each side of the magnet frame at the commutator end. These are closed by flat, rectangular machine-steel plates, each held by six \(\frac{1}{2}\)-inch cap screws in bottomed holes in the magnet frame; the cap screws are secured by lock washers. Wide, flat metal surfaces form the joint between the parts. A 3-inch-diameter hole just above one of the inspection openings is closed by the lead-entrance stuffing-box fitting, held by three \(\frac{5}{8}\)-inch cap screws in bottomed holes; the cap screws are secured by lock washers. Wide, flat metal surfaces form the joint between the magnet frame and this fitting.

The pinion end of the magnet frame is cast closed, except for a bored hole for the ball-bearing housing. A shoulder on the inner end of the housing bears against the inner side of the magnet frame and with the wide, cylindrical metal surfaces form a flambight step joint between the parts. A bearing retaining collar or cap is secured to the housing by three \(\frac{1}{2}\)-inch screws in bottomed holes in the housing. A key secured permanently in the key slot of the housing by a flat-headed screw prevents the bearing housing from revolving and closes the opening into the motor compartment.

A rubber-sheathed cable, having 4 no. 2 and 1 no. 10 conductors, enters the motor through an asbestos-packed stuffing box formed
Figure 6.—Goodman type 224-EJ slabbing machine.
in the fitting already mentioned. A special clamp attached to the stuffing-box nut holds the hose conduit.

The type 77-B motor (see c, fig. 6) has been discussed in connection with types 124-EJ and 324-EJ slabbing machines, approvals 118 and 118A.

The type 100-U controller (see d, fig. 6) contains the controllers for both motors in one unit. The semisteel case is divided into two isolated compartments by a vertical cast division wall; each compartment contains the controller for one motor. The bearings for the handle ends of the shafts of the main and reverse drums are in brass bearing plates or bushings. Each of the reverse-drum bushings is held by 2 flat-headed screws and each of the main-drum bushings, by 3 flat-headed screws; the screws are in bottomed holes and prick-punched to prevent loosening. The flame-tight joint between each bushing and the case is formed by cylindrical surfaces parallel to the shaft axis and flat surfaces at right angles to the axis. The bearings for the lower ends of the shafts are in bottomed holes in bosses on the bottom of the case. The entire front of the case is closed by a ribbed, malleable iron cover which makes an explosion-proof tongue-and-groove joint with the case; a tongue machined on the cover fits a corresponding groove machined around the opening in the case. Also, a groove in the partition between the two compartments of the case and a corresponding tongue across the cover prevent communication between the two compartments. The cover is held by two hinge pins which slip into holes in interleaving lugs along the upper and lower edges of the cover and case; the hinge pins are secured by a padlock to prevent unauthorized opening of the controller. The two studs securing the interlocking pawls go through the top of the case but are permanently welded in place to guard against through-holes. The electrical connections pass through the rear of the case as insulated studs. Special terminal lugs with D-shaped holes to fit a flat surface machined along the stud and so prevent turning are used. Lock washers prevent the terminal nuts from loosening. The outside connections are enclosed by the junction box between the controller and resistance compartments.

The resistance compartment (see c, fig. 6) contains the resistance elements for both motors. The case is of welded construction; the sides and bottom are of \( \frac{3}{8} \) inch steel plate, to which are welded numerous steel strips to give strength and rigidity. A rectangular frame of four \( 1\frac{1}{4} \) by \( 1\frac{1}{4} \)-inch machine-steel bars welded together is welded around the opening at the top of the case. The cover is a rectangular frame of four \( 1\frac{1}{4} \) by \( 1\frac{1}{4} \)-inch steel bars welded together with a \( \frac{1}{4} \)-inch dished-steel plate welded over them. It is held to the case by twenty-four \( \frac{1}{2} \)-inch cap screws secured by lock washers. The wide metal surfaces of the frames on the cover and the top of the case make a flame-tight joint between the parts. The circuits enter the case by insulated studs. Terminal lugs are not used for the outside connections. The ends of the wires are bent U-shaped, placed over the ends of the studs, and secured by a special clamp held by a nut on the stud. Lock nuts prevent loosening of the connections.

A sheet-steel terminal box attached to the resistance case covers and protects the outside connections. The controller terminals are
also in this terminal box, and the conduits to the other accessories are attached to it.

The switch, fuse, and cable-reel unit (see fig. 6) comprises the friction-driven reel for the cable and three isolated explosion-proof compartments—fuse, switch, and collector-ring. The three compartments are formed in two castings bolted together to form one unit. The switch is a two-pole, four-blade, single-throw type having quick-break blades isolated from each other and the case by arc barriers. It opens each side of the circuit in two places. The switch compartment is closed by a 32-inch machine-steel-plate cover \( k \) held by eight 1/2-inch hexagon-headed cap screws secured by lock washers; the screw holes do not lead to the inside of the compartment. The wide, flat, metal surfaces between the case and cover make a flameproof joint. The switch is operated by handle \( i \). The handle end of the switch shaft is journaled in a brass bearing nut screwed into a boss on the end of the case; the other end of the shaft is journaled in a brass bushing in a hole through the division wall between the switch and the slip-ring compartments. Cover \( j \) closes the section of the slip-ring compartment that extends over the switch compartment. The connections to the switch are directly under this cover. The cover is a 3/4-inch, flat, machine-steel plate held by ten 1/2-inch hexagon-headed cap screws secured by lock washers. The center cap screw on the slip-ring end is in a bottomed hole, and the other screws are in an overhanging lip of the casting and therefore do not enter the compartment. The wide, flat, metal surfaces between the cover and the case make a flame-proof joint. A hollow shaft carrying the slip rings is journaled in brass bushings held in cylindrical holes centered on the joint between the two castings of the unit. The journal on the cable-reel side is enlarged so that holes for the two wires from the reel can be drilled lengthwise through it. The entrances for the wires at the outer end are through asbestos-packed stuffing boxes machined in the end of the journal. The shaft for the reel passes through the center of the hollow shaft. The two castings meet in a plane joint, and the wide, flat, metal surfaces in contact make it flame-proof. Eight 1/2-inch square-headed machine bolts with nuts and lock washers hold the castings together. The fuse compartment is closed by cast semisteel hinged cover \( l \); which makes a tongue-and-groove joint with the case; a tongue on the surface of the cover fits into a groove machined around the opening in the case. Latchbar \( l \), hinged to the case, holds the cover shut. A mechanical interlock between the latchbar and switch prevents the cover from being opened when the switch is closed or the switch from being closed until the fuse cover is closed and latched. The fuse compartment contains a main fuse in the main positive line and an auxiliary fuse in the positive line to the small motor. The circuits leave the compartment through an asbestos-packed stuffing box by a rubber-sheathed cable having 4 no. 2 conductors and 1 no. 10 conductor. A clamp attached to the stuffing-box nut holds the end of the rigid conduit. The no. 10 and one of the no. 2 conductors are not used and are cut off short after the cable enters the compartment. The circuits through the switch-and-fuse unit are as follows: The two wires from the trailing cable
pass into the slip-ring compartment through stuffing boxes, from the slip-ring collectors the circuit is carried into the switch compartment by 2 insulated studs, from the switch it passes back into the slip-ring compartment by 2 insulated studs, and thence into the fuse compartment by 2 insulated studs; the outgoing circuits then leave the unit by the multiple-conductor cable through the stuffing box of the fuse compartment.

EXTENSIONS OF APPROVAL

Extensions of approval have allowed several changes and additions to the design originally approved. To permit trumming the machine without holding the trolley tap in the hand an extension of approval was issued authorizing arrangements for temporary connection of the trolley tap to a trolley pole while the machine is being trummed.

As already stated, the type 224–BJ slabbing machine was approved as optional under approvals 172 and 172A by extension of approval issued May 13, 1930. The two types of machines differ only in mechanical details, which do not affect the permissible features of the design in any way.

Two headlights were added by extension of approval, the change involving the addition of a headlight resistance compartment, fuses for the headlight circuit, and the conduit and wiring to the headlights. The fuses were placed in the interlocked main-fuse compartment and therefore did not require additional explosion-proof compartments.

The headlights are designated as the type V; they consist of a roughly hemispherical body and a cover or glass holder which screws into the body and is secured by a padlock. The glass is flat and one-half inch thick. It is cushioned with lead gaskets and is held firmly in place by a ring screwed against the back of the glass; a small set screw keeps the ring from loosening. The connections enter by insulated studs through the rear of the body. A terminal box formed in the body casting protects the outside terminal connections; the opening to the terminal box is closed by a sheet-steel cover held by two small screws. Tubular terminal lugs held by nuts secured by lock washers are used on the wires to the headlight, and a heavy paper barrier is held by the terminal studs between the lugs to prevent their coming in contact with each other. The hose conduit is secured in a special fitting bolted to the terminal box. A 95-watt bulb is used, and the socket is held in place by two studs permanently riveted in place through the bottom of the body casting of the unit.

The headlight resistance unit is enclosed in an explosion-proof compartment of welded construction; the bottom and sides are 1/16-inch sheet steel welded together and to a cast-steel frame at the top. Numerous stiffening pieces are welded to the plates. The cover is a flat, 3/8-inch, machine-steel plate held to the case by twelve 1/2-inch hexagon-headed cap screws in the top frame; the screws are secured by lock washers. The wide, plane, metal surfaces of the cover and top frame make a flametight joint. The connections to the inside of
the case are made by insulated studs; the outside connections are protected by a terminal box which is part of the case and is closed by a sheet-steel cover held by small machine screws. Tubular lugs are used on the wires and held by nuts secured by lock washers. Rigid metal conduit runs from the junction box at the main resistance to the junction box of the headlight resistance.

The headlights are mounted on the turret, one on each side of the machine. The two extra conductors in the cable from the fuse compartment which were dead in the original machine are used in the modified machine to carry the headlight circuit to the main junction box. A rigid conduit carries the circuit to and from the headlight resistance, which is mounted between the switch-and-fuse unit and the small motor. The headlight conductors from the main junction box to the turret are carried by the hose conduit to the turret motor. The hose clamp fitting at the turret motor is provided with a side outlet and clamp for a small hose, which carries the headlight conductors to one headlight. Another hose conduit carries the circuit from the first to the second headlight across the front of the machine; this conduit is run through a steel pipe to give better protection, as its position is somewhat exposed.

Approvals 172 and 172A were extended August 11, 1930, to include the type 424–BJ slabbing machine as optional. The machine is equipped with headlights. The electrical parts of the machine are the same as those for the type 224–EJ slabbing machine; the two types differ only in the mechanical parts and in the conduit leading from the fuse case to the junction box.

A type 77–D motor was allowed as optional with the type 77–B motor for 500-volt service. The explosion-proof features of the two motors are the same, the only difference between the motors being the use of a larger commutator with a corresponding brush rigging in the type 77–D motor.

The studs for the interlocking levers on the type 100–U controller which went through the explosion-proof case and were welded in place were replaced by a design bolting from the inside of the case, thus eliminating the through-holes. In the new arrangement the holes for the bolts are closed on the outside by plugs screwed and welded permanently in place. One object of the change was to permit ready replacement of parts.

The type 85–C motor, which differs from the type 85–A only in that the commutator is three fourths inch larger in diameter, with corresponding brush rigging, was included under the approvals.

The headlight resistance compartment has been changed from a box of welded construction to a malleable iron casting, and the lead entrances have been changed from insulated studs to asbestos-packed stuffing boxes.

The design of the cable-reel drum has been changed to conform with that allowed by extension of approvals 204 and 204A for the type 312–EJ shortwall machine described later. In the new design the enlarged journal is integral with the malleable iron end flange of the reel, and the leads enter it from an explosion-proof compartment also cast integral with this flange. The cables leave this compartment through asbestos-packed stuffing boxes.
MACHINES BUILT BY GOODMAN MANUFACTURING CO.  33

TYPES 12–EL3 AND 12–CL3, A–C. SHORTWALL CUTTING MACHINES, APPROVALS 197 AND 197A

Approvals 197 and 197A, covering types 12–EL3 and 12–CL3, a–c. shortwall cutting machines, were issued to the Goodman Manufacturing Co. on July 31, 1930. Approval 197 designates the 220-volt machines and approval 197A, the 440-volt machines. The electrical equipment on these machines is identical with that on the types 112–EL3 and 112–CL3 universal-control machines already described in connection with approvals 115 and 115A. The mechanical equipment is the same as that of the standard machines covered by approvals 105 and 105A. No further description of the machines will therefore be given.

TYPES 12–EK3 AND 12–CK3, A–C. SHORTWALL CUTTING MACHINES, APPROVALS 198 AND 198A

Approvals 198 and 198A, covering 220-volt and 440-volt, types 12–EK3 and 12–CK3, a–c. shortwall cutting machines, respectively, were issued to the Goodman Manufacturing Co. on August 1, 1930. The electrical equipment on these machines is identical with that on the types 112–EK3 and 112–CK3 universal-control, a–c. machines already described under approvals 114 and 114A. The mechanical equipment is the same as that of the d–c. shortwall machines covered by approvals 101 and 101A. No further description of the machines will therefore be given.

TYPE 312–EJ, D–C. SHORTWALL CUTTING MACHINE, APPROVALS 204 AND 204A

Approval 204, covering the 210-volt, type 312–EJ universal-control shortwall cutting machine, was issued to the Goodman Manufacturing Co. on October 13, 1930. Approval 204A, designating the 500-volt machine, was issued December 13, 1930. The electrical accessories of this machine comprise a type 97 motor unit (combining the motor, controller, and resistance) and a type 312–H automatic reel truck, which is a trailer separate from the rest of the machine. The trailer carries the main switch, the fuse protection, and the reel for the trailing cable.

The motor is compound-wound and rated at 50 hp. for 1 hour without exceeding a temperature rise of 75°C. The resistance and controller compartments are cast, one on each side of the motor field frame, but isolated from the motor compartment. The rear end of the motor is cast closed, except for a bored hole for the bearing housing, and the front end (commutator end) is closed by a cast-steel plate held by thirteen 5/8-inch studs, with lock washers securing the nuts, and one 5/8-inch flat-headed screw, prickpunched to prevent loosening. The holes for the fastenings are bottomed in the field frame. Wide, plane, metal surfaces in contact make the joint between the parts flametight; also, two short, circular lips which center the plate in the field frame form step joints for short distances at the top and bottom of the plate. The ball-bearing housings fit closely in bored holes through the end plate and the rear end of the field frame, respectively. The housings enter their bores from
the inside, and shoulders prevent them from passing completely through. At the front end of the motor an open bearing cap of larger diameter than the bore through the end plate is bolted to the bearing housing by four studs with nuts and lock washers to secure the ball bearing and the housing in place. The holes for the studs are bottomed in the housing. At the rear end a ring or cap which holds the bearing is fastened to the housing by four 3/8-inch flat-headed screws but is not large enough in diameter to clamp against the outside of the field frame. The wide metal surfaces in contact between the bearing housings and the field frame and the end plate make the joints flammertight. Keys are used to prevent rotation of the ball-bearing housings; small flat-headed machine screws fasten the keys in the keyways in the housings to guard against their omission in assembly. A bushing pressed into the inner end of the front bearing housing provides a close running fit for the shaft and should be in place to preserve the safety of the motor. Two circular holes in the field frame closed by screw covers permit access to the motor for inspection of the commutator and brushes. The resistance compartment is closed by a steel cover of welded construction held by twenty 1/8-inch cap screws secured by lock washers; the holes for the screws are bottomed in the casting to guard against through-holes. The cover is counterbored for the seven screws along the lower edge so that the screw heads are protected from damage and wear from the feed chain. The wide, flat, metal surfaces in contact between the cover and the main casting form a tight joint. Three operating rods which pass lengthwise through the resistance compartment are journaled with close fits in holes in bosses on the casting at each end of the compartment. The cover of the controller compartment is a ribbed, rectangular, semisteel cast plate, which makes a tongue-and-groove joint with the main casting; a tongue machined on the cover fits into a groove machined around the opening in the compartment. The cover is held by two steel pins through holes in interleaving lugs on the cover and casting along the two long sides of the compartment. The pins are arranged for padlocking to prevent the cover from being opened by unauthorized persons. A malleable iron bushing or bearing plate fits into a bored hole through the end of the controller compartment and is held by three flat-headed screws; these are in bottomed holes and are prickpunched to prevent loosening. The wide metal surfaces between the parts make a flammertight joint. A trunnion on the reverse drum is journaled in the bushing, and the shaft for the main drum is journaled in a hole through the center of the trunnion. The other bearings for the drums do not lead to the outside.

The leads from the cable-reel unit enter the end of the controller in a two-conductor rubber-clad cable through an asbestos-packed stuffing box. A combination bell mouth and clamp fitting protects and holds the cable and also prevents the stuffing-box nut from loosening. The wires between the controller and resistance compartments pass through the motor compartment in a rigid metal conduit welded at its end into the walls between the motor and the two other compartments. The wires between the motor and controller pass through a 2-inch length of conduit welded in place in the wall between the two compartments. There is no direct opening
from the resistance to the motor. Single-conductor, asbestos and varnished-cambrie, insulated cables are used for internal wiring. The cables fit in the conduits so closely that they obstruct propagation of explosions between the compartments of the motor unit.

The main switch, the fuse protection, and the reel for the trailing cable are carried on a separate two-wheeled truck, designated as the "type 312-H automatic reel truck." The reel is driven by friction wheels on the reel shaft which bear on the track wheels of the truck.

The switch-and-fuse unit differs in only a few details from that on the type 224-EJ slabling machine already described. The section of the case containing the switch is the same on both machines, except that the supporting lug has been shortened on the type 312-EJ machine. The slip-ring part of the fuse section has been lengthened about 2½ inches and the casting further modified to turn the lead entrance 90°; otherwise the unit is essentially the same as that on the type 224-EJ slabling machine. The cable-reel drum is an explosion-proof, welded-steel cylinder with flanges for retaining the cable welded to its ends. The large journal is welded to the flange on the end next to the switch-and-fuse unit; this end of the drum is thus closed, except for the holes for the shaft and the wires through the journal. The hollow shaft, of which the large journal was formerly a part, is omitted, and the large journal is keyed to the reel shaft. The end of the reel shaft is also journaled in the bearing between the two case castings in place of the hollow shaft. A steel ring is welded inside the other end of the drum, and a steel end plate is bolted to this ring by six ½-inch cap screws secured by lock washers; the holes for the screws are bottomed. The plate forms a step joint with the end of the drum, and the wide metal surfaces in contact make it flammetight. The shaft passes through a boss welded at the center of the end plate, and a ½-inch set screw in the boss prevents rotation of the drum relative to the shaft. The trailing cable enters the drum compartment through an asbestos-packed stuffing box. The 2 wires to the slip rings pass through 2 holes drilled through the large journal; connections between the trailing cable and these wires are made inside the explosion-proof drum. The short cable between the reel truck and the motor unit leaves the fuse compartment through an asbestos-packed stuffing box. A special fitting comprising an insulated strain clamp to hold the cable and a bell mouth to protect it from sharp bends is attached to the stuffing-box nut.

EXTENSIONS OF APPROVAL

The approval has been extended to include a type 97-B motor instead of the type 97 motor. The commutator for the type 97-B motor is three-fourths inch larger in diameter than that for the type 97, and the brush rigging differs accordingly; the two are the same in other respects.

The design of the reel for the trailing cable and the lead entrance from the reel to the slip-ring compartment has been changed considerably. A malleable iron casting comprising the large journal, one flange for the cable reel, and a short, cylindrical, explosion-proof compartment forms one end of the reel unit. Another malleable iron casting with a hub and set screw for securing it on the shaft forms
the other end of the reel. A riveted-steel cylinder fitting around the explosion-proof cylinder of the one end plate and riveted to a cylindrical portion of the other end plate connects the two. This riveted portion does not form an explosion-proof compartment. The wires from the slip-ring compartment pass through holes drilled lengthwise through the journal directly into the explosion-proof compartment of the reel flange casting and from there through individual asbestos-packed stuffing boxes into the reel cylinder, where connections are made with the wires of the trailing cable. The reel shaft fits closely through the large journal and a boss on the other end of the explosion-proof compartment of the reel flange casting. A key prevents rotation of the flange casting on the shaft.

TYPES 124–CJ AND 324–CJ, D.-C. SLABBING MACHINES, APPROVALS 207 AND 207A

Approvals 207 and 207A, covering types 124–CJ and 324–CJ slabling machines, were issued to the Goodman Manufacturing Co. on November 14, 1930. Approval 207 designates the 210-volt machines and approval 207A, the 500-volt machines. The main mechanical features of the machines are the same as those of types 124–EJ and 324–EJ described under approvals 118 and 118A, but the control equipment—which is on the rear platform—is essentially the same as that used on the type 224–EJ machine covered by approvals 172 and 172A.

The turret motor is the form of the type 56–D, with the front end plate fastened by 8 studs and with 2 inspection openings, already described. The cover of 1 inspection opening in the type 324–CJ machine is permanently secured in place by 12 flat-headed screws riveted inside the field frame, as in the type 324–EJ machine. The small motor is the type 77–B for 210-volt and the type 77–D for 500-volt machines described in connection with types 124–EJ and 224–EJ slabling machines, approvals 118 and 172A. The controller (type 100–U), rheostat, rheostat junction box, switch-and-fuse unit, and cable reel are essentially the same as those on the 224–EJ slabling machine. Two type V headlights and the headlight resistance unit are also the same as those for the 224–EJ machine. One headlight is mounted on the turret and one on the rear platform of the 124–CJ machine, whereas both are on the turret of the 324–CJ machine.

The wiring diagrams for types 124–CJ, 324–CJ, and 224–EJ machines are the same. The conduit to the headlight on the rear platform of the 124–CJ machine originates at the main resistance junction box; otherwise the arrangement of conduits is similar to that on the 224–EJ machine.

To permit tramming the machine without holding the trolley tap in the hand arrangements are provided for temporary connection of the tap to a trolley pole.

EXTENSIONS OF APPROVAL

The headlight resistance compartment has been changed from a box of welded construction to a malleable iron casting, and the lead entrances have been changed from insulated studs to asbestos-packed stuffing boxes.
The use of the type 77 motor on a few 210-volt machines has been allowed by extension of approval. This motor was described in connection with approvals 118 and 118A.

**TYPE 524–EJ, D.-C. SLABBING MACHINE, APPROVALS 216 AND 216A**

Approvals 216 and 216A, covering 210-volt and 500-volt, type 524–EJ slabbing machines, respectively, were issued to the Goodman Manufacturing Co. on February 12, 1931. The electrical accessories are nearly the same as those on the type 224–EJ slabbing machine covered by approvals 172 and 172A, but they have been rearranged on the type 524–EJ machine. This change requires different conduit and different junction-box arrangements at the resistance and the controller. An 85–B motor, which is somewhat different from the 85–C motor on the 224–EJ machine, is used. For 500-volt service the small motor is the type 82 motor of the type 124–EJ slabbing machine, not the type 77–B motor. Figure 7 shows the assembled type 524–EJ slabbing machine. The most noticeable difference between this machine and the type 224–EJ slabbing machine is the addition of a slack conveyor for carrying the slack to the rear of the machine while cutting. The duties of the two motors differ from those on the other slabbing machines. The turret motor, type 85–B, on the type 524–EJ machine drives the cutter chain, raises or lowers the cutter bar, turns the turret, and drives a small conveyor. The small motor, type 82 or 77–B, on the rear platform propels the machine and drives the main slack conveyor, the reel for the trailing cables, and a wire-rope power hoist drum.

The electrical accessories on the type 524–EJ slabbing machine include a type 85–B motor, a; a type 77–B motor for 210-volt and a type 82 motor for 500-volt machines, b; a type 100–U controller; a main resistance compartment, c; a switch, fuse, and cable-reel unit; 2 type V headlights (1 on the turret and 1 on the rear platform), d; and a headlight resistance compartment, e.

The type 82 motor was described in connection with the type 124–EJ slabbing machine. All other accessories except the type 85–B motor are the same as those described in connection with the type 224–EJ slabbing machine, but the junction boxes and arrangement of conduit are different. The type 85–B motor differs from the type 85–C motor in the following respects: The commutator end plate has been modified externally to provide for gears, etc., used with the drive for turning the turret, but the joint between the plate and the field frame and the fastenings for the plate have not been changed. The shaft has been extended for a pinion at the commutator end for the turret drive, and the bearing retaining cap is modified accordingly to allow the shaft to pass through it.

A rigid metal conduit runs from the switch-and-fuse unit to the controller junction box and thence to the main resistance, the small motor, and the headlight resistance unit. A hose conduit carries the wires from the controller junction box to the turret motor and the headlight on the turret; the hose-clamp fitting at the turret motor is provided with a side outlet and clamp for a small hose which carries the headlight conductors to the headlight. There is a small hose conduit from the headlight resistance box to the rear headlight.
Figure 7—Goodman type 524-EJ shoveling machine.
The wiring and scheme of connections are similar to those on the type 224-EJ slabbing machine.

EXTENSIONS OF APPROVAL

The approval has been extended to allow a change in the headlight resistance-box case—the box of welded construction has been replaced by a malleable iron casting. The lead entrances to this compartment were also changed from insulated studs to asbestos-packed stuffing boxes.

TYPE L-8CL3, A.-C. LONGWALL CUTTING MACHINE, APPROVALS 218 AND 218A

Approvals 218 and 218A, covering 220-volt and 440-volt, type L-8CL3, a-c. longwall cutting machines, respectively, were issued to the Goodman Manufacturing Co. on March 10, 1931.

The motor, type 78-C, is a three-phase, 60-cycle, squirrel-cage induction motor rated at 50 hp. on a 1-hour basis. A Y-delta scheme is employed for starting the motor. The rest of the electrical accessories at the machine are a type 86-E Y-delta reversing controller and a drum switch giving two breaks in each line. The machine is not permissible unless used with a permissible junction box to provide overload and short-circuit protection. The machine unit should be grounded to the junction box by a separate conductor in the trailing cable, which is therefore a four-conductor no. 3 rubber-sheathed cable. No cable reel is required.

The stator frame of the type 78-C motor is a ribbed-steel casting of rectangular cross-section. One end is closed by a cast-steel end plate carrying the ball bearing, and the other end is cast closed, except for a bored hole for a ball-bearing housing which fits into the bored hole through the stator frame; the wide, close-fitting, cylindrical metal surfaces between the parts make a fl ametight joint. The housing enters the bore from the inner side, and a lip on the inner end of the housing prevents it from going entirely through the bore. A dowel screw prevents the housing from rotating. A circular turned lip projecting from the inner side of the end plate fits the bored opening in the stator frame at the other end of the motor, and the inner surface of the plate rests against the machined surface of the end of the stator frame. A step joint is thus formed, with wide metal surfaces in contact between the parts. Six $\frac{3}{4}$-inch cap screws in bottomed holes in the stator frame hold the end plate; the screws are secured by lock washers. Since the fastenings are on a circle concentric with the opening into the stator a considerable width of the end plate at the sides of the motor is outside the bolt circle as the plate covers the whole end of the rectangular casting, the width of which is considerably greater than its height. The holes for the screws through the end plate are counterbored to bring the screw heads below the surface of the metal. The shaft is extended to take a pinion at both ends. Bushings pressed into the end plate and the bearing housing inside the ball bearings provide the close running fits necessary to the safety of the bearing assemblies; care should be taken that these bushings are in place. The wires from the controller enter the motor through a
short length of rigid conduit screwed into a hole through the end of the stator frame; the outer end of the conduit slips inside a short conduit or tube attached to the controller case, and the close fit between the cylindrical surfaces of the conduits makes a flamelight joint. The wires fit so closely in the conduits between the motor and controller that they obstruct propagation of explosions between the compartments. Asbestos and varnished-cambric cables are used so that hot gases will not burn the insulation and open a way for propagation of explosions between the compartments.

