

Auger Miner Safety Study

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16. Abstract This study developed designs to facilitate and accelerate auger rotation stoppage (and auger rotation start up so as to promote auger disengagement during miner responsibility) and to provide a time delay and warning signal prior to auger start up to permit any miners near the augers to get away from the augers before they start rotating. In the underground coal mines in the United States, there are four auger miners that are currently in use. They are the Jeffrey 100L (see figure 1-1) and 100M (see figure 1-2), and the Wilcox WCM and the MK20A (see figure 1-3).

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FOREWORD

This Final Report constitutes the documentary output of a two part study of Panic Bars and Auger Miner Safety that was performed by the Aerospace Systems Division of The Bendix Corporation for the Pittsburgh Mining and Safety Research Center of the U. S. Bureau of Mines.

The first part of the Final Report, on the Panic Bar Study, consists of six volumes. They provide design criteria for the installation of panic bars on self-propelled, electric and diesel face equipment, as follows:

- Volume 1 - Continuous Miners
- Volume 2 - Cutters/Face Drills
- Volume 3 - Loaders
- Volume 4 - Roof Bolters
- Volume 5 - Shuttle Cars ✓
- Volume 6 - Tractors and Scoops

These volumes provide an introduction to the subject of the necessity and requirements for panic bars on mine face equipment, mechanical and electrical drawings of the various face equipment models most frequently encountered in the underground coal mines in the U. S., and definitions of the various types of panic bar installations that are being recommended.

The second part of the Final Report, on the Auger Miner Safety Study, describes the need for safety improvements on auger-type continuous miners in terms of Auger Rotation Control and provides recommendations for design changes to satisfy this need.

ACKNOWLEDGEMENTS

We would like to express our sincere gratitude to the many individuals and organizations who gave generously of their valuable time and assistance throughout the course of these studies. Our greatest debt of gratitude is to our Bendix co-worker Mr. Paul Pilon and our consultant Mr. George Judy, without whose dedicated efforts these studies would not have been possible. We would also like to especially thank Messrs. John Murphy and James Ault (USBM) and Mr. John Greenhalgh (MESA), whose generous advice, counsel, and constructive criticism were indispensable throughout every phase of these programs.

Finally, we would like to express our gratitude to the innumerable individuals who freely provided data and assistance that were instrumental to the success of these programs. Since it is not possible to cite each individual by name, our gratitude is expressed, institutionally speaking, to all the face equipment and component manufacturers and to the mining companies that assisted us in these studies.

This acknowledgement of USBM's, MESA's and the mining industry's invaluable assistance does not imply that the individuals or organizations that are cited above necessarily concur with the findings and recommendations contained in this report; the responsibility for which lies solely with The Bendix Corporation, Aerospace Systems Division.

Leslie D. Marrus and Conrad Rogne
Principal Investigators
Panic Bar/Auger Miner Safety Studies

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1. INTRODUCTION

The purpose of this study is to develop designs to facilitate and accelerate auger rotation stoppage (and auger rotation start up so as to promote auger disengagement during auger miner repositioning) and to provide a time delay and warning signal prior to auger start up to permit any miners near the augers to get away from the augers before they start rotating.

In the underground coal mines in the U.S., there are four auger miners that are currently in use. They are the Jeffrey 100L (see Figure 1-1) and 100M (see Figure 1-2), and the Wilcox WCM and the MK20A (see Figure 1-3).



Figure 1-1 Jeffrey 100L Auger Miner

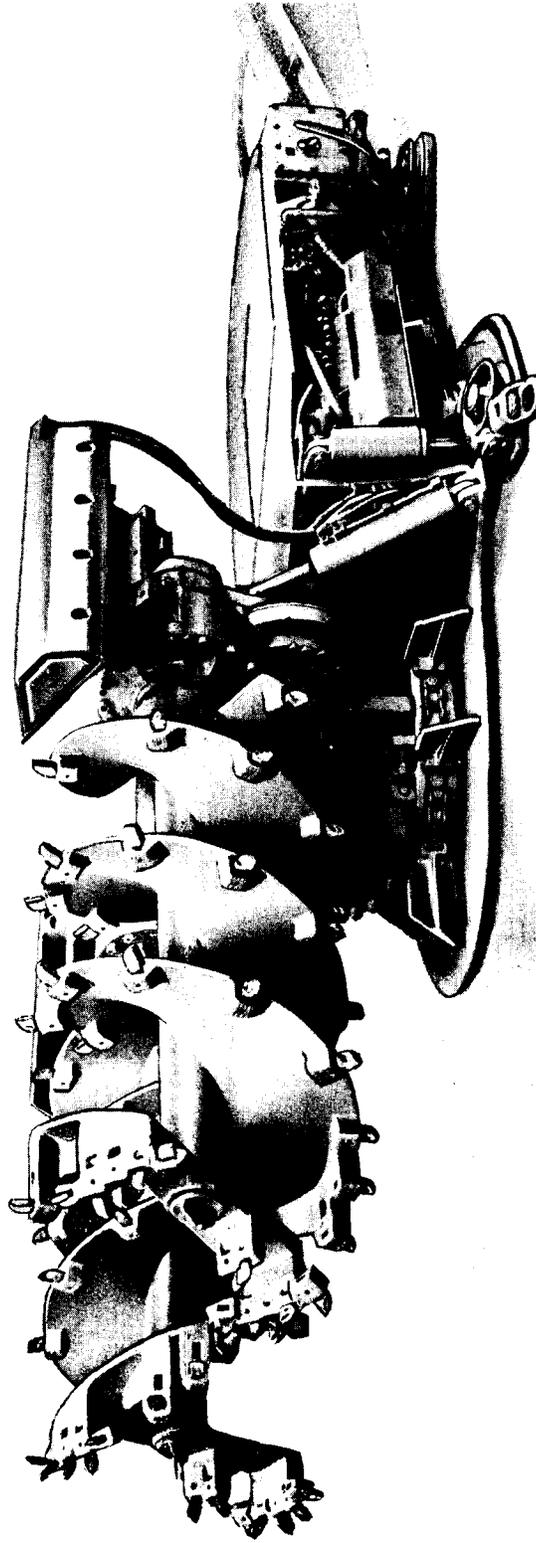


Figure 1-2 Jeffrey 100M Auger Miner



Figure 1-3 Wilcox MK20A Auger Miner

2. AUGER MINER DESCRIPTIONS

The Jeffrey 100L and 100M auger miners are described in Section 2.1 and the Wilcox WCM-EEA-25 and WCM-EEA-27, and the MK20A-PJ auger miners are described in Section 2.2.

2.1 JEFFREY AUGER MINERS

The Jeffrey 100L and 100M auger miners are essentially the same machine. The basic difference between them is in the cutting head. The 100L is designed to work in seams up to 41 inches and the 100M is designed to work in seams up to 50 inches. Figure 2-1 depicts the 100L auger miner and Figure 2-2 depicts the 100M auger miner. Figure 2-3 shows the operator's station on which the auger clutch (jaw clutch) engagement lever and the start/stop lever are identified. All of the controls that are necessary to operate the machine are in the operator's station.

The 100L and the 100M have two clutches. The first clutch is a mechanical jaw clutch which is located between the drive motor and the transmission. This clutch may be engaged or disengaged by the operator only. The clutch cannot be engaged when the auger drive motor is running and it cannot be disengaged when the clutch is fully loaded (i. e., during the fragmentation process). It cannot be disengaged under load because of the mechanical aspects of the lever arrangement and because of the physical strength limitations of the operator. The second clutch is a friction device located on the main drive shaft between the two augers. Its function is to slip under overload conditions in order to protect the transmission.

Figures 2-4 and 2-5 are views of the right hand or helper's side of the auger miner and show an emergency power shut off control. This pushbutton control has gone through a two step development process. The early machines were sold without it. The first change was to add the pushbutton on the helper's side of the auger miner by providing a bell crank coupling to the operator's power shut off lever, which resulted in power cutoff when the pushbutton was activated. Thus, the helper on the blind side of the machine could cut off the electric power if he was in trouble. This alone did not solve the complete problem, since the helpers were still being pinned against the rib because the winch motors were continuing to run on residual

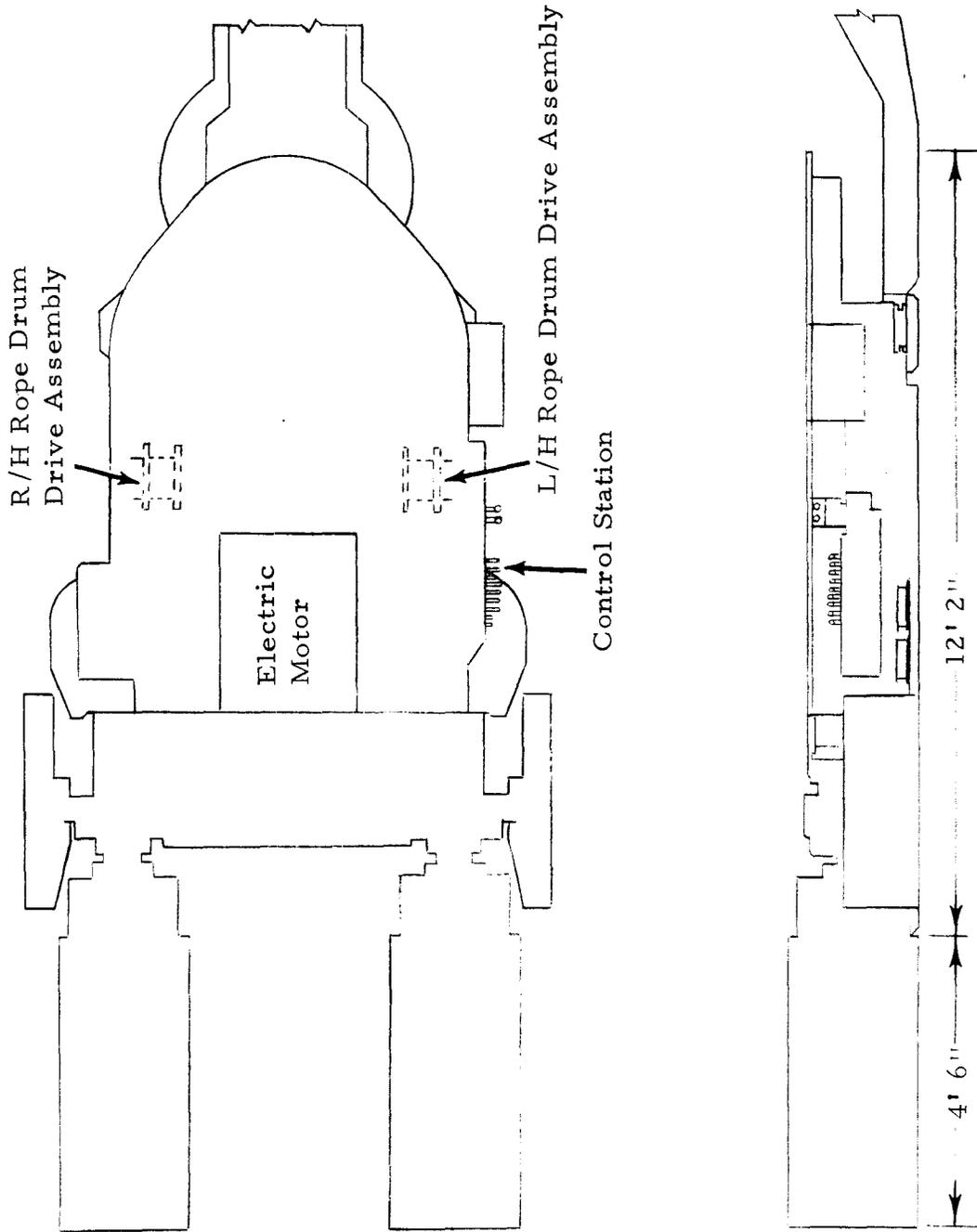


Figure 2-1 Jeffrey 100L Auger Miner

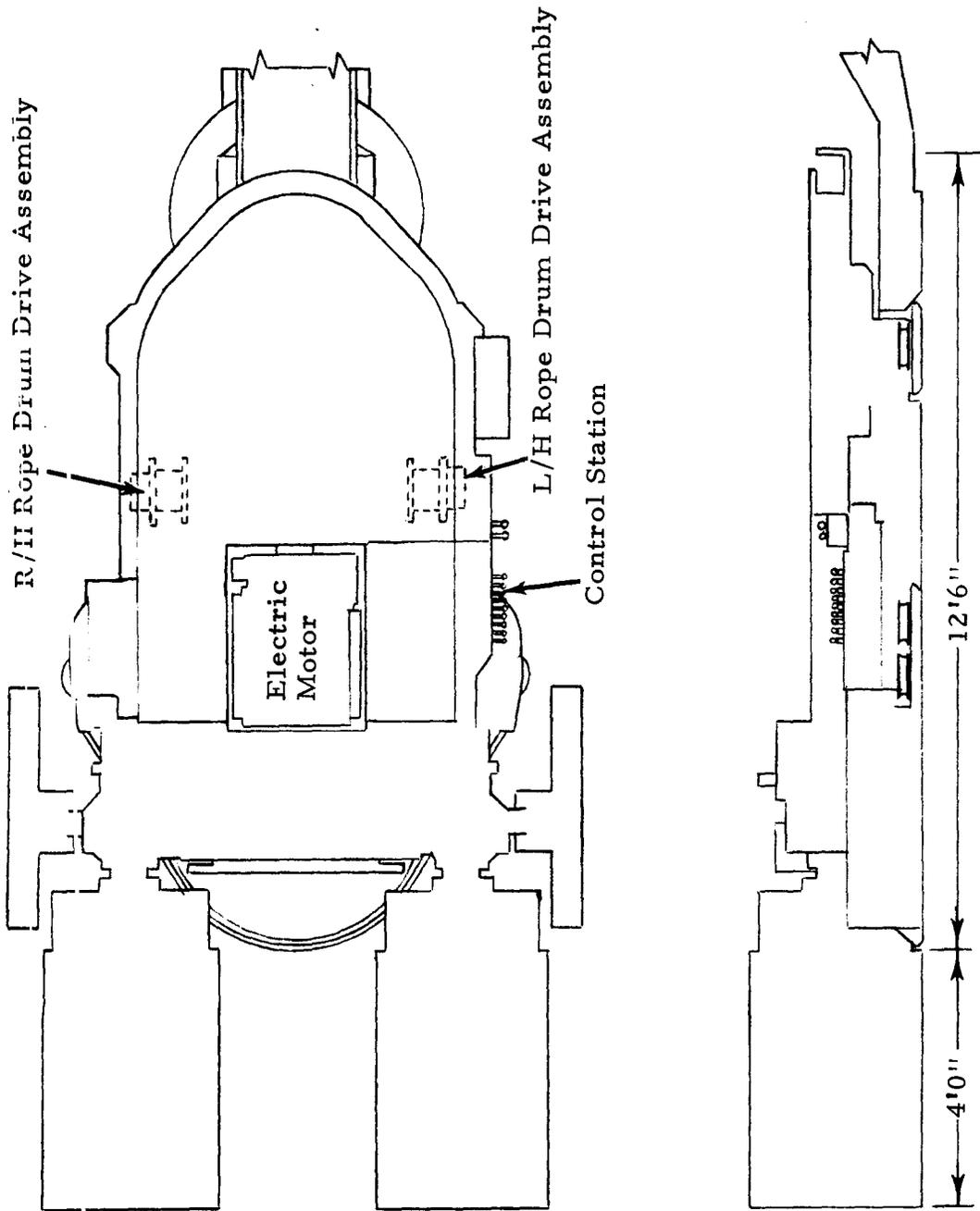


Figure 2-2 Jeffrey 100M Auger Miner

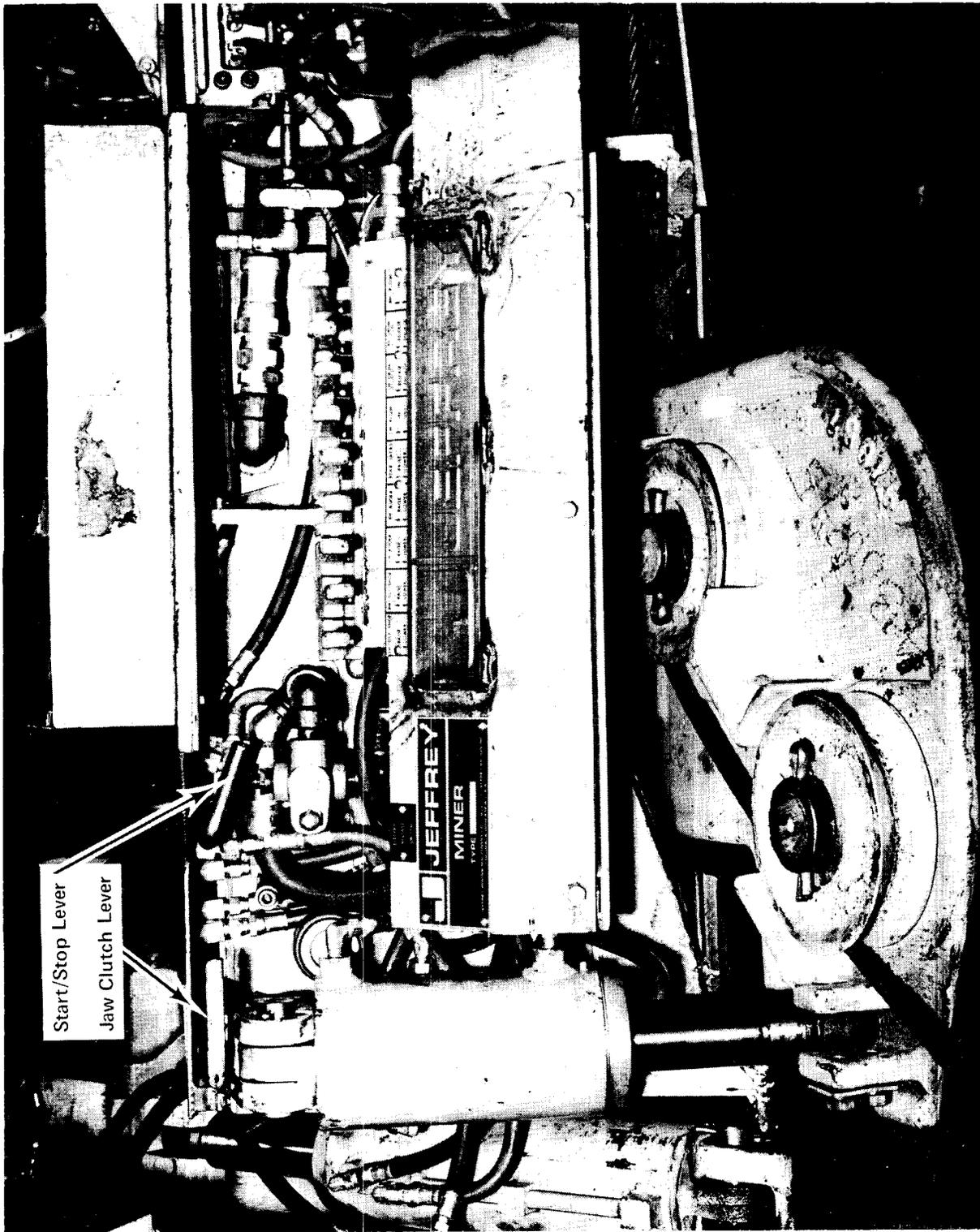
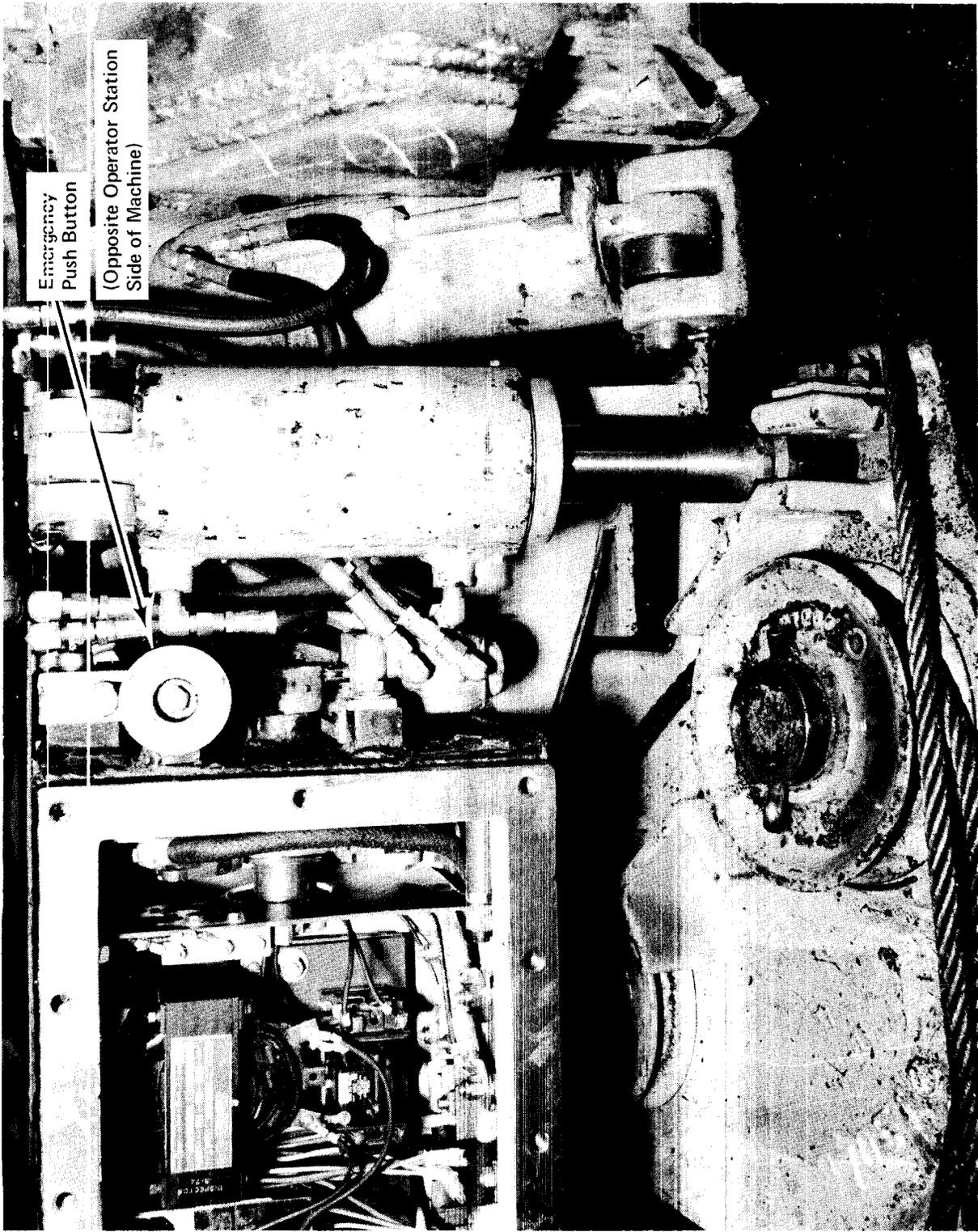