The controller case is a shallow rectangular box of welded construction, with one open side. A rectangular malleable iron cover closes the opening into the case. The joint between the cover and case is of tongue-and-groove type, a tongue on the face of the cover fitting into a rectangular groove machined in the surface of a cast-steel doorframe welded to the case. Steel pins passing through holes in interleaving lugs along the two long sides of the cover and doorframe secure the cover in place; the pins are arranged for pad-locking to prevent tampering. The handle ends of both the main- and reverse-drum shafts are journaled in two bearing plates or bushings that fit into large holes bored through bosses on the end of the case. The close-fitting cylindrical surfaces of the bushings in their holes through the case form flamelight joints. Three flat-headed machine screws secure each bushing; the six screws pass through lips on the outer ends of the bushings into bottomed holes tapped in the end of the case. The metal-to-metal contact between the lips and the end of the case adds to the effectiveness of the joint between the parts. The screws are prickpunched to prevent loosening. The bearings for the other ends of the drums are wholly inside the controller case. The short tube or conduit for the wires to the motor screws into a boss on the end of the case. The joint between this and the motor conduit has already been described. A short conduit welded to the controller case is provided for the wires from the switch; the end of the conduit terminates in a flange ring bolted to a corresponding ring on a short conduit attached to the switch case. A projecting end of the switch conduit slips inside the controller conduit, making a tight step joint held by four ½-inch cap screws secured by lock washers. The total length through the conduits from the switch to the controller is about 6 inches. The wires, which are asbestos and varnished cambric, insulated to prevent burning of the insulation by hot gases, obstruct the propagation of explosions between compartments.

The case for the drum switch is a cast-steel box-shaped casting closed by a flat, rectangular, ¾-inch, machine-steel cover held by twelve ½-inch cap screws; the screws are in bottomed holes in the case and are secured by lock washers. The wide, plane, metal surfaces of the case and cover in contact make a flamelight joint between the parts. The short conduit for the wires to the controller is cast integral with the case. The handle end of the switch-drum shaft is journaled in a brass bushing which in turn is journaled in a sleeve or hollow shaft journaled in a hole bored in a boss on the end of the case. The bearing for the other end of the drum does not cut through the case. The incoming circuits enter the case by a four-conductor rubber-sheathed cable through an asbestos-packed
stuffing box at the handle end of the case. A special fitting attached to the stuffing-box nut comprises an insulated strain clamp for the cable and a bell mouth to prevent sharp bends and damage to the cable insulation.

EXTENSIONS OF APPROVAL

No extensions of approvals 218 and 218A have been made to allow changes in the construction of the type L–8CL3 longwall machine.

TYPE 312–EL3, A.-C. SHORTWALL CUTTING MACHINE, APPROVALS 223 AND 223A

Approvals 223 and 223A, covering 220-volt and 440-volt, type 312–EL3, a.-c., universal-control shortwall machines, respectively, were issued to the Goodman Manufacturing Co. on May 13, 1931. The chief electrical parts of these machines are a type 103 motor, a type 115 controller, a type 21775 switch-and-fuse box, and a type 312–M cable-reel truck. The motor, controller, and switch-and-fuse box are bolted together to form a compact unit; the cable reel is mounted on a trailer truck.

The type 103 motor is a three-phase, 60-cycle, squirrel-cage induction motor rated at 50 hp. on a 1-hour basis. No resistance is used in starting the motor. The motor shell is cast steel; the inside cross-section is approximately trapezoidal, thus leaving considerable unoccupied space. Fan blades on the rotor and holes from end to end of the rotor are provided to circulate the air inside the motor shell and thus aid in cooling the windings. The sides of the shell are heavily ribbed to add strength and to aid in the dissipation of heat. The pinion end is closed by a ball-bearing housing which fits into a cylindrical bore through the end of the frame. The wide, cylindrical metal surfaces make a flametight joint between the parts. The housing enters its bore from the inside, and a lip on its inner end prevents it from going clear through. The bearing cap, which is attached to the housing by four 3/8-inch screws, is small enough to pass through the bore in the frame and thus allows slight endwise movement of the housing. A key fastened in its keyway prevents rotation of the housing in its bore. A bushing pressed into the inner end of the housing provides a close running fit for the shaft and prevents discharge of flame through the bearings. This bushing can be renewed if necessary to maintain the proper clearance, but care must be exercised to have it in place. The key that prevents rotation of the housing should also be in place for safety. The other end of the frame is closed by a cast-steel end plate which carries a ball-bearing housing. The construction is similar to that at the pinion end, except that the bearing cap is larger than the bore through the end plate and thus clamps the bearing housing and prevents any endwise motion. The cap is held by four studs with nuts and lock washers. The shaft projects through the cap at this end as well as at the pinion end. The joint between the frame and the end plate is plane except for short arcs at the top and bottom where short cylindrical lips accurately center the end plate. Twelve 3/8-inch studs with nuts and lock washers and one flat-headed screw prickpunched to prevent loosening secure the end plate. The wide
metal surfaces in contact between the end plate and the frame make the joint flammertight.

The type 115 controller case is a shallow, rectangular, cast-steel box with one open side. A rectangular cover made of a rectangular cast-steel frame closed by a plate of steel welded in place closes the open side of the case. The joint between the cover and case is of tongue-and-groove type, a tongue on the cover fitting into a rectangular groove machined around the opening into the case. Steel pins passing through holes in interleaving lugs along the two long sides of the case and cover hold the cover in place. One is permanently secured and serves as a hinge pin, while the other can be removed to open the cover; the latter pin is padlocked to prevent tampering. A malleable iron bearing bushing held by three flat-headed screws passing through a lip on its outer end and into bottomed holes in the end of the case fits into a bored hole through the handle end of the case; the heads of the screws are prickpunched to prevent loosening. The wide metal surfaces between the parts form a flammertight joint. A trunnion on the reverse drum is journaled in the bearing bushing, and the shaft for the main drum is journaled in a hole through the center of the trunnion. The other bearings for the main and reverse drums do not lead to the outside of the case.

The case for the type 21775 switch and fuse is an irregularly shaped cast-steel box with two main openings, one on the top over the switch section and one in the side into the fuse section. The two sections of the case are isolated from each other except for the opening for the wires between them. The switch is a three-pole, six-blade, single-throw type having quick-break blades, isolated from each other and the case by arc barriers. The opening into the switch section is closed by a 3/8-inch steel-plate cover held by fourteen 1/2-inch hexagon-headed cap screws secured by lock washers; the holes for the screws do not lead to the inside of the case. The wide, plane, metal surfaces in contact between the case and cover make the joint flammertight. The switch is operated by a controller-type handle. The handle end of the switch shaft carries a sleeve journaled in a brass bearing nut screwed into a boss on the end of the case. The metal surfaces at the handle are sufficiently long and close-fitting to make a flammertight joint through the bearing. The bearing for the other end of the shaft does not lead to the outside. The opening into the fuse section is closed by a cast-semisteel hinged cover. The joint between the case and cover is of tongue-and-groove type, a tongue in the surface of the cover fitting into a rectangular groove machined around the opening into the case. A latchbar hinged to the case holds the cover shut. A mechanical interlock between the latchbar and switch prevents the cover into the fuse compartment from being opened when the switch is closed or the switch from being closed when the cover is open; the fuse terminals, therefore, are always dead when the cover is open, and the fuses can be renewed safely without hazard of shock or explosion.

The hand cable from the cable-reel truck enters the switch-and-fuse compartment through an asbestos-packed stuffing box. A combination bell mouth and insulated strain-clamp fitting protects and holds the cable. The wires from the switch-and-fuse compartment
pass into the motor through a short tube on the motor shell that slips into a hole bored through a boss on the side of the switch-and-fuse compartment. The close-fitting metal surfaces make the joint flametight. Similarly, the wires from the controller to the motor pass through a short tube on the other side of the motor shell that slips into a hole bored through a boss on the controller case. There is no direct passage for wires between the controller and the switch-and-fuse compartments. The wires obstruct the propagation of explosions through the short communicating tubes between the compartments, and asbestos and varnished-cambric, insulated cables prevent hot gases from burning the insulation in case of an explosion. Although the tests have shown that propagation of an explosion from one compartment to another is possible under certain circumstances no high pressures or other dangerous conditions would be developed by an explosion if all the compartments are closed and in proper repair.

The reel for the trailing cable is carried by a separate two-wheeled truck, designated the "type 312-M automatic reel truck." The reel is driven by friction wheels on the reel shaft which bear on the track wheels of the truck. The cable-reel drum is explosion-proof. It is constructed of a welded-steel cylinder with flanges for retaining the cable welded to its ends. A large journal is welded to the flange on the end next to the slip-ring compartment; the flange closes this end of the drum, except for the holes through the journal for the shaft, the wires, a key, and a fiber pin which keeps the slip-ring assembly from turning. The shaft is keyed to the large journal so that the latter and the drum turn with the shaft. A steel ring is welded inside the other end of the drum, and a steel end plate is bolted to this ring by six ½-inch cap screws secured by lock washers; the holes for the screws are bottomed in the ring. The plate forms a step joint with the end of the drum, and the wide metal surfaces in contact make it flametight. The shaft passes through a boss welded at the center of the end plate, and a ½-inch set screw in this boss prevents endwise movement and helps the key at the other end to prevent rotation of the drum relative to the shaft. The trailing cable enters the side of the drum compartment through an asbestos-packed stuffing box, and a clamp around the cable inside the drum helps secure it in place. The 3 wires to the slip rings pass through 3 holes drilled through the large journal; connections between the trailing cable and these wires are made inside the explosion-proof drum. The slip-ring compartment is a short, cylindrical, cast-iron case, cast closed at one end. The other end is closed by a slightly dished, circular, cast-iron cover which makes a plane joint with the case; it is held by twelve ½-inch bolts passing through holes in the cover and the overhanging flange lip on the end of the case; the nuts are secured by lock washers. The wide metal surfaces in contact make the joint flametight. The large journal on the drum is journalled in a brass bushing in a hole through a boss at the center of the end of the slip-ring case. The shaft carrying the slip-ring assembly passes through and is journalled in a brass bushing in a hole through a boss at the center of the slip-ring-case cover. The long bearing fits make the bearings
flametight. A steel collar pinned to the shaft prevents displacement of the parts. The short cable to the motor unit is a rubber-sheathed cable and leaves the slip-ring compartment through an asbestos-packed stuffing box on the side of the case. A bell mouth at the outer end of the stuffing-box nut protects the cable.

**TYPE 624-CJ, D-C. SLABBING MACHINE, APPROVAL 242**

Approval 242, covering the 210-volt, type 624-CJ slabbing machine, was issued to the Goodman Manufacturing Co. on April 7, 1932. The essential difference between this machine and the other slabbing machines described lies in the addition of a second cutter bar, carried by the turret for shearing the coal.

Figure 8 shows the type 624-CJ slabbing machine. The turret at the front of the self-propelled truck carries the two cutter bars; a type 56-H motor, \(a\), which furnishes the power for operating them; and a type V headlight, \(b\). The turret is rotated about a vertical axis by gear \(c\). Splined shaft \(e\) supplies power to shearing bar \(d\) and permits it to be moved from the position shown to the rear, where it will not interfere with rotating the turret in undercutting with the other bar. The undercutting chain is also driven through a short, splined shaft which allows vertical movement through a limited range. Type 100-U controller \(f\), main resistance compartment \(g\), headlight resistance \(h\), cable-reel and switch-and-fuse unit \(i\), a second type V headlight, \(j\), and the propelling motor (type 77-B or type 77) at \(k\) are carried on the rear of the truck. The arrangement of the accessories on the truck is similar to that on the type 224-EJ slabbing machine already described in connection with approvals 172 and 172A.

The type 100-U controller and the main resistance are the same as those described under approvals 172 and 172A. The type V headlights and the headlight resistance have been described under extensions of these approvals. The headlight resistance compartment is that with malleable iron case and asbestos-packed stuffing-box lead entrances. The type 77-B motor is the same as that on the type 224-EJ machine. It was described under extensions of approvals 118 and 118A, type 124-EJ slabbing machine. The optional type of motor was described under approvals 118 and 118A. The cable-reel and main switch-and-fuse unit is the same as the original design described under approvals 172 and 172A, the form having a cable-reel drum of welded construction.

The type 56-H turret motor is similar to the type 56-D motor described under approvals and extensions of approvals 118 and 118A. The shaft is extended at both ends of the motor, making the bearing arrangement somewhat different at the commutator end from that of type 56-D. The commutator end plate, however, is virtually the same as that held by the eight fastenings on the type 56-D motor except for a somewhat larger diameter and a narrower seat for the ball bearing and external brackets for the gearing added in connection with parts driven from this end of the motor. The lower commutator inspection opening through the frame is closed permanently by a machine-steel plate welded in place. The lead entrance has been shifted to the other side of the motor.
The arrangement of conduit and wiring is similar to that on the types 124-CJ, 324-CJ, and 224-EJ machines; all conduit is rigid metal except the hose conduits to the two headlights and to the turret motor. Clamp l (fig. 8), fastened on top of the propelling motor, holds the hose conduit leading to the turret motor.

EXTENSIONS OF APPROVAL

No extensions of approval 242 have been allowed.

TYPE 319-C  D.-C. SHEARING MACHINE, APPROVAL 244

Approval 244, covering the 250-volt, type 319-C shearing machine, was issued to the Goodman Manufacturing Co. on June 18, 1932. Figure 9 shows the machine without the switch, fuse, and cable-reel unit, which is the 312-H automatic reel truck. (The 12-H reel truck is optional.) The reel truck is an essential part of the machine, as it carries the main switch, the fuse protection, and the reel for the cable. The machine is self-propelling and remains on the track at all times. While cutting, the machine remains stationary, and the cutting element advances; the cut is made about 8 inches to the right of the center of the track. The cutting arm is raised by power; the sumping cut is made at the too and the cutter arm then fed downward to complete the cut.

The electrical accessories on the type 319-C shearing machine include a 5B motor, a (fig. 9); a 109 controller, b; a resistance compartment, c; and a 312-H reel truck carrying the cable reel and the main switch and fuse.

The 5B motor is rated at 25 horsepower. One end of the cast-steel motor shell or magnet frame is cast closed, except for the shaft openings and the inspection opening to the commutator and brushes. A ½-inch steel plate, d, held by ten ¼-inch cap screws in tapped bottomed holes, closes the latter opening; lock washers secure the cap screws against loosening. The wide, flat, metal surfaces in contact form a flame-tight joint. The other end of the magnet frame is closed by a cast-steel end plate held by ten ¼-inch cap screws in tapped bottomed holes in the end of the magnet frame; the cap screws are secured by lock washers. Flat metal surfaces form the joint between the magnet frame and the end plate, except at two places, where lips on the face of the plate which fit into a partial bore in the magnet frame to center the end plate make a step joint. The wide metal-to-metal contact between the parts makes the joint flame-tight. The shaft extends through both ends of the motor; it is journaled in brass bushings fitting through the end of the magnet frame and the end plate, respectively. The long, close bearing fits prevent discharge of flame along the shaft. The upper oil reservoir of the end plate is isolated from the interior of the motor by a steel plate welded in place on the inside; a pipe plug and an oil pipe lead to it outside. The upper oil reservoir at the other end is separated from the interior of the motor by the casting wall; the opening to the outside is closed by a steel plate held by two cap screws. Both lower oil reservoirs are closed by special explosion-proof drain valves screwed and welded in place, because these reservoirs connect with the interior of the motor through oil drains drilled through the
Figure 9.—Goodman type 319-C shearing machine.
castings. The wires enter the motor through individual asbestos-packed stuffing boxes in the magnet frame under housing $e$. Two $\frac{1}{2}$-inch cap screws secured by lock washers in tapped bottomed holes in the magnet frame hold the housing to the motor.

The 109 controller was described under extensions of approvals 105, 105A, 106, and 106A. Housing $f$ not only carries the stuffing boxes for the wires entering the controller but serves several other purposes; it differs considerably from the housing for the shortwall machine. It is bolted to the motor and serves as a support for the controller, which is bolted to it by four $\frac{5}{8}$-inch cap screws secured by lock washers in tapped bottomed holes in the controller case. The wide, flat, metal surfaces in contact at the joint prevent discharge of flame from the controller lead entrance. The housing also has a bell-mouth entrance with an insulated strain clamp for the cable from the switch, fuse, and cable-reel unit. Connections between the various wires are made with Westinghouse knuckle-joint connectors in a junction box which forms one section of the housing; this section leads directly into cover $e$ over the lead entrance to the motor. (See fig. 9.)

The resistance compartment is a shallow cast-steel box closed by a $\frac{3}{8}$-inch steel plate held by sixteen $\frac{5}{8}$-inch cap screws secured by lock washers; 4 screw holes are bottomed to prevent their leading to the inside, and the others go through the overhanging lip of the casting outside the compartment. The wires enter through individual asbestos-packed stuffing boxes at $g$. A terminal cover protects the wiring at the lead entrance. Rigid conduit $h$ carries the wires from the motor lead-entrance housing to the resistance.

The 312–H automatic reel truck described in connection with the type 312–EJ shortwall machine, approvals 204 and 204A, is an essential part of the 319–C shearing machine. The revised design described under extensions of approvals 204 and 204A was the form approved for the present machine.

The optional 12–H reel truck was described under approvals 101 and 101A for the types 12–CC and 12–EC shortwall machines. The forms allowed for the type 319–C shearing machine embodied the various changes that have been allowed by extensions of approval.

EXTENSIONS OF APPROVAL

No extensions of approval 244 have been granted.

APPROVED MACHINES BUILT BY THE JEFFREY MANUFACTURING CO.

TYPE 28–A, D.-C. SHORTWALL CUTTING MACHINE, APPROVALS 102 AND 102A

Approvals 102 and 102A, covering 250-volt and 500-volt, type 28–A shortwall cutting machines, respectively, were issued to the Jeffrey Manufacturing Co. on November 2, 1917. The electrical accessories for these machines comprise the class MM–26–L motor unit (fig. 10), the reel, and the switch-and-fuse unit (fig. 11). The reel and the switch-and-fuse unit are mounted on the machine truck. This motor, reel, and switch are described in Bureau of Mines
Bulletin 78. For completeness, the motor unit will be described briefly and the reel and the switch-and-fuse unit, including changes in its construction made since the publication of Bulletin 78, in detail because they are used on several other cutting machines to be described.

The type MM-26-L motor unit (fig. 10) includes the motor, starting box \(a\), and resistance box \(b\). The motor is rated at 35 hp. for 1 hour without exceeding a temperature rise of 75° C. One end of the motor shell is cast closed, except for a comparatively small opening for the gear-end bearing housing; the other end is closed by commutator-end bearing housing \(c\), a large, steel casting covering the whole end of the field frame and fastened to it by screws. A large opening at the top of the commutator-end bearing housing permits access to the commutator and brush rigging; it is closed by cast-steel commutator door \(d\) fastened in place by eight \(\frac{3}{8}\)-inch studs with nuts and lock washers. Riveted to the field frame is a steel plate \(e\), to which the starting box is fastened by cap screws. The starting box is a two-part flanged casing, the parts of which are bolted together by six \(\frac{1}{2}\)-inch bolts with nuts secured by lock washers. Figure 10 shows a starting-box cover with a smooth outer surface; this was later replaced by one of ribbed construction, and two additional holes were added to fasten the top half of the case to the bottom half. The rheostat compartment is bolted to the field frame by four \(\frac{5}{8}\)-inch cap screws. Its heavily ribbed cover is fastened in place by twelve \(\frac{1}{2}\)-inch cap screws. The 250-volt resistor unit is the iron-grid type, and the 500-volt resistor originally was the pancake-coil type but later was changed to nichrome wire.

All joints between the covers and the various compartments have broad metal-to-metal contact between the parts. All holes that would otherwise lead into any compartment from the outside, except those for the brush rigging and for the field poles, are bottomed or are closed by studs permanently riveted in place. The motor is equipped

Figure 10.—Motor unit of the Jeffrey type 28-A shortwall machine.
with ball bearings, but these are not depended upon to prevent discharge of flame along the shaft; the shaft fits closely through baffles.

The wiring between the motor, the controller, and the rheostat compartments is run directly from one compartment to another through openings for that purpose. As these wires are within the casings they are well protected. Terminal cover $f$, with a bell mouth and an insulated strain clamp, secures the cable and protects the terminal connections. Connection to the inside is by insulated studs.

The cable reel and switch-and-fuse unit (fig. 11) is an essential part of the machine. The switch-and-fuse compartment (camel-back switch) is a substantial cast-iron box with a cast-iron cover hinged at the bottom and held by lugs $a$ at the top as shown. Switch handle $b$, in the position shown, prevents sidewise movement of the cover. When the switch is open the cover can be released from the

![Diagram](image.png)

**Figure 11.**—Jeffrey cable reel with switch and fuse.

lugs. The two connection plugs $c$ for the hand cable to the motor unit are secured by lugs on top of the cover. The interlocking arrangement prevents the cover from being open or the connection plugs inserted or removed, except when the switch is open. Connection to the inside of the compartment is by insulated studs. The outside terminal connections and the sockets for connection plugs $c$ are protected by sheet-steel cover $d$, which closes a recess formed in the top of the casting. This terminal compartment is not explosion-proof. The fuse is surrounded by barriers of insulating material, the single-pole knife switch is also isolated from the fuse and the wall of the compartment by insulating barriers, and the entire compartment is lined with asbestos.

The electrical connections from the trailing cable are made through the cable-reel bearings, the bearing surfaces serving as sliding contacts. A short, insulated, steel shaft attached to each end of the
reel is journaled in an insulated brass bushing enclosed by a cast-
iron bearing housing, as at e. Terminals are provided at the inner
ends of the shafts and at the bearing bushings for connecting the
wires. Pipe plug f closes a hole through which the terminal con-
nection on the bushing can be tightened. The parts are so housed
that any sparks at the bearing surfaces cannot initiate an explosion
that will ignite an explosive atmosphere surrounding the apparatus.
Figure 11 shows the bell-mouth lead entrances at the cable reel and
the switch and the flexible metallic conduit between these two com-
partments.

EXTENSIONS OF APPROVAL

The changes in the camel-back switch and fuse and the cable reel
were first authorized by approvals 103 and 103A covering the
type 35–B machine described later and were then applied to the type
28–A machine. Therefore, description of these changes will not be
given here. The authorized changes in the class 21 starting box are
also the same as those described under the 35–B machine. The
trailer-truck cable reel described under the type 35–BB machine has
also been added to the type 28–A machine by extension of approval.

A three-conductor hand cable has been allowed for the type 28–A
machine, the third conductor being used to connect the motor frame
to the reel truck, which is then grounded. A trolley pole was added
to the machine to afford a rolling contact for the trolley tap when
trammimg.

The Jeffrey types 28–A and 35–B shortwall machines were ap-
proved at the same time. The manufacture of the 28–A machine has
been discontinued because the more rugged construction of the 35–B
machine makes it more suitable for most mining conditions.

TYPE 35–B, D.-C. SHORTWALL CUTTING MACHINE, APPROVALS 103
AND 103A

Approvals 103 and 103A, covering 250-volt and 500-volt, type
35–B shortwall cutting machines, respectively, were issued to the
Jeffrey Manufacturing Co. on November 2, 1917. The electrical ac-
cessories for these machines are the class MM–125 motor, the class
21 starting box, the reel, and the switch and fuse. Figure 12 shows
a modern type of the complete machine. The type 35–B machine
was originally equipped with the same reel and switch-and-fuse box
as the 28–A machine previously described.

The MM–125 motor and the resistance are enclosed in the same
casting with a cast partition wall between them. Figure 12 shows
resistance compartment a with its cover fastened in place with cap
screws but does not show the starting-box compartment at b plainly.
The starting box is the same as that used on the type 28–A machine
previously described but is bolted directly to the outer wall of the
motor frame. Figure 13 shows a motor with the same mounting
for the starting box as that for the type 35–B machine. Thus the
motor is between the resistance and starting-box compartments.
The leads between the motor and starting-box compartments origi-
nally went directly through an opening; the leads between the motor
and the resistance go through packed stuffing boxes. One end of
the motor shell is closed, except for a comparatively small bored
opening for the gear-end bearing housing. The housing enters the bore from inside the motor, and a machined surface on the housing bears against the inside of the field frame; a step joint with wide metal surfaces is thus formed between the parts. Two studs permanently riveted in the housing pass through holes in the end of the field frame and hold the housing in place. The other end of the motor shell is closed by a large steel casting which covers the whole end of the field frame and is fastened to it by six large cap screws. This end plate carries a cartridge-type bearing housing which enters a bored hole through it from inside; a shoulder on the housing prevents it from going entirely through the bore. The bearing cap screws into the housing from the outside and fastens it in place, as a lip on the cap bears against the outside of the end plate. A small screw in a bottomed hole prevents the cap from unscrewing, and a key prevents rotation of the bearing housing; the key should be in place for safety. Cast-steel commutator door $d$, held by studs, permits access to the commutator and brushes.

The 250-volt resistor unit is the grid type, and the 500-volt unit originally was iron ribbon wound in pancake form.
All joints between the covers and the various compartments have
broad metal-to-metal surfaces in contact. All holes that would other-
wise lead into any compartment from the outside, except those for
the field-pole bolts, are bottomed or are closed by rivets or studs
permanently secured in place. The shaft fits closely through baffles
at the inner ends of the bearing housings. At the commutator
end a sleeve on the shaft provides the close fit necessary to prevent
discharge of flame along the shaft; the ball bearing, the bearing
cap, and a special washer attached to the end of the shaft furnish
additional protection. Similarly, at the pinion end the ball bearing
and the running fit between the bearing nut on the shaft and the
retaining ring screwed into the housing give additional protection.
The grease cups should be in place, as the grease holes lead to the
rear of the ball bearings.

A terminal cover, c, with a bell mouth (fig. 12) and an insulated
strain clamp secure the cable and protect the terminal connections.
Connection to the inside is by insulated studs.

EXTENSIONS OF APPROVAL

Certain changes were authorized in the MM–125 unit. Shortly
after the machine was approved permission was given to use open-
type frames converted to the closed type by welding a steel plate
over openings in the bottom of the resistance compartment. Later
the use of such converted frames was discontinued. The commu-
tator door was changed from steel to bronze and another fastening
added. Later the commutator door was changed to ¾-inch boiler
plate with two 6-inch holes threaded for screw covers. Finally the
frame casting was changed, and the commutator door was replaced
by two screw covers screwing into holes through the casting.

A ¾-inch plate-steel cover, welded in place instead of being held
by studs, has been allowed on some machines already in service.
The plate carries three screw-type handhole covers closing openings
through it. A locking bar held by a padlock prevents unauthorized
opening of the covers. The use of a roller bearing at the pinion
end was allowed for motors with the welded commutator door.

The field frame was provided with two additional holes for cap
screws to fasten the starting box. The two rectangular openings
at the pinion end of the motor (closed by steel plates riveted in place
on the original design) were replaced by 2 holes closed by 2¾-inch
pipe plugs welded in place. A plugged hole in the bottom of the
motor compartment was eliminated, and two special drain plugs
were installed there. Insulating bushings were added to the cable
stuffing boxes between the motor and the resistance compartments
for 500-volt equipment. Studs were placed in the bottom of the
motor frame to fasten cleats for holding cables in place. The cable
stuffing boxes between the motor and the resistance compartments
were replaced by plain insulating bushings threaded into the com-
partment wall; the single hole for cables between the motor and the
starting box was eliminated, and the leads were run through
individual insulating bushings screwed into threaded holes in the
compartment wall.

Changes in the starting-box unit included strengthening of the
starting-box case by increasing its thickness and adding ribs to the
outside. Later the ribs were removed, the thickness of the cover was increased, and the material was changed from cast iron to malleable iron. Two holes were provided, one at each end, for additional fastenings for securing the box to the motor frame. A special drain plug was inserted in the bottom of the case.

The resistance compartment was changed by decreasing the depth of the cover from 1½ inches to ½ inch. Later, however, different covers were used for the two voltages; the 250-volt cover was made of ¼-inch boiler plate with ground surfaces, and the 500-volt cover was a boxlike iron casting 4¾ inches deep. The depth of the resistance compartment itself was also increased ¾ inch. These changes were made to accommodate nichrome-wire resistor units for 500 volts.

The following changes were made in the main switch and fuse: The switch was changed from a single-pole to double-pole type, and the link fuse originally used was replaced by a standard cartridge fuse. The connections to the fuse were reversed to bring the positive connection at the top instead of the bottom. The end fastening for the cover was made to fit more closely to hold the cover tighter to the case, and the thickness of the cover was increased one eighth inch. A lug was also added to the right side of the cover and tapped for a screw, which is used to move the cover sidewise to release it from the holding lugs and thus facilitate opening it. The compartment was finally redesigned as follows: A tongue was added to the two end flanges of the case, and a corresponding groove was made in the end-flange surfaces of the cover. One side of the case-flange casting was built up and grooved so that a channel was formed parallel to the plane of the cover along the whole side of the flange; the outer top of this groove was tapered. The corresponding side of the cover formed a tongue tapered to fit the groove. The opposite flange was the same, except that the tongue and groove were reversed, the tongue being at the side of the case and the groove in the cover. The upper part of the cover rim was raised to make the cover stiffer. Later, the plug connections for the hand cables were eliminated in the redesigned switch and such of the original switch-and-fuse units as contained a double-pole switch. The length of the cover over the terminals was increased to give better protection to the lead entrances for the cables from the reel. The old-type or camel-back switch and fuse has been superseded by a new switch compartment with a screw cover. Figure 12 shows the back and one side of the new switch and figure 14 the front and the other side. This switch is described under the type 29-C arc-wall machine.

An automatic switching arrangement has been allowed as optional on 500-volt, type 35-B equipment. An overload relay and two contactors enclosed in an explosion-proof compartment replace the switch and fuse. The starting box operates the contactors, but the contactor compartment is provided with a push button for opening the contactors independently. A three-conductor cable between the truck and the motor and an additional insulated-stud lead entrance are required for the new arrangement. Because of some internal changes in the starting box, that used with the contactor arrangement is designated as the class 20 instead of the original class 21. The contactor compartment (fig. 18) is of cast iron with an alu-
minimum cover, a, fastened in place by cap screws going through the cover flange and threaded into the case flange. The wide, flat, metal surfaces in contact at the joint between the cover and case prevent the discharge of flame. The cover is fitted with a screw handhole cover, b, secured with a wire seal to prevent tampering. The operating handle or button passes through the front of the cover near the handhole cover and is used to reset the overload relay and to open the contactors independently of the starting box. It passes through the cover wall in a long, close-fitting bearing. The cables enter and leave the contactor compartment through packed stuffing boxes.

The following changes were made in the cable-reel equipment: A cable reel mounted on a trailer truck instead of on the machine truck and having collector rings instead of using the bearings for contact surfaces was allowed as optional equipment. This trailer-truck reel is described under the type 35–BB machine. The reel on the machine truck and the switch-and-fuse compartment were relocated to place them in different relative positions from those shown in figure 11. The reel bearings were provided with a pressure-greasing system similar to that used in automobiles. A new cable reel mounted on the machine truck but having collector rings instead of using the bearings for contact surfaces was added (fig. 14). This reel is described under the type 29–C machine, for which it was first developed.

A Chicago Pneumatic Tool Co. 2–BF, type NT, 230-volt coal drill was added to a few 250-volt machines. This drill is supplied with power cables from the main switch and fuse; the drill cables are protected by small fuses inside the switch-and-fuse compartment. A separate ground wire connects the drill frame to the machine truck. The drill is operated by hand, and therefore no special mounting is required.

When the type 35–B machine was first approved the conduit between compartments was hot-air tubing. This was later replaced by a better type of flexible metallic conduit and still later by rubber air hose, since metallic conduit protection was found inadequate for mine service.

A few machines were equipped with a three-conductor hand cable; one conductor was grounded to the frame of the machine motor and to the truck, which in turn was grounded to a water pipe in the room where the machine operated.

The insulated studs used on the 35–B machine were found to loosen and burn; a new stud having a positive lock for the set screw holding the cable end was therefore designed to replace the old type used in the camel-back switch and fuse and the motor.

A Jeffrey Manufacturing Co. type A–6–A, 250-volt, permissible drill was also allowed for use with the machine. The methods of connecting and grounding are the same as for the Chicago Pneumatic Tool Co. drill.

**Type 35–BB, D–C. Shortwall Cutting Machine, Approvals 111 and 111A**

Approvals 111 and 111A, covering 250-volt and 500-volt, type 35–BB shortwall cutting machines, respectively, were issued to the
Jeffrey Manufacturing Co. on October 16, 1922. The electrical accessories for this machine were the class MM–138 motor unit, the class 21 starting box, the reel, and the switch and fuse. Figure 13 shows a modern type of the complete machine. The type 35–BB machine was originally equipped with the same reel and switch and fuse as the 28–A and 35–B machines previously described. The contactor compartment at a is now standard equipment for 500-volt machines, but a switch-and-fuse compartment is still standard for 250-volt machines.

The 35–BB machine is of the same general design as the 35–B machine described but is somewhat larger. The MM–138 motor and the resistance compartment are enclosed in the same casting. Figure 13 shows the class 20 starting box e, which is the same as that used on the type 35–B machine and is fastened to the field frame in the same way; the class 21 starting box is used on 250-volt machines. The resistance compartment is on the side of the field frame opposite the starting box and was closed by a cast-brass cover similar to that (a) shown in figure 12 for the type 35–B machine. The cover is fastened by sixteen \( \frac{3}{4} \)-inch cap screws secured by lock washers. Two designs of covers were used—one for 250-volt and the other for 500-volt machines. These were alike except that the 500-volt cover was dished \( \frac{3}{4} \) inch deeper than the 250-volt cover. The cables go from one compartment to another through asbestos-packed stuffing boxes.

The motor is rated at 50 hp. on a 1-hour basis, with a temperature rise of 75° C. The gear end of the field frame is cast closed, except for a comparatively small bored opening for the gear-end bearing housing. The housing enters the bore from the inside of the motor, and a machined surface on the housing bears against the inside of the field frame; a step joint with wide metal surfaces is thus formed between the parts. Four studs permanently riveted in the housing pass through holes in the end of the field frame and hold the housing in place. The other end of the field frame is closed by a large steel casting which covers the whole end of the field frame and is fastened to it by six \( \frac{3}{4} \)-inch bolts screwed into bottomed holes in the field frame and two \( \frac{3}{4} \)-inch studs permanently riveted in place in the field frame; the bolts and nuts are secured by lock washers. The flange between the commutator end plate and the frame is partly flat and partly cylindrical. This end plate carries a cartridge-type bearing housing which enters a bored hole through it from the inside; a shoulder on the housing prevents it from going entirely through the bore. The bearing cap is bolted to the housing by three \( \frac{5}{8} \)-inch cap screws in bottomed holes in the housing, and a lip on the cap bears against the outside of the end plate to clamp the parts in place. Ribbed cast-brass cover d (fig. 13) permits access to the commutator and brush rigging; it is fastened to the field frame by twelve \( \frac{1}{2} \)-inch studs, 8 in bottomed holes and 4 permanently riveted in place in the field frame. The nuts are secured by lock washers. The 250-volt resistor was the grid type, and the 500-volt unit was iron ribbon wound in pancake form.

All joints between the covers and the various compartments have broad metal-to-metal contact between the parts. All holes that would otherwise lead into any compartment from the outside, except those for the field-pole bolts, are bottomed or are closed by rivets or studs.
permanently secured in place. The shaft fits closely through baffles at the inner ends of the bearing housings. At the commutator end the ball bearing probably furnishes some additional protection. An oil drain hole through the bearing cap makes its service in preventing discharge of flame questionable. At the gear end the ball bearing and the running fit between the bearing spacer and the retaining nut screwed into the housing give additional protection. The grease cups should be in place, as the grease holes lead to the rear of the ball bearings. The key that prevents the commutator-end bearing housing from rotating should be in place for safety.

A terminal cover with a bell mouth and an insulated strain clamp secures the cable and protects the terminal connections. Connection to the inside is by insulated studs.

EXTENSIONS OF APPROVAL

The following changes were made in the MM–138 motor: The field frame was provided with two additional holes for cap screws to fasten the starting box to it. Two special drain plugs were placed in the bottom of the motor compartment. A boiler-plate commutator door with ground surfaces replaced the cast-brass commutator door. An insulated stud was added to the motor compartment, and another stuffing box was placed between the motor and the starting-box compartment to accommodate a solenoid switch or contactor when used. Finally, a field-frame casting with two screw-type inspection covers instead of the bolted cover over the commutator replaced the original field frame. A seal secures the covers to prevent tampering.

Insulating bushings screwed into holes through the compartment walls replaced the stuffing boxes. The additional lead-entrance stud required for operation of the contactors on 500-volt machines was placed in the end wall of the resistance compartment beside the two main lead-entrance studs.

The changes made in the starting box are the same as those described under the 35–B machine.

The following changes in the resistance compartment were authorized: A special drain plug was placed in the bottom of the resistance compartment. A nichrome-wire resistor was allowed as optional with the pancake-coil resistor for 500-volt machines. To accommodate the wire resistor a deeper cover was specified; it is also used with the pancake-coil resistance. Later a boiler-plate resistance cover was allowed on 250-volt machines in place of the original cast cover. Finally, optional use of a combination nichrome-wire and grid-type resistance allowed for 500-volt machines required another design of cover for the resistance compartment. Part of the resistance elements are mounted on three studs permanently riveted in place in holes through the cover casting.

The changes made in the camel-back switch and fuse are the same as those for the 35–B machine previously described. This switch-and-fuse unit has been superseded by the new design with the screw cover (figs. 12 and 14). The new unit is described under the type 29–C machine. The automatic switching arrangement for 500-volt machines described in connection with the type 35–B machine has also been allowed for the type 35–BB machine. Before the auto-
matic switching arrangement was introduced the use of a single-pole solenoid switch was allowed with the new switch and fuse for 500-volt machines. The object of the solenoid switch is to break the main current and thus remove the intense arcing from the starting box. It is electrically connected to the starting box in such a way that the latter, instead of opening the circuit to the machine, opens the solenoid switch, thereby breaking the circuit before it is opened in the starting box. The solenoid-switch mechanism is mounted on the opposite side of the steel plate that supports the switch-and-fuse compartment. A cast-iron case or box fastened to this same mounting plate by fifteen \( \frac{1}{2} \)-inch cap screws with lock washers encloses the solenoid-switch mechanism; 4 of the cap screws are threaded into the plate, and the other 11 go through it and are provided with nuts.

The wide, flat, metal surfaces in contact between the box and the mounting plate make a flame-tight joint. The compartment is lined with vulcanized fiber. The front of the box is fitted with a screw-type cover secured by a seal to prevent tampering. The leads enter and leave the compartment through asbestos-packed stuffing boxes.

The cable reel first used with this machine was the same as that originally used with type 35-B machines. Virtually the same changes and additions to cable-reel equipment have been made for both the type 35-B and the type 35-BB machines; the description already given under extensions of approval, type 35-B machine, is therefore correct for the type 35-BB machine. The optional trailer-truck cable-reel equipment referred to by the description includes a truck and a cable-reel unit and the camel-back switch-and-fuse box mounted thereon. Collector rings mounted on the shaft of the reel and housed in an explosion-proof cast-iron case are used for connections between the stationary wiring and the trailing cable on the reel. This collector-ring box is in two parts, the shaft being journaled in cylindrical holes centered on the joint between the halves of the box. The bearings fit closely, and each has a circular slot machined in it to fit rings on the shaft, thus preventing the box from sliding along the shaft and at the same time obstructing the discharge of flame along the shaft. The halves of the collector box are held together by ten \( \frac{1}{2} \)-inch tap bolts screwed into tapped holes in the bottom half and secured by lock washers; the bolt holes do not go to the inside of the box. Wide, flat, metal surfaces in contact between the halves of the box make the joint flame-tight. Although the shaft is closed at the ends it is hollow and serves as a conduit for the cables between the reel spool and the collector rings on the part of the shaft in the box. The leads from the reel enter the shaft through a steel block fastened to it and provided with asbestos-packed stuffing boxes. The cables leave the collector box through stuffing boxes in the bottom half of the box. Figure 18 shows this reel and collector box plainly, but the truck illustrated is not fitted with a switch and fuse, as it is used with a machine of different design.

The changes described in connection with the type 35-B machine—the addition of a Chicago Pneumatic Tool Co. 2-BF, type NT, 230-volt coal drill, the change to rubber-hose conduit, the use of a three-conductor hand cable for grounding, the use of improved stud ter-
minals, and the use of a type A–6–A, 250-volt drill—were also allowed for the type 35–BB machine.

**TYPE 29–C, D–C. ARCWALL CUTTING MACHINE, APPROVALS 112 AND 112A**

Approvals 112 and 112A, covering 250-volt and 500-volt, type 29–C arcwall cutting machines, respectively, were issued to the Jeffrey Manufacturing Co. on March 13, 1924. Figure 14 shows a modification of the original machine. The equipment includes a self-propelled truck, a turret mounted on its front end, and a cutter bar and motor a mounted on the turret. This motor, type MM–144B, drives the cutter chain and supplies power to turn the turret. The control unit for the motor comprises a class 21 starting box, b, and a resistor compartment, c, the two being bolted together as shown. MM–146 motor unit d, on the side of the truck opposite the control for the MM–144B motor, propels the truck and raises or lowers the turret. The unit comprises a motor, a resistor compartment, and a class 21 starting-box compartment. Main switch and fuse e and cable reel f are mounted at the rear of the truck, and a class 15–B headlight is mounted on the turret at i. Drill g and the small switch-and-fuse box h for the drill are shown at the front of this particular machine.

As originally approved, the machine differed in several respects from that illustrated by figure 14. The drill and its switch-and-fuse box h were not part of the equipment; a cable reel of the design shown in figure 11 was used; the switch-and-fuse box at e was the redesigned camel-back switch described under the type 35–B shortwall machine; and the wiring of the machine, except that to the turret motor, was carried in flexible metal conduit instead of hose conduit.

The MM–144B motor is rated at 50 hp. The gear end of the magnet frame is cast closed except for a comparatively small bored opening for the gear-end bearing housing. The housing arrangement is identical with that described under the type 35–BB shortwall machine (approvals 111 and 111A). The commutator end of the magnet frame is closed by a cast-iron end bell or bearing bracket held by ten %1/2-inch cap screws fitting in bottomed holes in the magnet frame and secured by lock washers. The wide metal surfaces in contact at the joint between the parts prevent discharge of flame. The end bell carries a cartridge-type bearing housing which enters a bored hole through it from the inside; a shoulder on the housing prevents it from going entirely through the bore. The bearing cap screws into the housing from the outside of the end bell. A small screw in a bottomed hole prevents the cap from unscrewing, and a key prevents rotation of the housing; the key must be in place for safety. Two screw-type handhole covers in the top of the end bell permit access to the commutator and brushes; the covers are sealed to prevent tampering. Two screws sealed in place go through the top of the end bell to support the brush rigging. The shaft fits closely through baffles on the inner ends of the bearing housings. At the commutator end the ball bearing and the bearing cap furnish some additional protection, but oil drain holes in the cap make its service in preventing discharge of flame questionable. At the gear end the ball bearing and the running fit between the bearing spacer
Figure 14.—Jeffrey type 20-C, d-c, arcweld machine.
and the retaining nut screwed into the housing give additional protection. The grease cups should be in place, as the grease holes lead to the rear of the ball bearings. The wide metal surface of the joints between the housings and the magnet frame and end bell prevent discharge of flame at these points.

Connection to the inside of the motor is by insulated studs; these are protected on the outside by a cast-iron terminal cover with a bell-mouth entrance and a hose clamp for the hose conduit protecting the cable. On machines having a headlight the terminal cover is provided with an outlet for the cable to the headlight.

The resistor and starting-box unit for the 144-B motor includes a rectangular cast-iron resistance compartment, c (fig. 14), and a class 21 starting box, b, bolted to it, one end of the casting being extended to accommodate the starting box. The starting box was described under the type 35-BB shortwall machine (approval 111). It is the improved form—the ribbed cast-iron case is held to the base casting by 8 fastenings and bolted to the resistance compartment by 8 cap screws. The resistor units are cast-iron grids for the 250-volt machine and nichrome wire for the 500-volt machine. The side door or cover to the resistor compartment is of brass and is fastened in place by twelve 1/2-inch cap screws with lock washers. The cables from the resistor compartment to the starting box pass through the wall between the compartments in asbestos-packed stuffing boxes. Connection to the unit is by insulated studs at the back of the resistance compartment; these are protected on the outside by a cast-iron terminal cover with a bell-mouth entrance and a hose clamp for the hose conduit protecting the cables to the motor. The terminal cover provides for attachment of the conduit carrying the cables from the switch-and-fuse box. The wide, flat, metal-to-metal contact between the resistance cover and the resistance compartment and between the end of the resistance-compartment casting and the starting-box casting prevents discharge of flame from these joints.

MM-146A motor d (fig. 14) is rated at 16 hp. The motor and the resistor are enclosed in the same steel casting but are separated by a partition; the resistor compartment is at the top. The starting box is fastened to the outer side of the motor frame, which is machined for that purpose. The motor shell is cast closed, except for a circular bored hole in each end, two inspection holes, one on each side of the center just above the commutator, and an opening for the lead entrance. The hole at the commutator end is large enough to allow the armature to be inserted and is closed by the cast-iron commutator-end bearing housing. The hole at the gear end is much smaller and is closed by the cast-iron gear-end bearing housing. The inspection holes above the commutator are threaded for screw-type handhole covers. The commutator-end bearing housing is fastened in place by three 1/2-inch studs with nuts and lock washers; the studs are riveted inside the motor frame. The gear-end bearing housing is fastened by three 1/2-inch studs with nuts and lock washers; the studs are riveted to the bearing housing. The shaft fits closely through baffles on the inner ends of the bearing housings. At the commutator end a sleeve on the shaft provides the close fit necessary to prevent discharge of flame along the shaft;
the ball bearing and the running fit of a special washer on the end of the shaft in the bearing cap give some additional protection, but oil drain holes through the cap prevent it from completely closing the entrance to the bearing. At the pinion end the ball bearing and the running fit between the bearing nut and the bearing retainer give additional protection against discharge of flame. The grease cups should be in place, as the grease holes lead to the inner side of the ball bearings. The brush rigging is fastened by two screws through the top of the motor frame; these and the two inspection covers should be sealed.

The resistance compartment is closed by a 3/8-inch brass cover held by thirteen 1/2-inch cap screws secured by lock washers; the screw holes are bottomed in the casting. The class 21 starting box is fastened by eight 1/2-inch cap screws in bottomed holes in the magnet-frame casting; these are secured by lock washers. The wide metal surfaces in contact at the joints prevent discharge of flame from the resistance and starting-box compartments.

The leads between compartments go through the partitions in asbestos-packed stuffing boxes. The incoming circuit enters the motor compartment by two insulated studs carried by a 1/2-inch steel plate bolted over an opening through the magnet frame by four 1/2-inch cap screws secured by lock washers; the screw holes are bottomed. The wide metal surfaces in contact at the joint between the plate and the frame prevent discharge of flame. A terminal cover protects the outside connections and provides for attachment of the conduits on the cables.

As already mentioned, the switch-and-fuse case on the original design of the type 29-C arcwall machine was the “camel-back” switch, having tongue-and-groove joints for the cover, described under the type 35-B shortwall machine (approvals 103 and 103A). Another fuse is placed in the switch-and-fuse box to protect the MM-146 motor on the type 29-C machine; and for machines with headlights two additional small fuses are also placed in the compartment to protect the headlight circuits. The two-conductor headlight cable leaves the case through an asbestos-packed stuffing box, but the other lead entrances are insulated studs. A conduit support and a sheet-metal guard are attached to the back of the case.

The cable reel was the design in which the bearings served as sliding connections described under the type 28-A machine (approvals 102 and 102A). Figure 11 shows this cable reel.

The headlight first used with the 29-C machine was the class 15, form B, headlight shown in figure 14. The front cover or glass holder screws to the body, the screw fit making an effective flametight joint. A seal prevents removal of the cover by unauthorized persons. The glass is flat, is 3/4 inch thick, and has a lead cushion cast around its edge. A ring screwed against the rear of the glass holds it in place in its seat in the cover. Tests have shown that the construction is flametight. A screw cap, sealed to prevent tampering, closes an opening through the top of the case. The wires enter the rear of the case from below in a two-conductor cable through an asbestos-packed stuffing box. In the modern design the glass holder is extended to form a lip for protection of the glass. Before headlights were required to meet rigid explosion-proof requirements a rubber
cushion was used for the glass, but this has been replaced by the more permanent lead-cushion arrangement of the modern design. A chain and padlock are allowed as an optional method of securing the covers.

EXTENSIONS OF APPROVAL

Several optional arrangements or forms of the machine have been allowed. In addition to the type 29-C this approval also includes two other types—the type 29-D and the type 29-E—which differ from the type 29-C in mechanical details.

Several miscellaneous improvements were allowed in the equipment of the original machine—addition of a jack screw to aid in opening the switch-and-fuse-compartment cover, addition of a special drain device in the starting box, an increase of one fourth inch in the depth of the resistance cover of the MM-146 motor unit, optional changes in resistor units, addition of a greasing system for the cable-reel bearings, and an increase in clearance for the housing at the bearings. The metallic conduit was replaced by hose conduit, and the terminal covers were changed to accommodate the changed conduit. The insulated-stud terminals were improved to lock the outside terminal connections against loosening. An improved clamp was added for the hose conduit to the turret motor, and the wire-reinforced hose was replaced by a high-grade air hose.

The first considerable change in the design resulted in the machine shown by figure 14, having a new cable reel, f, and a new switch-and-fuse compartment, c. Drill g, with its switch-and-fuse unit h and headlight i, are optional equipment for 250-volt machines. The 500-volt machine had neither the drill nor the headlight. Small fuses in switch-and-fuse compartment e protect the circuit to the drill and the headlight. When both are used the headlight circuit is tapped off in drill switch-and-fuse box h, and additional small fuses are used at this point for the headlight circuit. The drill circuit is also protected at this point by additional fuses, which are readily renewed, being on the dead side of the switch. The headlight fuses, however, are not so placed as to be "killed" by opening this switch.

The new switch-and-fuse compartment e (fig. 14) contains a double-pole switch and two main fuses, one for the positive side of the circuit for each of the two motors. It also contains small fuses to protect both sides of the circuits to headlights and drills when these optional accessories are used. The switch gives one break per pole. The contacts are surrounded by barriers of asbestos board to form arcing chambers, and permanent magnets are used to furnish magnetic blow-outs for arcs formed when the switch is opened under load. The explosion-proof case enclosing the switch and fuses is a strong cast-iron box with a circular opening through the front closed by a ribbed aluminum cover which screws into the opening. When the switch is closed (fig. 14) the bar connecting the switch levers prevents the cover from being unscrewed. Downward movement of this bar or handle opens the switch and allows the cover to be unscrewed. An arm hinged to the case and attached by a pivot to the center of the cover prevents the switch from being closed after the cover has been unscrewed. The interlocking arrangement permits renewal of fuses without hazard. All the wires enter the compartment through asbestos-packed stuffing boxes. The
screw threads of the cover and long close-fitting bearings for switchoperating shafts prevent the discharge of flame from the case. A metal guard at the rear of the case protects the outgoing cables and provides for attachment of the hose conduit. The cables from the cable reel enter through the side of the case, and the hose conduits protecting them are attached to the stuffing-box nuts by special fittings.

The new cable reel \( f \) (fig. 14) includes the reel for the cable and the explosion-proof collector-ring compartment; the latter was originally made of cast iron, which was replaced by cast steel when mechanical changes in the "spooling" device were incorporated. A \( \frac{3}{8} \)-inch steel-plate cover fastened by eight \( \frac{1}{2} \)-inch cap screws permits access to the collector rings; the screw holes do not lead to the inside of the compartment. The wide, flat, metal surfaces in contact prevent the discharge of flame through the joint. The cast-iron spider of the cable reel is carried at one end by a bearing through the side of the collector-ring compartment and at the other end by a bearing in a cup-shaped bearing housing fastened to the supporting frame of the unit. A tierod which passes through the center of the reel spider ties the collector-ring housing to the bearing housing to prevent their spreading apart. The nuts on the ends of the tierod are locked to prevent loosening. Figure 14 shows the nut at the collector-ring end. The tight fit of the tierod through the wall of the collector-ring compartment makes a flame-tight joint. To prevent the propagation of flames through the hole for the tierod and out the other end of the spider the rod fits tightly through the back of the cup-shaped bearing housing. The long, close-fitting, cylindrical, metal surfaces prevent the discharge of flame through the bearings themselves. Cast-iron bearing sleeves on the spider and brass bushings both in the bearing housing and the bearing hole through the side of the collector-ring compartment permit renewal of worn parts. The leads leave the collector-ring compartment through asbestos-packed stuffing boxes in the bottom of the case, and the hose conduits are held by special fittings attached to the stuffing-box nuts. The connections from the cable reel enter through asbestos-packed stuffing boxes in the journal, which is large enough to allow holes for the wires through it. The collector rings are carried by an extension of the spider which projects into the collector-ring compartment.

The small switch-and-fuse box \( h \) (fig. 14), which serves primarily as a starting switch for the drill, contains a double-pole switch and two fuses, one in each side of the circuit to the drill. As already stated, it also contains two additional fuses, one in each side of the headlight circuit, when a headlight is used on the machine. The explosion-proof case is a strong cast-iron box with a circular opening through the front closed by a ribbed cast-iron cover which screws into the opening. When the switch is in the closed position the handle of the switch prevents the cover from being unscrewed; opening the switch allows the cover to be unscrewed. An arm or yoke hinged to the case and attached by a pivot to the center of the cover prevents the switch from being closed after the cover has been unscrewed. The interlocking scheme, the same as that used on the main switch-and-fuse compartment, allows renewal of the fuses for
the drill without hazard. The headlight fuses, which are not deener-
gized by opening this switch, cannot be renewed safely without cut-
ting off the power from the entire machine. They are therefore
covered by a barrier of asbestos board to prevent ready access to
them, and the screws holding the barrier are secured by a seal. The
cables enter and leave the compartment through asbestos-packed stuff-
ing boxes. The screw threads of the cover and the close-fitting metal
surfaces of the bearings for the switch-operating shafts prevent
discharge of flame. Asbestos-board barriers are used to isolate the
switch contacts, and the case and cover are lined with asbestos paper.