Figure 2-3 Operator's Station



Emergency
Push Button
(Opposite Operator Station
Side of Machine)

Figure 2-4 Emergency Shut Off Control on Helper's Side of Machine

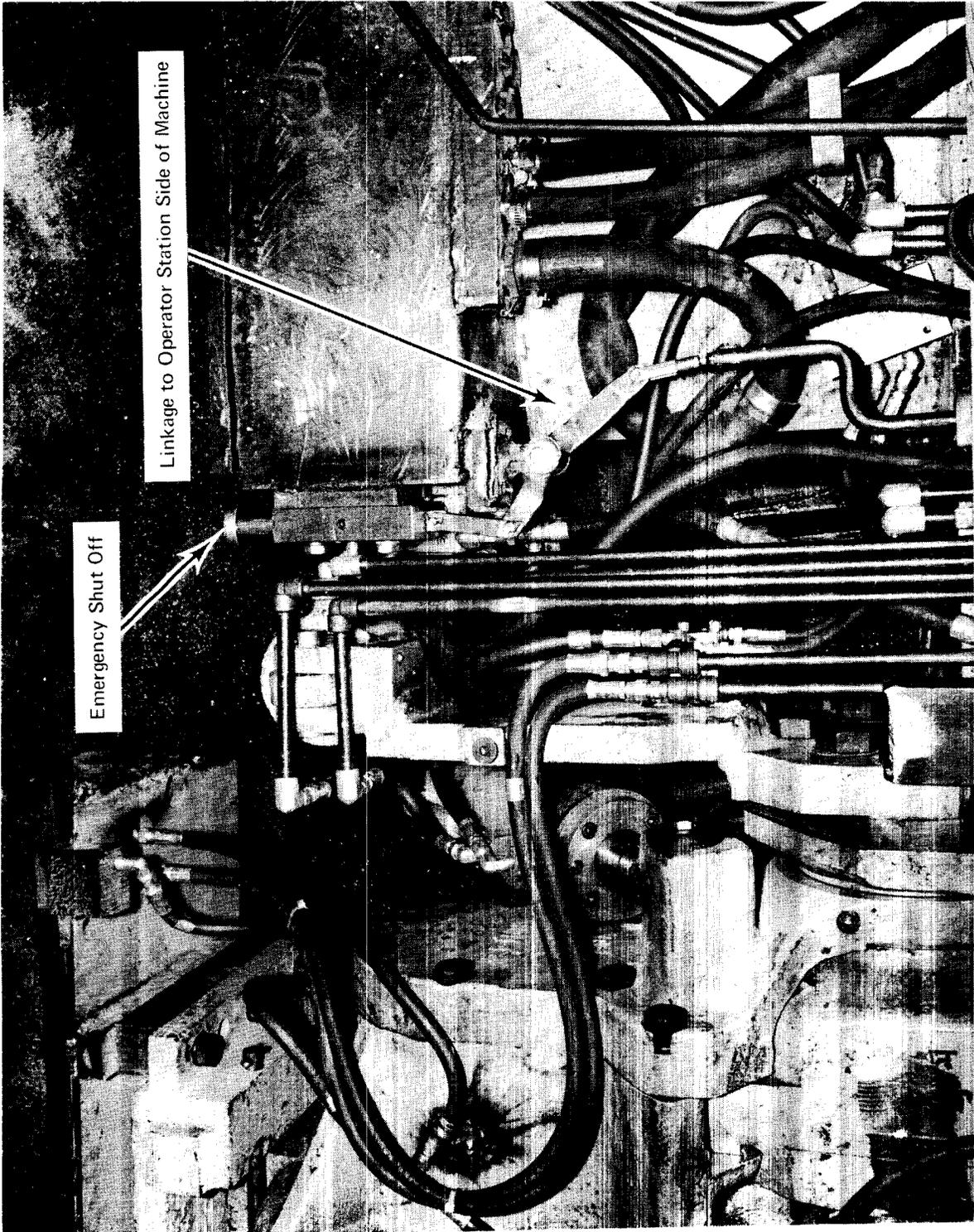


Figure 2-5 Linkage to Emergency Shut Off Control

hydraulic pressure. The second change was to add an hydraulic dump valve in conjunction with the existing power cutoff lever. This combination stopped the augers as well as stopping the machine's transverse across the face by stopping the winches. This last feature was introduced approximately three years ago, but the Jeffrey personnel do not know if all the 100L's and 100M's in the mines have been modified. There is a very good likelihood that they have not. However, all new machines incorporate this feature.

Figure 2-6 block diagrams the power train of the machines that were sold as originally developed. The jaw clutch that is depicted is manually engaged and disengaged from the operator's station only. Starting and stopping of the augers and the winches is by means of a lever located in the operator's station. Stopping the augers and winches may also be achieved from the helper's side of the machine by means of the emergency shut off control which is mechanically coupled to the power switch on the control box. The control box is located on the operator's side of the machine.

Fragmentation is accomplished by twin augers located at the front of the machine. The 100L and the 100M use a single drive motor for both augers. The augers may be independently positioned at the operator's discretion. A rotating vane type loader (see Figure 2-7) is located between and to the rear of the augers. The 100L and 100M do not provide for automatic cleanup. Helpers are necessary on each side of the machine and part of their duties are to provide manual cleanup by shoveling residual coal into the loaders as the machine progresses across the face. The vane loader dumps the coal onto a chain conveyor that is located in the middle of the machine and extends outby.

The main auger motor is electric and it also drives a hydraulic pump to provide hydraulic power for accessory operations. Hydraulic pressure is not present until the auger motor is running. Thus, machine movement will not occur unless the auger motor is running because the winch motors are hydraulic.

A new innovation that has been designed and prototype tested, but not yet sold to any of the mine operators, is a clutch/brake option that is designed to be interchanged with the present friction clutch. (See Figure 2-8.) This feature provides hydraulic engagement and disengagement of the clutch and auger braking following clutch disengagement. A new valve control is required to be added to the present valve control bank. Figure 2-9 block diagrams the drive train changes with the addition of the optional clutch/brake.

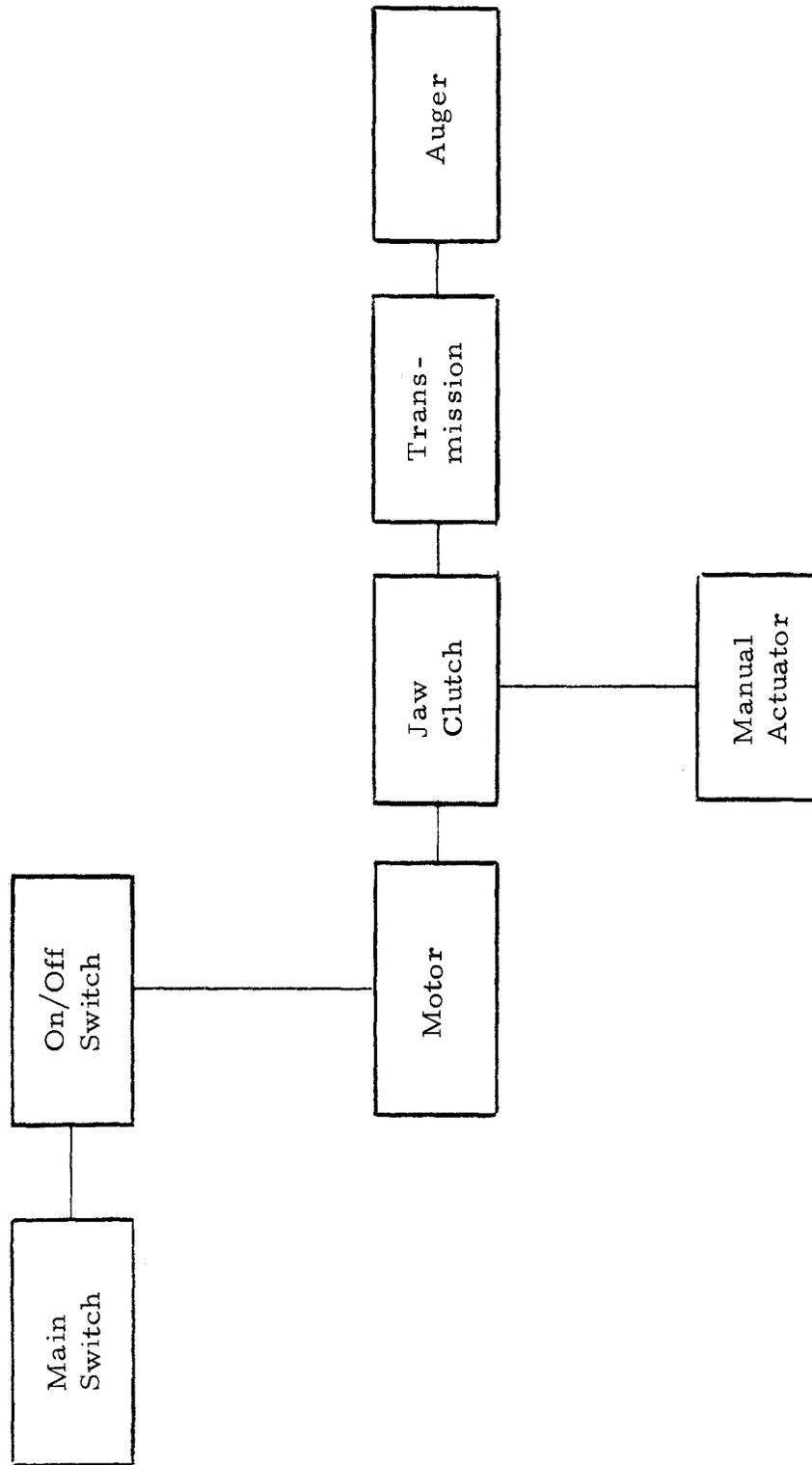


Figure 2-6 Functional Diagram - Jeffrey 100L and 100M Auger Drive Systems

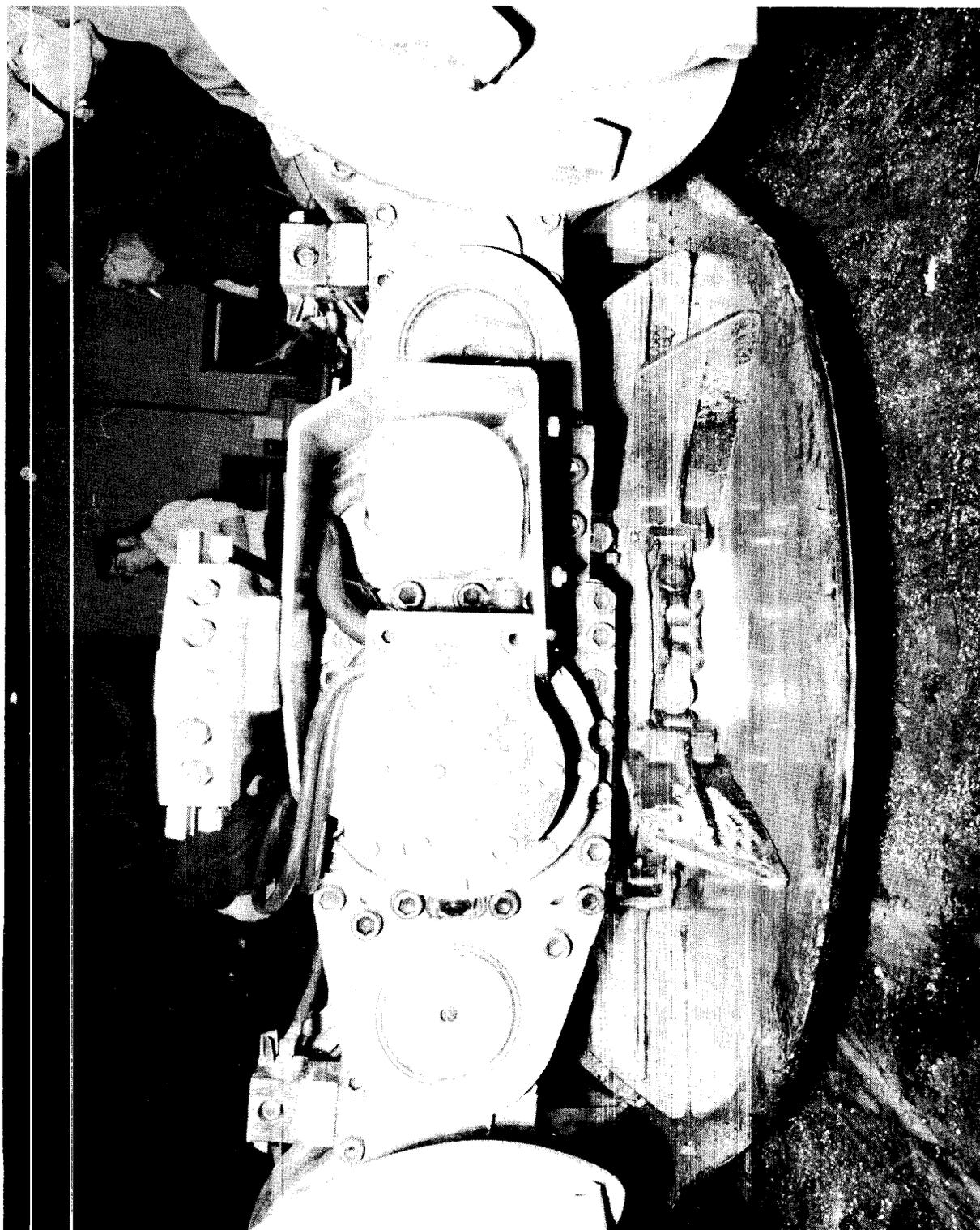


Figure 2-7 Vane Type Loader

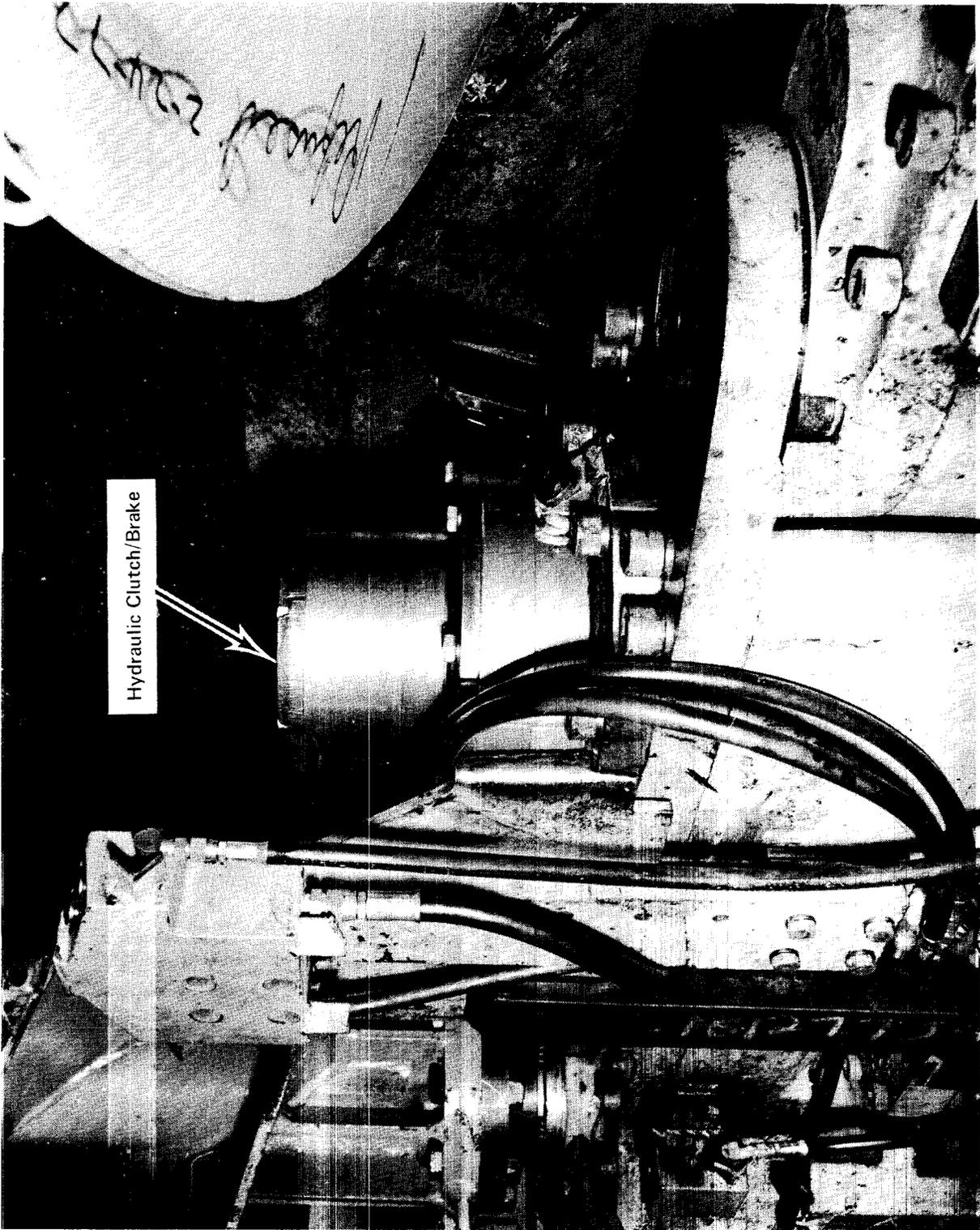


Figure 2-8 Hydraulic Clutch/Brake

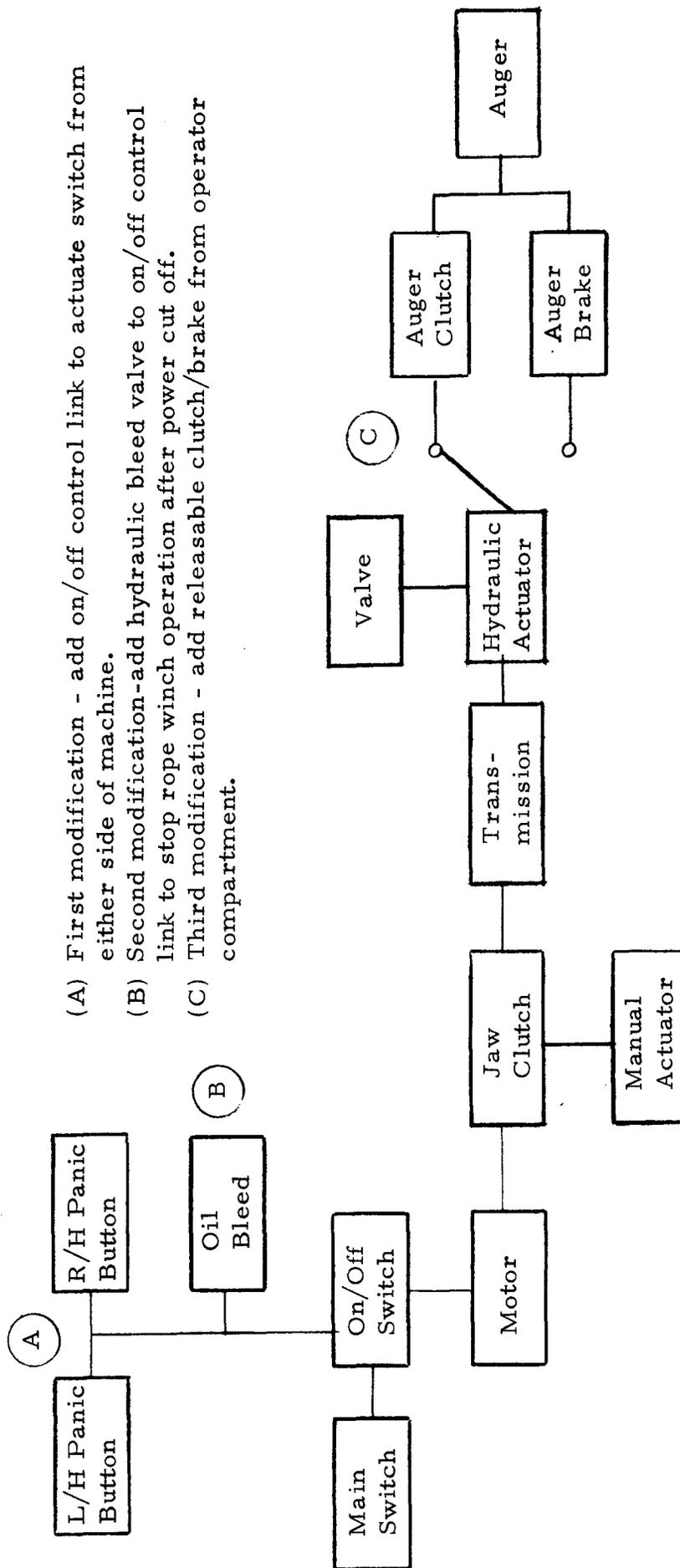


Figure 2-9 Functional Diagram - Jeffrey 100L and 100M Auger Drive Systems with Jeffrey Clutch/Brake, Hydraulic Bleed, and Remote On/Off Switch Modifications

2.2 WILCOX AUGER MINERS

The earlier Wilcox auger miners are the WCM-EEA-25 and -27. The -25 model has a low conveyor and the -27 has a high conveyor. The WCM's have a single drive motor. Figure 2-10 depicts the WCM-EEA auger miner. The operator's station is located at the machine's right, rear and is not provided with a platform. The auger drive jaw clutch is located between the drive motor and the auger transmission. The clutch may be engaged and disengaged from the operator's side only. The lever is not located in the operator's station. The auger clutch cannot be engaged when the auger drive motor is running and it cannot be disengaged when the clutch is fully loaded (i. e. , during the fragmentation process).

The original WCM's were sold with the Goodman 512 drive head with a friction slip clutch. Considerable difficulty was encountered with the slip clutch and these assemblies were subsequently replaced by the present Wilcox drive train. Wilcox personnel are quite certain that the original machines with the Goodman 512 transmission are no longer part of the mine machine inventory. The Wilcox drive trains omit the slip clutch and decoupling capability is provided by the jaw clutch.

The Wilcox designers have, in addition, chosen to utilize a thermal overload circuit breaker, which is set at 140 amps, to cut the auger drive motor during overload situation, rather than to continue with the slip clutch for transmission protection. The overload circuit breaker is also looked on as an automatic cutoff that will prevent machine walking. In discussions with mine operators, we determined that this feature is not entirely successful since it is possible to have machine walking without overloading the circuit and tripping the circuit breaker.

The dual augers are located in front of the machine and are positionable at the operator's discretion. Loading is accomplished by a single scroll positioned just behind (outby) the augers. As with the Jeffrey auger miners, helpers are required to do shovel cleanup as the machine moves across the face. The scroll transfers the coal to a chain conveyor, which is located on the centerline of the machine and moves the coal outby to the bridge conveyor.