The class A-5 drill motor $g$ (fig. 14) is rated at 3 hp. It is a
modification of the Jeffrey Manufacturing Co. class A-5, form D,
permissible coal drill covered by Bureau of Mines approvals 119 and
119A. When the drill motor is used with the present machine the
self-contained switch and fuses are eliminated from the drill unit
itself, as the separate switch-and-fuse unit just described serves the
purpose. The magnet frame of the motor is cast closed at one end,
except for 3 holes for bearings, 2 for the pinion shafts of the gear
reduction (closed by cup-shaped bearing bushings) and 1 for the
motor shaft. The other end of the motor is closed by a cast-iron end
bell or bearing bracket fastened by eight $\frac{1}{2}$-inch cap screws secured
by lock washers; the holes in the magnet frame are bottomed. The
wide metal surfaces in contact at the joint between the parts prevent
discharge of flame. Three small handhole covers which screw into
holes through the end bell afford access to the commutator and
brush rigging; they are sealed or secured by a chain and a padlock
to prevent tampering. A sleeve on the shaft increases its diameter
and provides a close running fit through baffles on the end bell and
thus prevents discharge of flame along the shaft. The ball bearing
and the close running fit of the bearing nut on the shaft in the cap
for the bearing seat add to the protection. At the other end of the
motor the close running fit of the shaft through baffles on the ball-
bearing retainer prevents discharge of flame; the retainer is fast-
tened to the inside of the magnet frame by four $\frac{1}{2}$-inch screws in
bottomed holes in the retainer. The ball bearing itself and the fact
that the bearing opening leads to the gear case and not directly out-
side probably add to the safety of the construction. A two-conductor
rubber-clad cable which enters through an asbestos-packed stuffing
box in the end bell supplies power to the motor; the hose conduit
for this cable is held by a special fitting attached to the stuffing-box
nut.

The 500-volt design with interlocked main switch-and-fuse com-
partment was soon superseded by a design using contactors and over-
load relays in place of the switch and fuses. These developments
led to two standard basic assemblies of the type 29-C arcwall
machine: (1) The 250-volt machine using the main interlocked
switch-and-fuse compartment and (2) the 500-volt machine using a
contactor compartment. Either of the assemblies may include a
class 15-B headlight, but the 500-volt machine requires a headlight
resistance compartment, as the headlight is not built for 500-volt
service. Small fuses in the main switch and fuse or in the contactor
compartment protect the headlight circuits. A small fuse in the posi-
tive side of the operating circuit for the contactors is also placed in
the contactor compartment for 500-volt machines.
These developments introduced two new explosion-proof compartments—the contactor and the headlight resistance. An additional lead-entrance stud was also added to the MM-146 motor unit and to the control unit of the turret motor for the control circuits to the contactors. The added terminal for the MM-146 motor was first placed in the magnet frame but was later moved to the terminal plate carrying the insulated studs for the main circuit. Internal changes in the starting boxes for the 500-volt machines change their designation from class 21 to class 20.

Contactor compartment (fig. 15, A) is cast iron with an aluminum-alloy cover fastened by twenty 1/2-inch hexagon-headed cap bolts which screw into tapped holes in the case; the bolt holes do not lead to the inside of the compartment. The wide, flat, metal surfaces in contact prevent the discharge of flame through the joint. Two screw-type handhole covers, sealed to prevent tampering, give access to the overload relays. The compartment contains 2 magnetic overload relays and 3 contactors, 1 in the negative line from the cable reel and 1 in each of the positive lines to the motors. The overload relays are connected in the positive lines to the motors. The compartment also contains the small fuses for headlight and control circuits. The contactors are normally actuated by the starting boxes but may be opened by the reset buttons for the overload relays journaled in bushings through the cover. These buttons can be seen in figure 15, A, just below the handhole covers. The connections enter and leave the compartment through asbestos-packed stuffing boxes.

The headlight resistance compartment is a rectangular cast-iron box closed by a 3/8-inch plate-steel cover. The cover is fastened by eight 3/8-inch hexagon-headed cap screws secured by lock washers; the screw holes do not lead to the inside of the compartment. The wide, flat, metal surfaces in contact between the cover and case prevent discharge of flame through the joint. The circuits enter and leave the compartment by two-conductor rubber-sheathed cables through asbestos-packed stuffing boxes. The hose conduits protecting the cables are attached to the stuffing-box nuts by special fittings.

A drill unit consisting of a class A-5 motor and the small interlocked switch-and-fuse box, combined as in figure 15, A, has been added to the 500-volt, type 29-C machine as another optional assembly. The drill motor differs from that previously described in that an additional screw-type handhole cover closing an opening through the commutator end bell is added, and one of the holes for bearings through the end of the magnet frame for gear reduction is omitted. Moreover, the bearing cap and the retaining nut for the ball bearing at the commutator are different. The end bracket also carries the supporting brackets of the motor. On the type 29-C machine the drill unit is carried by a long arm pivoted to a framework at the center of the truck instead of being mounted as shown in figure 15, A. The arrangement places the drill unit over the rear end of the cutter bar. The class 15-B headlight for this assembly has been modified by the addition of a snap switch inside the headlight case; it is operated by a shaft journaled in a hole through the small screw cap which closes the top of the case. Both the circuit for the drill and the circuit for the headlight originate in the contactor compartment and are protected by separate small fuses at that point.
A new headlight (class 17) has been approved as optional equipment for the standard 250-volt and 500-volt, type 29-C machines without drills. On the 250-volt machine no change is made except substitution of the new headlight, but on the 500-volt machine the use of the class 17 headlight allows the headlight resistance to be eliminated. A switch for the headlight is placed in the contactor compartment to comply with the latest requirements, since headlight fuses for 500-volt machines are not readily renewable.

A class 17 headlight is shown at b, figure 15, A. The body of the headlight is made of a short section of 6-inch steel tubing threaded at both ends. The covers or glass holders screw onto the ends of
the body and are sealed to prevent removal by unauthorized persons. The option of securing the covers with a padlock and chain has been allowed. The glasses are about 1 inch thick and are flat but are ground at the edges to fit spherical seats machined in the covers. Brass retaining rings faced with lead screw against the glasses from the rear and hold them firmly in place. Small rivets, used to lock the retaining rings, must be in place to close the rivet holes into the compartment and to prevent the glasses from loosening. A two-conductor rubber-sheathed cable enters the side of the body through an asbestos-packed stuffing box in a sleeve welded in place. The headlight contains two light bulbs connected in parallel or in series as required for different voltages of bulbs and power supply.

An assembly of the 250-volt machine, with the class 17 headlight and without a drill, in which the position of the switch-and-fuse box has been changed to allow for a slabbing device has been approved as optional. Another assembly of the standard 250-volt machine with two headlights instead of one and without a drill has been approved. A new design of headlight, the class 19, is used in this assembly, and a headlight junction box is mounted on the turret to divide the circuit for the two branches to the headlights.

The class 19 headlight is similar in construction to the class 17 headlight, except that only one end has glass, the other end of the body being closed by a steel disk welded in place. Also, the lead-entrance stuffing box is in the end disk instead of in the side of the body.

The headlight junction box is a small rectangular cast-iron box closed by a screw-type cover, sealed to prevent tampering. The circuits enter and leave the compartment in two-conductor rubber-clad cables through asbestos-packed stuffing boxes.

The hose conduits for the cables to the class 17 headlights and the headlight junction box are secured at these points by special fittings attached to the stuffing-box nuts.

As already mentioned, two other types which differ in some mechanical features from the type 29–C machine have been covered by extensions of approval. The first of these machines, the type 29–D machine, is essentially the standard 250-volt, type 29–C machine with a drill and a class 15 headlight. The drill and its mounting are virtually the same as shown in figure 15, A. The option of a snap switch in the headlight is allowed. The headlight and the drill circuits are fused separately in the main switch-and-fuse box. The machine differs mechanically from the type 29–C in that the cutter head is arranged to permit shearing. The other machine, the type 29–E, is shown in figure 15, A. It differs mechanically from the type 29–C machine in that it has a revolving cutter head. Electrically, this machine is the same as the standard 500-volt, type 29–C machine with a class 17 headlight and a drill of the type illustrated. The drill and the headlight circuits are fused separately in the contactor compartment. All accessory parts of these two machines were described under the type 29–C machine. A class A–5–0 drill motor has been allowed as optional for the 500-volt, 29–E machine in connection with a hydraulic instead of a mechanical feed for the drill. Although this motor is similar to the other drill motor it differs from it in several respects. The
gear end of the magnet frame is cast closed except for the bored hole for the ball-bearing housing. A lip on the housing enters the bore from the inside of the motor, and the face of the housing bears against the inside of the end of the magnet frame, which is counterbored to receive the housing. A step joint with wide metal surfaces in contact between the parts is thus formed. Four \( \frac{3}{8} \) -inch cap screws secured by lock washers pass through the end of the magnet frame and screw into bottomed holes in the housing to hold it in place. The commutator end of the magnet frame is closed by a cast-steel end bell or bearing bracket held by eight \( \frac{3}{8} \) -inch screws secured by lock washers; the screw holes are bottomed in the magnet frame. The wide metal surfaces in contact at the joint prevent the discharge of flame. Three holes closed by screw-type covers permit access to the commutator and brushes; the covers are sealed to prevent tampering. The close running fit of a sleeve on the shaft through baffles on the end bell prevents discharge of flame along the shaft. The ball bearing and a running fit between the bearing cap and a spacer on the shaft add to the protection. The bearing cap and the spacer are machined to form a tortuous path for any products of combustion tending to escape from the bearing. Three \( \frac{3}{8} \) -inch hexagon-headed cap screws secured by lock washers and screwing into bottomed holes in the end bell fasten the bearing cap in place. At the other end of the motor the shaft fits closely through baffles on the bearing housing to prevent discharge of flame along the shaft. The ball bearing and a tortuous path between the bearing nut on the shaft and the bearing retainer which screws into the end of the bearing housing add to the protection. A small screw in a bottomed hole in the housing prevents the bearing retainer from unscrewing. The connections enter the motor through an asbestos-packed stuffing box in the end bell.

A 250-volt, type 29-E machine carrying a new drill, the type A-6-A, has been allowed as optional under approval 112. Electrically, except for the addition of the new drill, this machine is essentially the same as the standard type 29-C machine using two class 19 head-lights. The headlight circuit is protected by two small fuses in the main switch-and-fuse compartment. The circuit to the drill is spliced to the headlight circuit in the junction box of the resistance-and-control unit for the turret motor; the fuses thus protect the cable to the drill also. From the junction box the drill circuit goes first to a connection box similar to that for the headlamps and then to the drill itself. As the drill is mounted on the cutter bar and therefore must be removed when the machine is cutting, the cable from the connection box to the drill is free and not clamped in place. It is protected from mechanical injury by a hose conduit, and a clamp holds its end to prevent strains on the junction-box connections. The junction box is the same as the headlight junction box already described, except that the cable stuffing box for the cable to the drill is formed in a plug which fits into a hole bored through the side of the compartment. Two \( \frac{3}{8} \) -inch cap screws secured by lock washers and screwing into bottomed holes hold the stuffing-box plug. The close fit of the plug in the bore makes the joint flammertight. This arrangement permits the drill to be removed readily from the machine for repairs or other reasons. When the drill is absent the hole
for the stuffing box must be closed by a solid plug furnished with the machine for this purpose.

The type A-6-A drill is an approved post drill covered by Bureau of Mines approval 228, which has been adapted for mounting on the cutter bar of the type 29-E machine. The magnet frame is a steel casting closed at the gear end except for a bored hole for the shaft. It is closed at the commutator end by the cylindrical switch-housing casting, the end of which enters the bored opening into the magnet frame. Four \( \frac{3}{16} \)-inch screws secured by lock washers hold the switch housing in place; the screw holes are bottomed in the magnet frame. The wide metal surfaces in contact make the joint between the casting flametight. The switch housing is an aluminum-alloy casting separated into two isolated sections by a cast dividing wall. Two small aluminum screw-type handhole covers which close openings into the section next to the magnet frame permit access to the commutator and brushes; the covers are sealed to prevent tampering. The other section of the casting contains a double-pole snap switch and a cartridge fuse and is closed by an aluminum cover screwing into the end of the casting. The operating shaft for the switch is journaled in a brass bushing in a hole through the center of this cover. The long bearing fit of the switch shaft in the bushing makes a flametight joint. At the pinion end of the motor the long, close running fit of the motor shaft through the end of the magnet-frame casting and a spacing bushing on the shaft which gives a tortuous path at the outer end of the hole prevent the discharge of flame. The ball bearing, carried in a seat machined in the outside of the casting, furnishes some additional protection. At the commutator end the ball-bearing seat is machined in the dividing wall of the switch housing but does not go through the wall to the switch-and-fuse section. A mechanical interlocking arrangement prevents the cover of the switch-and-fuse section from being open except when the switch is turned off. The fuse can be renewed without hazard, as its terminals are dead when the cover of the switch-and-fuse section is unscrewed. The circuit enters the compartment in a two-conductor rubber-sheathed cord through an asbestos-packed stuffing box on the side of the switch housing. The wires from the switch-and-fuse section to the motor are carried by insulating bushings screwed into the dividing wall of the casting. A clamp on the outside of the switch-housing casting holds the hose conduit and the cable and thus prevents pulls on the cable from being transmitted to the terminal connections.

Several improvements, not necessarily confined to any one of the various assemblies, have been made. The most important are the optional use of stuffing-box lead entrances instead of insulated studs on the turret motor, the optional use of a trolley-pole support for the trolley tap to avoid holding the tap in the hand while tramping, and the change in the starting-box cover from ribbed cast iron to heavy malleable iron.

Two special developments have resulted from modifications of machines already in service.

The first of these special assemblies used the type 19-Y motor on the turret instead of the type MM-144 motor. The cable reel was the improved design having a collector-ring compartment. The rest
of the accessories were the same as those on the original assembly of the type 29–C machine, except that the wiring between the parts was carried in hose conduit instead of flexible metallic conduit.

The type 19–Y motor was converted from a ventilated design to an explosion-proof design for use on the type 29–C machine. The gear end of the magnet frame is cast closed, except for the bored hole for the bearing housing and a rectangular ventilation opening; the latter was closed by a rectangular cover of 3/8-inch boiler plate held by six 3/8-inch studs riveted to secure the cover permanently in place. The wide, flat, metal surfaces prevent the discharge of flame through the joint. The commutator end of the magnet frame is closed by a cast-iron end bell or bearing bracket held by seven 3/8-inch bolts in bottomed holes in the magnet frame. The wide metal-to-metal contact between the parts makes the joint flamelight. A rectangular ventilation opening through the bottom of the end bell was closed in the same way as that in the end of the magnet frame. Two rectangular openings, one through the top and one through the side of the end bell, give access to the commutator and brushes. These are closed by 3/8-inch boiler-plate covers held by 3/8-inch studs with nuts secured by lock washers; 8 studs are used for the top and 4 for the side cover. The pinion-end ball-bearing housing enters the bore through the end of the magnet frame from the inside of the motor, and a machined surface on the housing bears against the inside of the magnet frame. A step joint with wide metal surfaces is thus formed between the parts. Two studs permanently riveted in the housing pass through holes in the end of the magnet frame and hold the housing in place. The commutator end bell carries a cartridge-type ball-bearing housing which enters a bored hole from the inside; a shoulder on the housing prevents it from going entirely through the bore. The bearing cap screws into the housing from the outside to fasten it in place, a lip on the cap bearing against the outside of the end bell. A small screw in a bottomed hole prevents the cap from unscrewing, and a key prevents rotation of the housing; the key should be in place to guard against the discharge of flame through the keyway. The shaft fits closely through baffles on the inner ends of the bearing housings to prevent the discharge of flames along the shaft. At the commutator end the ball bearing and the bearing cap in conjunction with a special washer attached to the end of the shaft furnish additional protection. Similarly, at the pinion end the ball bearing and the running fit between the bearing nut on the shaft and the bearing retaining ring which screws into the housing give additional protection. Connections are made to the inside of the motor by wires passing through asbestos-packed stuffing boxes in the magnet frame.

The second development resulted from the addition of a headlight and a drill to some 500-volt machines. These machines were like the type 29–C arcwall machine originally approved, except that the metallic conduit had been replaced by hose. The parts added were an A–5 drill, the small switch-and-fuse box for the drill, the class 15 headlight, and the headlight resistance compartment described. The drill motor was the form first used on the type 29–C machine (the drill shown at g, fig. 14). The headlight circuit was tapped off on the dead side of the switch in the switch-and-fuse box for the
drill. The positive side of the circuit for the headlight and drill is tapped off the positive wire to the small motor in the junction box of the resistance-and-control unit for the turret motor. The negative side of the circuit is tapped off the negative line at the turret motor. A no. 6 single-conductor cable is used for the positive line as far as the turret-motor terminal box, and a two-conductor no. 10 cable carries the circuit from this point to the small switch-and-fuse box. The large wires are used because the circuit depends on the fuse for the MM-146 motor for protection. The scheme was altered by placing two additional fuses for the headlight circuit in the small switch-and-fuse box and connecting this circuit on the live side of the switch because with the first arrangement the headlight was cut off except when the drill was running. The headlight fuses, which are not deenergized by opening the switch, cannot be safely renewed without cutting off the power from the entire machine; they are therefore covered to prevent ready access to them, and a seal is used to prevent renewal by unauthorized persons.

Finally, the drill and its switch-and-fuse box were eliminated; a class 17 headlight was substituted for the class 15 headlight, eliminating the headlight resistance compartment; and a new switch-and-fuse compartment containing a two-pole switch and two fuses for the headlight was added. The compartment is a cast-iron case closed by a screw cover or cap through which the operating shaft is journaled. The circuits enter and leave the case through asbestos-packed stuffing boxes.

**TYPE 30-A, D.C. SHEARING-DRILLING MACHINE, APPROVALS 125 AND 125A**

Approvals 125 and 125A, covering 250-volt and 500-volt, type 30-A shearing-drilling machines, respectively, were issued to the Jeffrey Manufacturing Co. on April 26, 1926. Figure 15, B, shows the complete machine as first approved. It is used to shear the center of the coal face and make the shot holes after the coal has been undercut by some other machine; the cutter bar therefore moves only in a vertical plane. A small conveyor under the rear end of the cutter bar carries the cuttings to the side of the machine. The arms that support drill motors a are carried by pivoted mountings, and the drill-motor mountings are pivoted to the bars; the drills can thus be swung to the side to bring them in position for drilling.

The electrical accessories of this machine are 2 class A-5 drill motors a, 2 switch-and-fuse units b for the drills, a class MM-138-D motor unit at c, class 15 headlight d, a headlight resistance compartment, a cable reel at e, and a main switch-and-fuse compartment. The wiring between the various accessories is carried in hose conduits.

The drill motors and the switch-and-fuse units for them are the same as those described under the type 29-C arcwall machine (approvals 112 and 112A). These accessories are the forms first used on the arcwall machine. The switch-and-fuse units do not contain the extra fuses for headlight-circuit protection.

The class MM-138-D motor unit is similar to the MM-138 motor unit described under the type 35-BB shortwall machine (approvals 111 and 111A). It differs mainly in that the shaft at the commu-
tator end was extended for a pinion to drive the cutter bar. The class 21 starting box was the modified form, with a ribbed cast-iron cover held by eight 1/2-inch bolts with nuts and lock washers and secured to the magnet frame of the motor by eight 1/2-inch cap screws. The commutator cover was the boiler-plate design. For 500-volt service the resistance was of nichrome wire, and the resistance-compartment cover was the dished cast-brass design. For 250-volt service the resistance was a cast-grid type, and the resistance-compartment cover was the flat boiler-plate design. The construction at the bearings also differs somewhat. The hub of the pinion fits closely through the bearing cap at the commutator end, whereas a cap pierced only by an oil drain was formerly used. At the other end the ball bearing and the pinion are carried by a sleeve on the shaft; the pinion hub is machined to make a close running fit with a baffle ring and the retaining nut which screws into the bearing housing. A tortuous path is thus provided for any products of combustion issuing from the bearing. The baffles inside the ball bearing are the same at both ends of the motor as formerly.

The class 15 headlight and the headlight resistance compartment are the same as those described under the type 29–C arcwall machine (approvals 112 and 112A). The headlight resistance compartment is used for both 250-volt and 500-volt service, but its omission from 250-volt machines is optional.

The cable reel was the design using the bearings as sliding contact surfaces for conducting the current from the trailing cable. This reel was described under the type 28–A shortwall machine (approvals 102 and 102A).

The main switch-and-fuse compartment was the redesigned camel-back switch having tongue-and-groove joints for the cover, described under the type 39–B shortwall machine (approvals 103 and 103A). Small fuses in this compartment protect the headlight circuit, which leaves through an asbestos-packed stuffing box, but the other lead entrances are insulated studs.

**EXTENSIONS OF APPROVAL**

The main switch-and-fuse box was superseded by the design shown at $e$, figure 14; it is described under the type 29–C arcwall machine (approvals 112 and 112A). The compartment contains the double-pole switch, one main fuse which is in the positive line, and small fuses to protect both sides of the circuit to the headlight.

The cable reel was superseded by the design shown at $f$ in figure 14; it is described under the type 29–C arcwall machine. As already mentioned, omission of the headlight resistance compartment from 250-volt machines is optional.

The bearing construction of the motor was altered at the commutator end to accommodate a larger shaft. The ball bearing was mounted on the pinion hub instead of directly on the shaft, and a tortuous path for products of combustion from the bearing was provided by the running fit between a baffle plate attached to the bearing cartridge and a spacing bushing or sleeve on the pinion hub. The baffle plate is attached to the bearing cartridge by four 1/8-inch screws, and the new bearing cap is held to the cartridge by four 3/8-inch screws; the screw holes are bottomed in the cartridge.
and the screws secured by lock washers. The baffles at the inner end of the bearing cartridge were altered slightly.

To accommodate a larger resistance for 500-volt machines a box-shaped cast-iron cover about 4 3/4 inches deep was allowed for the resistance compartment. Part of the resistor elements are fastened to the cover by studs permanently riveted in place. This change is similar to those mentioned under the type 35-BB shortwall machine (approval 111A).

**TYPE 35-BB, A-C. SHORTWALL CUTTING MACHINE, APPROVALS 153 AND 153A**

Approvals 153 and 153A, covering 220-volt and 440-volt, type 35-BB, a-c. shortwall cutting machines, respectively, were issued to the Jeffrey Manufacturing Co. on July 31, 1928. The electrical accessories for this machine are the class MM-133 motor, the class 22-D starting box, the contactor compartment, and the cable reel. Figure 16 shows the complete machine.

Motor a is a three-phase, 60-cycle, squirrel-cage induction motor rated at 50 hp. The motor frame is cast iron; the sides are deeply corrugated to provide the maximum cooling surface. The pinion end is closed by a cast-iron end plate or ball-bearing housing. A turned lip on the plate fits the bored opening into the frame, and the surface of the plate bears against the outside of the frame; a step joint with wide metal surfaces in contact is thus formed between the parts to prevent discharge of flame. Four 5/8-inch bolts secured by lock washers and screwing into bottomed holes in the frame hold the end plate in place. The other end of the frame is closed by a cast-steel bearing housing. The joint between the parts is similar to that at the pinion end, but the housing is held by four 5/8-inch studs with nuts secured by lock washers; the studs are permanently riveted in place in the motor frame. A rectangular opening through the side of the frame gives access to a terminal board; it is closed by a 5/8-inch boiler-plate cover held by six 1/2-inch bolts screwing into bottomed holes in the frame and secured by lock washers. The wide, flat, metal surfaces in contact at the joint prevent discharge of flame. A hollow steel sleeve or shaft on which the rotor laminations are mounted is carried by the ball bearings in the end plates or bearing housings, and a solid shaft carrying a pinion is journaled in bushings in the ends of the hollow shaft. A multiple-disk clutch at the end opposite the pinion ties the two shafts together. Thus the rotor can be started without load by disengaging the clutch. The inside of the hollow shaft does not communicate with the interior of the motor. At the pinion end the close running fit of the hollow shaft through a cup-shaped cast-iron bearing retainer or shell which closes the inner end of the bearing seat prevents discharge of flame through the ball bearing. The retainer is held to the bearing housing by four studs with nuts secured by lock washers; the studs are permanently secured to the retainer, as omission of a stud would leave a hole into the motor. The ball bearing and the close running fit between baffles on the housing at the outer end of the bearing seat and a nut or sleeve screwed on the end of the hollow shaft furnish additional protection. At the clutch end the close running
Figure 16.—Jeffrey type 35-BB, a-c. shortwall machine.

a, b, c, d
fit of a sleeve or bearing spacer on the hollow shaft through baffles on the bearing housing itself guards against discharge of flame. The close running fit of the bearing retaining ring, which screws into the housing, with the bearing nut on the hollow shaft furnishes additional protection here.

A six-conductor rubber-clad cable from the contactor compartment enters the end of the motor frame through an asbestos-packed stuffing box. A malleable iron housing bolted over the lead entrance carries an insulated clamp for the cable, and the bell-mouth entrance to the housing prevents damage to the cable insulation.

The class 22-D starting box b has the same case as the improved class 21 starting box with ribbed cast-iron case held to the base casting by eight fastenings; the class 21 starting box was described under the type 35-BB shortwall machine (approval 111). A 3/8-inch boiler-plate base plate closes the rear of the compartment, and the eight 1/2-inch studs which bolt the compartment to the motor frame also clamp the base plate; the stud holes are bottomed in the bosses on the motor frame that carry the starting box, and the nuts are secured by lock washers. The wide, flat, metal surfaces in contact prevent the discharge of flame from the starting box. The wires pass from the motor into the starting box through insulating bushings screwed into holes through the motor frame. A rectangular hole through the starting-box base plate admits the wires. The wide, flat, metal surfaces in contact between the starting-box base plate and a machined pad on the motor frame around the lead holes prevent the discharge of flame to the outside from the starting box or from the lead-entrance holes to the motor. The starting box actuates the contactors and serves as an interlocked reverse switch. No main conductors are opened or closed in the starting box while they are carrying current.

Contactor compartment c contains a two-element magnetic overload relay, a three-pole contactor, three small fuses to protect the control circuits to the starting box, and a snap switch in the operating circuit for the contactors. The explosion-proof case is cast iron with an aluminum-alloy cover held by sixteen 1/2-inch bolts screwing into tapped holes in the case; the bolts are secured by lock washers, and the holes are bottomed where necessary to prevent their leading to the inside of the compartment. The short shaft for the snap switch is journaled in a hole reamed through a boss on the case. The six-conductor hand cable leaves the compartment through an asbestos-packed stuffing box in the front of the case and is held by an insulated clamp on the frame of the machine. The three cables from the cable reel enter the compartment through asbestos-packed stuffing boxes in the rear of the case. A sheet-metal cover over the lead entrances provides for attachment of a hose conduit for the cables from the cable reel.

Cable reel d is essentially of the same design as that described in connection with extensions of approvals 112 and 112A for the type 29-C areawall machine. The collector-ring compartment is cast steel. Additional stuffing boxes are added to accommodate three conductors. A sheet-metal guard under the collector box provides for attachment of the hose conduit for the cables to the contactor compartment.
EXTENSIONS OF APPROVAL

A few changes have been allowed by extensions of approval. A special drain plug was added in the contactor compartment, and the ribbed cast-iron cover of the starting box was changed to heavy malleable iron. A single stuffing box for a three-conductor cable replaced the three stuffing boxes for single-conductor cables in the contactor compartment. A three-element overload relay replaced the two-element relay of the original design.