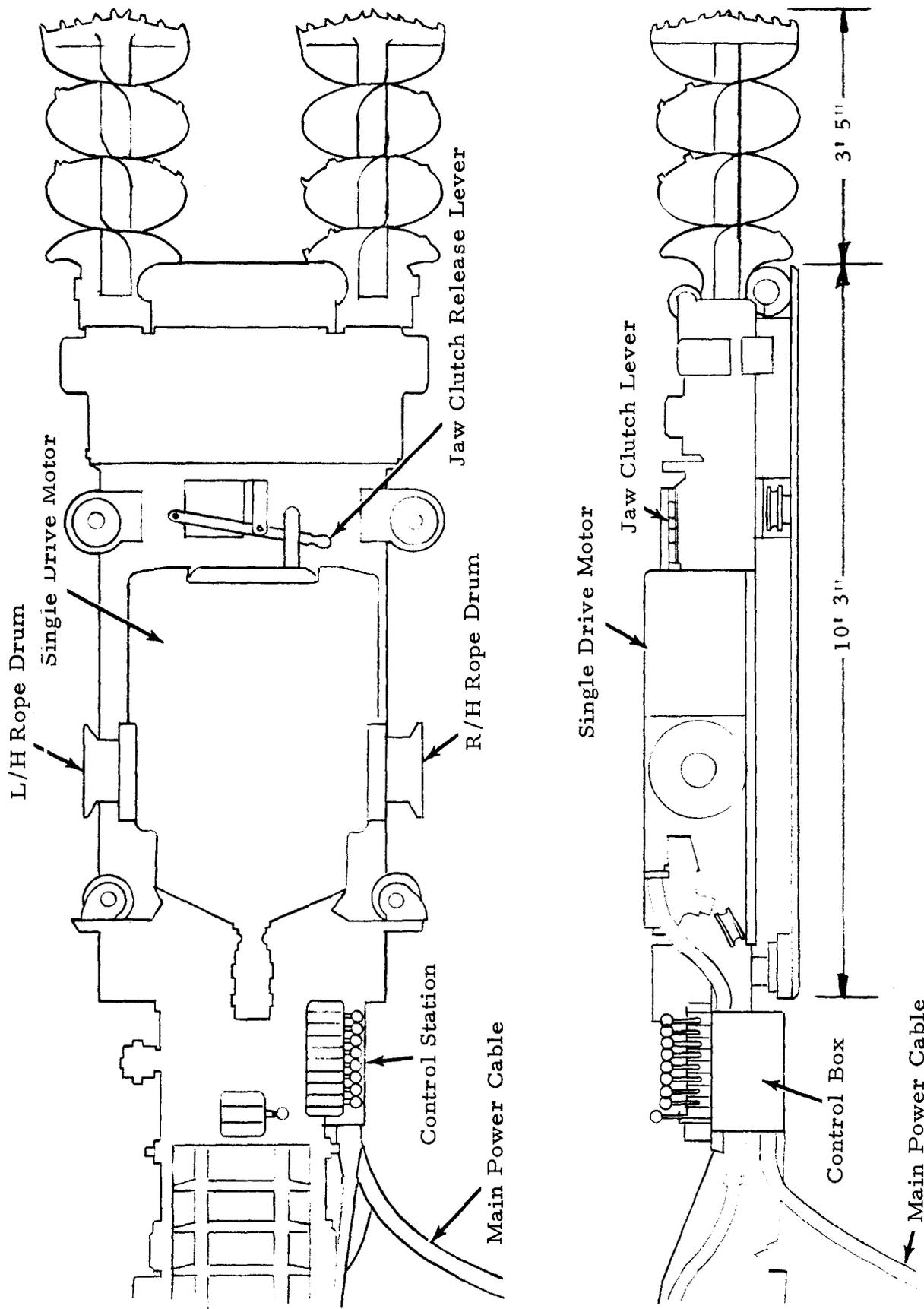


Figure 2-10 Wilcox WCM-EEA Auger Miner

Repositioning of the auger miner is accomplished by means of rope winches that are located on each side of the machine. The rope is fed through the forward or aft pulleys, depending on the machine's motion, and attached to anchor jacks. The rope winches are powered by the auger drive motor through a transmission that is apart from the auger transmission. The rope winches are operable only when the auger motor is running.

Approximately 200 of these machines were sold. The number of WCM-EEA models that are still in operation is unknown. The factory has heard very little about them in recent years.

The later Wilcox MK20A auger miners are similar to the WCM-EEA auger miners in terms of their general configuration. (See Figure 2-11.) Figure 2-12 block diagrams the power trains for both the WCM and the MK20A models and points out some of the differences between the two series. The major changes are:

1. Dual auger motors are provided. Each auger has its own motor and transmission. This feature permitted the use of smaller motors and, thus, permitted a lower machine profile.
2. Dual rope winch transmissions are provided.
3. Cleanup scrolls are provided on each side of the machine to reduce manual cleanup.
4. An operator's platform was provided and the control console was redesigned.
5. Each auger was provided with its own jaw clutch for decoupling from the auger motor.
6. Redesigned chain conveyor.
7. Redesigned boom, etc.

Approximately 250 MK20A auger miners have been sold and, because the machine is relatively new, all are probably in operation.

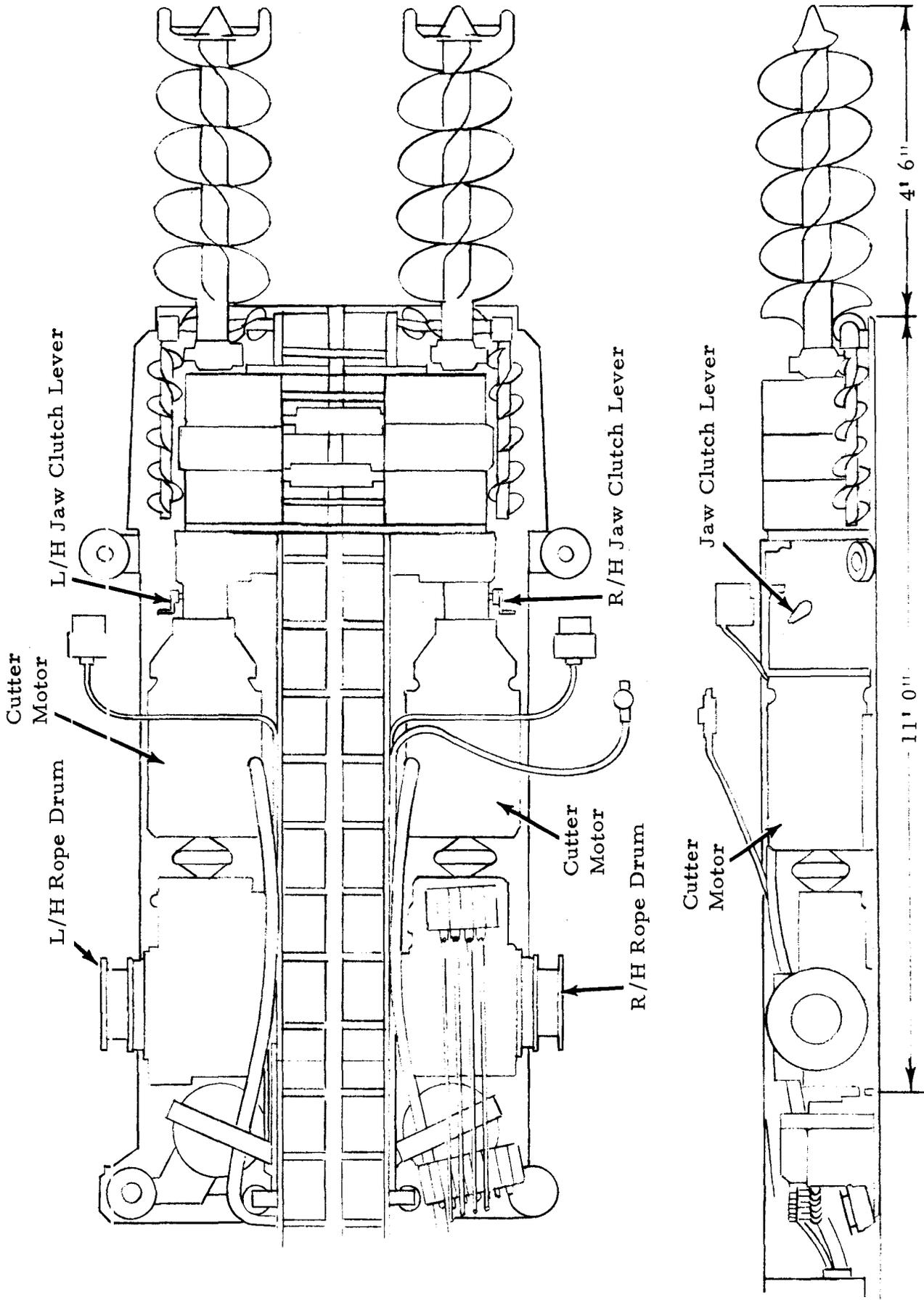


Figure 2-11 Wilcox MK20A Auger Miner

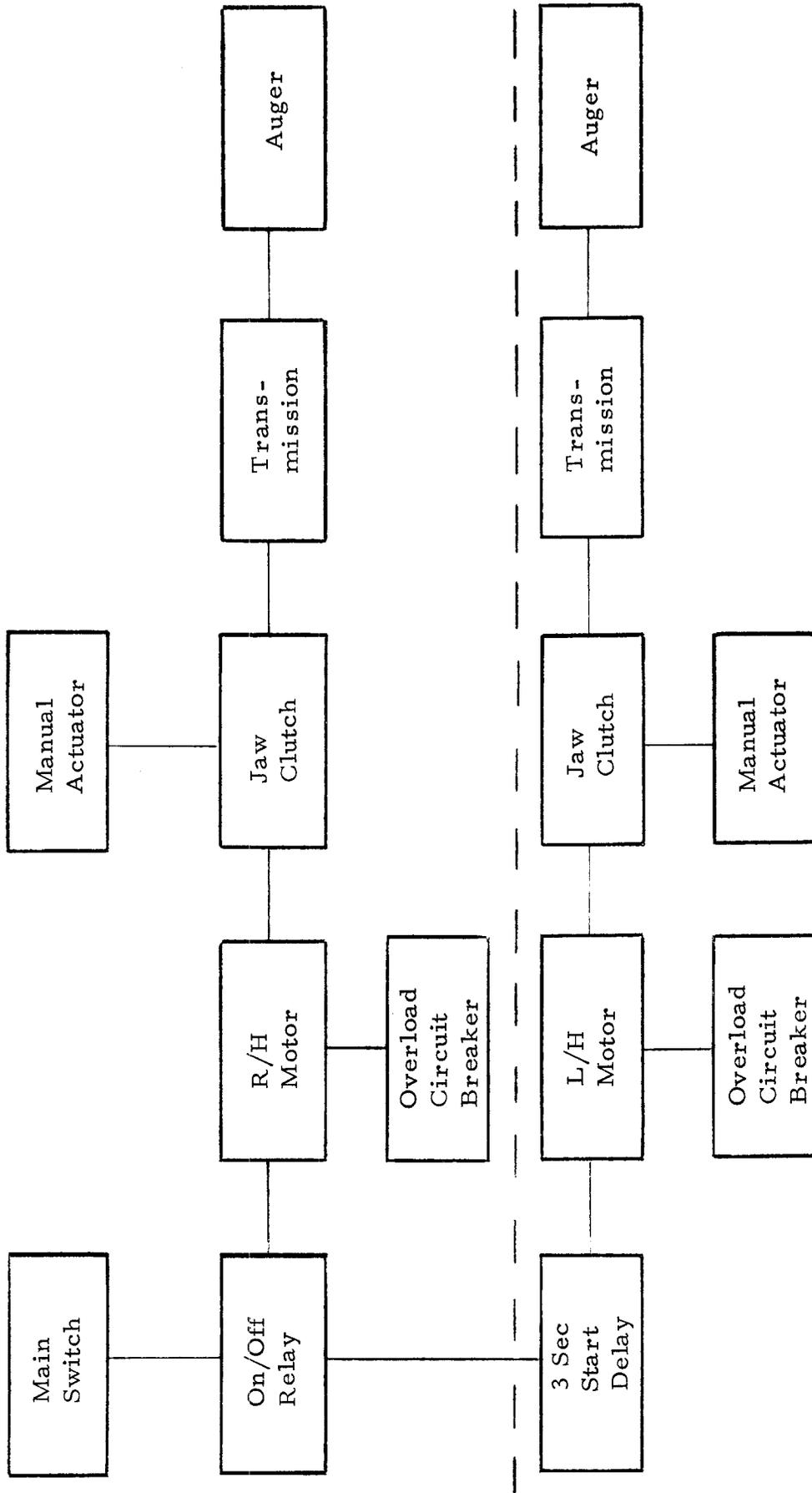


Figure 2-12 Functional Diagram - Wilcox WCM Auger Drive System
 (above phantom line) Wilcox MK20A Auger Drive System
 (above and below phantom line)

A lever for decoupling the auger clutch is located forward on each side of the machine. Each auger must now be decoupled from its own drive motor, rather than there being a single jaw clutch as on the WCM-EEA models. The levers are well out of the reach of the operator.

The MK20A-PJ auger miner is a basic MK20A with a pivot jack (PJ) located on each side of the machine, approximately in line with the conveyor boom/bridge conveyor pivot point. Figure 2-13 shows the pivot jack in use (at the left and shows the operator's location under actual mining conditions.

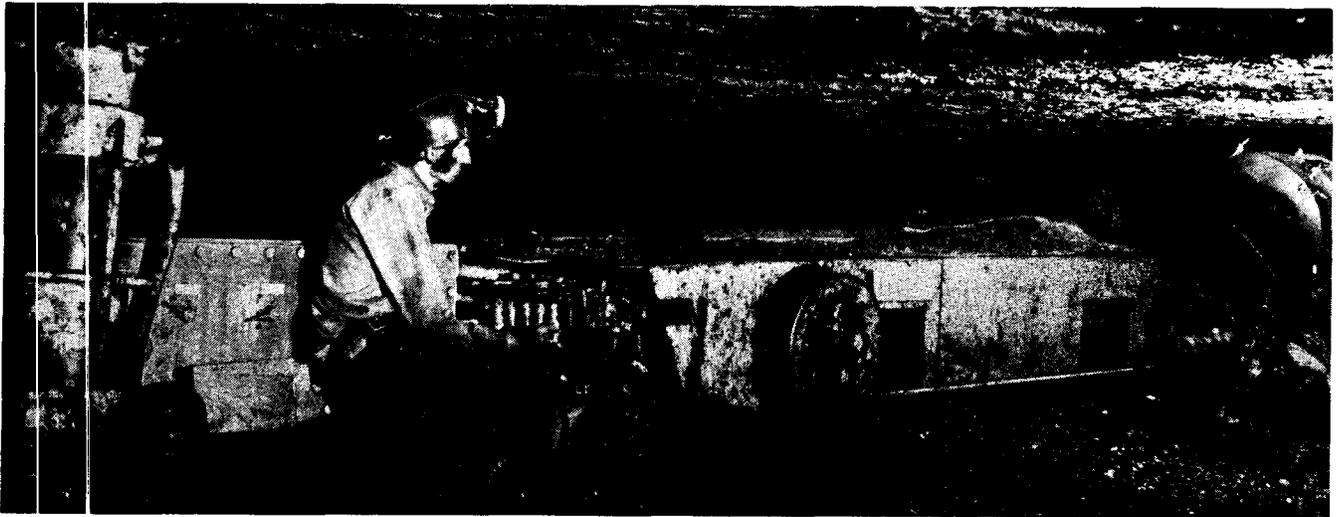


Figure 2-13 Wilcox MK20A-PJ Auger Miner

The PJ feature is available in kit form to be welded onto a basic MK20A auger miner. The machine may remain in the mine to accomplish this retrofit. There is little doubt that the PJ feature increases both this machine's productivity and its safety. Mine operator comments indicate that there is some question as to the utility of the MK20A-PJ auger miner under soft roof and/or poor floor conditions.



3. AUGER MINER OPERATIONS

Auger miner operations have remained fairly consistent from the time of their first introduction in mines to the present day. However, with the recent introduction of the Wilcox MK20A-PJ the change in mode of operation could, potentially, be quite significant. Conventional auger mining involves the moving of the machine for place change, sumping in, and sweeping the face by utilizing the rope winches. The ends of the ropes extending out from the winches are anchored to jacks. Figure 3-1 shows typical jack placement for machine sump in (left side of miner) and for sweeping the face (right side of miner). As may be envisioned from this drawing, the machine may be moved in any lateral direction by proper placement of the anchor jacks.

The ribs of all auger entries are differentiated from other types of continuous miner operations in that, in plan view, the ribs tend to be slightly saw tooth in nature. This is a necessary result of the fact that the main body of the machine extends out from the augers and, secondly, rib room must be maintained for the operator and the helpers.

When the machine is positioned with the augers against the face, the sump in operation can take place. Sumping in is initiated by emplacing the anchor jacks on each side of the machine and forward toward the face (inby). Next, the ropes from the winch drums on each side of the machine are threaded through the rear pulleys and brought forward to the anchor jacks. The operator starts the augers, engages the two winch drums and the machine moves into the face to normal auger depth. The operator then positions the augers up and down so that the full depth of the seam can be taken. The jacks are now positioned on each side of the entry, near the face, so that by threading the rope through the forward pulleys and attaching laterally to the respective jacks, the machine can be pulled across the face.

Mention must be made, at this time, of the load dynamics associated with the usual methods of dragging the machine across the face. Figure 3-2 clearly demonstrates why a machine can get into trouble, in the form of "swinging" out of control, in this mode of operation. It should be noted that the pivot or balance point of the total machine occurs at the forward pulleys. As can be seen in Figure 3-2, the distance from the center of the bearing load on the augers to the center of the forward pulleys is much shorter than the distance from the center of the pulleys to the conveyor. In order to keep the machine from swinging, the "feed" or winch rate is extremely important and must be consistent with the hardness of coal. Fortunately, the consistency of seam coal is generally

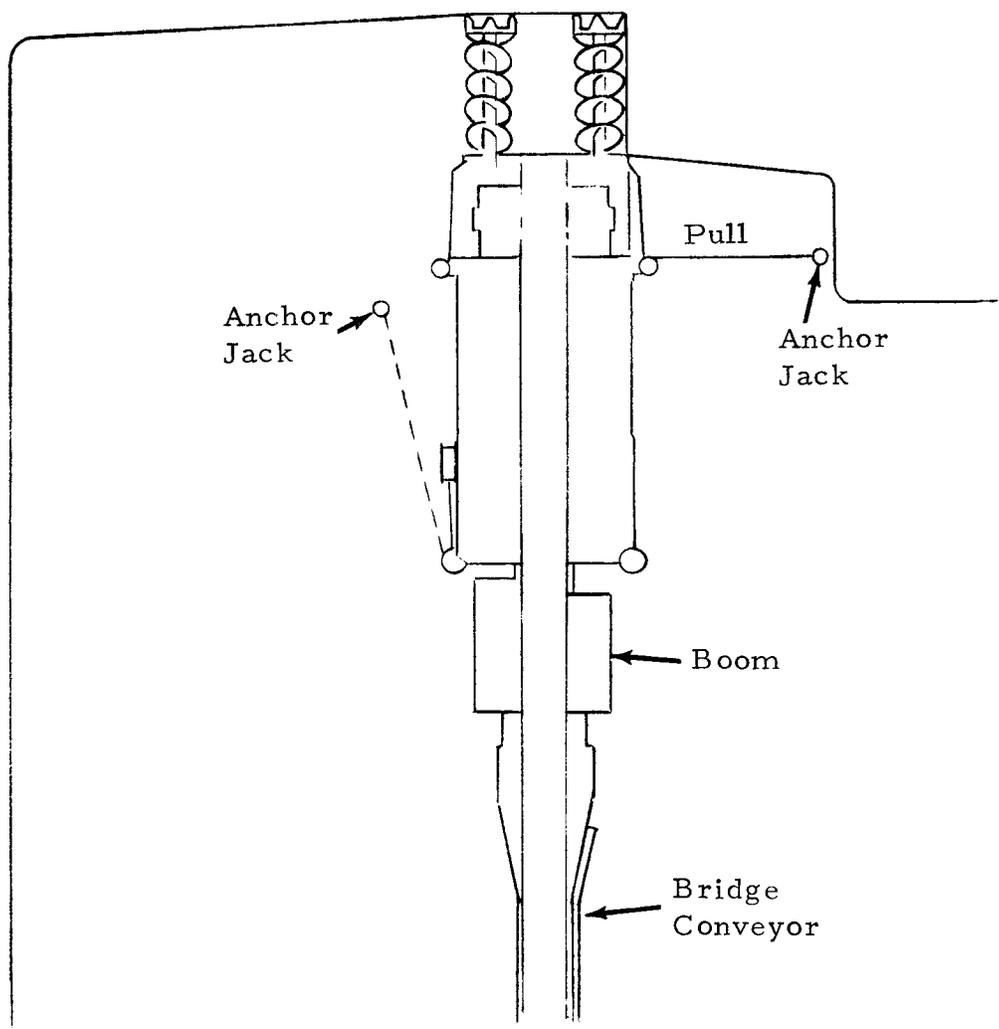


Figure 3-1 Conventional Auger Mining

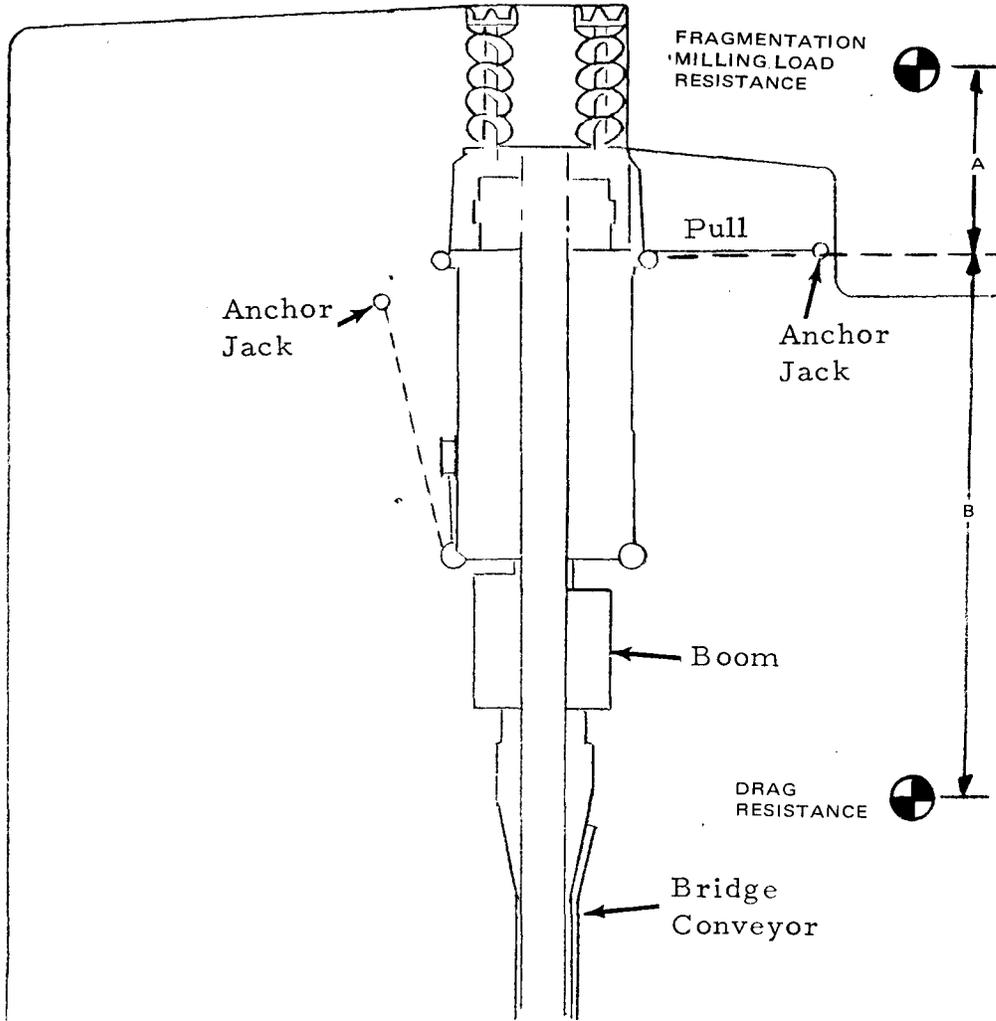


Figure 3-2 Auger Miner Load Dynamics

good and does not change rapidly. Roof and floor obstructions are prevalent, however, and can quickly change the feed or bite due to the short distance from the hinge point to the center of the auger bearing load. Any machine/conveyor load change will result in a rapid auger load change. Due to the long moment arm from the drag resistance summation point, the resistance change to the conveyor load can be quite small and can cause major changes in auger bite and, as a result, machine instability.

With this condition of rather delicate balance, many factors present in the mine/machine relationship can cause the machine to walk across the face and present a hazard to the miners. The machine walk situation is, no doubt, an ever-present hazard, since the conditions that can bring about machine walking are always present during the fragmentation process. If a plan view model of an auger miner with a bridge conveyor were constructed utilizing the forward pulleys as pivot points, one could easily demonstrate machine pitching resulting from auger attitude changes. As the machine pitch changes, there is a tendency for one auger or the other to bite into the floor or the roof and this causes the machine to walk across the face. Also, roof support timbers on either side of the machine block the free travel of the auger miner across the face. In our mine surveys, we have found that, in some cases (to save time), these posts are allowed to be knocked down by the auger miner instead of being removed by the helpers. If the auger miner should climb a fallen post, the load resistance will change as well as there being a change in the machine tilt. If the operator is not fully alert to the situation, the auger can dig in and start the machine to operate in the walk mode.

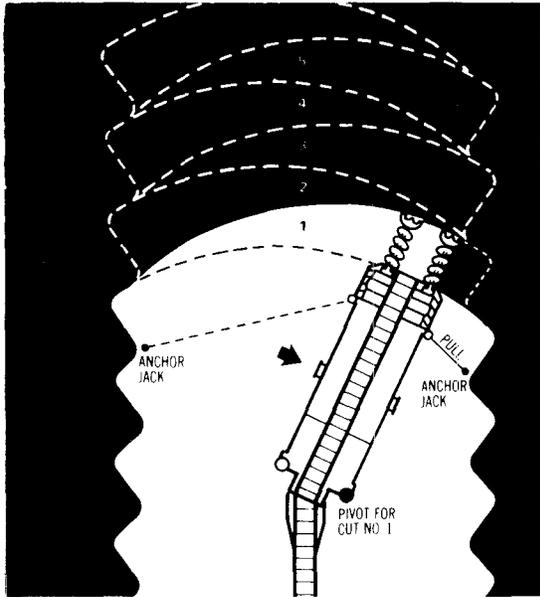
Where coal conditions are such that feed control cannot adequately maintain the auger miner in balance, additional anchor jacks may be set and the ropes may be threaded through the rear pulleys to increase the auger miner's stability. These procedures do much to stabilize the auger miner and prevent machine walking, but they are not very popular due to the additional load they impose on the operator and helper activities.

When the miner has reached the rib in its travel across the face, the cut is not complete. The augers must be repositioned and the auger pulled across the face on an identical return path to "core" out the cut and establish a uniform face configuration. The miner is then repositioned against the rib, ready for the sump in, and a repeat of the previously described fragmentation process is commenced.

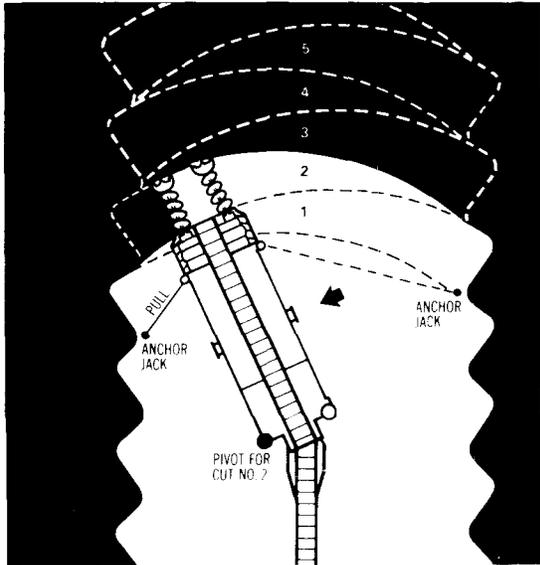
Place change for the auger miner is a process of proper anchor jack placement in the direction of motion and utilizes the rope winches to pull on the rope, thus dragging the miner in the desired direction. Appropriate handling of the bridge conveyor is, of course, an essential part of this process.

The Wilcox MK20A-PJ departs from the above described procedure in that it eliminates the coring out and the customary sump in operation. As may be noted in Figure 3-3, Wilcox has added two hydraulic jacks, one on each side of the machine near the bridge conveyor/boom pivot point. The miner is placed in the center of the entry and pointed to the starting corner of the face/rib juncture. The jack on the side of the auger miner that is in the desired direction of travel is extended with adequate pressure to establish a firm anchor on the roof. The pull rope is threaded through the forward pulley and tied to an anchor jack that is located near the rib on the far side. The auger is started and the feed is started by the rope winch. As the machine swings in an arc, the augers embed deeper into the seam, until full auger depth is reached at the rib. The anchor jack procedure is then reversed, the extended jack is retracted and the jack in the new direction of travel is extended. The rope winch exerts a pull on the rope and the machine swings in an arc, returning to the original starting rib. Because of the gradual sump in created by the arc, coring out is automatically accomplished. The machine fragmentation can be quite continuous with this approach, in that the time-consuming and dangerous coring out and sump in operations are eliminated. This is a rather simple but effective innovation.

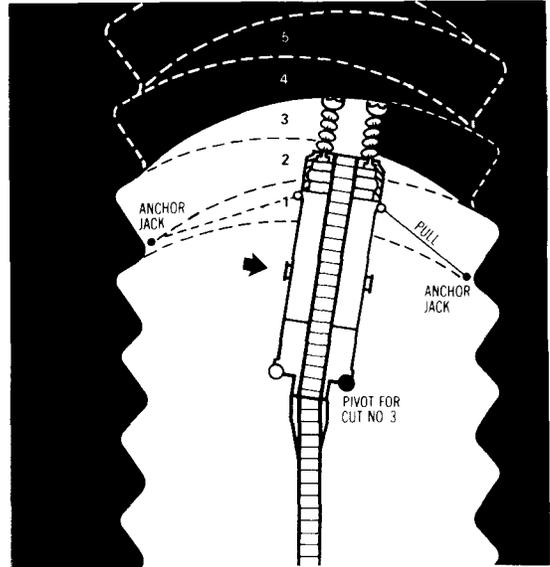
This operation also reduces the retimbering procedure on each side of the bridge conveyor, thus reducing the dangers of removing and replacing roof supports as the machine moves across the face. With the conventional auger mining operation, the entire length of the auger miner sweeps across the face and necessitates removal and replacement of the roof supports all along the length of the miner. With the pivot jack miner the major roof support involvement is only within the confines of the swing arc and, hence, the time and dangers for timbering and retimbering are reduced. The MK20A-PJ is a definite departure from the conventional auger miner operation.



1. Miner pivots on extended right pivot jack as it swings to right making cut no. 1. Retracted left pivot jack swings forward toward no. 2 pivot point.



2. Pivoting on extended left pivot jack, miner swings to left through cut no. 2. Retracted right pivot jack advances toward no. 3 pivot point.



3. Again pivoting on extended right pivot jack, miner swings right, making cut no. 3. Retracted left pivot jack moves ahead toward no. 4 pivot point.

Figure 3-3 Pivot Jack Auger Mining

4. MANPOWER DEPLOYMENT AND HAZARDS

Mine operators generally deploy six men at the face for auger miner operation. The operator is stationed at the machine's side. Two helpers are deployed; one on each side of the machine. Two timbermen are deployed; one on each side and to the rear of the machine. One man monitors the bridge and services the conveyor.

The operator is responsible for machine operation, gas and dust measurement, etc. Technically, the operator is responsible for safe machine operating practices. He is the one man who starts and fully controls the operation of the machine.

The Jeffrey 100L and 100M operator's station is in the forward position and in full view of the augers. An operator's platform is not provided and, therefore, the operator has to crawl with the machine during its pass across the face or in any machine repositioning. All the controls that are necessary to operate the machine are in the operator's station, including the jaw clutch engagement and disengagement control. The operator must initiate all machine movement, adjust the augers' position in the coal, and maintain watch over the conveyor operation within his line of sight. The controls are rather complex and, in combination with the crawling and the operator's other duties, the operator has little time to watch out for his fellow crew members.

The operator's station on the Wilcox WCM and MK20A models is at the machine's right rear. The WCM-EEA model does not have an operator's platform and, therefore, the operator's activities are similar to those on the Jeffrey models. The left side of the machine is blind to the operator, especially if he is in 30 inch or lower coal. Also, the Wilcox operator does not have the relatively clear view of the auger operation as does the Jeffrey operator. The MK20A machines do have an operator's platform and this significantly reduces the demands on the operator since it eliminates the need for crawling and, thereby, reduces fatigue. The auger jaw clutch controls for all of the Wilcox models are forward and out of reach of the operator. The WCM-EEA model has a clutch control lever on the operator side of the miner and the MK20A series has a clutch control lever on both sides of the machine. The operator duties on the Wilcox miners are similar to the duties on the Jeffrey auger miners.

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The two helpers, one on each side of the machine, move anchor jacks, change auger bits, clean up, engage in roof control operations (adding and removing temporary jacks and posts), as well as signal progress to the operator. All of this activity occurs near the face and on each side of the machine. For clean up, the helpers often work in by the pull ropes. On the Jeffrey auger miner, the helper and the operator occupy nearly the same space during the clean up activity and it becomes quite crowded in the near rib position.

The two timbermen move up the permanent supporting timbers and replace the temporary jacks. When the work activity becomes too much for the helpers, the timbermen will move forward to assist. At times the situation will be reversed if too many supporting timbers are taken out by the conveyor swing. The helpers and the timbermen, thus, may interchange work activity to a degree and, thereby, the timbermen can be exposed to the greater dangers of face activity.

The bridge conveyor man must maintain his position in order to control the traveling section of the bridge conveyor and to observe coal flow conditions. His providing an early warning of conveyor problems can prevent a transfer of flow problems to the face equipment.

Both manufacturers have the same activity associated with jaw clutch engagement and disengagement. The clutch can be disengaged while the augers are running out of coal, but not when they are in the coal. The jaw clutch cannot be engaged, without damage, when the motor is running. Once the auger is disengaged, the probability of the jaw teeth being aligned for engagement is remote. This necessitates the operator hitting the start switch momentarily until the point is reached where the jaws will engage. The Jeffrey machine has both the engagement lever and the start switch convenient to the operator. The Wilcox does not. In the case of the Wilcox, the operator must crawl back and forth between the start switch and the clutch engagement lever until he is successful in engaging the clutch jaws. Alternatively, he can engage the helpers in this activity and, both working together, can complete the clutch engagement. The frustration and the time-consuming aspects of this activity leads the miners to leave the augers engaged during machine movement (when not mining coal) and this can lead to the augers catching on the top or the bottom, the machine's unexpectedly and rapidly walking across the face, and injury to one of the helpers (or a timberman) or, even, a fatal accident. There are several other hazards to the miners associated with auger miner operations. These include:

1. Auger rotation during machine movement out of coal can also result in the helpers being struck or caught up in the augers or their being struck by flying debris.
2. The Jeffrey operator is close to the augers and, hence, more subject to auger rotation associated accidents than the Wilcox operator.
3. Helper and operator rib pinning are hazards even without machine walking, if proper care is not exercised.
4. Helper clean up operations near the rotating augers are quite hazardous.
5. Auger bit changing entails the helper's working in between the two augers and subjects him to the hazard of inadvertent auger start up.
6. Coal or rock getting jammed in the loader or jammed between the augers also entails the helper's working between the augers and subjects him to the hazard of premature auger start up.
7. The auger miner running over the operator on those machines that have no operator's platform is another potential hazard.
8. Pull rope breakage can be a direct cause of accidents to helpers who may be struck by the rope.
9. Anchor jack pull out can be a direct cause of accidents and can, also, lead to rope accidents as well.
10. The machine knocking down posts can cause a helper to be struck by the posts or, even, by roof falls, etc.

5. AUGER CLUTCH AND START UP DELAY AND WARNING SYSTEMS

All auger miners used in underground coal mines have a releasable clutch with provisions for reengagement of the auger. The clutches are of the jaw type (tooth engagement) which do not lend themselves to engagement in the manner normally experienced with friction facings. The Jeffrey auger miners' jaw clutch is located between the drive motor and the auger transmission. The lever to operate the clutch is in the operator's station. All the models of the Wilcox miners have the jaw clutch located between the auger motor and transmission. The Wilcox jaw clutch control levers are not in the operator's station. This necessitates the operator leaving his station for clutch operation or necessitates his engaging the assistance of the helpers. All these machines presently require that the motor be stopped for auger disengagement (or re-engagement). Thus, in order to provide the operator with the capability to control auger rotation from the operator's station, both will require the addition of a suitable clutch.

Jeffrey has designed and proof tested a releasable clutch which replaces the slip clutch now used to protect the transmission. The hydraulic clutch/brake installation is quite complex in that the gear box cover plate must be remachined to accept the new clutch. The control console valve bank must also be modified to accept the new valve and the necessary hydraulic plumbing changes that are incorporated. The effort is so extensive that it requires that the auger miner be moved out of the mine to machine shop facilities. The very nature of the mines that require a low profile miner, such as the Jeffrey auger miners, will most often require that the miner be removed from the mine since low seam mines using this type of machine seldom have underground shop facilities. Jeffrey does not have an up-to-date cost estimate for this modification, but a three year old engineering estimate suggested \$5000.00 as the cost for the parts and labor required to install the modification, but not including the costs for removing the machine from the mine, the costs in lost productivity, etc. Consultation with mining companies disclosed that machine removal from the mine can run from \$600.00 on up, depending on mine conditions, etc. Jeffrey has had the clutch/brake option on the market for several years without a single sale being made. This is truly indicative of the mine owner's real interest in this feature, even though (if the reliability of this option is, in fact, high) there is a slight potential for increased productivity.

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The optional clutch/brake would undoubtedly increase safety, but this has not resulted in a high volume of sales or, for that matter, in any sales. There is little doubt that the new clutch eliminates the difficulty of jaw clutch re-engagement. Also, it facilitates rapid stopping of auger rotation. However, along with this relative ease of operation, one must consider that inadvertent re-engagement of the augers is also a very real possibility and that this could introduce a new hazard to auger operations with regard to unintentional auger start up. Therefore, to use the Jeffrey clutch brake option on the 100 L or M, a control system must be devised.

As previously indicated, the Wilcox miners do not offer the clutch/brake option as noted on the Jeffrey machine. Examination of the Wilcox miners disclosed considerable design change would be required to accommodate a clutch/brake feature under any condition. This is not intended to imply that a clutch/brake option could not be designed and incorporated in future models.

A means for jaw clutch disengagement by the operator under any operating conditions was considered but rejected as of little value in emergency shut down and did not improve the engagement situation which is the real deterrent to clutch disengagement. At the present time both manufacturers utilize the jaw clutch to disengage the auger drive system. Because of the problems of reengagement of the jaw clutch, the augers are most often left running during place change.

If the addition of an operator controlled friction clutch/brake were to be considered, both the motor and clutch/brake excitation would have to be controlled. The three basic modes of auger start up to consider are:

1. Auger rotation time delay and warning when the clutch is engaged with the motor running.
2. Auger rotation time delay and warning when the motor is started with the clutch engaged.
3. No time delay and warning when the motor is started with the clutch disengaged.

This set of conditions prevails as long as a means is provided to disengage the auger drive train from the motor. In the case of jaw clutches only, the reengagement with the motor running is rather remote. However clutch position indication must be present to perform the start up time delay and warning excitation logic.

The report has discussed the principal hazards involved in auger operation and the estimated cost by the machine manufacturer who has considered the addition of a controllable clutch. The net result is that a controllable clutch is very expensive and is projected as prohibitive in terms of retrofit. This should not preclude the possibility of clutch/brake development as a feature added to the machine during the initial manufacturing process. The auger concept does have the possibility of inclusion in the true continuous concept when the Wilcox PJ features are considered. Jeffrey has developed the clutch/brake for the 100 series machines. Thus evidence is present to portray a future for auger miners and the possibility for a truly safe auger miner can be considered possible. There is little doubt that innovative auger manufacturers can maintain their position in the mining industry or possibly improve it.

One feature stipulated in this program's original statement of work was the use of a spring-loaded valve which would require constant pressure by the operator to keep the clutch engaged. Such a feature was very unpopular with auger miner operators as they constantly use both hands to control the machine during the fragmentation process. Such a feature would not remove the necessity for additional auger rotation controls.

The state of the art design for both augers is to employ a jaw clutch coupling which is not readily engaged. Neither auger has a brake to stop rotation as quickly as possible. The cost of retrofit to include a friction clutch/brake is considered prohibitive relative to the value of the machine. Interviews with auger miner operators have disclosed a distinct pattern of values.

1. Quick de-energization of the machine and rapid stoppage of the augers were considered quite important.
2. Start up time delay and warning were considered an important feature.

3. Clutch disengagement by the operator was not considered to be very important.
4. The capability for the helpers to stop the winches and the augers was believed to be far more important.

In light of the clutch introduction problem, the pattern of operator values opened the door for further investigation which would result in safety improvement in auger operation. A study of the hazards present was made and a series of ideas were investigated and reported on during the course of the study. The result was the formulation of two options for each manufacturers' machine which are expected to improve auger miner safety and are feasible.

6. BENDIX RECOMMENDATIONS

6.1 WILCOX MODELS

The Wilcox auger miner is equipped with a jaw clutch for the purpose of drive train disengagement and has discontinued the use of a slip clutch for drive train protection. Thus, the drive train does not present a convenient location for an operator-actuated slip clutch. With this condition present, the tradeoffs resulted in:

Option 1 - Primarily, emergency power cut off with a brake to stop auger rotation as quickly as possible. Time delay and warning on start up of auger rotation.

Option 2 - Is emergency power cut off provisions without the brake. Time delay and warning on start up of auger rotation.

Wilcox Option 1

The emergency power cut off provisions are introduced in terms of Type 6 panic bars located on each side of the machine. The purpose of the panic bars is to enable section crew members, other than the operator, to shut down the machine.

The only reasonable position for a brake to improve the stopping time of the auger is between the motor and rope winch transmission. This is certainly not the ideal location as the WR^2 of the motor, augers and drive train are involved. The location requiring the smallest brake energy would be on the auger shaft. Unfortunately, this location turns out to be less than ideal in that the brake would be subject to considerable abuse during the fragmentation process. Figure 6-1 represents the inertial energy curve of the Wilcox MK20A machine to the extent investigated. As may be noted, the relationship between the number of auger revolutions to various stopping points have been designated as a reference in the determination of the alternate brake torques required. The curve is a composite of the energy involved in the motor with a WR^2 of 36 lb ft² at 1200 rpm and an auger WR^2 of 644 lb ft² at 77 rpm. The drive train components were neglected in this analysis because this information was not available from the manufacturer.

Also, a brake determination, from a structural viewpoint, was not possible because the drive train has not been sufficiently investigated by the manufacturer. Given the possibility of drive train damage being present as a result of too abrupt a stop, a friction drive clutch value was chosen. This turned out to be a load factor of 21, 180 in lb^2 , which was considered to provide adequate protection to the drive train, as well as to protect the transmission. The information was obtained by extrapolating a Stearns clutch at a load factor of 4 which is considered adequate for auger drive purposes.

An examination of the curve in Figure 6-1 will disclose the motor acceleration time (100% brake), which is the standard reference point for all brake investigations. The additional points noting the various numbers of auger revolutions indicate the average brake energy required for achievement. The ultimate desire would be the ability to stop auger rotation instantly. However, the curve indicates such a feature is most impractical since the torque requirements quickly increase. Actual tests of an auger (with no braking) resulted in a count of 6 full revolutions before stopping and the coast down time was found to be 8.4 seconds. (These measurements were taken on a Wilcox MK20A.)

The brake to be considered must be of the fail safe type, that is, a brake which will automatically go into action when power is lost. A spring-loaded disk caliper brake was chosen which requires hydraulic pressure to hold off the brake. The spring actually drives the puck against the facing with the necessary force required. Two major brake firms were contacted for this investigation: Bendix and Goodrich. As it turned out, Goodrich was able to furnish the most favorable combination of components for the present purpose. A Goodrich 419-152 caliper is suggested with a 20 inch diameter disk. This will result in auger stoppage within 0.2 second and 0.2 revolutions of the auger. Goodrich does not normally furnish the disk but expects the customer to adapt the disk to his needs. The Wilcox machine will accept a 20 inch diameter disk attached to the motor side of the winch drive coupling. (See Figures 6-2 and 6-3 for general and detailed installations for this brake.)