TYPE 24–B, A.-C. LONGWALL CUTTING MACHINE, APPROVALS 185 AND 185A

Approvals 185 and 185A, covering 220-volt and 440-volt, type 24–B, a.-c. longwall cutting machines, respectively, were issued to the Jeffrey Manufacturing Co. on February 24, 1930. The electrical accessories for this machine were a class MM–139 motor, a class 22 starting box, and a contactor compartment with a fuse box. The motor and starting box are on the cutting unit, and the contactor and fuse box are mounted on a separate skid. A 300-foot six-conductor rubber-clad cable connects the motor with the contactor, and a separate ground conductor connects the cases of the accessories to a common ground. A short length of three-conductor rubber-clad cable connects the fuse box to the power supply.

The three-phase, 60-cycle, squirrel-cage induction motor (fig. 17, A) is rated at 50 hp. A clutch allows the motor to start without load. The motor is connected directly across the line in starting.

Stator frame a is an iron casting with open ends and a rectangular opening through one side back of starting box b. A lip on the inner face of cast-iron end plate or bearing housing c fits the bored opening of the frame, and the face of the plate bears against the end of the frame; a step joint with wide metal surfaces in contact is thus formed to prevent discharge of flame. Four 5⁄8-inch bolts screwing into bottomed holes in the frame hold the end plate. The other end of the motor is closed by a cast-steel end plate or bearing housing held by six 5⁄8-inch bolts screwing into bottomed holes in the frame. The bolts for both end plates are secured by lock washers. The wide metal surfaces in contact at the joint prevent discharge of flame. The 3⁄16-inch steel plate d, which carries the starting box, closes the rectangular opening through the side of the frame. It is fastened to the motor by four 1⁄2-inch cap screws and eight 1⁄2-inch studs with nuts; the fastenings are secured by lock washers. The holes for the cap screws do not open to the inside of the motor, but the studs are permanently secured in the frame of the motor because the holes for the studs go through to the inside. The wires enter the motor through insulating bushings screwed into holes through the end of the frame. The casting for plug-and-socket connection e is bolted over the lead entrance by two 1⁄2-inch bolts screwing into bottomed holes and secured by lock washers. The wide, flat, metal surfaces in contact between the motor end plate, the motor frame, and the casting for the plug-and-socket connection prevent discharge of flame to the outside from the lead entrance. The leads from the motor to the starting box pass through insulating bushings screwed into holes in a steel block riveted to plate d, which carries the starting box.
The close running fits of the shaft at one end and the spider of the rotor at the other end through baffles on the inside of the end plates prevent discharge of flame through the bearings. At one end the ball bearing and the close running fit between a spacing collar on the shaft and the bearing retainer ring which screws into the bearing seat add to the protection. At the other end the parts of a thrust bearing, together with the other bearing parts, probably add considerably to the construction.
The starting box is the same as that described under the type 35-BB, a.-c. shortwall machine (approvals 153 and 153A). A notched disk has been added in connection with an interlock for the plug-and-socket connection. The starting box is held by 3 bolts with nuts, 2 cap screws screwing into holes tapped in the mounting plate, and 3 studs permanently riveted in place in the mounting plate; the fastenings are all secured by lock washers. The wide, flat, metal surfaces in contact between the mounting plate and starting box prevent the discharge of flame from the joint. The lead entrance was described with the motor.

Plug-and-socket connection e (fig. 17, A) allows the cable to be disconnected from the motor. The plug is interlocked so that it cannot be inserted or removed, except when the starting box is in the off position. In addition, a padlock prevents unauthorized removal of the plug. A clamp attached to the machine prevents pulls on the cable from being transmitted to the plug.

Figure 17, B, shows the contactor compartment. In the original assembly the skid carried a fuse box as well as the contactor compartment. Later changes in the control equipment made the fuse box unnecessary. The contactor case was the same as that described under the type 35-BB shortwall machine (approvals 153 and 153A). The compartment contained a three-pole contactor, a two-element thermal overload relay, three small fuses for the control circuit, and a two-pole switch by which the control circuit could be opened independently of the starting box at the motor. The cable to the motor is held by a clamp under shield a. The operating button for the control switch is at b.

The fuse box was included in the original design because the thermal overload relays were not considered adequate protection under short-circuit conditions. The compartment was a rectangular, cast-iron box closed by a 3/4-inch boiler-plate cover held by sixteen 3/8-inch cap screws secured by lock washers; the screw holes do not open to the inside of the box. The wide metal surfaces in contact at the joint between the box and the cover prevent discharge of flames. The wires enter and leave through asbestos-packed stuffing boxes. The compartment contains three cartridge fuses (one in each line) isolated from each other and from the sides and top of the compartment by insulation barriers.

EXTENSIONS OF APPROVAL

The two thermal overload relays were replaced by three magnetic relays, and the fuse box was eliminated. The lead entrance from the power supply was changed to a single stuffing box for a three-conductor cable. The cable between the motor and contactor units was changed to a seven-conductor type, one conductor being used for a ground wire.

TYPE 35-L, LOW-VEIN, D.-C. SHORTWALL CUTTING MACHINE, APPROVALS 193 AND 193A

Approvals 193 and 193A, covering 250-volt and 500-volt, type 35-L, low-vein, d.c. shortwall cutting machines, respectively, were issued to the Jeffrey Manufacturing Co. on June 3, 1930. The elec-
trical accessories for this machine are the class MM-163 motor unit and the cable reel. The motor unit includes motor, contactor, and resistance compartments in the same casting. Figure 18 shows an optional assembly of the machine allowed by an extension of approval. In the original assembly the cable reel was mounted at the rear of the truck that carried the motor unit instead of on a trailer truck as illustrated.

The motor is rated at 50 hp. The motor compartment is directly between the contactor and the resistance compartments. The commutator end of the motor is cast closed, except for a comparatively small bored hole for a cast-steel ball-bearing housing. This housing enters the bore from the inside of the motor, and a shoulder machined on the inner end of the housing prevents it from passing entirely through the bore. A step joint with wide metal surfaces in contact between the parts is thus formed to prevent discharge of flame. A key permanently fastened in its keyway in the housing prevents rotation, and two 3/4-inch cap screws in holes tapped in the housing in a radial direction prevent endwise motion. A hole large enough to permit the armature to be removed is bored through the gear end of the motor frame. It is closed by a cast-iron end plate or bearing housing held by six 5/8-inch studs with nuts secured by lock washers; the studs are permanently riveted in place in the motor-frame casting. A turned surface or lip on the inner face of the end plate fits into the bore in the motor frame, and the plate bears against
the outside of the frame; a step joint with wide metal surfaces in contact is thus formed between the parts. Two screw-type handhole covers at b permit access to the commutator and brushes; these should be sealed to prevent tampering.

The close running fits of the shaft at the pinion end and the spacing sleeve on the shaft at the commutator end through baffles on the inner sides of the bearing housings prevent discharge of flame through the ball-bearing seats. The parts are arranged to make tortuous paths. The ball bearings and the running fits between the parts at the outer ends of the bearing seats furnish additional protection. To realize full benefit from the external parts the grease cups must be in place.

The contactor compartment contains four magnetic contactors, a magnetic overload relay, a reverse switch, a small master-control drum, and a small fuse to protect the control wiring. It is closed by a trough-shaped cast malleable iron cover, c, held by nineteen $\frac{1}{2}$-inch cap screws secured by lock washers; the screw holes do not lead to the inside of the compartment. The wide, flat, metal surfaces in contact at the joint between the cover and the main casting prevent discharge of flame. Screw cover d, which closes an inspection opening through the cover, should be sealed to prevent tampering. A rod for resetting the overload relay is journaled in a reamed hole in the end of the cover. The operating rod for the reverse switch and the bearing for one end of the master-control cylinder are in the end of the case. The long, close bearing fits prevent discharge of flame. A mechanical interlock outside the compartment prevents improper operation of the reverse switch.

The connections from the cable from the cable reel enter the motor unit by insulated studs in the end of the resistance compartment. A malleable iron cover bolted in place over the terminals by three $\frac{1}{2}$-inch cap screws in bottomed holes in the main casting protects the outside terminal connections. A bell-mouth entrance to the cover prevents wear and sharp bends in the cable, and an insulated strain clamp prevents pulls on the cable from being transmitted to the terminal connections. The wires pass between the compartments of the motor unit through individual insulated bushings screwed into holes through the partitions of the casting.

The cable reel was of the same general design shown in figures 12 and 13. (The first form of this cable reel is shown in fig. 14.) It was described in connection with extensions of approvals 112 and 112A for the type 29-C arewall machine. The hand cable to the motor is held by an insulated clamp attached to the frame of the truck to prevent pulls on the cable from being transmitted to the connections in the collector box of the reel.

EXTENSIONS OF APPROVAL

The trailer-truck cable reel in figure 18 was allowed as an optional arrangement. Collector box a and other explosion-proof features of the reel are the same as those described for the trailer-truck reel under the type 35-BB shortwall machine (approvals 111 and 111A). Use of the machine without a cable reel and truck has been authorized where the mining system does not necessitate moving the ma-
chine from place to place. A storage spool for the cable may be used, but it has no electrical connections.

**TYPE 35–L, LOW-VEIN, A.-C. SHORTWALL CUTTING MACHINE, APPROVALS 201 AND 201A**

Approvals 201 and 201A, covering 220-volt and 440-volt, type 35–L, low-vein, a.-c. shortwall cutting machines, respectively, were issued to the Jeffrey Manufacturing Co. on September 8, 1930. The electrical accessories for this machine comprise the class MM–164 motor unit and the cable reel. The motor unit includes motor and contactor compartments in the same casting. This machine is the a.-c. counterpart of the type 35–L, d.-c. machine described under approvals 193 and 193A.

The motor (fig. 19) is a three-phase, 60-cycle, squirrel-cage induction motor rated at 50 hp. A 3/8-inch boiler-plate cover, \( a \), held by eight 1/2-inch cap screws in bottomed holes in the casting, permits access to a terminal block inside the motor compartment where connections can be made for 440 volts or 220 volts as required. Wide, flat, metal surfaces in contact between the cover and the casting prevent discharge of flame through the joint. The coupling end of the cast-steel stator frame is closed by bearing housing \( b \), which fits a bored hole through the end of the casting. The construction is identical with that at the commutator end of the motor for the type 35–L, d.-c. machine described under approvals 193 and 193A. The pinion end of the motor is closed by a cast-iron end plate or bearing bracket held by six 5/8-inch cap screws secured by lock washers; 4 of the screws are bottomed in the frame casting, while the 2 top screws are arranged as shown in figure 19. A turned lip on the inner face of the end plate fits into the bored opening of the frame casting, and the surface of the plate bears against the outside of the frame; a step joint with wide metal surfaces in contact is thus formed between the parts to prevent discharge of flame. The arrangement of the bearings at both ends of the motor is the same as for the d.-c. motor described under approvals 193 and 193A. Also, the trough-shaped contactor-compartment cover \( c \), the external operating levers, the interlock, and the bearings through the end of the compartment are identical with those of the d.-c. machine.

The contactor compartment contains a three-pole magnetic contactor, three magnetic overload relays (one in each line), a small control drum, a reverse switch, and a small stop switch which opens the contactor independently of the control drum. The contactor starts the motor by connecting it directly across the line at full voltage. The control drum is so arranged that the motor will not automatically restart when stopped by failure of power, action of the overload relays, or the auxiliary stop switch. The wires pass between the contactor and motor compartments through individual insulated bushings screwed into holes through the partition in the casting. The three-conductor rubber-clad cable from the cable reel enters the motor compartment through an asbestos-packed stuffing box at \( d \). The lead-entrance cover, the same as that for the d.-c. machine, is shown in figure 19. An insulated strain clamp (not shown) is used to hold the cable.
The cable reel is mounted on the truck which carries the machine; it is essentially the same as that in figure 16. The explosion-proof features are virtually the same as those of the d.-c. cable reel described in connection with extensions of approvals 112 and 112A, type 29-C arcwall machine. The collector-ring compartment is cast steel; additional stuffing boxes are included to accommodate the three conductors. Short lengths of single-conductor cable are spliced to the three-conductor cable to the motor at the entrance to the collector compartment of the reel; the splices are carefully made and insulated.
EXTENSIONS OF APPROVAL

No extensions of approval have been allowed.

TYPE 29-L, D.-C. ARCWALL CUTTING MACHINE, APPROVALS 231 AND 231A

Approvals 231 and 231A, covering 250-volt and 500-volt, type 29-L, d.-c. arcwall cutting machines, respectively, were issued to the Jeffrey Manufacturing Co. on August 31, 1931. The general arrangement of these machines is similar to that of the type 29-C machines described under approvals 112 and 112A. Figure 20 shows a complete 500-volt, type 29-L arcwall machine. The equipment comprises a self-propelled truck, a turret mounted on its front end, and a cutter bar and a class MM-144 motor, a, mounted on the turret. The motor drives the cutter chain and furnishes power for turning the turret. Two class 19-D headlights b or one class 17 headlight is mounted on the turret. A junction box at c divides the headlight circuit when the two headlights are used. The control unit for the class MM-144 motor comprises a class 20 starting box, d, and a resistance compartment, e, the two being bolted together as one unit. Class MM-2146 motor unit f propels the truck and supplies power to raise and lower the turret. It comprises a motor, a resistance compartment, and a class 20 starting-box compartment. Contactor compartment g and cable reel h occupy the rear of the truck. On 250-volt machines a switch-and-fuse compartment replaces the contactor compartment, and a class 21 starting box is used in place of the class 20; the starting boxes differ only in their internal arrangements. The approval called for malleable iron starting-box covers instead of the ribbed cast-iron covers in figure 20.

The MM-144 motor is rated at 50 hp. The bearing housings and the end-bell constructions are the same as those for the MM-144 motor on the type 29-C arcwall machine. The only notable difference between these two motors is the improved lead-entrance construction of the motor, as used on the type 29-L machine. The leads enter the magnet frame by a seven-conductor rubber-clad cable through an asbestos-packed stuffing box. The stuffing box is formed in a sleeve or bushing which fits a bored hole through the frame casting and is held by two ¾-inch cap screws screwing into bottomed holes and secured by lock washers. The long, cylindrical fit of the bushing in its bore makes a flametight joint. The two screws also hold the special fitting that secures the end of the hose conduit protecting the cable. The conductors of the cable terminate at binding posts on a terminal block just inside the entrance; by loosening the connections and the two screws holding the stuffing-box bushing the cable can be readily detached from the motor. A rectangular, ¾-inch boiler-plate cover held by six ½-inch cap screws in bottomed holes permits access to the terminal block. The wide, flat, metal surfaces in contact between the cover and the magnet-frame casting make a flametight joint. The circuit for the headlights runs from the terminal block to the other end of the motor, where it leaves the compartment by a two-conductor rubber-clad cable through an asbestos-packed stuffing box in the magnet frame.
The resistance and starting-box unit for the MM-144 motor is similar to that on the type 29-C machines. It consists of a rectangular cast-iron resistance compartment, e (fig. 20), and a start-

ing box, d, bolted to it, one end of the casting being extended to accommodate the starting box. A 3/8-inch boiler-plate cover held by twelve 3/2-inch cap screws screwing into bottomed holes in the cast-
ing and secured by lock washers closes the resistance compartment.
The starting box is held by six ½-inch cap screws in bottomed holes in the casting and two ½-inch bolts with nuts; the fastenings are secured by lock washers. The wide, flat, metal surfaces in contact between the cover and the resistance compartment and between the starting box and resistance-compartment casting form flamelight joints. The wires pass from the resistance compartment to the starting box through individual insulated bushings screwed into holes through the end wall of the resistance-compartment casting, which separates it from the interior of the starting box. The leads enter and leave the unit through asbestos-packed stuffing boxes going into the starting box. A terminal box formed in the casting and closed by a light sheet-steel cover provides for attachment of the hose conduits protecting the cables.

Contactor compartment $g$ is the same as that described under extensions of approvals 112 and 112A for the type 29–C arcwall machine. The compartment contains the double-pole switch for the headlight circuit. The switch-and-fuse compartment which replaces the contactor for 250-volt machines is the same as the design shown at $e$ in figure 14, described under extensions of approvals 112 and 112A.

The class MM–2146 unit $f$ (fig. 20) has the same general form as the class MM–146 motor used on the type 29–C arcwall machines. The motor and resistance compartments are enclosed in one steel casting, the two compartments being separated by a division wall of the casting. The starting box is bolted to the side of the casting by eight ½-inch cap screws fitting in bottomed holes and secured by lock washers. Two screw-type handhole covers in the top of the motor compartment permit access to the commutator and brush rigging; the covers are sealed to prevent tampering. Bored holes through the ends of the magnet frame accommodate the ball-bearing housings. A turned surface on the inner face of the cast-iron bearing housing or end plate at the commutator end fits into the bore, and the housing bears against the outside of the magnet frame; a step joint with wide metal surfaces in contact is thus formed to prevent discharge of flame. Three ½-inch studs riveted permanently in place in the magnet frame hold the housing in place; the nuts are secured by lock washers to prevent loosening. A cast-iron bearing housing also makes a step joint with the magnet frame to close the bore at the pinion end. The turned surface on the housing enters the bore from within the motor, and the three ½-inch studs holding the housing are riveted permanently in place in the housing; the studs pass through holes in the magnet frame, and the nuts are secured by lock washers on the outside. The shaft fits closely through baffles on the inner ends of the bearing housings. At the commutator end a sleeve or spacer on the shaft provides the close fit necessary to prevent discharge of flame. The ball bearing and the running fit between a special washer attached to the end of the shaft and the bearing cap give some additional protection. Oil drain holes through the cap prevent it from closing the entrance to the bearing completely. At the pinion end the ball bearing and the running fit between the bearing nut and the bearing retainer give additional protection against discharge of flame. The grease cups should be in place as the grease holes lead to the inner side of the
bearings. The bearing arrangement of this motor is identical with that of the class MM-146 motor described under the type 29–C arc-wall machine (approvals 112 and 112A). On 250-volt machines the resistance compartment is closed by a flat, 3/8-inch boiler-plate cover and on 500-volt machines, by a cast malleable iron cover. The covers are held by fourteen 1/2-inch cap screws fitting in bottomed holes in the compartment casting and secured by lock washers. The wide, flat, metal surfaces in contact at the joint between the covers and the casting prevent discharge of flame from the compartment. The leads between compartments are carried in insulated bushings screwed into holes through the dividing walls of the casting. The incoming leads enter the motor compartment through asbestos-packed stuffing boxes, and a screw-type handhole cover permits access to the terminal connections; the cover should be sealed to prevent tampering. A welded plate-steel guard bolted over the lead entrance provides for attachment of the hose conduit protecting the wires to the motor.

The headlight junction box at c is the same as the design used on the type 29–C machine, approvals 112 and 112A; it is a small, rectangular, cast-iron box closed by a screw-type cover sealed to prevent tampering. The circuits enter and leave the compartment by two-conductor rubber-clad cables through asbestos-packed stuffing boxes. The hose conduits protecting the cables are attached to the stuffing-box nuts.

The construction of the headlights is the same as that described under extension of approvals 112 and 112A for the type 29–C machine. The explosion-proof features of the cable reel are the same as those of the reels in figures 13 and 14; these were described under extensions of approvals 112 and 112A. All wiring between accessories is protected by hose conduit.

EXTENSIONS OF APPROVAL

No extensions of approval materially affecting the design have been granted.

APPROVED MACHINE BUILT BY THE JOY MANUFACTURING CO.

TYPE S–3, D.–C. SHEARING MACHINE, APPROVAL 148A

Approval 148A, covering the 500-volt, type S–3, d.–c. shearing machine, was issued to the Joy Manufacturing Co. on February 8, 1928. The machine is self-propelling, normally moving on two caterpillar treads. When the mine-propelling gage is large enough two axles can be extended so that track wheels may be mounted on them; the machine can thus be made to move at greater speed when some distance is to be traveled. For narrower gages the calls on the treads are spaced to correspond to the track gage and thus act as flanges to keep the treads on the track. The cutter bar is mounted at the front of the machine so that it can swing in a vertical arc to shear. Hydraulic jacks provide the force required to swing the cutter bar.

The motor, through suitable gearing and clutches, drives the cutter chain, the caterpillar treads, and an oil pump for the hydrau-
lic cylinders. A reversing controller with a rheostat in the back, mounted in front of the operator's seat, provides for starting, stopping, and reversing the motor. The only other electrical parts are a headlight and the wiring between the accessories and to the power supply. No cable reel is used; the cable must therefore be dragged when the machine is moving away from the point of connection to the power circuit and must be coiled by hand on two horns at the rear of the machine when it is moving in the opposite direction.

The first motor used on the Joy permissible type S-3 shearing machine was the type CCM, size 35-K; it had an intermittent rating of 35 hp, and compound winding. The frame section at right angles to the shaft was approximately 22 inches square and the length, 28 inches. A circular opening at each end of the frame was closed by a cast-iron end plate held by four 3/4-inch cap screws in bottomed holes; the screws were secured by lock washers. Lips on the plates not only centered them properly in the frame but also formed part of the step joint; the wide metal-to-metal contact prevented discharge of flame. Each end plate carried a single-row roller bearing for the armature shaft, and the shaft extended through at both ends of the motor to take a pinion. Close running fits of the shaft through the inner bearing retainers prevented discharge of flame through the bearings. Four studs welded permanently in place to each retainer passed through holes in the end plates and corresponding holes in the outer bearing caps; nuts secured by lock washers fastened the parts. The wide metal-to-metal fits between the retainers and the end plates and the close fits of the studs through the end plates prevented discharge of flame at these points.

In the frame on opposite sides of the commutator were two rectangular openings, each closed by a ribbed cast-bronze plate held by 3/8-inch cap screws, 14 for one cover and 10 for the other; the screws fitted in bottomed holes and were prevented from loosening by tie wires through holes in their heads. Plane metal surfaces in contact formed the joints between the plates and the frame. Two 6 3/8-inch-diameter openings, 1 above the commutator and 1 at the side, permitted inspection of the commutator or brushes; these openings were closed by bronze screw-type covers secured by seals to prevent removal by unauthorized persons.

Five asbestos-packed stuffing boxes, each for a single-conductor cable, served as lead entrances to the motor. A conduit box held to the motor frame by two studs permanently riveted in place in the magnet frame covered the lead entrance to provide for rigid metal conduit leading to the controller.

The 35-K motor was later superseded by a 35-KT motor by extension of the approval.

The control mechanism comprises a reverse switch and a controller drum for "cutting out" the resistance when the motor is started; it also includes a single-pole magnetic contactor and a magnetic time-limit overload relay. Two small levers—marked "Start" and "Stop"—on top of the controller case operate contacts in the control circuit for the magnetic contactor. To start the motor the controller handle is moved to the first point, and the start lever is pushed to the left and held in this position while the con-
controller handle is moved through the various accelerating points. The contactor closes when the start lever is pushed and will remain closed only so long as the lever is held, until the full-speed position of the controller handle is reached, when the start lever may be released. If for any reason the contactor opens, the controller must be returned to the first point before it can be closed again. Pressing the stop lever or moving the control drum back one or more points opens the contactor and stops the motor.

The controller compartment has two main parts, a boxlike steel casting which houses the controller proper and a smaller steel casting which encloses the rheostat. The two are bolted together by sixteen 1/2-inch hexagon-headed cap screws fitting in bottomed holes in the controller casting and secured by tie wire through holes in their heads. The wide, flat, metal surfaces in contact at the joint between the two castings prevent discharge of flame. An insulating panel which carries studs for making connection from the resistance element to the controller fingers separates the two sections.

The rheostat is a ribbon resistor tightly packed in quartz sand, which fills the resistance section of the case. The insulating panel also prevents the sand from flowing into the controller section of the case.

Two 6 1/2-inch-diameter openings are in the left side of the controller section of the case. These are closed by circular, brass, screw-type covers secured by seals. A large 18-inch-diameter opening in the front permits ready access to the interior; this is also closed by a brass screw-type cover, sealed to prevent tampering. The screw-type joints are effective in preventing discharge of flame.

The shaft of the controller drum extends through a plain bearing in the center of a circular malleable iron plate which closes a circular opening through the top of the case large enough to permit the drum to be lifted out for examination or repair. The joint consists of flat, machined surfaces and a lip on the plate, which fits snugly in the bored hole through the case. Six 1/2-inch cap screws fitting in bottomed holes in the case and secured by tie wire hold the plate to give a flametight joint. The bearing for the outer end of the controller shaft does not go to the outside. The shafts for the reverse switch and the start and stop contacts are journaled in holes through the top of the case. The long, close fits of these shafts in their bearing holes prevent discharge of flame at these points.

Connection is made to the inside of the controller case by 7 insulated studs embedded in treated wooden blocks; 2 of these serve as the point of connection for the trailing cable, and the other 5 are for connections to the motor. A cast-steel cover over the terminal block guards the terminals and secures the end of the rigid conduit leading to the motor. Similarly, a cast-steel cover over the two terminals for the trailing cable secures the end of a hose conduit which protects the cable to the point where it leaves the machine. A clamp at the rear of the machine holds the other end of the hose conduit. A fiber clamp at the controller secures the cable itself to prevent stress on the terminal connections.

The headlight circuit taps onto the main circuit in the controller and is protected by two 3-ampere fuses. A resistance is necessary
to limit the current, as the headlight bulb is designed for a 250-volt supply. The circuit between the headlight and the controller is carried in hose conduit; it enters the controller through an asbestos-packed stuffing box in the left side of the case.

The headlight is the Mancha Storage Battery Locomotive Co. type F described in connection with the Sullivan Machinery Co. type CLU, d-c. machine, approvals 134 and 134A.

EXTENSIONS OF APPROVAL

The use of a type 35-KT motor on one machine in place of the type 35-K was allowed by extension of approval. The type 35-KT motor does not have the two rectangular openings at the commutator end but has a third screw cover underneath the commutator. Some changes were made in the bearings to add oil drain holes and special parts to prevent the entrance of oil into the motor. Also, a double-row roller bearing was used in place of a single-row bearing at one end. In other respects the new motor was virtually the same as the type 35-K.

APPROVED MACHINE BUILT BY MAJOR & COULSON, LTD.

"SAMSON", A-C. LONGWALL CUTTING MACHINE, APPROVAL 220A

Approval 220A, covering the 440-volt, "Samson", a-c. longwall cutting machine, was issued to Mavor & Coulson, Ltd., on April 21, 1931. The motor, type HT (12 by 11½), is a 3-phase, 60-cycle, squirrel-cage induction motor rated at 35 hp. A drum-type starting switch having two contacts per phase starts the motor by connecting it directly across the line at full voltage. A spring arrangement in the handwheel gives the switch a quick opening and closing action. An emergency operating spindle allows the switch to be opened from the cutter-bar end of the machine. The starter is arranged for operation of the motor in either direction. The machine must not be used without a permissible junction box which provides overload and short-circuit protection, as these features are not included in the design of the cutting unit. The machine frame and the junction-box frame must be connected to a common ground. The power wires must not be used for grounding; a four-conductor (no. 4) rubber-sheathed cable is therefore used. No cable reel is required.