At this time, the Wilcox discussion should cover the control system associated with auger brake control, as well as all of the other components involved in Option 1. Figure 6-4 depicts the Wilcox MK20A Option 1 auger control system which consists of four primary areas of change beyond the present basic system:

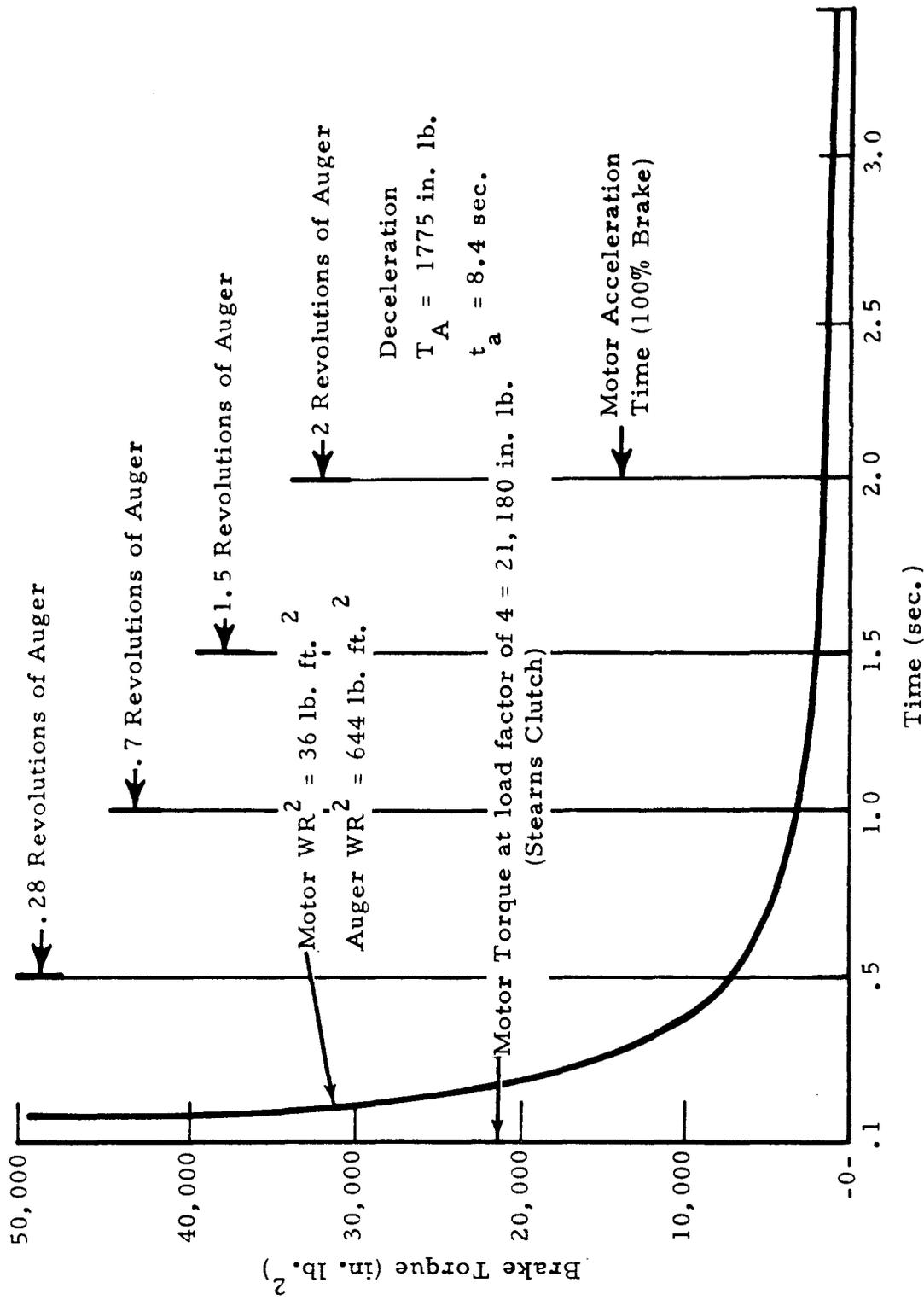


Figure 6-1 Wilcox MK20A Auger Miner Brake Torque Curve

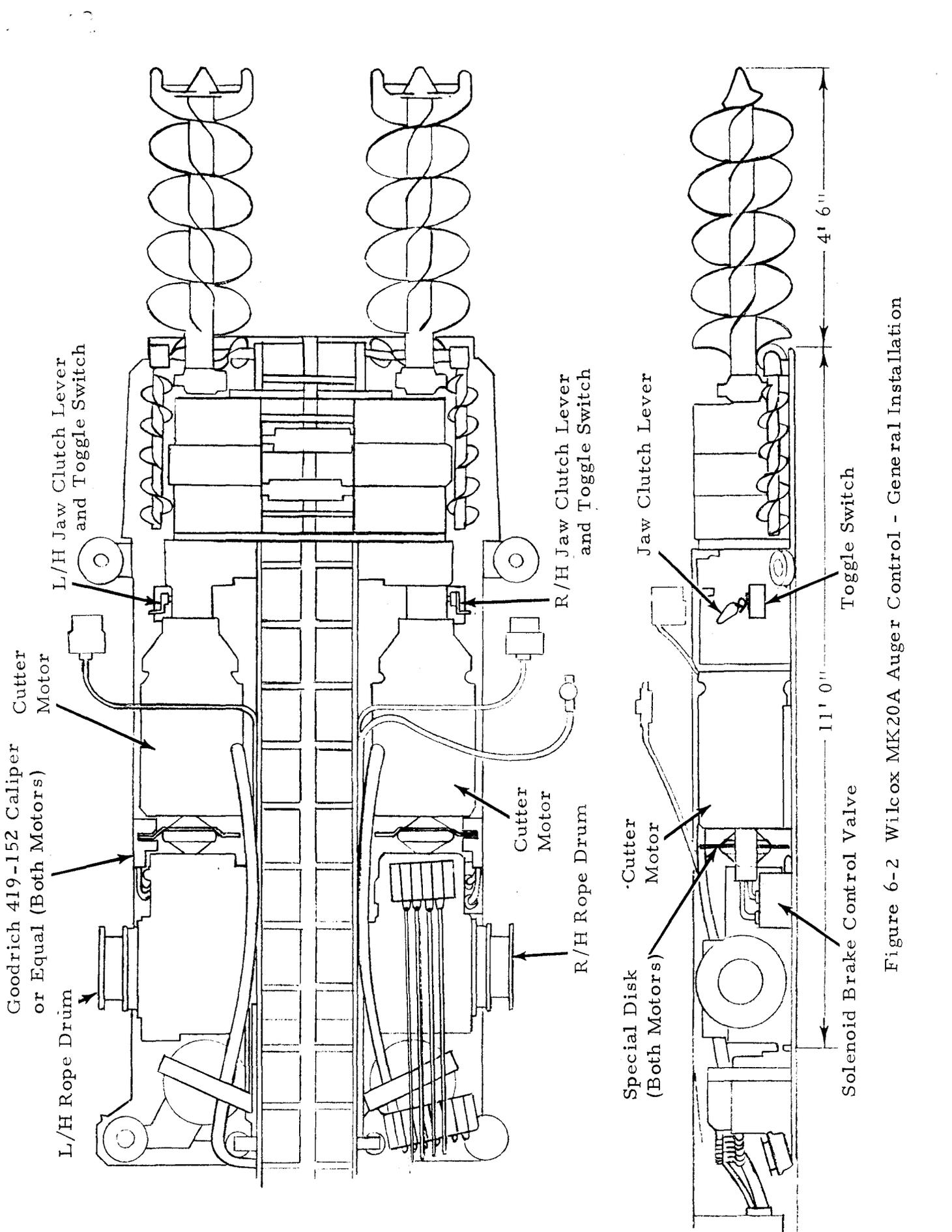
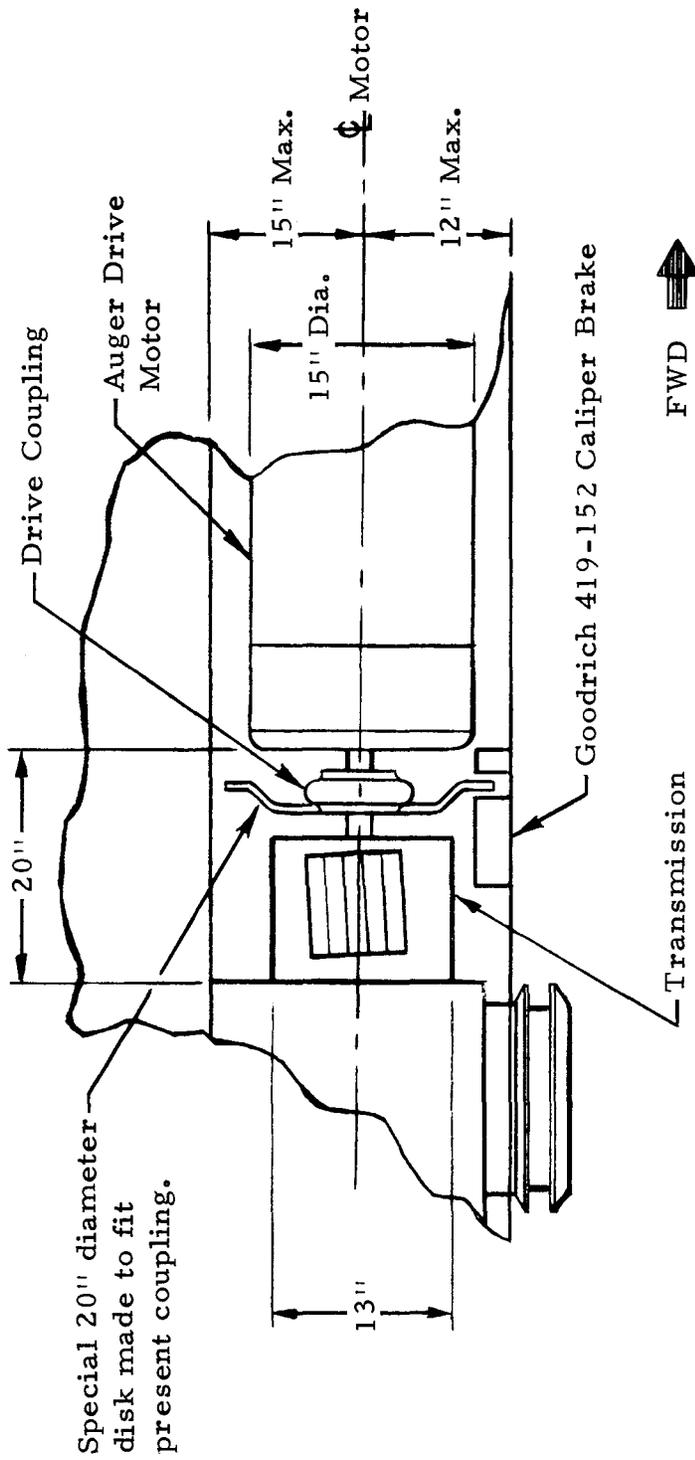


Figure 6-2 Wilcox MK20A Auger Control - General Installation



Plan view of motor
Installation
(R/H side shown).

Figure 6-3 Brake Location on Wilcox MK20A Auger Miner

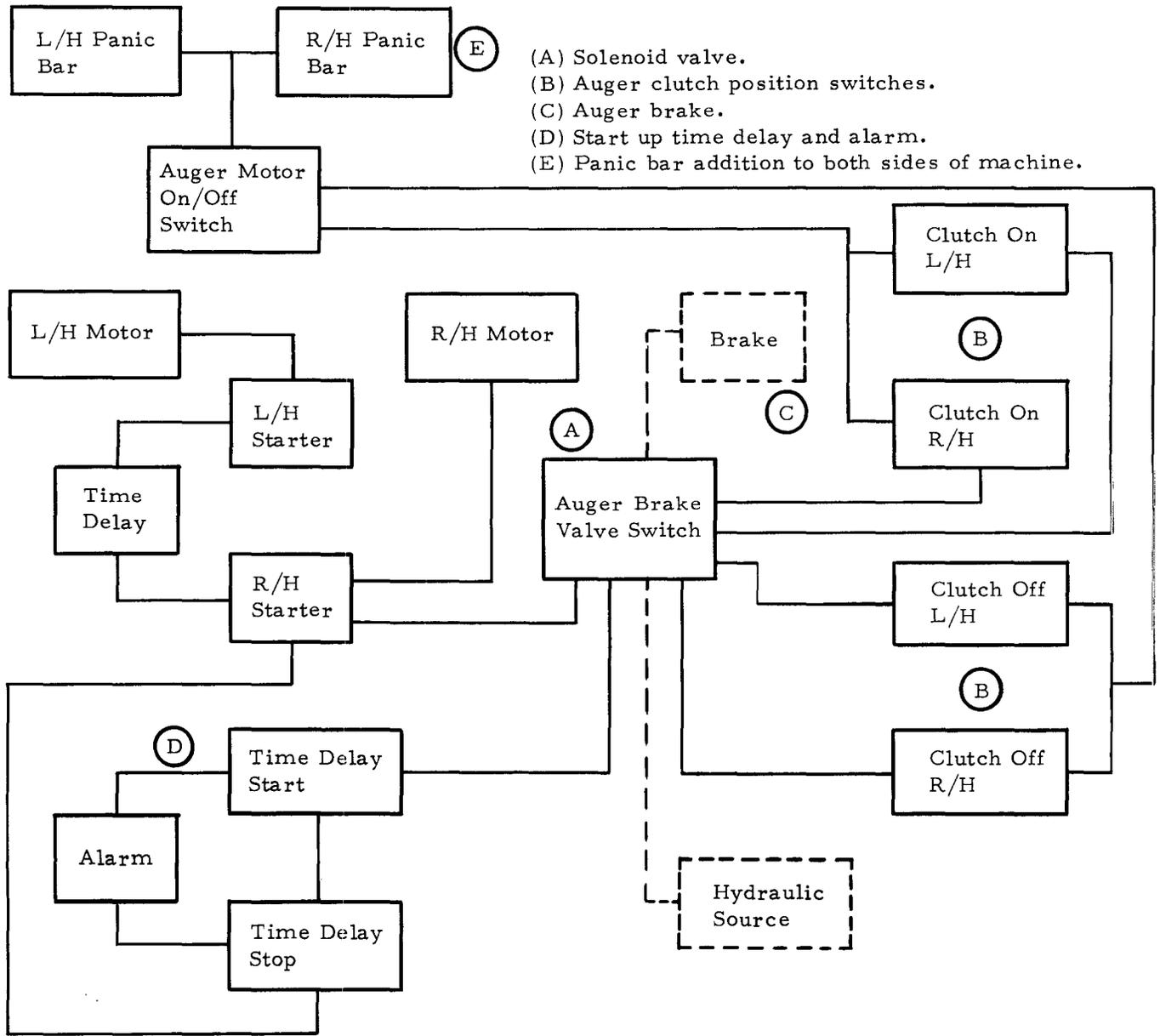


Figure 6-4 Functional Diagram - Wilcox MK20A Auger Drive System with Bendix Control Option 1

- (A) A solenoid valve with valve position sensing or switches to drive the brake.
- (B) Auger clutch position switches to determine if the augers are engaged or disengaged and to initiate auger start up delay and alarm or delay and alarm bypass.*
- (C) The auger brake located on the motor shaft drive, coupling to the rope winches.
- (D) Is the start up time delay and alarm circuit. In the Wilcox machines, this should not be confused with the start delay for the L/H motor.
- (E) Panic bars located on both sides of the machine in a position to enable face crew members other than the operator to shut down the machine. Type 6 panic bars were selected. A discussion of panic bar types and their installation instructions will be found in Section 7.
- (F) The basic MK20A machine, as furnished by the manufacturer, without the Option 1 recommendations.

* NOTE: Since a motor is used to drive each auger, the auger clutch position switches must be duplicated and electrically interlocked.

Figure 6-5 is a Wilcox MK20A Control Box Schematic modified to include the two panic bars and time delay and warning.

As may be noted in the block diagram, the auger motor on/off switch is wired through the auger clutch position switches. This results in two basic determinations being made:

1. A solenoid valve command to lift the brake and initiate auger motor start up through the time delay and alarm circuit.
2. A solenoid valve command to lift the brake and start the drive motor without time delay and alarm.

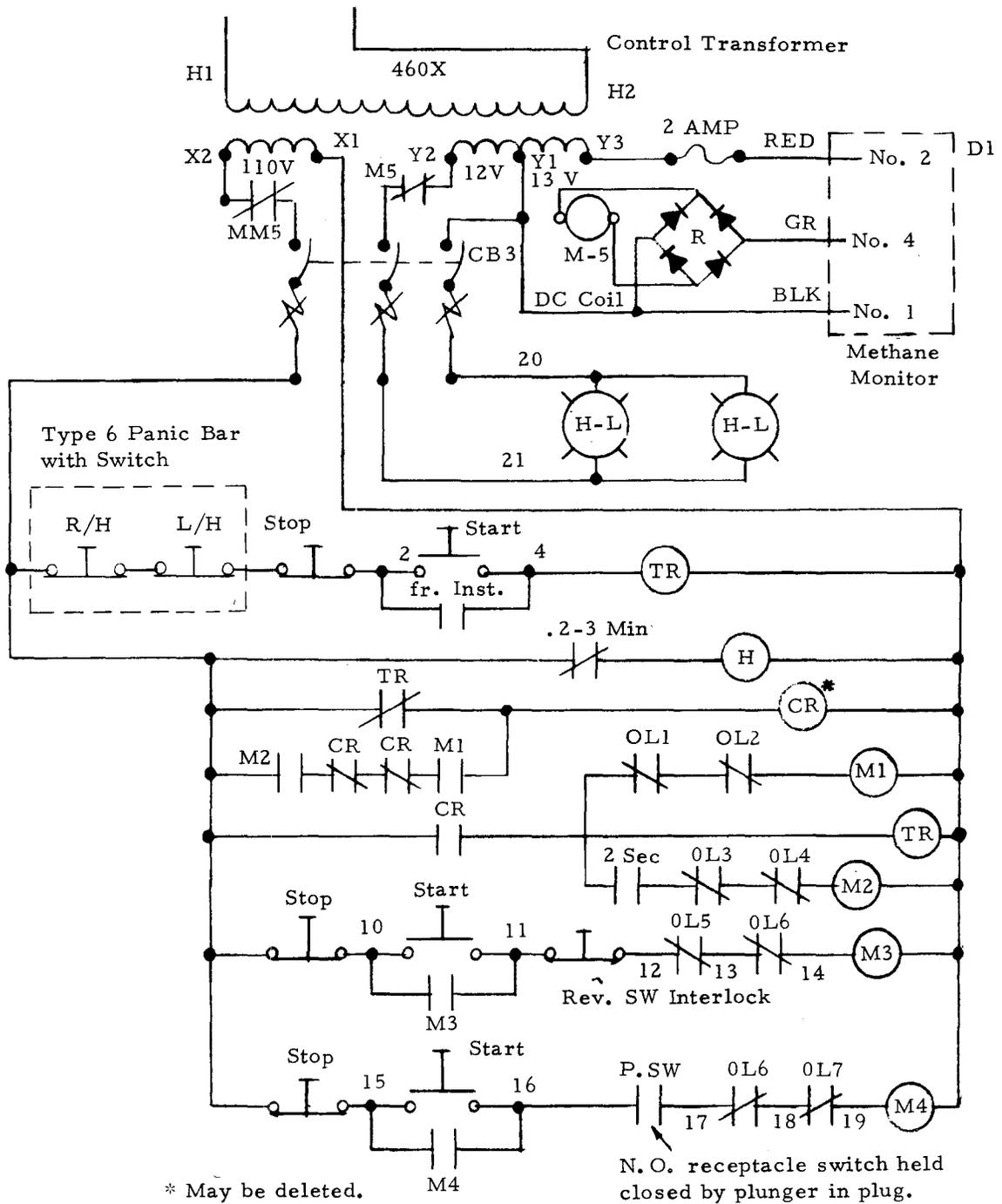


Figure 6-5 Wilcox MK20A Auger Miner Control Box Schematic Modified for Panic Bar, Time Delay, and Warning Signal

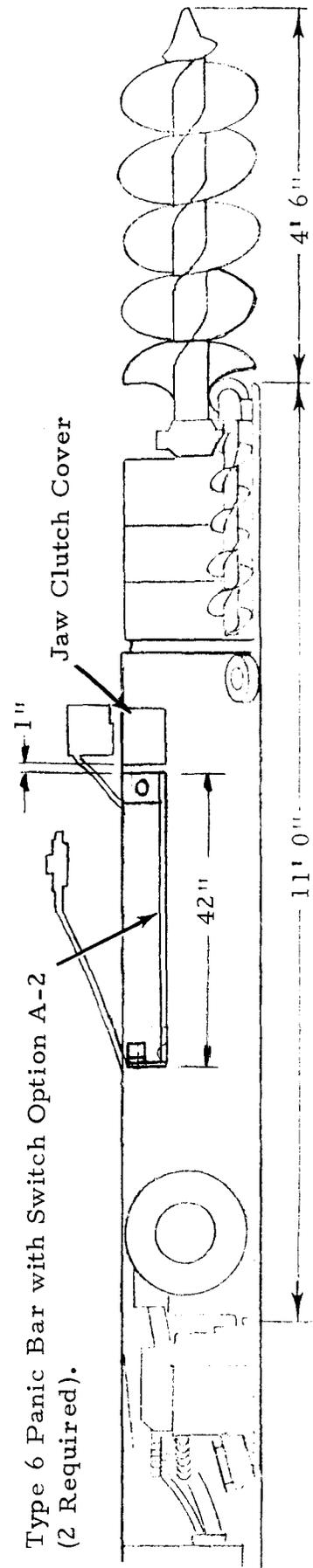
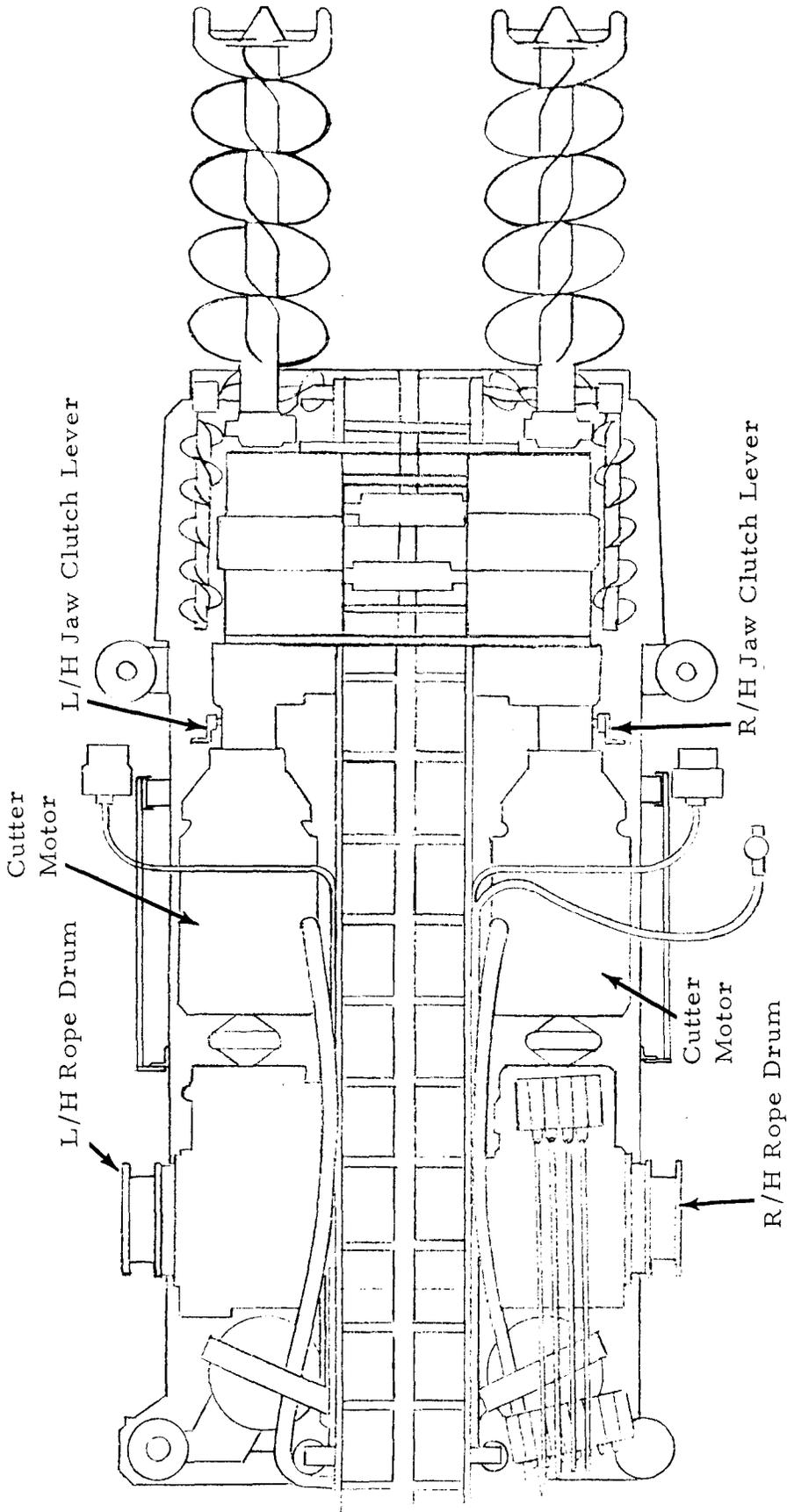
In this latter case, the solenoid valve position switches are used to close the starter circuit after the valve position has changed to lift the brake. The time delay and alarm or no time delay and alarm decision is made by which set of contacts are open and closed by the jaw clutch actuation lever. As may be surmised, when the jaw clutch is in the disengaged position, time delay and alarm is bypassed and start up can occur through the normal machine sequence. This permits machine movement (without time delay) when the augers are disengaged and, hence, do not present a hazard.

The Type 6 panic bars are additional switches wired in series with the off switch. Figure 6-6 outlines the suggested location for the panic bar. The basic switches that are obtainable for the Type 6 panic bar are regular on/off switches and must be reset when the bar is pushed to trip the off switch. Easy access is provided for this purpose by the Ensign kit. See Section 7 for panic bar details and instructions.

As will be noted on the block diagram, Figure 6-4, an additional hydraulic source will be required for brake operation. The existing hydraulic source is driven by the auger motor and will be of little value to lift the brake. There are several hydraulic source options. However, caution must be used in this selection to permit oil flow cut off and bleed to the brake on power cut off. The suggested options are:

1. An additional motor/pump.
2. Add a pump to another motor that can be tied into the control circuit.
3. An hydraulic accumulator charged by the main hydraulic pump.
4. A hand pump to lift the brake with pressure maintained by the main pump after the motor has started.

The actual brake action is applied by the brake's spring pressure. The hydraulic pressure compresses the spring, eliminates puck pressure on the disk and allows the shaft to rotate freely. If the control system permits gradual reduction in hydraulic pressure, the brake will be applied very slowly. Therefore, a rapid valve position change must occur or the oil pressure must be dumped in some manner. Any delay in releasing hydraulic pressure will result in additional rotation of the auger.



Type 6 Panic Bar with Switch Option A-2
(2 Required).

Figure 6-6 Wilcox MK20A Auger Miner Panic Bar Installation

Wilcox Option 2

The introduction of Option 2 is greatly simplified in that the auger brake has been omitted. This is considered to constitute a major cost saving but some question exists as to its safety effectiveness because of the amount of auger rotation that will still be present.

Option 2 primarily offers the ability to shut down the machine by cutting power to the auger drive motors and adding the time delay and warning circuit. Figure 6-7 is a control diagram for the Wilcox MK20A machines without the auger brake. The Option 2 primary functions are:

- (A) Clutch condition starter relay, energized by clutch switches, to make a delay start or immediate start decision.
- (B) Auger clutch position switches to determine if the augers are engaged or disengaged and to initiate auger start up delay and alarm bypass.*
- (C) Is the start up time delay and alarm circuit. In the Wilcox machines, this should not be confused with the start delay necessary for the L/H motor.
- (D) Panic bars located on both sides of the machine. Type 6 panic bars were chosen. Section 7 should be read to review panic bars and their application instructions.
- (E) Is the standard drive train as furnished by Wilcox.

**

NOTE: Since a motor is used to drive each auger, the auger clutch position switches must be duplicated and electrically interlocked.

The panic bar location depicted in Figure 6-6 and the information discussed with respect to Option 1 will apply to Option 2 as well.

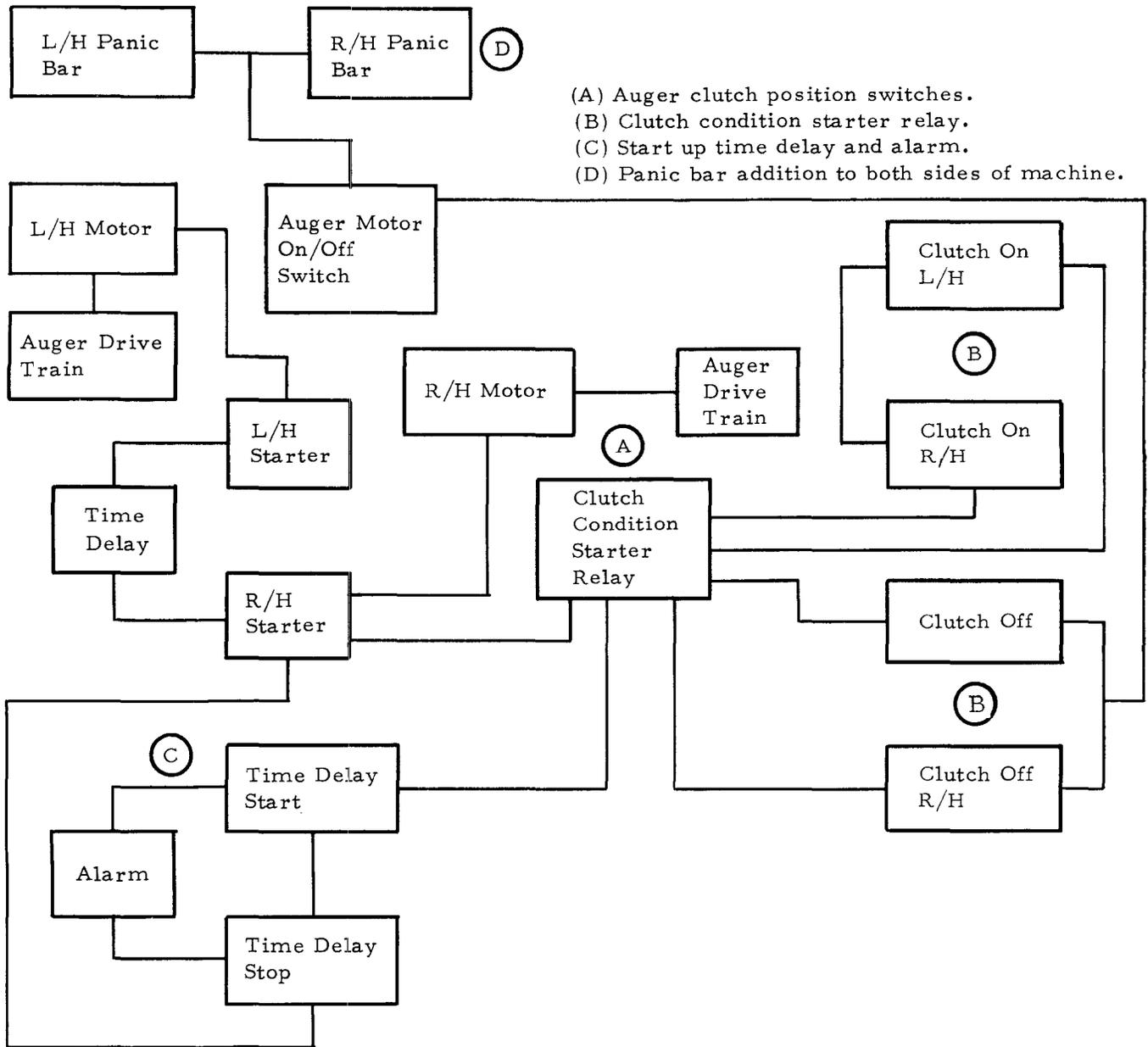


Figure 6-7 Functional Diagram - Wilcox MK20A Auger Drive System with Bendix Control Option 2

Wilcox Summary

There are three outstanding hazards associated with all auger miner operation:

1. Place change with the auger running.
2. A man between the augers, clearing the loader.
3. A man falling into the augers while they are running.

The recommended safe practice for place change or conveyor clearing is to disengage both augers. The Wilcox machine is ideally suited for ensured safety for the helpers in that the operator cannot conveniently reengage the augers along. Thus the operator cannot accidentally or unwisely initiate auger movement, or machine and auger movement if the helpers take the necessary precaution of disengaging the augers. Secondly, if the panic bars are tripped on both sides, reset is necessary to start the auger drive motors (due to the low voltage cut off circuit). The operator must leave his station to do this and walk over to the panic bar installations. If the helpers are the only personnel who are permitted to press these start buttons, increased safety results, and, last, even if the operator was able to accomplish all of this without the helper's knowledge (if he were working between the augers) the start up time delay with an audible warning signal would be present and would allow sufficient time for the worker to move out of the way.

Thus Option 1 and 2 both offer a measure of protection. Option 1 will stop the auger from free wheeling in addition to all of the other safety features offered by Option 2. Option 2 offers delayed start up and warning, with emergency shut down capability by any member of the face crew, and at lower cost than Option 1. The difference is that Option 1 reduces the number of auger rotations from 6.0 to 0.2 and the stopping time from 8.4 to 0.2 seconds, but this does not take into account factors such as miner reaction time in initiating auger stoppage, etc. Hence, it appears that the brake feature of Option 1 is not a very cost-effective means for stopping auger rotation in the instance of a man falling into the augers. (Guards would be more cost-effective and would probably offer a greater measure of safety - i.e., in 0.2 to 0.5 seconds a man would probably be fatally injured by the augers. In the case of machine walking,

the brake is a much more attractive safety feature, but is probably still not cost-effective when we are talking about machine retrofitting.

In the case of the Wilcox machines, operator declutching is not an effective emergency shut down tool, nor will it in any way enhance the desire of the face crew to decouple the auger during place change. A properly designed clutch would accomplish this end. However, due to the construction presently employed, the design of a suitable clutch will require a major machine modification which might well be a new model feature in the future.

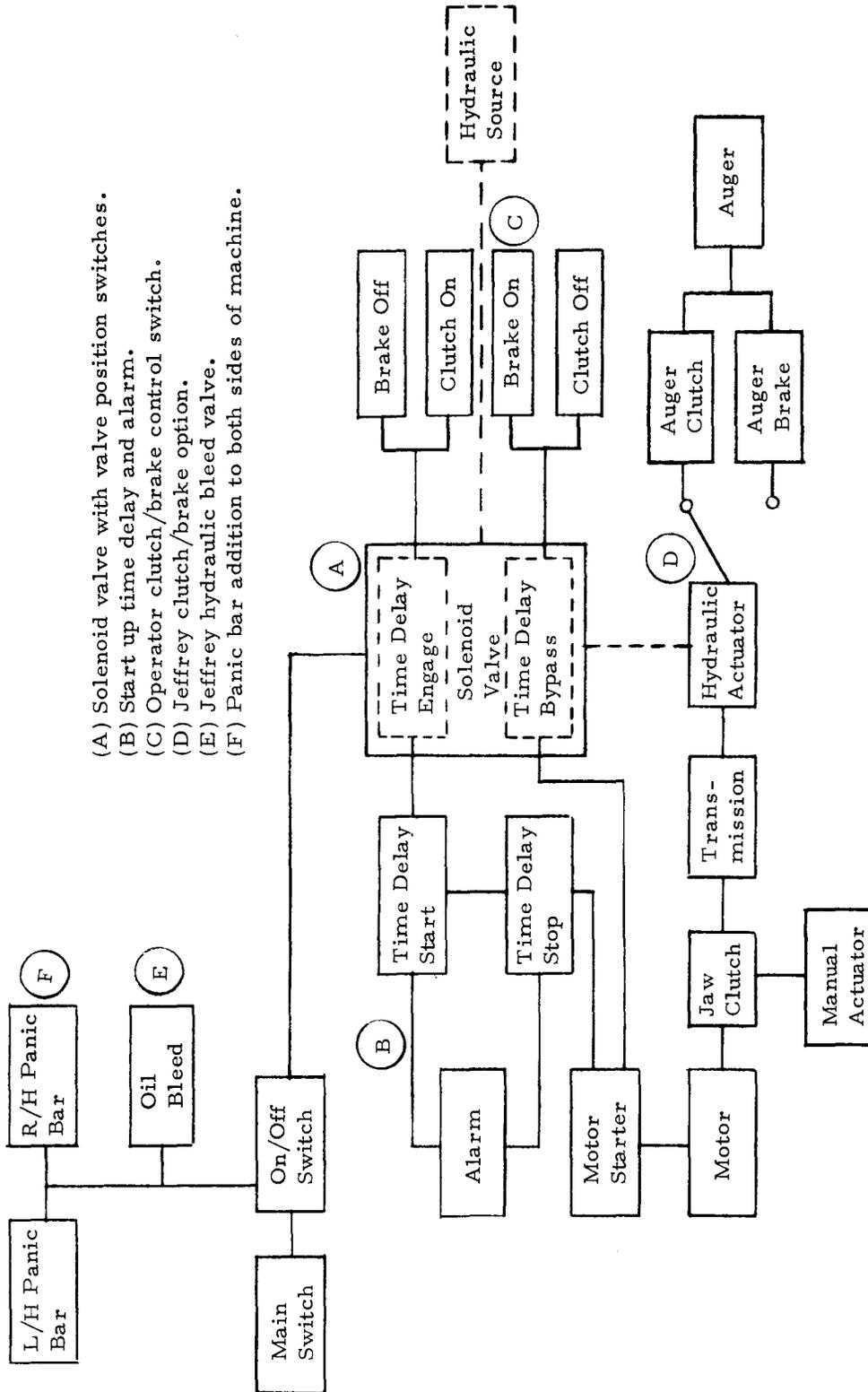
6.2 JEFFREY MODELS

The Jeffrey 100L and 100M auger miners have a single motor device with a transmission arranged to drive both augers. The two machines are identical outby the aft face of the augers. In order to make Wilcox and Jeffrey control systems similar, discussions were held with Jeffrey and we were informed that the WR² of the Jeffrey is larger than the Wilcox and, secondly, that sufficient space was not available to add a motor brake to the system. Jeffrey has an off-the-shelf design for an auger clutch/brake which can be adapted to the area now occupied by the fixed slip clutch. The general machine operation of the 100L and 100M is quite similar to the Wilcox MK20A.

Jeffrey Option 1

As previously noted, the Jeffrey machine has a clutch/brake option available and therefore can be included as part of the Option 1 package without any new developments other than the suggested control system. Figure 6-8 is a control diagram for the 100L and 100M machines with the friction clutch/brake. The Jeffrey Option 1 consists of:

- (A) A solenoid valve with valve position switches or a signal which can be utilized to operate switches.
- (B) Start up time delay and alarm system.
- (C) Operator clutch/brake control switch. In this instance, the solenoid valve can be used to control the oil flow. Therefore, the operator would have a switch which would command "clutch" or "brake" action, depending on the circumstances, instead of a valve lever.



- (A) Solenoid valve with valve position switches.
- (B) Start up time delay and alarm.
- (C) Operator clutch/brake control switch.
- (D) Jeffrey clutch/brake option.
- (E) Jeffrey hydraulic bleed valve.
- (F) Panic bar addition to both sides of machine.

Figure 6-8 Functional Diagram - Jeffrey 100L and 100M Auger Drive Systems with Bendix Control Option 1

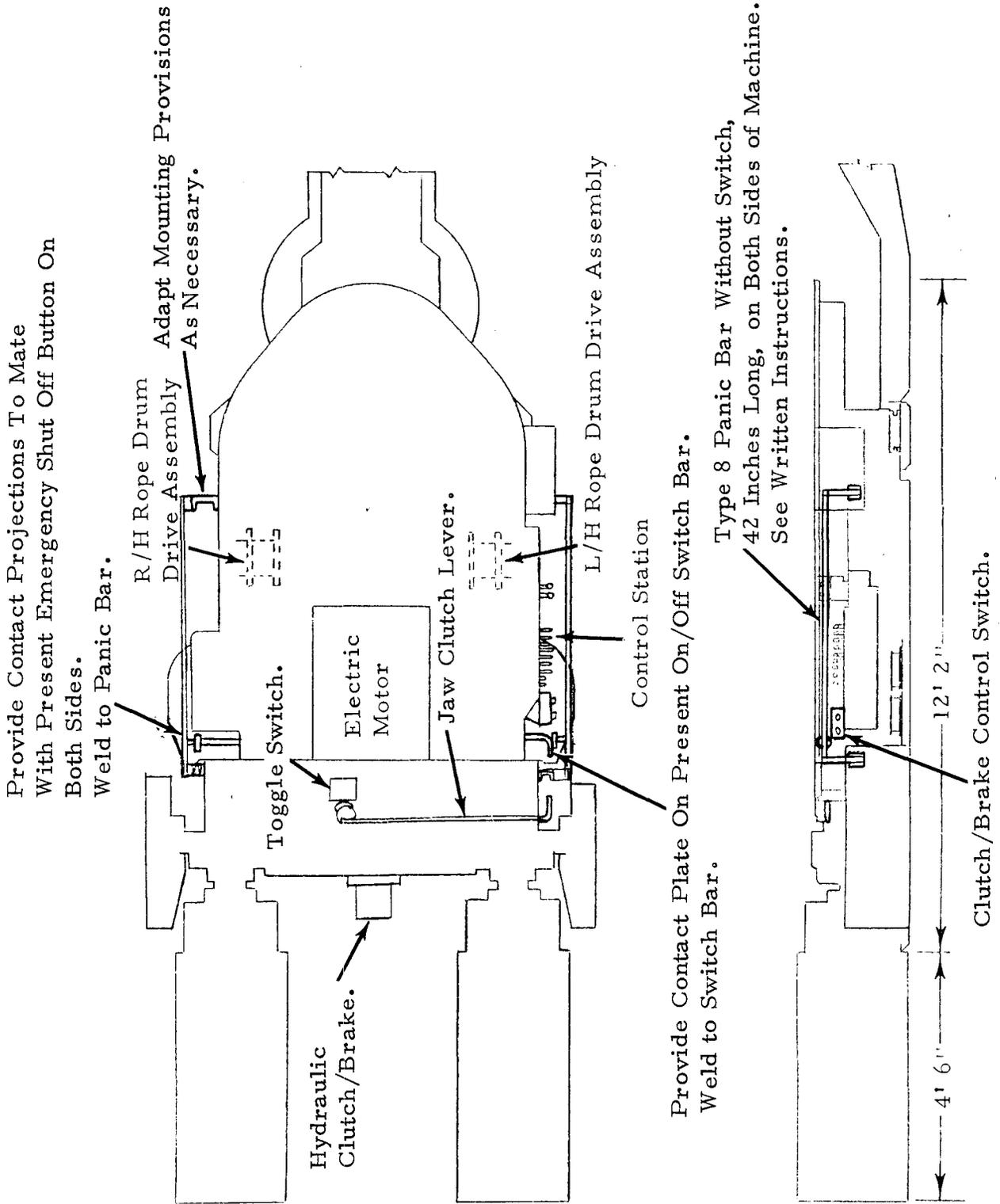


Figure 6-9 Jeffrey 100L and 100M Auger Miners with Panic Bars

(D) Jeffrey clutch/brake option. As a result of previous work, Jeffrey has developed and tested a clutch/brake combination for the 100L and 100M and this option is available from them.

(E) A Jeffrey hydraulic bleed valve.

(F) Panic bar located on both sides of the machine. The panic bar that has been chosen is the Type 8 of the Jeffrey Company which is modified to actuate the present on/off push-pull rod.

(G) The standard drive train as furnished with all models.

Note: The oil bleed feature was an add-on and machines may be in service without it. If such is the case, the oil bleed kit should be obtained from Jeffrey.

The Jeffrey Option 1 differs from the Wilcox Option 1 in that a clutch/brake controlled by the operator is present. The control over auger rotation must include both the electric and hydraulic circuits. In terms of general operation, the control systems for both manufacturers' machines were made as similar as possible. The major control difference between the two machines is the switch that is present in the Jeffrey operator's compartment to control the clutch action. (See Figure 6-9). The Jeffrey Option 1 also differs slightly with respect to the clutch position control in that the solenoid valve position switches are utilized to determine time delay or bypass.

Thus, the valve position switches become a secondary set of contacts depending on the clutch's open or closed position to command time delay on full-electric start up with the clutch engaged, or oil flow time delay if the motor is running and the clutch switch is depressed. For this reason, an additional solenoid valve is actuated by a motor condition sensor. If the motor is up to speed, the valve opens (on command) and initiates the clutch action. If the motor is not running, the condition sensor will initiate the electric circuit time delay and open this valve to permit oil flow as pressure build up occurs. The motor condition sensor may need only be a relay in which the contacts are normally closed. Motor excitation would open the contacts and cause current flow through the time delay circuit if the clutch "on" button is activated. When the

55

oil flow command is given, with the motor running, the time delay circuit would reenergize and would close the second set of contacts, causing the valve to open after the time delay cycle.

The described control circuit changes the operator clutch/brake valve control to a switch which is used to command the main oil flow solenoid valve position. The main on/off switch is wired through the main valve contacts utilizing the valve contacts as a second order of switches to determine start up time delay and alarm or bypass.

The control plan is quite complex in that both hydraulic and electric circuits are involved. The circuit attempts to use a single electric time delay starter. This study has not uncovered a satisfactory hydraulic time delay device and, even if such a device were found, considerable energy would have to be expended to simplify the control interlock circuit. For this reason, the control plan has been generated around electrical devices.

During the time the Jeffrey machine utilizes the hydraulic device, the additional switching logic provided by modifying the jaw clutch actuation lever is not necessary.

For immediate machine shutdown, panic bars of the Type 8 variety (see Section 7 and Figure 6-9), which are furnished by Jeffrey, are intended to be modified and installed in such a manner as to actuate the present on/off push-pull lever. Hydraulic bleed on shutdown is provided on new machines and may be obtained from Jeffrey in kit form, if it is not presently installed. This device is important to the overall safety of operation.