The motor and the starting switch are enclosed in a single explosion-proof steel casting, the ends of which are closed by rectangular, cast-steel end plates. Turned projections or spigots on the faces of the plates fit into bored holes in the ends of the enclosure casting to align properly the bearings which are carried by the end plates. The joints are therefore part step and part flat metal surfaces in contact. Each plate is held by four 1½-inch and one 1-inch tap bolts in tapped holes in the casting; the bolt holes do not lead to the inside of the compartment. The wide metal surfaces in contact prevent discharge of flame from the joints between the end plates and the casting. Lock washers secure the bolts against loosening.
A ribbed cast-steel cover which closes a rectangular opening through the side of the casting permits access to the starting switch; it is held by fourteen $\frac{3}{4}$-inch tap bolts secured by lock washers in tapped bottomed holes in the casting. Wide, flat, metal surfaces in contact prevent discharge of flame from the joint. The roller bearing at the cutter-bar end of the motor is carried in a cast-iron bearing housing which fits into a bored hole through the end plate from inside the motor. The inner end of the housing is larger than the bore so that the housing cannot slide clear through the bore; a step joint with wide metal surfaces in contact is thus formed between the parts. The housing is permanently secured in place by four $\frac{3}{4}$-inch screws which screw into the end plate and are riveted over on the outside, as omission of a screw would leave a hole into the compartment. The close running fit of the shaft through a baffle plate or bushing at the inner end of the housing prevents discharge of flame through the bearing. The baffle plate is machined to make a step joint with the inner end of the housing, with wide metal surfaces in contact, and is held by four $\frac{3}{4}$-inch studs permanently riveted to it. The studs pass through to the outside and also hold the outer bearing cap; the nuts are secured by lock washers. The roller bearing and the running fit between outer bearing cap and the pinion hub probably add to the protection against discharge of flame. The bearing seat at the other end of the motor is machined in the end plate itself. The shaft fits closely through a baffle plate or bushing which fits a counterbore at the inner end of the bearing seat. The baffle plate is held by four $\frac{1}{4}$-inch studs permanently riveted to it and fitted with nuts and lock washers; these studs also hold the outer bearing cap. A double-thrust ball bearing and a double-row radial ball bearing probably increase considerably the protection against discharge of flame along the shaft. The close running fit between the outer bearing cap and the pinion hub add to the protection, but the grease holes must be closed for full protection from the outer bearing caps.

The clutch-operating shaft passes through both ends of the switch section of the enclosure. One end of the switch shaft and one end of the emergency-switch shaft are journaled in the cutter-bar end of the enclosure; the other end of the switch shaft passes through the haulage end of the enclosure. The long, close bearing fits of the shafts make the bearings flametight.

Electrical connections are made to the inside by three insulated studs through the haulage end plate. The cable is connected to the machine by a plug-and-socket-connection interlock to prevent insertion or withdrawal of the plug when the starting switch is closed. Provision is also made for padlocking the plug to prevent removal by unauthorized persons. An insulated strain clamp in the plug prevents pulls on the cable from straining the terminal connections.

EXTENSIONS OF APPROVAL

No changes in the design of this machine have been allowed by extension of approval.
Extensions of approval allowed changes in the Oldroyd cable reel to accommodate twin-conductor trailing cable; two asbestos-packed stuffing boxes instead of the one used with concentric cable are provided.

A padlock was allowed as optional in place of a seal for the screw-type cover of the contactor compartment. A mechanical arrangement was added for operation of the control switch from the rear of the machine.

Goodman types 109 and 109A controllers have been allowed as optional equipment by extension of approval. Controllers of these types were described under approvals 105, 105A, 106, and 106A issued to the Goodman Manufacturing Co.

A Goodman type 70–R controller was added to allow operation of the contactors by the controller. When the operating switch on the contactor compartment is closed the controller operates to close the contactors on the first point. If the contactors open, the controller must be returned to the first point to close them. The explosion-proof features of the type 70–R controller are the same as those for the 70–L controller, except that a control cable through the lead entrance was added to the former. An asbestos-packed stuffing box for the three-conductor control cable to the controller was added to the contactor compartment. Because of changes in wiring the terminal cover formerly attached to the motor was eliminated, and sheet-steel guards attached to the side frame of the machine were added to protect the terminals.

APPROVED MACHINES BUILT BY THE SULLIVAN MACHINERY CO.

TYPE CE–7, D.-C. SHORTWALL CUTTING MACHINE, APPROVALS 100 AND 100A

Approvals 100 and 100A, covering the type CE–7, d.-c. shortwall cutting machine, were issued to the Sullivan Machinery Co. on September 30 and October 20, 1914, respectively. Approval 100 designates the 250-volt machine and approval 100A, the 500-volt machine. These were the first approvals for coal-cutting machines granted by the Bureau of Mines. Bureau of Mines Bulletin 78 describes the investigation of the electrical parts of these machines. The principal features of the design, including the changes made since publication of Bulletin 78, will be discussed here.

Figure 22, A, shows the complete type CE–7, d.-c. shortwall machine with the cable reel and truck, essential parts of the approved machine. The machine illustrated is one with a drum controller and a separate switch-and-fuse compartment. It is an optional form allowed by extension of approval and differs in some details from that originally approved, which used a disk-type controller with a fuse plug incorporated in its design.

The motor is a d.-c., multipolar, compound-wound machine designed to deliver 30 hp. for 1 hour without exceeding a temperature rise of 75° C. Cast-iron cover a, closing an opening through the top of the magnet frame, permits access to the brush holders and commutator. Six 1/2-inch studs with nuts secured by lock washers hold the cover joint tight, and the wide metal surfaces in contact form a flame-tight joint. The holes for the studs are bottomed in the frame to
Figure 21.—Oldroyd type B-2 machine.
No headlights were included in the accessories of the first design approved.

The wiring between the accessories is well-protected from mechanical injury. The wires to the motor and to the resistance and the cable to the reel leave junction box $e$ in hose conduits. The wires to the controller enter it direct from the junction box, as the controller is bolted to the junction box which supports it. The hose conduits are laid in channels or raceways formed in the side frames and heavy cast-iron floor plate of the machine and are covered by sheet-steel plates bolted in place. Sheet-metal guard $f$ protects the wires between the end of the hose conduit and the entrance to the resistance. The cable to the reel truck reaches the bell mouth and insulated cable clamp $g$ through a cored hole in the heavy cast-iron bumper after crossing the machine from the junction box in the covered raceway. The hose conduit also extends up to the underside of the bell-mouth fitting. An opening through the right side frame of the machine permits access to the motor-terminal cover; it is closed by a cast-iron cover bolted in place. Junction box $e$ is not an explosion-proof compartment; it provides a place for connections between the wires to the various accessories. Connections are made with Westinghouse knuckle-joint connectors secured between blocks of ebony-asbestos wood; as the connectors are not taped insulating sleeves are placed on the bolts holding the clamp blocks. The cast-iron junction box is bolted to the left side frame; the top is closed by a cast-iron cover bolted in place (not a sheet-metal cover, as shown in fig. 21).

**Extensions of Approval**

Several important changes in the design of the machine have been allowed by extensions of the approval.

The first important change allowed use of an entirely new resistance compartment and resistance for 500-volt machines. The new resistance compartment, with suitable resistance units, was later allowed for 250-volt machines as well. The new resistance case is rectangular in section and of welded construction, with $\frac{3}{16}$-inch steel-plate sides and bottom; all joints are welded inside and out. Steel pieces are welded to the sides to give strength and stiffness. Angles were first used for this purpose but were later changed to steel strips welded edgewise. A rectangular frame made of four $1\frac{3}{4}$-by $1\frac{1}{2}$-inch rectangular steel bars welded together is welded around the opening at the top of the case for the joint with the cover. The cover is also of welded construction, with $\frac{3}{8}$-inch sheet-steel top and sides; all joints are welded inside and out. No stiffeners are welded to the cover plates. A frame of the same construction as that on the case is welded around the opening of this shallow cover. The cover is held to the case by sixteen $\frac{3}{4}$-inch cap screws passing through holes in the cover frame and into tapped holes in the frame around the opening into the case; the screws are secured by lock washers. The wide metal surfaces in contact at the joint prevent discharge of flame. The circuits enter the end of the case by insulated studs. Terminal lugs are not used for the outside connections; instead the ends of the wires are bent U-shaped around the studs and secured by special clamps held by nuts on the studs; lock nuts pre-
vent the connections from loosening. The new resistance is placed in virtually the same location as the old, and the wires from the hose conduit to the terminals are protected by a sheet-steel terminal cover bolted to the resistance case and the floor plate.

The type 70-E controller, allowed as optional equipment for 500-volt machines, is essentially the same as the type 70 controller described under extensions of approvals 105A and 106A for the Goodman Manufacturing Co. shortwall machines. The changes in the fastenings for the bottom cover mentioned had already been made before the controller was applied to the Oldroyd machine. The material of this cover was also changed to machine steel for the Oldroyd machine. The type 70-L controller, similar to the type 70-E, has been added as optional by extension of approval. The only important difference in the explosion-proof features of the two type 70 controllers is that the top cover of the type 70-L is secured by twelve 1/2-inch hexagon-headed cap screws in tapped holes in the flange lip of the case instead of 12 flat-headed bolts with nuts. The original top cover of the type 70-L controller was cast steel, but this was later changed to steel plate. The type 70 controllers are supported and clamped at the center of the case to supplement the support furnished by the neck, which is bolted to the junction box.

On April 1, 1930, approvals 152 and 152A were extended to allow a design without the trailer-truck cable reel; a new reel mounted on the machine itself and a contactor compartment to furnish overload and short-circuit protection were substituted. Headlights were also added for this arrangement of the machine.

The new cable reel is mounted outside the side frame on the right side near the center of the body. The cable-reel drum 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 through a long hub provided for the hollow shaft that supports the reel. The slip rings—the means of connection between the trailing cable and the stationary wiring of the machine—are housed within the cable-reel drum. They are assembled on a spider-mounted on the end of the shaft, and the brush rigging is fastened on insulated studs screwed into bottomed holes in the end of the drum. The large opening into the drum is closed by a screw-type cover secured by a padlock to prevent tampering. The hub for the shaft is 7 1/4 inches long and carries a bronze bearing bushing for the shaft. In addition to the long joint between the shaft and bushing, a shoulder on the shaft fits against the outer end of the bushing and so increases the length of path from the interior of the drum to the exterior. A nut on the end of the shaft holds the parts in place; a small set screw secures the nut. The trailing cable enters the drum through an asbestos-packed stuffing box in a depression in the curved surface of the drum and is held by an insulated clamp just inside the entrance. The cable from the machine wiring to the slip rings passes through the hollow shaft, which does not rotate. An asbestos-packed stuffing box in the end of the shaft inside the drum closes the opening for this cable.

The contactor compartment is a rectangular, ribbed cast-steel box; the cover for the compartment is a ribbed cast-steel plate held by twenty 3/4-inch hexagon-headed cap screws screwing into bottomed
holes in the case and secured by lock washers. A large circular inspection opening through the cover plate is closed by a ribbed cast-brass screw-type cover sealed to prevent tampering. All cables enter the compartment through asbestos-packed stuffing boxes, which are made separate and screwed into tapped holes through the sides of the compartment and are then welded in place. The shafts for the control and headlight switch are journaled in bushings similarly installed. Several alternate holes are drilled and tapped into the compartment, but those not used are closed by screw plugs welded in place. Provision is thus made for 2 or 3 headlight circuits. The compartment is mounted outside the side frame near the front of the body of the machine.

The contactor compartment contains two single-pole magnetic contactors, an overload relay, a headlight switch, and a combination start-and-stop switch for operating the contactors. Small fuses are placed in each side of the headlight circuit and in each side of the circuit for operating the contactors. All these parts are mounted on a panel of insulating material. Insulating barriers are used above, in front, and at one side of the contactors to prevent arcs from the contactors from jumping to the case of the compartment.

The body of the Westinghouse headlight is a cylindrical, boxlike, cast-iron case, into which a cover holding a glass \( \frac{1}{2} \) inch thick is screwed. The glass is held between lead gaskets by a ring drawn against the rear gasket by six screws in bottomed holes in the cover. A seal prevents unauthorized removal of the cover. The lead entrance for the two-conductor cable to the headlight is a stuffing-box fitting screwed into a tapped hole in the headlight body.

Addition of the new parts required considerable change in the wiring of the machine. The trailing cable goes directly to the cable-reel drum on the machine. The two-conductor cable from the cable reel to the contactor compartment is carried in a raceway formed in the outside of the side frame of the machine; a sheet-metal cover fastened by screws closes the raceway. The return cable from the contactors and the two-conductor cable for the rear headlight follow the raceway as far as the reel and a continuation of the raceway from there to the motor, where the raceway opens into the inspection opening through the side frame at the motor terminal cover. The cable to the right front headlight mounted on a bracket attached to the side frame of the machine in front of the contactor compartment is protected by a short length of hose conduit. The cable from the contactor compartment to the left front headlight crosses the machine in a rigid conduit. A short length of rubber hose protects it from the end of the conduit to the headlight. Appropriate guards protect the cable at the ends of the rigid conduit. A special conduit fitting bolted to the side frame provides an outlet and secures a short length of hose conduit protecting the cable to the rear headlight. The cast-iron cover closing the opening through the right side frame at the motor was changed to sheet steel at this time.

On a few machines the cables between the reel and the contactor compartment were carried inside the side frame; they were protected by sheet-steel covers and passed through the side frame at the contactor box and at the cable reel. The cables to the headlights were also arranged differently.
Extensions of approval allowed changes in the Oldroyd cable reel to accommodate twin-conductor trailing cable; two asbestos-packed stuffing boxes instead of the one used with concentric cable are provided.

A padlock was allowed as optional in place of a seal for the screw-type cover of the contactor compartment. A mechanical arrangement was added for operation of the control switch from the rear of the machine.

Goodman types 109 and 109A controllers have been allowed as optional equipment by extension of approval. Controllers of these types were described under approvals 105, 105A, 106, and 106A issued to the Goodman Manufacturing Co.

A Goodman type 70-R controller was added to allow operation of the contactors by the controller. When the operating switch on the contactor compartment is closed the controller operates to close the contactors on the first point. If the contactors open, the controller must be returned to the first point to close them. The explosion-proof features of the type 70-R controller are the same as those for the 70-L controller, except that a control cable through the lead entrance was added to the former. An asbestos-packed stuffing box for the three-conductor control cable to the controller was added to the contactor compartment. Because of changes in wiring the terminal cover formerly attached to the motor was eliminated, and sheet-steel guards attached to the side frame of the machine were added to protect the terminals.

APPROVED MACHINES BUILT BY THE SULLIVAN MACHINERY CO.

TYPE CE-7, D.-C. SHORTWALL CUTTING MACHINE, APPROVALS 100 AND 100A

Approvals 100 and 100A, covering the type CE-7, d.-c. shortwall cutting machine, were issued to the Sullivan Machinery Co. on September 30 and October 20, 1914, respectively. Approval 100 designates the 250-volt machine and approval 100A, the 500-volt machine. These were the first approvals for coal-cutting machines granted by the Bureau of Mines. Bureau of Mines Bulletin 78 describes the investigation of the electrical parts of these machines. The principal features of the design, including the changes made since publication of Bulletin 78, will be discussed here.

Figure 22, A, shows the complete type CE-7, d.-c. shortwall machine with the cable reel and truck, essential parts of the approved machine. The machine illustrated is one with a drum controller and a separate switch-and-fuse compartment. It is an optional form allowed by extension of approval and differs in some details from that originally approved, which used a disk-type controller with a fuse plug incorporated in its design.

The motor is a d.-c., multipolar, compound-wound machine designed to deliver 30 hp. for 1 hour without exceeding a temperature rise of 75° C. Cast-iron cover a, closing an opening through the top of the magnet frame, permits access to the brush holders and commutator. Six 1/2-inch studs with nuts secured by lock washers hold the cover joint tight, and the wide metal surfaces in contact form a flame-tight joint. The holes for the studs are bottomed in the frame to
guard against through-holes. Cast-iron front head \( b \), held by six \( \frac{5}{4} \)-inch tap bolts secured by lock washers, closes the commutator end of the magnet frame. The joint is part plane and part step; a lip on the head which fits a bored surface in the frame and alines the parts forms the step section of the joint. The wide metal surfaces in contact prevent discharge of flame through the joint. The holes for the bolts are bottomed so that omission of a bolt will not leave a through-hole. Provision is made for safe ventilation of the motor by a protective device or muffler, \( c \), in the head designed to cool any products of combustion before they can reach the outside of the motor. The muffler discharges through openings \( d \), which slope downward to prevent excessive clogging of the passages by coal dust. The muffler is made of 35 ring-shaped sheet-steel punchings or plates.
0.0187 inch thick, separated by spacers of the same thickness. This stack of plates and spacers is riveted between two malleable iron end plates. Figure 22, A, shows the outer end plate. Three studs hold the muffler; the holes for these are bottomed to guard against through-holes, and the nuts are secured by lock washers. The wide metal-to-metal joints between the end plates and the frame head prevent passage of the products of an explosion, except radially outward through the narrow openings between the cooling plates of the muffler. On the original design the shaft was journaled in a brass bushing in a hole through the center of the end plate. (The machine illustrated has roller or ball bearings.) No bearing cap was used. A 1-inch hole closed by a pipe plug led from outside to the oil well for oiling. Cast-iron rear head or distance piece $e$, held by six 3/4-inch tap bolts secured by lock washers, closes the pinion end of the magnet frame. The joint is part plane and part step; a lip on the head which fits a bored surface in the frame and aligns the parts forms the step section of the joint. The wide metal surfaces in contact prevent discharge of flame through the joint. The rear head is also equipped with a muffler of the same design as that in the front head. The muffler discharges through two openings, one on each side of the head. On the original design the pinion hub was extended in the form of a sleeve and was journaled in a split-brass bushing in a hole through the center of the end plate. Four small cap screws passing through lips on the outer end of the bushing and screwing into bottomed holes in the end head secured it in place. The pinion was keyed on the end of the motor shaft. A drain hole closed by a pipe plug and an oil hole closed by a screw plug led to the oil well on the original design. The openings to the oil wells must be kept closed to preserve the safety of the sleeve-bearing-type motor. If a plug is omitted a path is opened to the outside from the interior of the motor through the oil well.

The resistance and controller are housed in two separate explosion-proof compartments, one formed in each side of the main feed frame. Each compartment communicates with the motor through a large opening through the rear motor head. Wide, plane, metal-to-metal joints between the motor head $e$ and the end of the feed frame prevent discharge of flame. Six 3/4-inch tap bolts secured by lock washers bolt the feed frame to the motor head and hold the joints tight; these bolts screw into bottomed holes in the feed frame. A duct for wires also connects the resistance with the controller compartment in the feed frame. Covers closing openings in the sides of the feed frame permit access to the resistance and controller. On the original design and on the other form of the machine from that illustrated the resistance cover at $g$ is a 3/4-inch, flat, steel plate. The controller compartment is closed by a dished cast-iron cover. Each cover is held by ten 3/8-inch studs with nuts and lock washers; the holes for the studs are bottomed in the feed frame to guard against through-holes. The wide, flat, metal surfaces in contact at the joints between the covers and the feed frame prevent discharge of flame. The original design uses a disk-type controller equipped with magnetic blow-out coils. The controller assembly is attached to the cover of the compartment and is operated by a hollow shaft journaled in a hole through the center of the cover. A special fuse
plug having a sliding fit through the center of the hollow shaft furnishes short-circuit protection. It is interlocked with the controller handle so that it cannot be inserted or withdrawn, except when the controller is in the off position. When this controller is used the cover employed for the resistance is the simple, flat, steel plate mentioned and not the arrangement illustrated. The circuit from the cable reel enters the rear of the controller compartment by insulated studs with a special set-screw-type terminal; a bell-mouth fitting and insulated strain clamp at the rear of the machine protect and hold the cable.

Cable reel \( f \) is mounted on an extension of the power car or truck used for transporting the machine. Figure 22, A, shows one of the two disconnecting plugs \( h \), by means of which connection is made between the machine and cable reel. The plug slips into an extension from the slip-ring housing, where it is held by a bayonet lock. A magnetic blow-out in the plug prevents an arc from being drawn into the atmosphere when contact is broken in withdrawing the plug. The cable is connected by a special insulated set-screw terminal at the outer end of the plug. Each of the two slip-ring compartments, one at each end of the reel, is in two parts; the outer part carrying the plug connection is stationary, while the other part turns with the reel. The wide, close-fitting, cylindrical metal surfaces between the parts make flametight joints. The reel shaft fits closely through holes in the center of the cases to give flametight joints. Steel pins through the shaft hold the slip-ring assemblies together. Insulated studs with set-screw-type terminals connect from the cable on the reel to the inside of the slip-ring cases.

EXTENSIONS OF APPROVAL

Several important changes in design have been allowed by extensions of approval.

A powder-filled fuse element was specified to replace the link fuse originally used in the fuse plug. Changes were also made to improve the interlock for the fuse plug in the disk controller. The controller cover was modified to protect the fastenings along the lower edge from the feed chain by thickening the metal and counterboring to bring the nuts below the surface. The studs holding the covers of the resistance and the controller compartments were increased from \( \frac{3}{8} \) to \( \frac{1}{2} \) inch as an optional provision. The motor heads were changed to accommodate roller or ball bearings. The close running fit of the shaft through baffles inside the bearings protects against discharge of flame through the bearing, and danger of propagation of an explosion through the oil well of the sleeve-bearing design is eliminated. Two bolts have been added to secure the joint along the upper side of the front head, which apparently tends to open slightly as a result of warping of the head in service.

The design using a drum-type controller and a separate switch-and-fuse compartment \( i \) was approved as optional. (See fig. 22, A.) The controller is held in place by a steel frame secured by two flat-headed screws so that the main cover can be removed without disturbing the controller assembly. The dished cast-iron cover is held by 10 cap screws passing through holes in the controller frame
and into bottomed holes in the feed frame. The controller-operating shaft is journaled in a hole bored through a boss at the center of the main cast-iron cover. A double joint is thus formed, one between the controller frame and the feed frame and one between the controller frame and the main cast-iron cover. These joints are flat, and the wide metal surfaces make them flametight. The switch-and-fuse compartment contains a double-pole switch and a removable fuse plug. An interlock prevents the switch from being in the closed position, except when the fuse plug is in place. A ¼-inch steel plate closes the side of the compartment from the resistance. Insulated studs carry the connections from the resistance to the switch-and-fuse compartment. Ten studs in bottomed holes in the feed frame bolt the assembly in place, and the wide metal surfaces make the joints between the parts flametight.

To permit tramming the machine without holding the trolley tap in the hand an extension of approval was issued authorizing arrangements for temporary connection of the tap to a trolley harp on a pole.

The machine having the switch-and-fuse compartment has been authorized for use without the cable reel and truck where the mining system does not necessitate moving the machine from place to place.

The bayonet lock for the connection plug at the cable reel has been modified to prevent the plug from jarring loose. The collar and key of the fuse plug have been changed to brass to prevent sticking of the plug caused by rusting.

**TYPE CE-7, A.-C. SHORTWALL CUTTING MACHINE, APPROVALS 104 AND 104A**

Approvals 104 and 104A, covering 220-volt and 440-volt, type CE-7, a.-c. shortwall cutting machines, respectively, were issued to the Sullivan Machinery Co. on January 16, 1919. These machines are the a.-c. counterparts of the d.-c. machines covered by approvals 100 and 100A. Bureau of Mines Bulletin 78 describes the investigation of the machines; the electrical accessories will be described briefly here.

The general design of the type CE-7, a.-c. machine is similar to that of the d.-c. machine shown in figure 22, A. The motor unit for the a.-c. machine is shown in figure 22, B. The motor is an a.-c., squirrel-cage, three-phase, 60-cycle induction motor designed to deliver 30 hp. for 1 hour without exceeding a temperature rise of 75° C.; it is equipped with roller bearings. One end of the cast-steel stator frame is closed by cast-iron front head a, held by six ¾-inch cap screws secured by lock washers; the holes for the screws are bottomed in the stator frame to guard against through-holes. A turned lip on the face of the front head fits into a bored hole in the stator frame to center the parts properly. A flametight step joint with wide metal surfaces in contact is thus formed. The head is equipped with two protective devices or mufflers for ventilating the motor of the same design as that described under the type CE-7, d.-c. machine. The arrangement is such that the products of an explosion must pass through both mufflers before reaching the outside of the motor. The mufflers discharge through openings b, which slope downward to prevent excessive clogging of the passages by coal dust. Three studs hold each muffler in place; the holes for the
studs are bottomed to guard against through-holes, and the nuts are secured by lock washers. The wide metal-to-metal joints between the muffler end plates and the motor head prevent passage of the products of an explosion, except radially through the narrow openings between the cooling plates of the mufflers. The close running fit of the shaft through baffles on the end head behind the roller bearing prevents discharge of flame through the bearing. Bearing cap $c$, secured by three cap screws in bottomed holes in the end head, holds the bearing assembly and is essential to the effectiveness of the outside muffler unit. It also adds to the safety of the bearing if the oil hole through the cap is closed. The wide metal-to-metal joints between the cap, the outer end plate of the muffler, and end-head casting are flame-tight. Cast-iron rear head or distance piece $d$ closes the pinion end of the stator frame. It is bolted to the stator frame by six $\frac{3}{4}$-inch cap screws secured by lock washers; the screw holes are bottomed in the stator frame. A step joint similar to that for the front head prevents discharge of flame. The rear head is equipped with two mufflers. Any products of combustion, after passing through both mufflers successively, are discharged through an opening on each side of the head, one of which is shown at $e$ in figure 22, B. The close running fit of the shaft and pinion hub through baffles on the head behind the roller bearing prevents discharge of flame from the bearing. The close running fit of the extended hub of the pinion through the bearing cap furnishes an added factor of safety. The bearing cap, held by three cap screws secured by lock washers in bottomed holes in the end head, is not essential to the effectiveness of the second muffler, as at the other end of the motor.

A switch-and-fuse unit occupies the compartment in the main feed frame that housed the resistance on the d-c. machine, but the controller is in the same position. The feed frame is identical with that of the d-c. machine, except that the wire duct between the two explosion-proof compartments is smaller in section to obstruct the propagation of explosions from one compartment to the other. Likewise, the passages for wires through the motor end head are small instead of large, as on the d-c. machine. The wide, plane, metal-to-metal joints between the motor head and the end of the feed frame prevent discharge of flame from the openings for the wires. Six $\frac{3}{4}$-inch tap bolts secured by lock washers bolt the feed frame to the motor head; these bolts screw into bottomed holes in the feed frame. The switch-and-fuse unit comprises a three-pole switch and three fuses carried by removable plugs, so interlocked with the switch that they cannot be withdrawn or inserted when the switch is closed; nor can the switch be closed with any one of the plugs out of place. The cast-iron cover that closes the explosion-proof compartment carries the switch-and-fuse assembly; it is held by ten $\frac{3}{8}$-inch studs with nuts and lock washers. The wide, plane, metal surfaces in contact at the joint make it flame-tight. The fastenings are in bottomed holes in the feed frame. The cast-iron cover that closes the controller compartment likewise carries the controller; it is also held by ten $\frac{3}{8}$-inch studs in bottomed holes in the feed frame. The wide, flat, metal surfaces of the joint prevent discharge of flame. The controller is operated by a hollow shaft journaled in a hole through a boss on the cover. The reverse shaft is
journaled in the center of the hollow shaft. The long, close fits prevent discharge of flame through these bearings.

The cable from the cable reel is held and protected by a bell-mouth fitting with an insulated strain clamp on the switch cover. The connections pass into the switch compartment by insulated studs with set-screw-type connections under terminal cover/.

The cable reel is essentially the same as that for the d.c. machines described, except that it is built for a three-phase instead of a two-wire circuit. One of the slip-ring compartments is arranged for 2 plug connections and contains 2 slip rings instead of 1.

EXTENSIONS OF APPROVAL

Extensions of approval specified a powder-filled fuse element to replace the link fuse originally used in the fuse plugs. Some changes have also been made in the interlock to make the d.c. and a.c. parts similar. The controller cover was modified to protect the fastenings along the lower edge from the feed chain by thickening the metal and counterboring to bring the nuts below the surface. The studs holding the covers of the switch and the controller were increased from \( \frac{3}{8} \) to \( \frac{7}{8} \) inch as an optional provision. The collar and key of the fuse plugs were changed to brass to prevent sticking caused by rusting of the plugs.