Jeffrey Option 2

Option 2 for the Jeffrey 100L and 100M machines is almost identical with the Wilcox Option 2. The primary drive train disconnect device is the jaw clutch. In the case of the 100L and 100M, only one jaw clutch is used and the push-pull rod to actuate it is in the operator's compartment. This is not as desirable as the jaw clutch actuator which is out of the operator's reach from the point of view of the face crew member who is chosen to clear the conveyor between the augers. He is not in control of his own safety. This situation is somewhat improved by the operator

being located in such a position as to have full view of the augers. Figure 6-9 shows the panic bar and other components' locations. Figure 6-10 is a control diagram for the 100L and 100M machines without the friction clutch/brake. The Option 2 features are:

- (A) Jaw clutch position switches, whose function is to determine start up time delay and alarm or bypass.
- (B) Time delay and alarm.
- (C) A Jeffrey hydraulic bleed valve. *
- (D) Panic bars or both sides as defined in Option 1.
- (E) Standard drive train as furnished by the manufacturer.

* NOTE The oil bleed feature was an add-on and machines may be in service without it. If such is the case, the oil bleed kit should be obtained from Jeffrey.

The actual function of the control circuit is handled largely by the jaw clutch position switch. If the clutch is engaged, the time delay and alarm contacts are closed and the motor starts with time delay and alarm. If the jaw clutch is disengaged, the time delay and alarm contacts are open and the bypass contact is closed. This allows running the motor for place change with the augers disconnected.

Jeffrey Summary

The same logic that applied to the Wilcox machines would pertain to the Jeffrey auger miners and, hence, Option 2 would be the more cost-effective approach in terms of machine retrofitting.

6.3 ALARM SYSTEMS

At present, two alarm systems look promising for use in underground mines. However, neither has established permissibility.

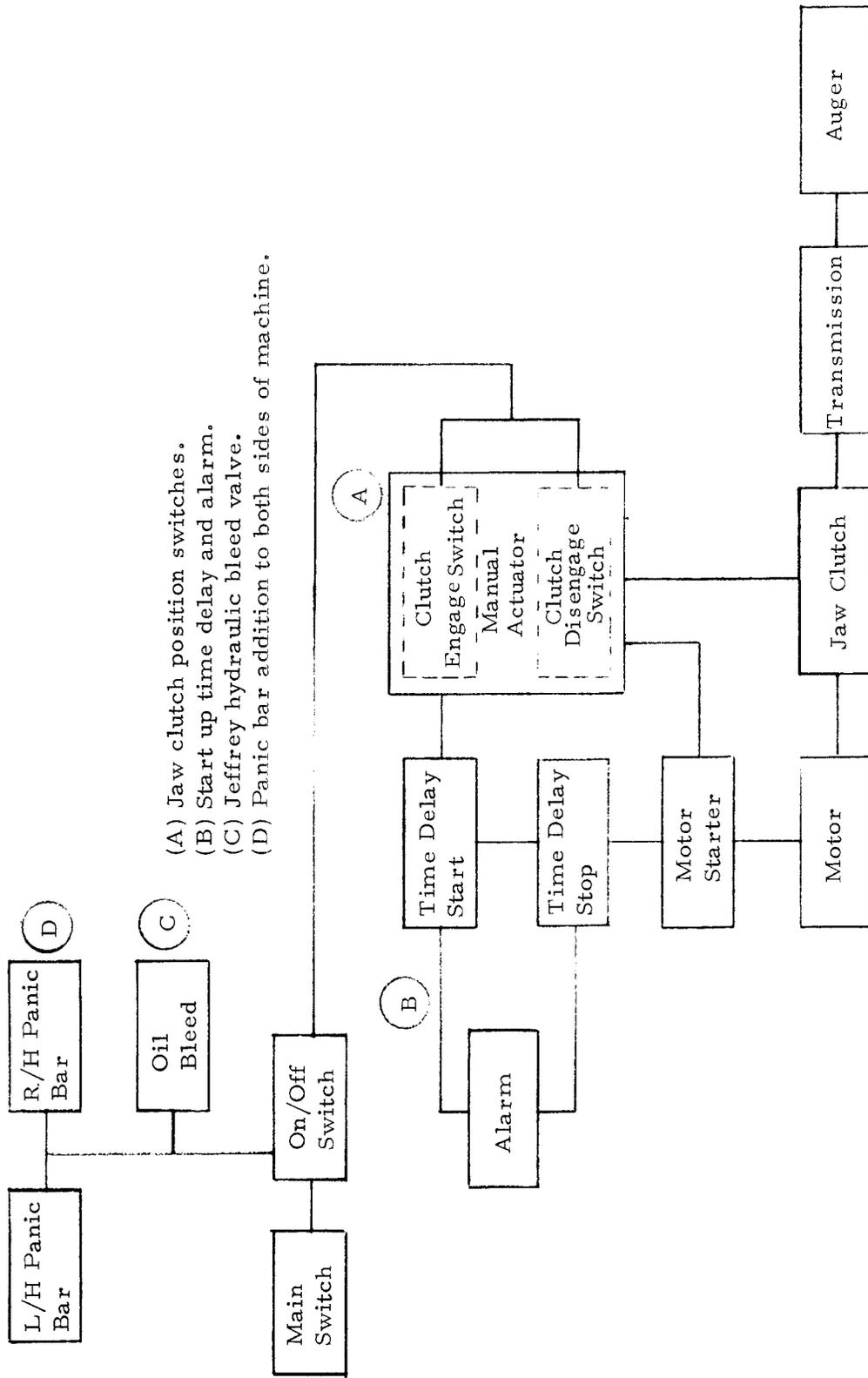


Figure 6-10 Functional Diagram - Jeffrey 100L and 100M Auger Drive Systems with Bendix Control Option 2

1. FEMCO
12 VDC, 2A
National Mine Service (Distributor)
2. Mine Safety Appliances
12 to 36 VDC, 0.5A

The Mine Safety Appliances' device is solid state and provides an audio tone at approximately 1100 Hz at one pulse/sec. National Mine Service has developed an alarm system for their shuttle cars, but was unable to provide information in time to be included in this report. Time delay starters (0.2 to 120 seconds are readily available (e. g., from Service Machine Company).

Time Delay Recommendations

All of the conditions capable of being present have been considered impossible to determine. Tests conducted under simulated circumstances indicated at least 20 seconds minimum time delay and alarm must be present. When considering very low coal, poor floor, and partially sumped in auger, time delay and alarm would be safer with 25 seconds startup delay. From this, Bendix recommends the time delay starter be set at a minimum of 20 seconds and preferably 25 seconds delay with the alarm sounding in a pulse mode during the entire delay period before actual motor start.

6.4 SUMMARY OPINIONS

In the opinion of the investigators, Option 2 would be the most practical of the approaches investigated in that it provides:

1. Auger rotation control (time delay initiation or bypass depending on jaw clutch status).
2. Time delay start up and alarm when clutches are engaged.
3. Emergency deenergization by means of panic bars available to crew members on each side of the machine.
4. Standardization of operation.

Option 1 is a very expensive installation when considering retrofit. This condition prevails for both manufacturers' machines. Option 1 does, however, offer an operational safety advantage and would be lower in cost as a standard feature and, hence, might be considered for incorporation in new models. Auger guards, which were beyond the scope of this study, should be considered for both retrofit and new models. If they are incorporated the benefits of the auger brakes are reduced, but not eliminated.

Option 2 primarily involves changing the present starters to the time delay type, and adding the warning system and panic bars (which involve additional switches for the Wilcox installation and utilizing the present contact bar in the Jeffrey installation). In terms of cost-effectiveness and improved operational safety, the addition of Option 2 to both machines would be recommended and could be accomplished in the mines with rewiring consultation available from the respective manufacturers.

7. PANIC BAR TYPES AND WRITTEN INSTRUCTIONS

NOTE: The panic bars identified for use on the Wilcox and Jeffrey miners are identified as Types 6 and 8, respectively. However, all panic bars developed during the panic bar criteria study have been included in order to provide complete panic bar information.

WRITTEN INSTRUCTIONS

There are nine types of panic bars that are defined in this study. The variations are primarily in their construction. The materials that are used in these panic bars are low carbon steels (SAE 1020, 1025), hot or cold rolled, steel pipe (without galvanizing, if welding is to be done indoors or underground), or steel tubing in the form of electrical conduit.

The recommended panic bar installations fall into two categories:

- 1. Those in which the panic bar actuates the present tram power on/off switch.
- 2. Those in which the panic bar interfaces with a new tram power on/off switch.

Panic bar types 1, 2, and 5 are designed to be constructed by the mining companies and are intended to provide adaptations to the machine's present tram power on/off switch. Panic bar types 3, 4, 6, and 7 contain purchasable components that are sometimes used as is or are intended to be modified as shown on the individual panic bar drawings. Panic bar types 8 and 9 are purchasable from Jeffrey Machinery Company and may be obtained with or without a switch.

All nine types of panic bars are of the same basic configuration; that is, a hinged bar which is pushed to actuate a tram power on/off switch. The preceding panic bar installation drawings define a specific panic bar type for each model. This type was selected based on information provided by the machine manufacturers. However, since there are often significant variations within any one model from a given machine manufacturer and since machines are frequently extensively modified by

mine operators and/or machine rebuilders, it is advisable to determine if a particular machine configuration fully accepts the recommended type of panic bar before proceeding with the recommended installation. Prior to the installation of any of the panic bar types, a review of all nine panic bar types should be made and a more appropriate choice may thereby be discovered. With the same basic panic bar action being common to all of the types, the variations between the types are primarily a matter of mechanical experience.

If one of the other types of panic bar is selected (or if the recommended panic bar type is modified to account for any variations in the construction of an individual machine), the general location designated in the installation drawing should be adhered to so as to ensure the satisfaction of the operational requirements and to provide the desired operator-panic bar interface. It may be noted that specific dimensions for the panic bar's location are not always given in the assembly drawings. The drawings, in these cases, are intended to convey the appropriate location and, during installation, the installer should optimize the precise panic bar position so as to permit free action of the various machine operating controls. Thus, the installation drawings are a guide to panic bar installation, and yet permit some degree of freedom to account for variations in machine design, as well as differences in mine operators' facilities, and materials availability.

Most of the preceding installation drawings call out the basic panic bar dimensions as A, B, C, and (in some cases) D. The following panic bar drawings define the location of each of the applicable dimensions. Panic bar types 6 and 7 call out the specific bar lengths on the installation drawing. For panic bar types 1, 2, and 5 the installation drawings require the addition of a switch contact strap during installation of the panic bar on the machine. These notes instruct the installer to align a 1/4" thick by 2" wide steel strap to contact the tram power off pushbutton. The length of this strap is variable depending on the accuracy of installation. Therefore, the length of the strap will be determined during the panic bar installation.

Where the panic bar installation requires a new switch be installed, the switch which is to be wired into the machine should be hooked up in accordance with the applicable machine's electrical schematic and/or wiring diagram and the requirements of Bureau of Mines Schedule 2G.

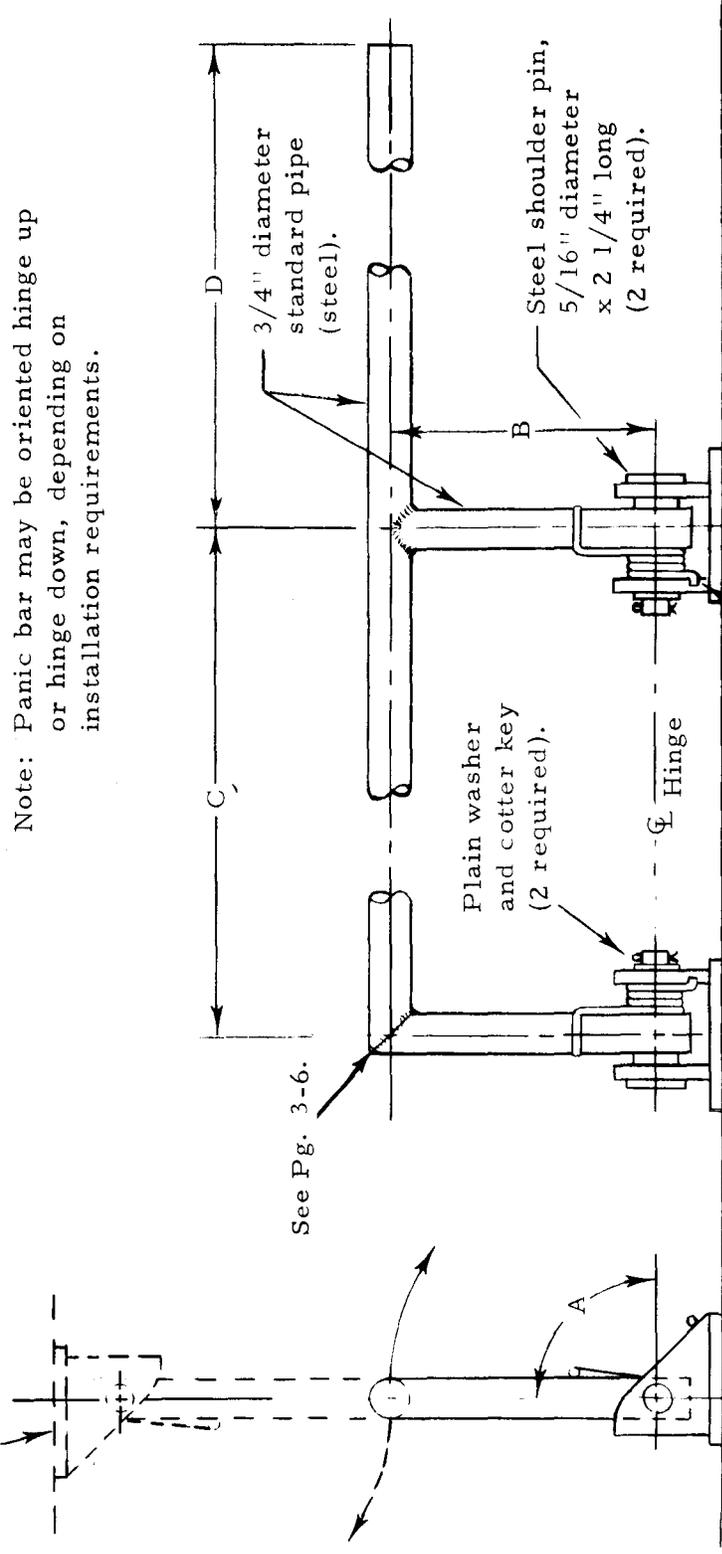
The panic bars may, generally, either be welded or bolted in position. In those instances where panic bars are to be installed in front of valve bodies or starter boxes, it is recommended that bolting be used.

The following guidelines are suggested for review, before the panic bar installation is attempted:

1. Review the recommended panic bar location with respect to the machine that is to be modified. Check the machine dimensions and the recommended panic bar position to ensure that the machine to be modified will accept the recommended installation. If there is not a proper fit, determine if any interfering machine components can be moved, if any machine structure can be modified, or if any changes in the panic bar dimensions (within the intent of the recommended panic bar position) will correct the situation.
2. Compare the panic bar switch installation electrical schematic or wiring diagram with the schematic or wiring diagram for the machine that is to be modified. The machine may have been modified, which would affect the applicability of the recommended installation. If in doubt, consult with the machine manufacturer.
3. Any one of the nine types of panic bars will satisfy the operational requirements. If a particular installation problem prevents the use of the recommended panic bar type, the selection of a different panic bar type would be appropriate. For example, if a Type 2 panic bar is recommended and an existing component on the machine prevents mounting the hinge bracket in the specified location, the substitution of a Type 1 panic bar will permit relocating the hinge bracket, while still maintaining the recommended panic bar length.
4. Where additional supports have been recommended in the installation of the panic bar in order to improve its position relative to the operator, freedom of material choice is provided. The supports may be pipe, bar stock, angle iron, channel, etc., whichever is most readily available. However, the support must be sturdy and free of sharp edges and corners.

5. The panic bar assembly should be coated with a good grade of metal primer (e. g., zinc chromate) and final finished with red enamel paint that is suitable for finishing metal.
6. When the panic bar installation is completed and all adjustments have been made, the following performance requirements should be met:
 - a. Power cutoff should be achieved with 2" or less of panic bar travel.
 - b. A force of no more than 15 pounds applied to the panic bar should result in the activation of the tram power off switch.
7. The springs that are recommended should be of the torsion type, approximately 20 inch pounds of torque, 3 coils, and are generally available from hardware stores, farm machinery houses, and spring manufacturers (such as Midwest Spring Manufacturing Company, 4632 South Western Avenue, Chicago, Illinois 60609).

Plane of attachment,
hinge up.



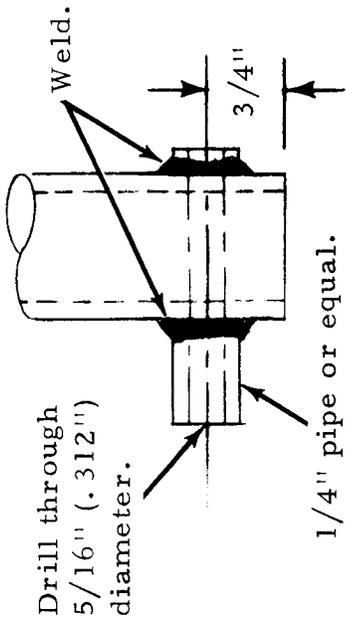
Note: Panic bar may be oriented hinge up or hinge down, depending on installation requirements.

Hinge bracket
(2 required).
See Pg. 3-7.

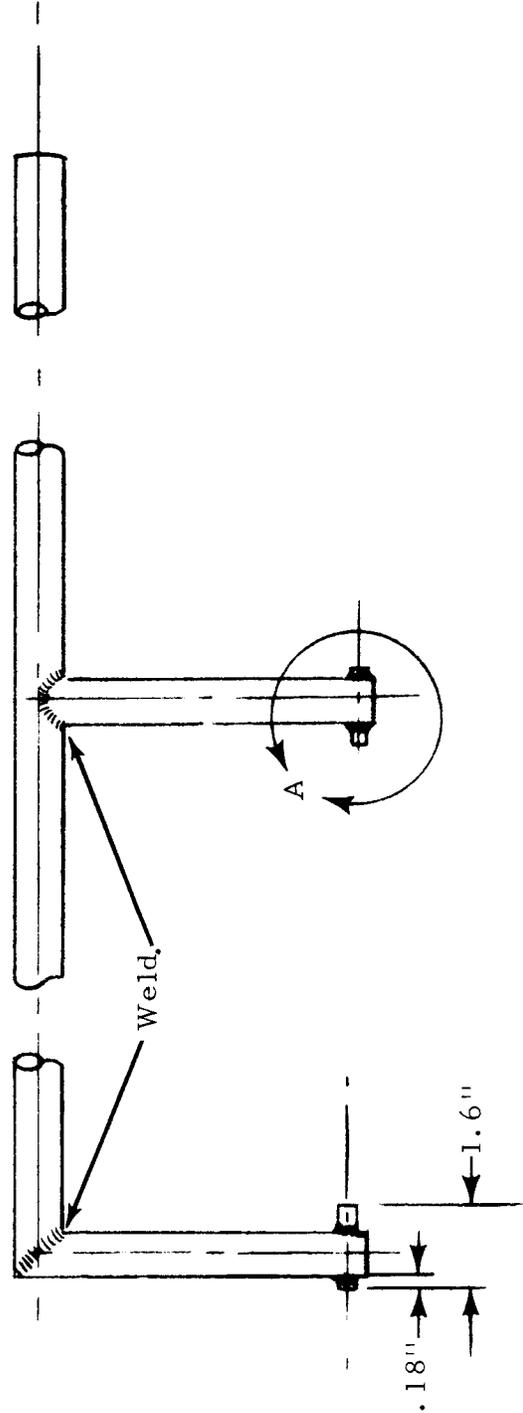
Torsion spring,
20 inch pounds torque
(2 required).