TYPE CLU, D.C. CUTTING-SHEARING MACHINE, APPROVALS 134 AND 134A

Approvals 134 and 134A, covering 250-volt and 500-volt, type CLU, d.c. coal-cutting machines, respectively, were issued to the Sullivan Machinery Co. on March 18, 1927.

Figure 23, A, shows the completely assembled machine. It is self-propelling and remains on the track at all times. Cutter bar \( a \) turns about an axis at its rear end and thus describes an arc when cutting. The motor and the whole cutter-bar mechanism can also be rotated on an axis parallel to the track to place the cutter bar in a position for shearing or, by turning 180° from the position illustrated, to place it in a position for undercutting. The whole machine can be raised or lowered relative to the wheel axles, which are carried on arms or brackets hinged to the body of the machine. The mechanism permits raising or lowering either end of the machine independently of the other.

The magnet frame of the motor is a ribbed-steel casting of rectangular cross-section. Heavy cast-steel heads, each held by twelve \( \frac{3}{4} \)-inch cap screws secured by lock washers, close the ends of the frame; the screw holes are bottomed in the magnet frame to guard against through-holes. Each of the 2 brush sets is held by 2 studs in the brush rigging passing through the side of the magnet frame; the studs must be in place to prevent through-holes. Two 6-inch-diameter cast covers which screw into holes through the magnet frame permit access to the brushes and commutator; these are padlocked to prevent tampering. The threaded joints are flameright. The joints between the end heads and the magnet frame are part plane and part step; the lips on the heads which aline the parts form step joints at the top and bottom. The wide metal surfaces in contact make the joints flameright. The close fit through baffles
on the heads inside the ball-bearing seats prevents discharge of flame along the shaft. Each end of the shaft carries a coupling and extends through the end head. Sleeves on the shaft at the commutator end and on the coupling at the other end provide the close clearances through the heads required for safety. Large-diameter bearings project from the outer surfaces of the end plates to support the motor and allow rotation of the magnet frame in adjusting the position of the cutter bar. The bearing at the commutator end is journaled in the end of the slip-ring compartment, and a cylindrical wearing ring is interposed between the bearing surface on the end plate and the casting of the slip-ring compartment. A smaller cylindrical projection from this end plate forms a cylindrical joint with a hollow spider carrying the slip rings which permit rotation of the motor shell. A shaft through the center of the spider supplies power to the feed-frame parts. The bearing on the surface of the other end plate is journaled in a gear-case casting and has no direct
effect on the safety of the motor. The wide metal surfaces of the joint with the spider and the wide bearing surfaces prevent discharge of flame from the end of the slip-ring compartment next to the motor. The lower half of the slip-ring compartment is formed in the rear truck-frame casting; the upper half is a separate steel casting bolted to the lower half by six 1-inch screws. The wide, plane, metal surfaces in contact make the joint flammertight; the bolt holes do not go through to the inside of the compartment. One end of the slip-ring compartment is closed by the motor head as described; the other is closed by the feed-frame casting, which is shaped for this purpose. The parts are held together by eight 7/8-inch bolts with nuts and lock washers. The step joint with wide metal surfaces in contact between the parts prevents discharge of flame. The hollow spider carrying the slip rings is journaled in a hole through the end of the feed frame that closes the slip-ring compartment. The interior of the spider is thus isolated, and the long bearing surfaces prevent discharge of flame from the slip-ring compartment. A dished cast-steel cover closing an opening in the top half of the case permits access to the slip rings; it is held by sixteen 7/8-inch cap screws secured by lock washers. The wide, flat, metal surfaces in contact make the joint flammertight. The screw holes do not go through to the inside of the compartment.

The electric circuits enter the slip-ring compartment by two 3-conductor rubber-clad cables through two asbestos-packed stuffing boxes in one side of the upper half of the case; the cables are protected by rubber-hose conduit held by a special fitting at the lead entrance. Controller-type fingers attached to the upper half of the case make contact with the slip rings. Individual wires which fit closely through six holes in the motor head carry the connections from the slip rings to the inside of the motor. The wire holes are lined with insulation bushings which should be in place to obstruct propagation of an explosion from one compartment to the other.

The controller, resistance, and switch-and-fuse assembly are housed in one irregularly shaped cast-iron compartment. A rectangular cast-iron cover permits access to the resistance; a similar cast-iron cover over the controller section of the compartment allows access to the controller. The covers are held by 5/8-inch studs with nuts secured by lock washers, 14 for the resistance and 16 for the controller cover. Cast-iron cover $b$, held by fifteen 5/8-inch cap screws secured by lock washers or tie wires through holes in their heads, closes the opening to the switch-and-fuse section of the compartment. The wide, plane joint is flammertight, and the screw holes are bottomed. The switch-and-fuse assembly is attached to the cover; it consists of a double-pole switch with quick-break blades separated by arc barriers and two fuses carried by removable plugs $e$. The fuse plugs and switch are interlocked so that the plugs cannot be removed when the switch is closed and the switch cannot be closed when a plug is out.

A drum controller is used. Forward rotation is controlled by movement of the controller handle in one direction from the neutral or off position and reverse, by movement in the opposite direction. A mechanical interlock prevents moving the handle through the neutral position without stopping. Plate or bracket $d$, which carries
the controller handle, operating shaft, and interlocking mechanism, closes a circular opening through the front of the compartment. This bracket makes a step joint and is held by two ½-inch screws secured by lock washers; the screw holes are bottomed. The wide metal surfaces in contact make the joint flametight. The cup-shaped hub of the controller handle closes the outer end of a cylindrical hole through the bracket. The shaft is permanently pinned in a hole through the center of the hub, and its other end is pinned to the controller cylinder. A cylindrical rack sliding in the hole through the bracket and on a square portion of the shaft meshes with gear teeth on interlock shaft e. Stop screw f, working in a Z-shaped slot in the rack surface, completes the interlocking mechanism. The rack also obstructs the discharge of flame, but the stop screw must be in place to close the opening through the Z-slot; the screw is therefore sealed. Pins through the shaft prevent the shaft and handle coming free from the rack, and the interlock shaft is permanently secured by riveted pins.

An isolated compartment formed in the casting for the controller, resistance, and switch compartment contains the resistance and fuses for the headlight circuit. A slightly dished cast-iron cover, held by twelve 5¼-inch screws secured by lock washers, permits access to this compartment; the screw holes are bottomed in the casting. The wide, plane, metal surfaces of the joint prevent the discharge of flame.

The case of each of the slip-ring compartments (g), one at each end of the cable reel, consists of two parts; the outer part, carrying the insulated-stud connection for the cable to the switch and fuse is stationary, while the other part turns with the reel. The wide, close-fitting, cylindrical, metal surfaces between the parts make a flametight joint. The reel shaft fits closely through holes in the center of the cases to give flametight joints. Steel pins through the shaft hold the slip-ring assemblies together. Insulated studs with setscrew-type terminals connect from the cable on the reel to the inside of the slip-ring cases.

The 2 cables, 1 from each slip-ring compartment, to the switch and fuse are protected by hose conduit held to the terminal housing at the slip-ring casing by a special fitting secured by 2 screws, as illustrated. The cables enter the rear of the switch-and-fuse section of the compartment through asbestos-packed stuffing boxes. The hose conduit is secured in the same way as that used at the cable reel. The two 3-conductor cables to the motor (slip ring) leave the compartment through two asbestos-packed stuffing boxes. Insulated studs carry the headlight circuit from the main compartment into the headlight fuse-and-resistance compartment. An asbestos-packed stuffing box arranged to accommodate a hose-conduit attachment provides an outlet for a two-conductor cable to the headlight.

The headlight may be mounted on either side of the machine. It is manufactured by the Mancha Storage Battery Locomotive Co. and was investigated in connection with that company’s permissible locomotives. It is a cylindrical shell closed at the ends by screw-type covers. The threaded joints make effective seals to prevent
discharge of flame. The covers are locked by a rod, the ends of which rest in notches in the periphery of the covers. The rod passes through lugs cast on the case and is secured by a padlock. The bulls-eye lens seats against a spherical surface machined in the front cover and is held by a ring which screws against its back; a set screw prevents the ring from working loose. The wide surfaces in contact between the glass and front cover and retaining ring have proved effective in preventing discharge of flame. The two-conductor cable enters the case through an asbestos-packed stuffing box in the rear cover; a set screw prevents the gland nut from loosening. The gland nut is extended in the form of a cylinder which slips inside the hose conduit. A clamp around the outside of the hose secures it in place. The lamp socket is held by a spider designed to slide inside the cylindrical shell. The reflector is clamped between the spider and a projecting ring within the shell.

EXTENSIONS OF APPROVAL

The original design of the CLU machine specified a smaller motor and insulated-stud connections instead of stuffing-box lead entrances; it also differed in other details. The earlier machines will not be described here as they are obsolete, and it is understood that none with the small motor are in service.

To permit tramming the machine without holding the trolley tap in the hand an extension of approval was issued authorizing arrangements for temporary connection of the trolley tap to a trolley pole.

Two additional handhole covers and a set of brush holders were added to the motor by extension of approval. These were duplicates of those in use.

A contactor control replaced the drum controller as optional equipment. A new explosion-proof compartment containing the control and protective features replaced the controller, resistance, and switch-and-fuse unit of the other design. Contactors and overload relays furnish overload and short-circuit protection. Small fuses are included in the compartment for the headlight and control circuits. A headlight switch is included in the design. Provision is made for either one or two headlights. The control can be operated from either side of the machine by means of duplicate controls on both sides of the compartment; a shaft from the reverse switch extends through each side. The reverse shafts are mechanically interlocked with both push buttons so that they must be in the off position before the reverse switch can be operated. A magnetic interlock also prevents operation of the reverse switch while the motor is running. An auxiliary push button shuts off the machine independently and must be closed before the others can operate. The compartment is rectangular in section and is built of steel plate and bars with welded joints. The top and bottom are closed by 3/4-inch steel plates held by 5/8-inch studs with nuts secured by lock washers; 26 studs are used for the top and 34 for the bottom. Wide, plane, metal-to-metal joints between the covers and case prevent discharge of flame. The reverse shafts are journaled in holes through the sides of the case with close fits to prevent discharge of flame. The metal push rods for the operating push buttons and
headlight switch have long, close, sliding fits. The cables enter the case through asbestos-packed stuffing boxes; special fittings secure the hose conduit protecting them.

An optional arrangement of the motor assembly which permits only partial rotation of the motor shell and cutter-bar mechanism is allowed. For this arrangement the slip rings and contact fingers are eliminated; flexible cables in the slip-ring compartment allow the assembly to rotate 30° in either direction.

The collar and key of the fuse plug have been changed to brass to obviate trouble from rusting of these parts.

**TYPE CLE, D.-C. LONGWALL CUTTING MACHINE, APPROVALS 136 AND 136A**

Approvals 136 and 136A, covering 250-volt and 500-volt, type CLE, d.-c. longwall machines, respectively, were issued to the Sullivan Machinery Co. on May 28, 1927. As the design does not include a switch and overload protection the machine is permissible only when used with a permissible junction box supplying both these features and approved by the Bureau of Mines.

The machine frame and junction box should be connected to a common ground, and the machine plug should be locked or sealed in place during operation of the machine. The negative power wire must not be used for grounding. The machine plug must not be removed unless the junction-box switch is open, and the switch must not be closed unless the plug is in place. No cable reel is used with this machine. Figure 28, B, shows the complete machine without the cutter bar and trailing cable. Cast-steel cover a, which closes the controller pocket in the side of the feed-frame casting, permits access to the controller unit. A similar cover gives access to the resistance on the other side. Each cover is held by eighteen 5/8-inch studs with nuts secured by lock washers; the holes for the studs are bottomed to guard against through-holes. The feed gears and clutches occupy the center portion of the castings between the two explosion-proof compartments. The wide, plane, metal surfaces of the joints prevent discharge of flame. The ends of the compartments are closed by cast-iron head b, held by eight 3/4-inch studs with nuts and lock washers; none of the stud holes go through to the inside of the controller or resistance compartments. The cylindrical shell or case c for the plug-and-socket connection fits into a hole bored through the head and is secured in place by two 1/2-inch cap screws with lock washers; the screw holes are bottomed. The wide metal surfaces make the joint between the parts flammetight. A cast-iron plate or disk attached to the resistance assembly and carrying four insulated connection plugs slips into the inner end of the case. The hole through the case is thus closed off from the resistance compartment. A connection plug carrying 4 socket connections slips into the outer end of the case; all 4 plugs and sockets with their connection screws and all other parts of the assembly must be in place for safety. Special care is necessary as all four connections are not used. The plug is mechanically held by a latchpin fitting through the case into a hole in the plug. It is also secured by an interlock shaft operated by the controller handle when the controller is in the on position. The outer end of the plug is equipped with a bell-mouth fitting containing an insulated
strain clamp for the cable. An auxiliary insulated clamp attached to the head by a chain relieves the plug from the pull of the cable. Controller bracket \( d \), held by three \( 1\frac{1}{2} \)-inch cap screws passing through a flange near its end and into bottomed holes in the head, fits into a hole bored through the head; lock washers secure the screws. The wide metal surfaces of the joint prevent discharge of flame. The controller shaft not only turns but slides in and out, the movement being constrained by stop screw \( e \) working in a Z-slot in the surface of the shaft. Also, circular rack teeth on the shaft rotate the interlock rod that prevents removal or insertion of the plug connection except when the controller is in the off position. A wire seal is used to prevent removal of the stop screw or the retaining plug for the interlock rod.

The wires between the resistance and the controller compartments are carried by a \( 1\frac{1}{2} \)-inch rigid conduit passing through the gear case; nuts on the ends of the conduit hold it in place. The metal surfaces in contact form flamelight joints. The motor end of the feed frame is cast closed, and the connections to the motor are carried through the wall of the controller section by insulated studs. Plug-and-socket-connection boards at the rear of the compartments permit removal of the resistance and the controller assemblies through the end of the feed frame without disconnecting any wires; head \( h \) must first be removed.

The commutator end of the motor shell is closed by the end of the feed frame. Eight \( 7\frac{3}{4} \)-inch studs with nuts secured by lock washers hold the two parts together; the stud holes are bottomed in the feed-frame casting. The flat metal surfaces form the joint except at the center of the top and bottom where a cylindrical ball-bearing housing which fits bores in both the feed frame and motor shell provides for the necessary width of metal contact. Two cast-iron covers \( f \), each held by eight \( 5\frac{3}{4} \)-inch studs with nuts secured by lock washers, permit access to the commutator; the stud holes are bottomed in the magnet frame. The wide, flat, metal-to-metal joints of the covers are flamelight. Each of the 2 brush sets is held by 2 studs passing through the top of the magnet frame and held by nuts with lock washers. The cutter-bar end of the magnet frame is cast closed, except for a bored opening for the cylindrical ball-bearing housing; the housing is held by four \( 3\frac{1}{2} \)-inch cap screws in bottomed holes. The wide, cylindrical surfaces form a flamelight joint at this end. The shaft extends through at both ends of the motor. Close running fits through baffles on the ball-bearing housings back of the bearings seal the openings. Sleeves on the shaft at the feed end and on the extended hub of the pinion at the other end give the close fits required.

**Extensions of Approval**

No extensions of approvals 136 and 136A have been granted to allow changes in the construction of the type CLE longwall machine.

**TYPE CLE-2, A.-C. LONGWALL CUTTING MACHINE, APPROVALS 181 AND 181A**

Approval 181, covering the 220-volt, type CLE-2, a.-c. longwall cutting machine, was issued to the Sullivan Machinery Co. on December 2, 1929. Approval 181A, covering the 440-volt machine, was
issued January 6, 1930. Figure 24, A, shows the assembled cutting unit of the type CLE-2, a-c. longwall machine. As the cutting unit does not include overload and short-circuit protection the machine is permissible only when used with a permissible junction box furnishing these features and approved by the Bureau of Mines. The machine frame and junction box should be connected to a common ground, and the machine plug must be locked in place during operation of the machine. The machine plug must not be removed unless the junction-box switch is open, and the switch must not be closed unless the plug is in place. No cable reel is used with this machine.

The motor is a three-phase, 60-cycle, squirrel-cage induction motor rated at 30 hp. The stator frame is a ribbed-steel casting containing the motor and a controller compartment on the right side. The cutter-bar end of the motor is cast closed, except for a bored hole for a ball-bearing housing; the housing is held by four 3/4-inch cap screws secured by lock washers in bottomed holes. The wide, cylindrical, metal-to-metal joint between the housing and the stator frame prevents discharge of flame. The cutter-bar end of the controller pocket is also cast closed. Thus at this end the two explosion-proof compartments do not depend upon the cutter head bolted to the stator frame to close them. The other end of the motor is closed by the feed-frame casting; the two parts are held together by eight 3/8-inch studs with nuts secured by lock washers in bottomed holes in the feed frame. Flat metal surfaces form the joint between the parts except at the center of the top and bottom where a cylindrical ball-bearing housing which fits bored surfaces in the stator frame and feed frame provides the necessary width of metal contact to prevent discharge of flame. The housing is held by two 3/4-inch cap screws secured by lock washers in bottomed holes in the stator frame. The feed-frame end of the controller pocket is cast closed. Four holes, 1 for the controller shaft and 3 for wires, pass through the wall. Also, three holes for wires pass directly from the controller pocket to the motor. The joint between the feed frame and stator frame must be tight as products of explosion in either the motor or controller could otherwise be discharged to the outside. Cast-steel cover a, held by fourteen 5/8-inch studs in bottomed holes in the stator-frame casting, permits access to the controller; the nuts for these studs are secured by lock washers.

An explosion-proof compartment on the side of the feed frame in line with the controller forms the housing for the receptacle for connection plug b. The top of the compartment is closed by the feedframe cover. The wide, flat, metal surfaces held in contact around the opening by ten 5/8-inch cap screws secured by lock washers form the joint between the parts. The cylindrical shell of the receptacle fits in a hole bored through the end of the compartment and is held in place by two 1/2-inch cap screws secured by lock washers; the screw holes are bottomed in the feed-frame casting. The wide, cylindrical metal surfaces form a flametight joint. The receptacle carries four insulated contact plugs; connection plug b, carrying four socket connections, slips into the receptacle. The plug and receptacle parts should be assembled properly to close the opening into the compartment. A latchpin fitting through the case of the receptacle into a hole in the plug secures the latter in place. The knob or handle c of the latch is detachable to prevent unauthorized
removal of the plug. An interlock operated by the controller shaft also prevents removal or insertion of the plug except when the controller is in the off position. The outer end of the plug is equipped with an insulated strain clamp for the cable. An auxiliary insulated clamp, \( d \), attached by a chain to the machine relieves the plug from the pull of the cable. Handwheel \( e \) operates the controller. The shaft is journalied in a bracket fitting a bored hole through the end of the receptacle compartment; the bracket is held by a \( \frac{1}{2} \)-inch cap screw screwed into a bottomed hole and secured
by a lock washer. The other end of the shaft is journaled in a steel bushing screwed into the end of the compartment and then passes through a hole bored in the end of the controller compartment. All of the bearings and fits are flamed tight except the fit of the shaft in the controller where communication between the motor and controller is possible through the ½-inch clearance on the diameter of the shaft in its hole.

The 3 leads from the receptacle contacts pass through insulating bushings 3 inches long screwed into the wall of the compartment; the wires are sealed through the bushings with asbestos packing held by nuts screwing on the ends of the bushings inside the receptacle compartment. The wires to the controller enter the compartment through 3 holes in line with those in the feed frame. The controller communicates with the motor through these holes as well as through the hole for the controller shaft as they are not filled completely. The 3 wires from the controller to the motor pass through 3 bushings similar to those for the wires from the receptacle compartment to the controller.

The controller is essentially a three-pole reversing-drum switch giving two breaks per pole. The motor is thus connected directly to the line with full potential in starting.

EXTENSIONS OF APPROVAL

No important extensions of approval have been granted, except one to allow the use of the machine on 50-cycle supply systems.

TYPE CLU, A.-C. CUTTING-SHEARING MACHINE, APPROVALS 188 AND 188A

Approvals 188 and 188A, covering 220-volt and 440-volt, type CLU, a.-c. coal-cutting machines, respectively, were issued to the Sullivan Machinery Co. on April 15, 1930.

The general design of the a.-c. machine is the same as that of the d.-c. machine covered by approvals 134 and 134A. The electrical accessories used on the a.-c. machine comprise the control unit, the motor-and-slip-ring unit, the cable reel, and a headlight.

The control unit contains a switch-and-fuse assembly and a drum controller in one compartment and the headlight fuses and resistances in another compartment. The casting, covers, and other explosion-proof features of the control unit are the same as those of the d.-c. machine, except that the a.-c. machine has 3 instead of 2 lead entrances (for single-conductor cables) and 1 instead of 2 exits for cables (three-conductor) to the slip rings. The switch-and-fuse assemblies are the same, except that the a.-c. design uses 3 switch blades and 3 fuse plugs instead of 2. The controller itself is essentially a three-pole reversing-drum switch giving two breaks per pole. The motor is thus connected directly across the line in starting. The resistance used in the d.-c. design is absent, and the unoccupied volume of the compartment is increased.

The motor is a three-phase, 60-cycle, squirrel-cage induction motor rated at 50 hp. (75°C. rise) on a 1-hour basis. The stator frame is a ribbed-steel casting having about the same shape and over-all dimensions as the motor of the type CLE-2, a.-c. longwall machine shown in figure 24, A, but without the controller pocket.
The cutter-bar end is closed by a cylindrical ball-bearing housing fitting a bore in the end of the stator frame; the housing is held by four cap screws in bottomed holes. The wide metal surfaces of the joint between the housing and the stator frame make this end of the motor flametight. A heavy cast-steel head is bolted to the end of the stator frame; it is not essential to the flametightness of this end of the motor, although it probably adds to the safety of the construction. The other end of the motor is closed by a heavy cast-steel end head. The flat metal surfaces form the joint between the parts except at the center of the top and bottom where a cylindrical ball-bearing housing which fits bored surfaces in both the stator frame and end head provides the necessary width of metal-to-metal contact to prevent discharge of flame. As the bore in the stator frame extends only over short arcs at the top and bottom the bearing housing does not close the motor completely, as at the other end; it is held in place by two 3/4-inch cap screws in bottomed holes. The end head is bolted to the stator frame by eight 7/8-inch bolts with nuts secured by lock washers. In addition, the two heads are tied together at the top and bottom outside the stator frame by two heavy channel pieces (name plates), each end of which is fastened to each end head by two 7/8-inch tap bolts. The close fits through baffles on the bearing housings inside the ball-bearing seats prevent discharge of flame along the shaft. Each end of the shaft carries a coupling. At the cutter-bar end the coupling extends through the bearing housing and carries a sleeve which provides the close clearance necessary to prevent discharge of flame through the bearing. At the other end the close fit is between the shaft and the bearing housing, the coupling being entirely outside the bearing.

Large-diameter bearings project from the outer surfaces of the motor end plates to support the motor and allow rotation of the stator frame in adjusting the position of the cutter bar. The bearing at the commutator end is journaled in the end of the slip-ring compartment, and a cylindrical wearing ring is interposed between the bearing surface on the end plate and the casting of the slip-ring compartment. A small cylindrical projection from this end plate forms a cylindrical joint with a hollow spider carrying the slip rings which permit rotation of the stator frame. A shaft through the center of the spider supplies power to the feed-frame parts. The bearing on the surface of the other end plate is journaled in a gear-case casting and has no direct effect on the safety of the motor. This construction is the same as that of the type CLU, d.-c. machine. The explosion-proof features of the slip-ring compartment are the same, except that 3 instead of 6 wires enter the motor and 1 instead of 2 stuffing-box lead entrances is provided for the incoming cable (three-conductor).

The cable reel differs from that of the d.-c. machine in having 2 slip rings in the explosion-proof slip-ring compartment at one end and 1 slip ring in the explosion-proof slip-ring compartment at the other end of the reel, instead of having 2 similar compartments with 1 slip ring in each.

The headlight is the same as that described for the d.-c. machine.
The wiring outside the explosion-proof compartments is protected by hose conduit. The lead entrances at the cable reel are by insulated studs both from the trailing cable and for the wires to the control unit. All other cable entrances to explosion-proof compartments from the outside are through stuffing boxes. The wires between the motor and the slip-ring compartment pass through individual insulating bushings. The connections from the control compartment to the headlight fuse and resistance compartment are carried by insulated studs through the dividing wall between them.

Except for the differences introduced by the use of an a.-c. motor the a.-c. machine is virtually the same as the d.-c.

EXTENSIONS OF APPROVAL

The only important extension of approval granted permits the use of brass key and collar for the fuse plugs instead of steel to facilitate their removal and thus guard against breakage and other trouble.

TYPE CR–3, 30-HP., A.-C. SHORTWALL CUTTING MACHINE, APPROVALS 191 AND 191A

Approvals 191 and 191A, covering the type CR–3, a.-c. shortwall machine, were issued to the Sullivan Machinery Co. on May 21, 1931.

Figure 24, B, shows the type CR–3, a.-c. shortwall machine. This machine is designed for wire-rope feed instead of the chain feed used on the type CE–7 machine. The electrical accessories are virtually the same as those used on the type CE–7 machine described. The construction corresponds to that of the earlier machine as modified by extensions of approval.

The only differences are in the feed frame. The compartments containing the controller and the switch assemblies differ in shape from those on the CE–7 machine. The feed frame is of welded construction instead of cast as on the CE–7 machine. The slight differences in the joints for the covers do not warrant description.

EXTENSIONS OF APPROVAL

No extensions of approvals 191 and 191A have been granted.

TYPE CR–3, 30-HP., D.-C. SHORTWALL CUTTING MACHINE, APPROVALS 192 AND 192A

Approvals 192 and 192A, covering the type CR–3, d.-c. shortwall cutting machine, were issued to the Sullivan Machinery Co. on June 3, 1930. This machine is the d.-c. form of the wire-rope-feed shortwall machine which corresponds to the a.-c., type CR–3 machine covered by approvals 191 and 191A.

The electrical accessories are nearly the same as those used on the company type CE–7, d.-c. machine covered by approvals 100 and 100A. The feed frame, however, is of welded construction instead of cast as on the CE–7 machine. In fact, it is identical with the feed frame of the type CR–3, a.-c. machine, except for the covers of the compartments and the parts contained therein. (The wire duct be-
tween the controller and switch on the a.-c. design is narrowed by a babbitt filling to correspond with the type CE–7 design.) The other chief difference between the type CR–3 and the CE–7 machines is the use of asbestos-packed stuffing-box lead entrances on the CR–3 design in place of stud-type lead entrances for the short cable from the reel. The connections at the reel and the reel itself are the same for both designs.

The motor has a roller bearing at the pinion end and a ball bearing at the other end and is identical with the same form on the type CE–7 machine. Two optional assemblies of the feed frame are approved. One uses a dial or disk controller having an interlocked fuse plug in the center of the controller handle; the corresponding resistance-compartment cover carries a stuffing-box lead entrance. The controller, controller cover, and fastenings are the same as those on the type CE–7 machine, but the resistance covers differ in that they are of \( \frac{3}{2} \)-inch plate and carry the stuffing-box lead entrance. The fastenings for the resistance cover are the same as those for the CE–7 machine. The second optional assembly uses a drum controller of identical construction with that of the type CE–7 machine and a main-line switch-and-fuse unit which differs from the construction of the type CE–7 machine only in having a stuffing-box lead entrance in the switch-and-fuse-compartment cover.

A short length of hose conduit is used to protect and support the cable next to the lead entrance because of the location of the wirerope feed drum.

EXTENSIONS OF APPROVAL

No important extensions of approval have been granted since the type CR–3 machine made use of the newer construction developed on the type CE–7 machines.

TYPE CS–4 SWIVEL SHEARER, APPROVALS 202 AND 202A

Approvals 202 and 202A, covering 250-volt and 500-volt, type CS–4, d.-c. swivel shearers, respectively, were issued to the Sullivan Machinery Co. on September 17, 1930. The machine is self-propelling and always remains on the track. The cutting unit is mounted on a horizontal bed or frame along which it is driven to bring the cutting unit up to the coal in sumping the cutter bar. The cutter bar turns about a horizontal axis and thus travels in a vertical arc to shear the coal after the machine has been sumped. The bed is carried by a turntable over the front axle of the four-wheel truck and can be turned or swiveled to bring the cutter bar to faces at various angles with the track. An adjustable support at the end of the swivel bed overhanging the truck prevents tipping when the cutting unit is moved toward the outer end. The control unit and a cable reel are mounted on the rear end of the truck. With the swivel bed turned in the direction of the track and the cutting unit moved to its rear end, connection is made from the motor through gears and sprocket chains to the two rear wheels of the truck to furnish the power for propulsion.

The motor is the same as that used on types CR–3 and CE–7 short-wall machines, approvals 192 and 100, respectively. As the feed
frame on the shortwall machines is not used on the swivel shearer the passages for the wires through the end head (distance piece) are closed by a 1/2-inch steel plate bolted to the magnet frame in place of the feed frame of the shortwall machines; six 3/4-inch bolts with nuts secured by lock washers hold the plate to the motor head. The wide, plane, metal surfaces in contact prevent the discharge of flame from the ducts for the wires through the motor head. A small push-button compartment of welded construction is built on the outer surface of the plate opposite one of the ducts through the motor head. Two holes through the bottom of this compartment admit the connections to the motor; the holes are lined with insulating bushings screwed in place. The close fit of the wires through these holes obstructs propagation of explosions between the push-button and motor compartments. The 5/8-inch plate cover of the compartment carries a stuffing-box lead entrance for the rubber-sheathed multiple-conductor cable from the control. A steel block welded on and drilled provides a long bearing fit for the push-button operating rods. Five 3/4-inch cap screws in bottomed holes and three of the 3/4-inch bolts that hold the end plate hold the cover; the fastenings are secured by lock washers. The wide, plane, metal-to-metal joint prevents discharge of flame.

A push-button-operated automatic starter with starting resistance is housed in a rectangular 1/2-inch steel-plate box of welded construction. The open side is closed by a 5/8-inch steel-plate cover held by twenty-four 5/8-inch studs with nuts and lock washers; the studs are in bottomed holes in 1/2-inch square bars welded around the opening. The wide, plane, metal-to-metal joint between the cover and compartment prevents discharge of flame. Steel pieces are welded on to provide the long bearing fits of the push rods operating the push button and at the stuffing-box lead entrances. The starting panel provides overload and low-voltage protection and two steps of starting resistance. Small fuses protect the circuits to the push buttons.

Two single conductors from the cable reel enter the control compartments through individual asbestos-packed stuffing boxes. Hose conduits protect these cables. The round, four-conductor rubber-clad cable to the cutting unit leaves the compartment through an asbestos-packed stuffing box. A hose conduit protects this cable, and insulated strain clamps hold it inside the control compartment and the push-button compartment at the cutting unit. The cable is long enough to allow for the movement of the cutting unit along its swivel bed.

The cable reel is similar to that used with the type CLU, d.c. machine, approvals 134 and 134A. Insulated studs are used for the connections on both reels. The chief difference is that the stationary parts of the explosion-proof cases on the reel for the type CS-4 machine slip inside the rotating parts to allow the reel to be driven by a belt riding over a pulley surface formed on the case. The other reel is driven by gears through the shaft and the stationary halves of the cases fitted outside the rotating halves.

EXTENSIONS OF APPROVAL

No extensions of approval requiring description have been made.
TYPE CR–3, 50-HP., A.-C. SHORTWALL CUTTING MACHINE, APPROVALS 232 AND 232A

Approvals 232 and 232A, covering 220-volt and 440-volt, type CR–3, 50-hp., a.-c. shortwall cutting machines, respectively, were issued to the Sullivan Machinery Co. on September 29, 1931. These machines correspond to the 30-hp. machines covered by approvals 191 and 191A. There are slight differences in the mechanical features of the feed frame, but the chief difference is in the motors.

The feed frame is of welded construction. Its explosion-proof features are identical with those of the 30-hp., type CR–3 machine, except that the duct for the wires between the switch and fuse and the controller pockets is not narrowed by the babbitt filling used on former designs of a.-c. shortwall machines. In other respects it does not differ greatly from either the Sullivan type CE–7 or type CR–3 machines described.

The motor is a three-phase, 60-cycle, squirrel-cage induction motor having a 50-hp. intermittent rating. The end heads closing the stator frame are the same as those used on the 30-hp., type CR–3 machines and the type CE–7 machines. The stator frame is a ribbed-steel casting open at both ends; it is about 3 inches longer than the frame for the 30-hp. motors but is about the same external breadth and thickness. The internal arrangement, however, is somewhat different. The bearing construction, mufflers, and other explosion-proof features are virtually the same as those of the 30-hp. roller-bearing motors described.

The cable reel is the same as that for the type CR–3 and type CE–7, a.-c. machines described under approvals 191–191A and 104–104A, respectively.

EXTENSIONS OF APPROVAL

One important change in the design of the type CR–3, 50-hp., a.-c. machine has been allowed by extension of approvals 232 and 232A—the ventilating mufflers were removed from the motor heads. Except for changes in the castings to close the openings for the mufflers the redesigned heads are the same as the ventilated ones.

TYPE CR–3, 50-HP., D.-C. SHORTWALL CUTTING MACHINE, APPROVALS 233 AND 233A

Approvals 233 and 233A, covering 250-volt and 500-volt, type CR–3, 50-hp., d.-c. shortwall cutting machines, respectively, were issued to the Sullivan Machinery Co. on September 30, 1931. These machines correspond to the 30-hp., d.-c. machines covered by approvals 192 and 192A. There are some slight differences in the mechanical features of the feed frames, but the chief difference between the machines is in the motors.

Figure 25 shows the motor unit without the gearing. The feed frame is of welded construction and is identical, except for the covers to the compartments and the parts contained therein, with the feed frame of the 50-hp., a.-c., type CR–3 machine described in connection with approvals 232 and 232A. Cover a over the resistance compartment is made of ½-inch steel plate with a stuffing-box lead entrance welded to it. (On later machines the contour of the stuffing box was
changed.) It is held by ten \( \frac{3}{8} \)-inch studs with nuts secured by lock washers; the stud holes are bottomed in the feed frame. The controller, controller cover, and fastenings are the same as those on the type CE–7, d.-c. machine, using the dial controller, described under

approvals 100 and 100A. The nuts along the lower edge of the cover are recessed as on the later type CE–7 machines. Also, the controller and resistance arrangement of the 50-hp., type CR–3 machines is the same as for the 30-hp., type CR–3 machines using a dial controller. The joint between the feed frame and the motor end head or distance
piece b is the same as that on the d.-c., type CE-7 and 30-hp., type CR-3 machines. Six \( \frac{3}{4} \)-inch tap bolts screwing into bottomed holes in the feed frame and secured by lock washers fasten the distance piece to the feed frame. The wide, flat, metal surfaces in contact at the joint prevent discharge of flame from the large ducts for the leads that pass through the distance piece from the motor into the controller and resistance pockets.

The motor is rated at 50 hp. The joint between the magnet frame and malleable iron head b is held by six \( \frac{3}{4} \)-inch tap bolts and four \( \frac{3}{4} \)-inch bolts with nuts; the holes for the bolts are bottomed where necessary to prevent their opening into the explosion-proof enclosures. All fastenings are secured by lock washers. The wide metal surfaces in contact prevent discharge of flame at the joint. Cast-steel commutator end head c is fastened to the magnet frame by ten \( \frac{3}{4} \)-inch tap bolts secured by lock washers; the holes are bottomed to prevent possible openings into the motor. A cylindrical lip turned on the surface of the end plate fits into a bored hole in the end of the magnet frame; a flamelight joint with wide metal surfaces in contact is thus formed. The inspection opening over the commutator is closed by a \( \frac{1}{2} \)-inch steel plate, d, held by twelve \( \frac{1}{2} \)-inch studs with nuts secured by lock washers; the holes for the studs are bottomed in the magnet frame. The wide, plane, metal surfaces in contact form a flamelight joint between the parts. Ball bearings are used at both ends of the motor. Cap e, held by four cap screws in bottomed holes in the end head, closes the bearing opening at the commutator end. The bearing seat is machined in the end head, and a brass bushing pressed on the shaft provides a close running fit through a baffle on the end head inside the bearing to prevent discharge of flame along the shaft. The bearing seat at the pinion end is in a cartridge that fits a bored seat in the end head. The close running fit of the shaft through a baffle formed on the cartridge prevents discharge of flame along the shaft. A brass bushing pressed on the shaft provides the close fit as at the commutator end. The wide metal surfaces between the cartridge and the end head prevent discharge of flame from this joint. The close running fit of the pinion hub through a bushed hole in the outer half of the bearing cartridge probably adds to the safety of construction. Three studs in bottomed holes in the bearing cartridge pass through the end head and hold the assembly in place in its cylindrical seat. There are no external connections at the motor. The wire ducts between the motor, resistance, and controller compartments are comparatively large and short, allowing free communication between these compartments and the motor.

The cable reel is the design described under the type CE-7, d.-c. shortwall machine, approvals 100 and 100A.

EXTENSIONS OF APPROVAL

No extensions of approvals 233 and 233A have been allowed.

TYPE CR-3, 30-HP., D.-C. SHORTWALL CUTTING MACHINE WITH REMOTE CONTROL, APPROVALS 238 AND 238A

Approvals 238 and 238A, covering 250-volt and 500-volt, type CR-3, 30-hp., d.-c. shortwall coal-cutting machines with remote con-
control, respectively, were issued to the Sullivan Machinery Co. on January 13, 1932. The machine is for use only with a mining system that allows it to remain in one working place; therefore a truck and automatic cable reel are not included in the accessories. A round, four-conductor rubber-clad cable with 2 no. 2 and 2 no. 12 conductors connects the cutting unit to the remote-control unit. The small conductors connect with the circuit operating the remote-control unit. The enclosure of the two units should be connected to a common ground. The control unit must not be connected to the power supply when the plug connecting the cable from the motor is not in place.

Figure 26 shows the storage reel for the cable and the control compartment with the connection plug for the cable to the motor. Control compartment a is an aluminum casting closed by a cast-aluminum cover held by twenty-two 5/8-inch studs in tapped bottomed holes in the case; the nuts are secured by lock washers. The wide, flat, metal surfaces in contact between the case and the cover make the joint flame-tight. Cast-iron case b for the cable plug-and-socket connection is held by six 3/8-inch cap screws in tapped bottomed holes; the screws are secured by lock washers. The wide, flat, metal surfaces in contact make a flame-tight joint between the parts. The four wires from the control compartment enter the case through individual holes through an insulating plug or bushing which fits reamed holes through the cast-iron case and the end of the aluminum control compartment. A shoulder on the insulating bushing fitting into a counterbore in the cast-iron case secures the bushing in place. The ends of the wires are soldered to four plug connections held by suitable insulators, which also serve to block off the opening of the case. The connection plug carrying four socket connections slips into the outer end of the case; the plug is mechanically held by latch-pin c. The outer end of the plug is equipped with an insulated strain clamp to prevent strain on the cable from being transmitted to the electrical connections. One of the plug connectors is shorter than the other three. When the plug is removed this short plug opens the control circuit and therefore the main contactors before the main circuit is opened by the plug. Thus arcing is prevented in case the plug is removed under load. It also necessitates the main circuit connections being made in the plug before the contactors can be closed. An electrical interlock, designed to prevent the removal of the plug while the control unit is connected to the power supply, is also provided. Connection to the power supply is made by 2 single-conductor rubber-clad cables which enter the end of the control compartment by 2 asbestos-packed stuffing boxes d. The stuffing-box bodies screw into holes tapped through the case and are prevented from loosening by small headless set screws in tapped bottomed holes. The control compartment contains a control panel, a push button, and the electrical interlock for the connection plug. The two plungers e, which operate the push button, are journaled in holes reamed through the end of the case. The long, close fits of the plungers in their holes prevent discharge of flame at these points. The control panel carries 2 main contactors—1 in each incoming line—an overload relay in the positive line, 2 time-limit accelerating relays, a series relay, the starting resistance, fuses
Figure 26—Cable storage reel and remote control for Types CR-3 and CR-2 machines.
for both sides of the control circuit, and other accessory parts. It is automatic, the motor being started and stopped by closing and opening the control circuit. Both the push button in the control compartment and the control contacts at the cutting unit must be closed to start the motor as they are connected in series. If the motor is stopped by action of the overload relay the control circuit must be opened, either at the motor or the control, to reset the overload-relay contacts.

Storage reel \( f \) has no electrical connections. To unwind the cable it must be disconnected by removing the connection plug at the control box. As only a short length of cable is unwound at one time no special mounting for the cable reel has been provided. Care should be taken in placing and handling the reel to protect the cable from injury.

The motor is identical with that used on the type CR–3, d.c. shortwall machine covered by approvals 192 and 192A. It is also the same as the motor having a roller bearing at the pinion end and a ball bearing at the commutator end described under the type CE–7 machine. The feed frame is of welded construction. It is the same, except for the covers to the two explosion-proof compartments and parts contained therein, as that of the feed frame of the a.c. machine described under approvals 232 and 232A. The explosion-proof features are therefore essentially the same as those of the feed frames of the type CR–3 machines already considered. The compartment formerly occupied by the controller is closed by a dished cast-iron cover carrying a reverse switch, a push button, and a magnetic interlock for the reverse switch. The cover is held by ten \( \frac{3}{8} \)-inch studs in tapped bottomed holes; the nuts are secured by lock washers. The wide metal surfaces in contact between the cover and feed frame make a flametight joint. The operating shaft of the reverse switch is journaled in a hole reamed through a boss on the cover, and the 2 plungers (start and stop) that operate the push button are journaled in 2 holes reamed through another boss on the cover. The long, close fits prevent discharge of flame through these bearings. Two stop pins for the reverse-switch handle and three of the studs supporting the accessories carried by the cover are threaded into through-holes but are riveted to secure them permanently in place. The magnetic interlock prevents operation of the reverse switch while the motor is running. The push buttons are mechanically interlocked with the reverse switch so that it cannot be operated when the control circuit is closed, nor can the control circuit be closed unless the reverse switch is closed. The four-conductor cable from the remote-control unit enters the compartment through an asbestos-packed stuffing box carried by the cast-iron cover that closes the side of the feed frame opposite the reverse switch. The stuffing-box body screws into a hole tapped through the cover and is prevented from loosening by a small, headless set screw in a tapped bottomed hole. An insulated strain clamp inside the compartment prevents displacement of the cable. The cover is deeply dished to leave as little unoccupied volume as possible since on this machine the compartment contains no equipment, but on machines without the remote control it contains the resistance units. It is held by ten \( \frac{3}{8} \)-inch
studs in tapped bottomed holes; the nuts are secured by lock washers. The wide metal surfaces in contact at the joint prevent discharge of flame.

EXTENSIONS OF APPROVAL

No extensions of approvals 238 and 238A have been granted.

TYPE CR-3, 50-HP., D-C. SHORTWALL CUTTING MACHINE WITH REMOTE CONTROL, APPROVALS 239 AND 239A

Approvals 239 and 239A, covering 250-volt and 500-volt, type CR-3, 50-hp., d-c. shortwall coal-cutting machines with remote control, respectively, were issued to the Sullivan Machinery Co. on January 14, 1932. This machine corresponds to the 30-hp., type CR-3 machine described under approvals 238 and 238A. The machine is for use only with a mining system that allows it to remain in one working place; therefore a truck and automatic cable reel are not included in the accessories. A round, four-conductor rubber-clad cable having 2 no. 2 and 2 no. 12 conductors connects the cutting unit to the remote-control unit. The small conductors connect with the control circuit. The enclosures of the two units should be connected to a common ground. The control unit must not be connected to the power supply when the plug connecting the cable from the motor is not in place.

The storage reel for the cable and the remote-control unit are the same as those for the 30-hp., type CR-3 machine with remote control described in connection with approvals 238 and 238A. (See fig. 26.) The feed frame and its accessories are also the same as those for the 30-hp., type CR-3 machine, approvals 238 and 238A.

The motor is the same as that for the type CR-3, 50-hp., d-c. machine described in connection with approvals 233 and 233A. Figure 25 shows this motor assembled with a feed frame for the conventional shortwall machine.

EXTENSIONS OF APPROVAL

No extensions of approvals 239 and 239A have been granted.

TYPE CR-2, D-C. SHORTWALL CUTTING MACHINE WITH REMOTE CONTROL, APPROVALS 241 AND 241A

Approvals 241 and 241A, covering 250-volt and 500-volt, type CR-2, d-c. shortwall coal-cutting machines with remote control, respectively, were issued to the Sullivan Machinery Co. on March 18, 1932. The machine is for use only with a mining system that allows it to remain in one working place; therefore a truck and automatic cable reel are not included in the accessories. A round, four-conductor rubber-clad cable having 2 no. 2 and 2 no. 12 conductors connects the cutting unit to the remote-control unit. The enclosures of the two units should be connected to a common ground. The control unit must not be connected to the power supply when the plug connecting the cable from the motor is not in place.

The control and the storage reel for the cable are the same as those for the 30-hp., type CR-3, d-c. shortwall machine with remote control described under approvals 238 and 238A. (See fig. 26.)
Figure 27, B, shows the electrical parts of the cutting unit for the type CR–2 machine. The motor is rated at 50 hp. The magnet frame is a trough-shaped steel casting open at the commutator end. The top is closed by a heavy steel plate, \( a \), held by twenty-four \( \frac{3}{8} \)-inch cap screws in tapped holes in the frame casting; the holes are bottomed where necessary to prevent an opening into the motor enclosure. Lock washers are used to secure the screws. The wide, flat, metal surfaces in contact at the joint between the cover plate and frame prevent discharge of flame. This construction was adopted to facilitate machining inside the motor. Two \( \frac{3}{8} \)-inch steel-plate covers closing rectangular openings through the sides of the frame casting, as at \( b \), permit access to the commutator and brushes. Each cover is held by eight \( \frac{1}{2} \)-inch cap screws in tapped bottomed holes; the screws are secured by lock washers. The wide, flat, metal surfaces in contact form flametight joints between the parts. The cutter-bar end of the motor is closed by the cast semisteel end head or bearing housing \( c \) which fits a bored hole in the end of the frame. The housing is held by four \( \frac{3}{4} \)-inch cap screws in tapped bottomed holes in the frame; lock washers prevent the screws from loosening. The wide, close-fitting, cylindrical metal surfaces form a flametight joint between the parts. The commutator end of the motor is closed by the end of the feed frame. Eight \( \frac{3}{8} \)-inch studs with nuts on both ends, as at \( d \), hold the parts together; the nuts are secured by lock washers.

The cylindrical, cast, semisteel bearing housing at this end of the motor fits a partial bore in the end of the motor frame. This construction leaves openings at the sides of the housing. The wide metal-to-metal contact between the end of the magnet frame and the feed frame at the sides and the cylindrical fit of the bearing housing near the center of the top and bottom of the motor prevent discharge of flame. The outer end of the bearing housing fits into a counterbored recess in the end of the feed frame to isolate the opening for the shaft into the feed frame from the motor. The bearing housing is held in place by four \( \frac{3}{4} \)-inch screws in lugs inside the motor. At the commutator end the close running fit of a bushing on the shaft in a hole through the rear of the bearing housing guards against discharge of flame along the shaft. Similarly, at the cutter-bar end a bushing pressed on the hub of the pinion prevents discharge of flame. Individual insulating bushings screwing into holes through the side of the magnet frame and registering with holes bored through the back of the reverse-switch compartment \( c \) carry the wires into the motor. Four \( \frac{3}{8} \)-inch studs in tapped bottomed holes in the magnet frame hold the reverse-switch compartment in place. The wide, flat, metal surfaces in contact between the back of the compartment and the magnet frame prevent discharge of flame from the lead-entrance holes. The reverse-switch compartment and its cover are of welded construction; the cover is held by ten \( \frac{1}{2} \)-inch cap screws fitting in tapped holes in the case and secured by lock washers. The holes for the four screws at the ends of the cover are bottomed so that they will not lead into the compartment. The wide, flat, metal surfaces in contact form a flametight joint between the parts. Handle \( f \) operates the reverse switch and the contacts of the control circuit. The mechanical arrangement prevents operation of the reverse switch unless the power has been shut off at the remote control.
by opening the control circuit. An electrical interlock also prevents operation of the reverse switch while the motor is running. The operating shaft is journaled in a bushing or bracket which fits into a hole reamed through the end of the compartment. The bracket is held by a 1/2-inch cap screw fitting in a tapped bottomed hole in the end of the compartment and secured by a lock washer. The long, close, metal-to-metal fits make the joint and the bearing flametight. The four-conductor trailing cable from the remote control enters the compartment through asbestos-packed stuffing box \( g \). An insulated strain clamp inside the compartment prevents strains on the cable from being transmitted to the connections.

**EXTENSIONS OF APPROVAL**

No extensions of approvals 241 and 241A have been granted.

**TYPE CR-2, D.-C. SHORTWALL CUTTING MACHINE, APPROVALS 243 AND 243A**

Approvals 243 and 243A, covering 250-volt and 500-volt, type CR-2, d.-c. shortwall coal-cutting machines, respectively, were issued to the Sullivan Machinery Co. on May 18, 1932. The equipment comprises a cutting unit, a magnetic control compartment, and a cable reel. The last two are mounted on the truck that transports the machine. A short, four-conductor rubber-clad hand cable having 2 no. 2 and 2 no. 12 conductors connects the cutting unit to the magnetic control on the truck.

Figure 27, B, shows the electrical parts of the cutting unit, which is the same as that described under approvals 241 and 241A for the type CR-2, d.-c. shortwall machine with remote control.

Figure 27, A, shows the control compartment but not in place on the machine truck. The case is of welded construction; the sides and back are 3/8-inch steel plate. A rectangular frame made of four 1½ by 1½-inch steel bars is welded around the opening at the front of the case. The cover is a flat 1/2-inch steel plate held by twenty-two 5/8-inch studs in tapped bottomed holes in the 1½-inch square bars around the opening. The wide, flat, metal surfaces in contact at the joint prevent discharge of flame. The four-conductor cable from the motor enters the case through an asbestos-packed stuffing box in the back of the case, and an insulated strain clamp inside the compartment holds the cable to prevent strains on the connections. Two single-conductor cables from the cable reel enter through individual stuffing boxes in the back of the case. The stuffing-box nuts for these are extended to slip inside the hose conduits on the cables and thus secure them; hose clamps around the outside clamp the hose securely in place. All three stuffing-box bodies screw into steel blocks welded to the case and are then welded to prevent them from unscrewing. The compartment contains a control panel and a push button. The two plungers that operate the push button are journaled in holes through a steel block welded to one end of the case. The long, close fits of the plungers in their holes prevent discharge of flame at these points. The control panel carries 2 main contactors, 1 in each incoming line, an overload relay in the positive line, 2 time-limit accelerating relays, a series relay, the starting resistance, fuses for both sides of the control circuit, and other accessory parts. It
is automatic, the motor being started and stopped by closing and opening the control circuit. Both the push button in the control compartment and the control contacts at the cutting unit must be closed to start the motor, as they are connected in series. If the motor is stopped by action of the overload relay the control circuit must be opened, either at the motor or the control, to reset the overload-relay contacts. This control is essentially the same as that for the type CR–3 machine, approvals 238 and 238A.

The cable reel is essentially the same as that used on the type CLU, d.-c. machine described under approvals 13+ and 134A. (See fig. 28, A.)

EXTENSIONS OF APPROVAL

No extensions of approvals 243 and 243A have been granted.

URGENT NEED OF SAFE COAL-CUTTING MACHINES

In considering safety in connection with the application of electrically driven machinery to the mining of coal first consideration must be given equipment that operates at or near the working faces, for here, in general, the greatest danger of explosions of gas and coal dust exists. The working faces are more difficult to ventilate properly and liberate gas more rapidly than other parts of the mine; gas in explosive quantities is therefore most likely to accumulate here. In pillar workings and other places bodies of explosive
gas in the gob or worked-out sections may be driven into active workings by falls or by dislocations of the ventilating system.

Rock-dusting cannot prevent the ignition of a body of explosive gas, but it can prevent such an ignition from initiating a dust explosion that might spread to other sections. Therefore:

To prevent the propagation of mine explosions, the Bureau of Mines, Department of Commerce, recommends rock-dusting all coal mines, except anthracite mines, in every part, whether in damp or dry condition. It also recommends that rock-dust barriers be used to sectionalize the mine and as additional defense; but these should not be regarded as a substitute for generalized rock-dusting.

The specifications for rock-dusting require that all open accessible parts of coal mines be rock-dusted to within 50 feet of the face. These, if conscientiously carried out, will confine any incipient explosion to the section in which it originates but will still leave a large area which has not been rock-dusted and the men in that section exposed to the danger of any explosion that occurs there.

"An ounce of prevention is worth a pound of cure" in coal mining as well as in other places. It is better to prevent an explosion than to depend entirely upon measures that may become ineffective through neglect or accident and cannot protect the men in the immediate vicinity of the particular active workings where an explosion starts. Apparently, then, the two most important safety measures in preventing ignitions are (1) adequate ventilation to dilute and remove the mine gases so that explosive mixtures will not accumulate and (2) elimination of all factors that might ignite explosive gas mixtures if such should inadvertently accumulate through accident or failure of proper ventilation or from other circumstances.

Coal-cutting machines must work at the coal face and therefore are in the most dangerous part of the mine. Machines that will not ignite explosive gas are therefore essential for the safety of any mine in which such gas may inadvertently accumulate. The object of the work of the electrical section of the United States Bureau of Mines on coal-cutting machines has been to cooperate with the manufacturers and operators in making safe machines available: (1) Features of design necessary for such machines are determined and a schedule of the minimum standards essential for safety is prepared; (2) proposed designs are thoroughly inspected and tested in explosive gas to determine whether or not they measure up to safety standards.

The principal explosion-proof features of the coal-cutting machines approved by the Bureau of Mines have been outlined in this bulletin. A chronological examination of the subject shows consistent improvement in design as well as the introduction of new types of machines and accessories. The original approved machines were all of the shortwall type. Track-operated overcutting, undercutting, and shearing machines, longwall machines, combination cutting and drilling machines, and others have been added to the list of permissible machines. The original machines carried a switch and fuse and a simple drum- or disk-type manual starter. A wide variety of contactors, remote- and automatic-control, and protective devices

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have been developed. Improved switches, fuses, and manual-control schemes have been introduced. Improved trailing cables have been designed for use on coal-cutting machines through cooperation between the Bureau, the manufacturers, and coal-mine operators.

Continuation of the steady advance in the development of coal-cutting machines is to be expected in the future as in the past. The Bureau of Mines will cooperate heartily with this progress to the end that it may continue without sacrifice of safety.