Type 1 Panic Bar

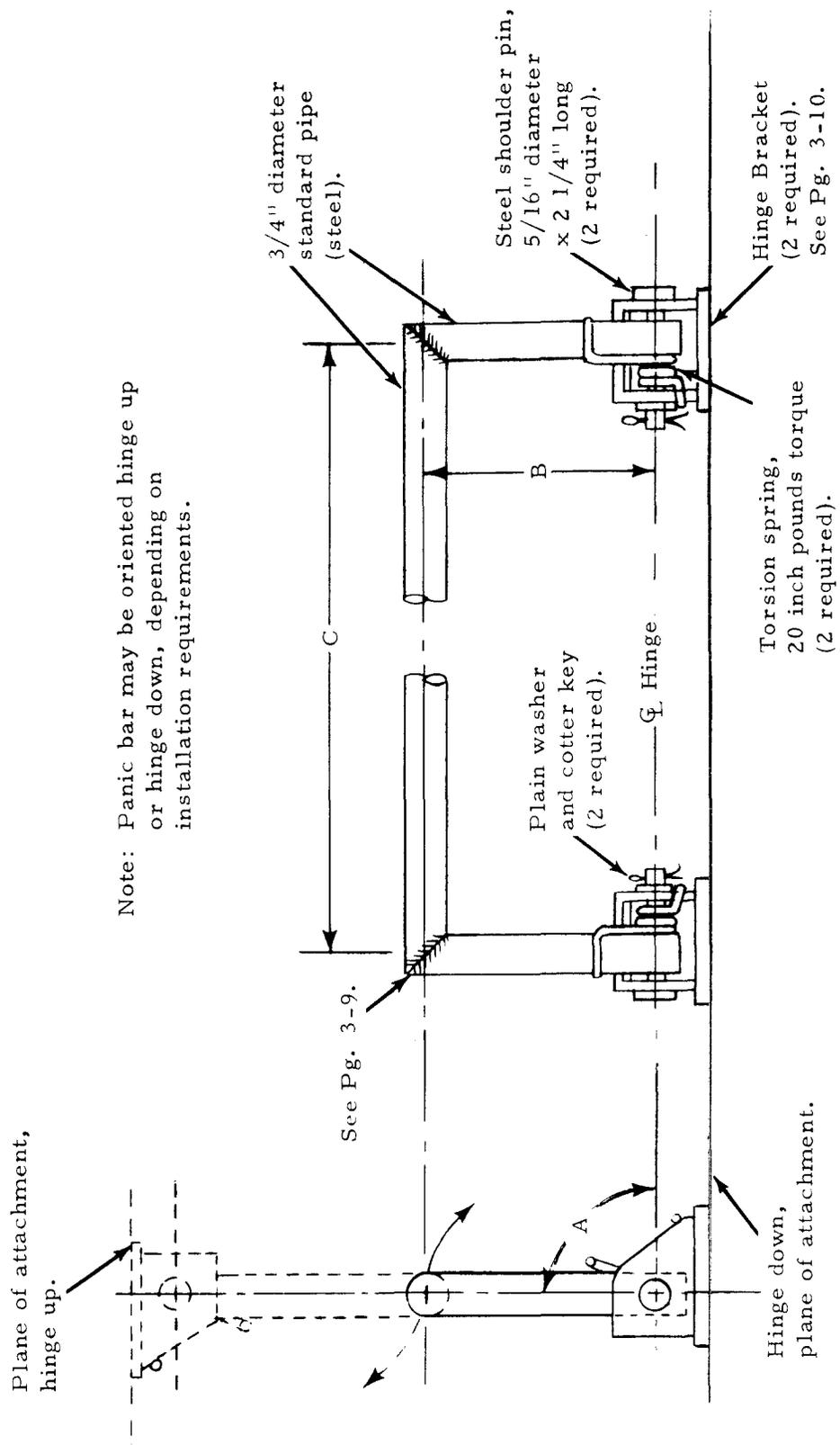
1
1
2
3



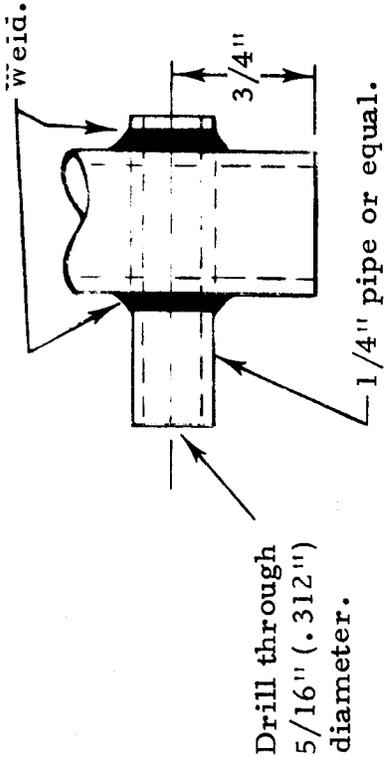
View A



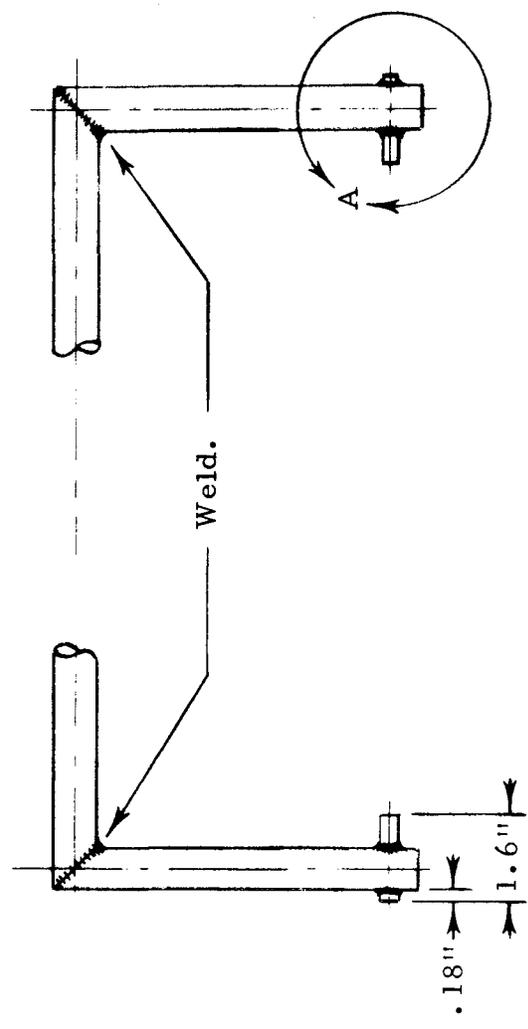
Type I Panic Bar - Weld Assembly



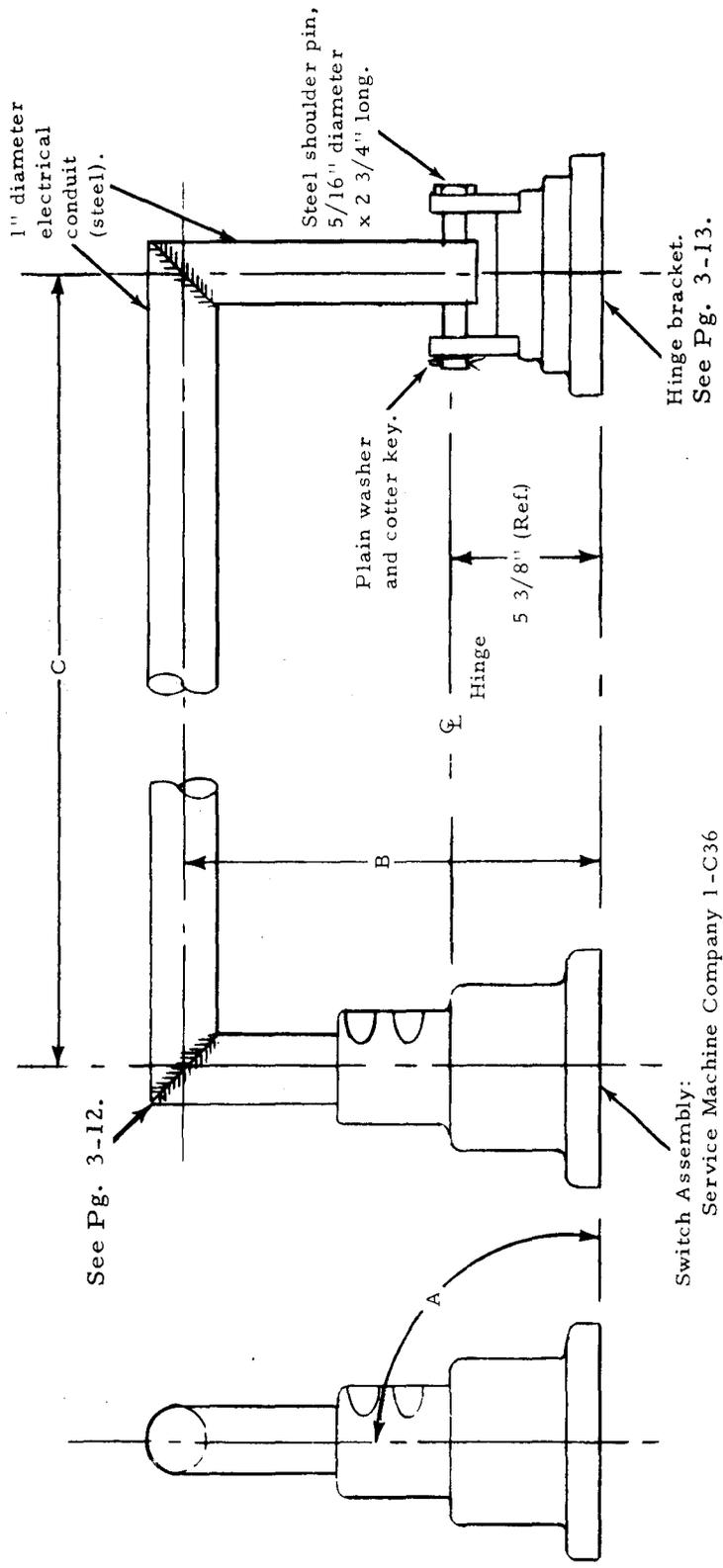
Type 2 Panic Bar



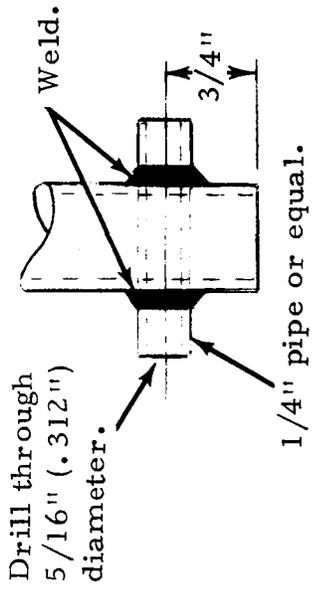
View A



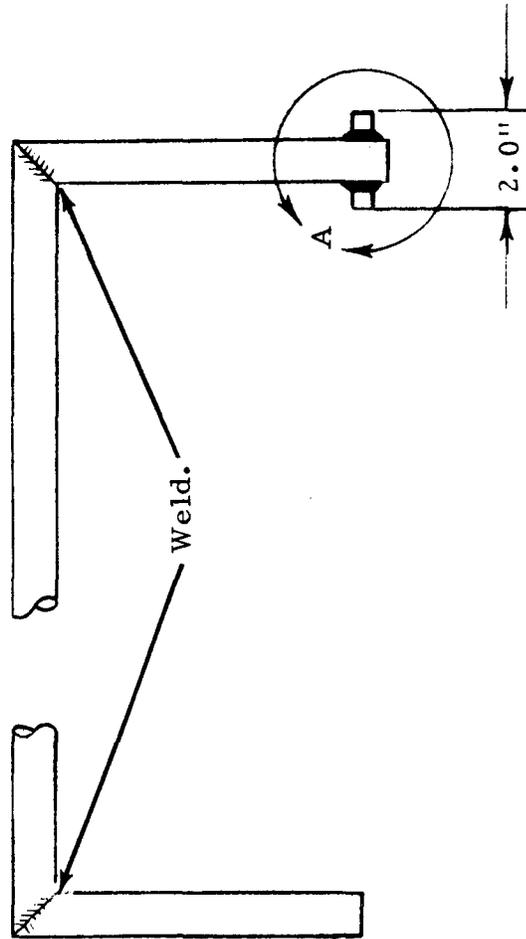
Type 2 Panic Bar - Weld Assembly



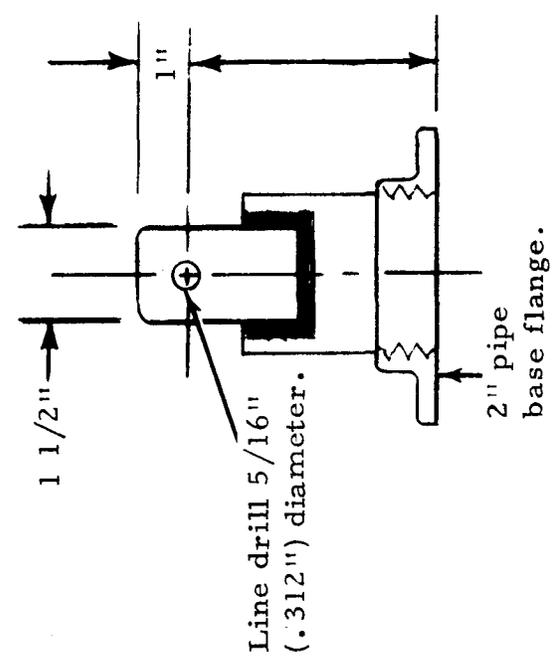
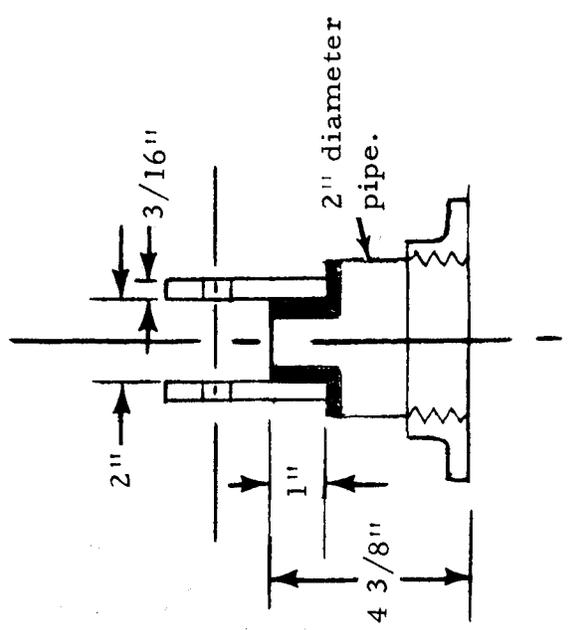
Type 3 Panic Bar



View A

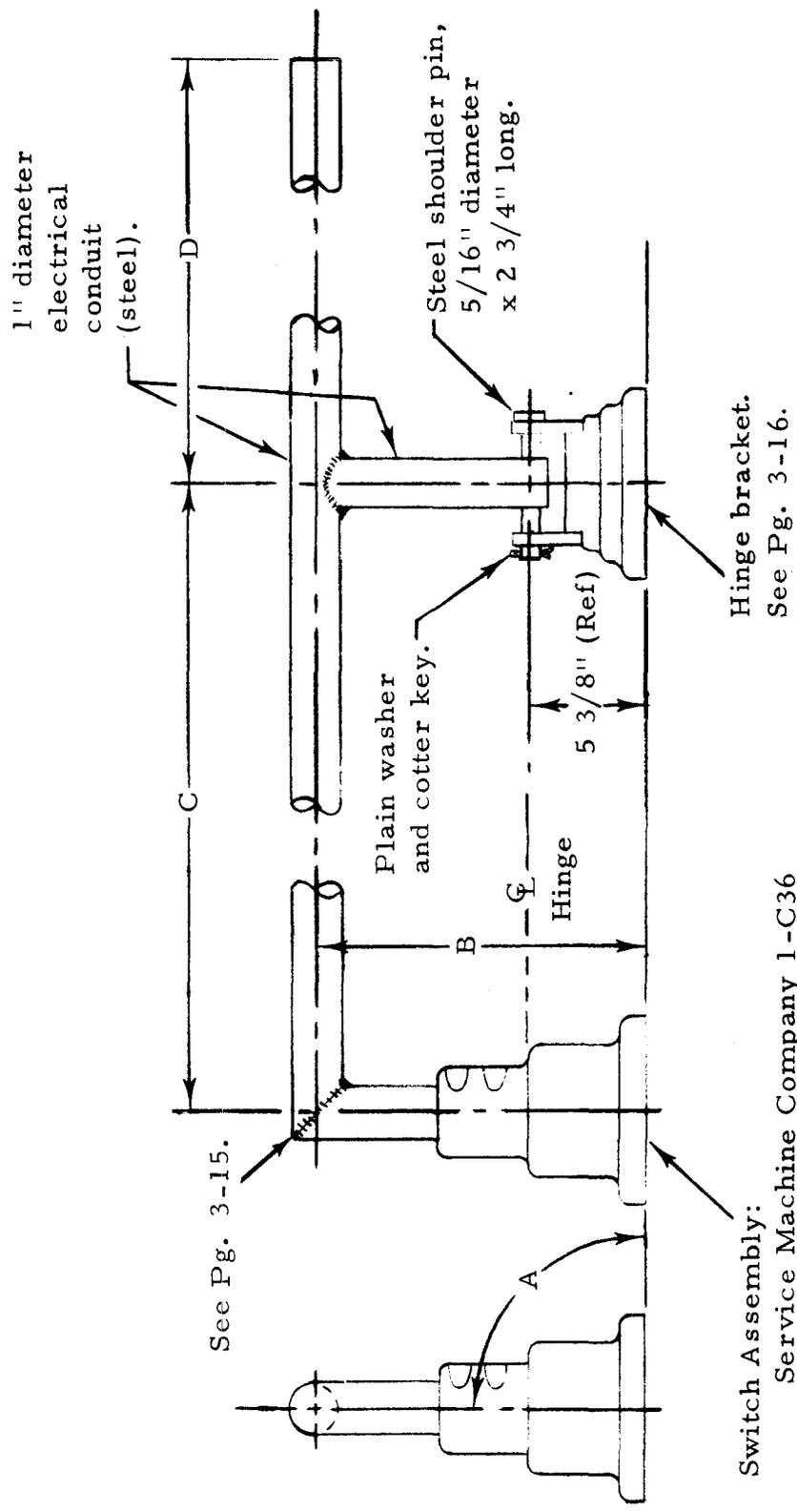


Type 3 Panic Bar - Weld Assembly



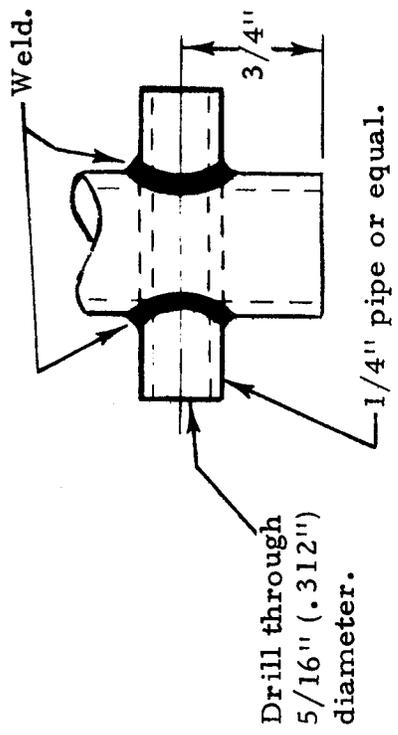
Note: Make from SAE 1020 carbon steel plate, bar or equivalent

Type 3 Panic Bar - Hinge Bracket

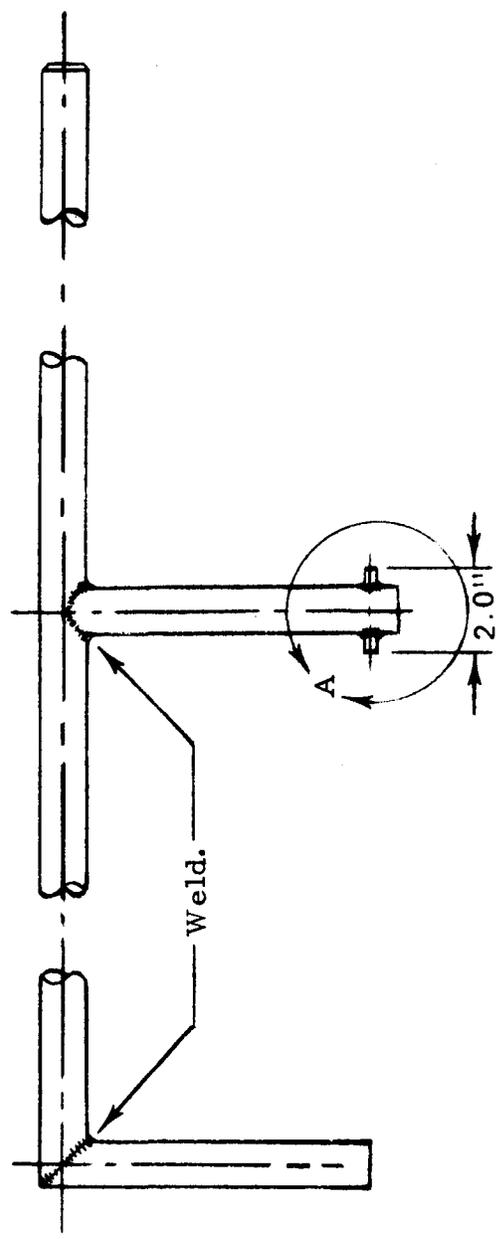


Switch Assembly:
 Service Machine Company 1-C36
 Joy Manufacturing Company U138-28

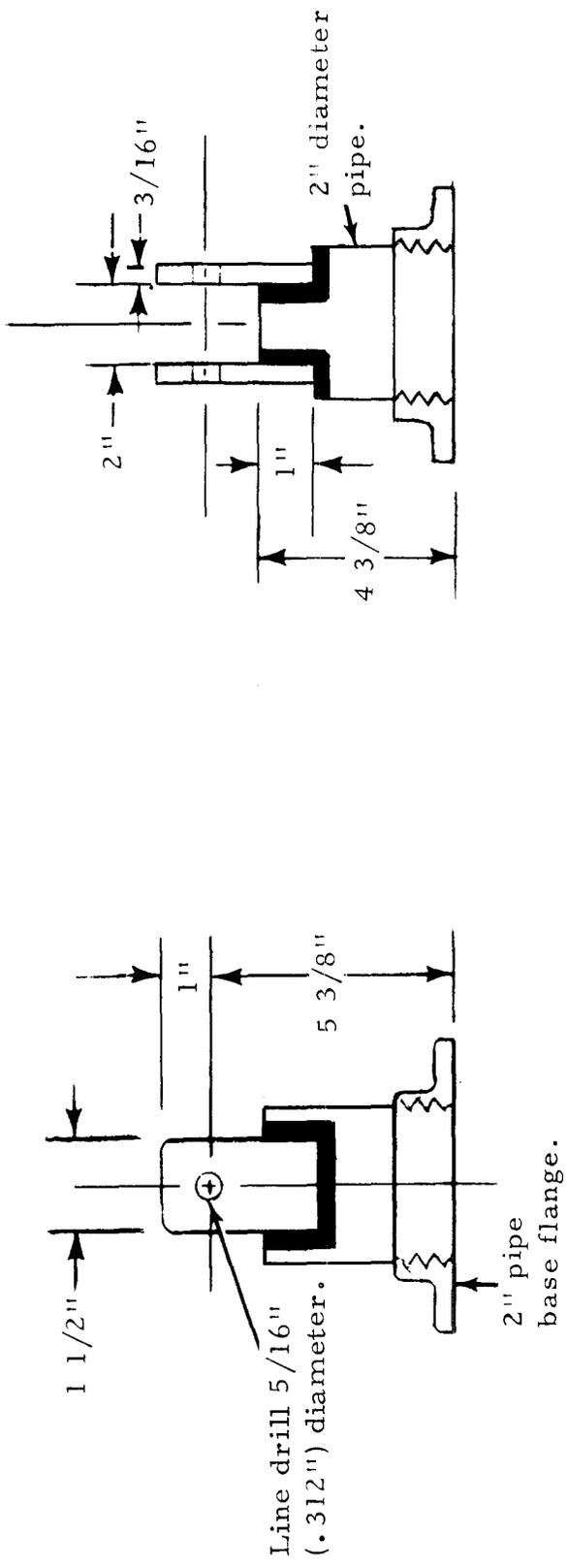
Type 4 Panic Bar



View A



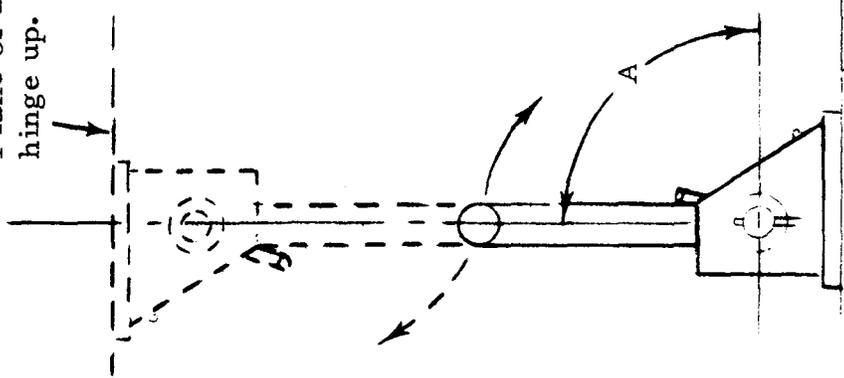
Type 4 Panic Bar - Weld Assembly



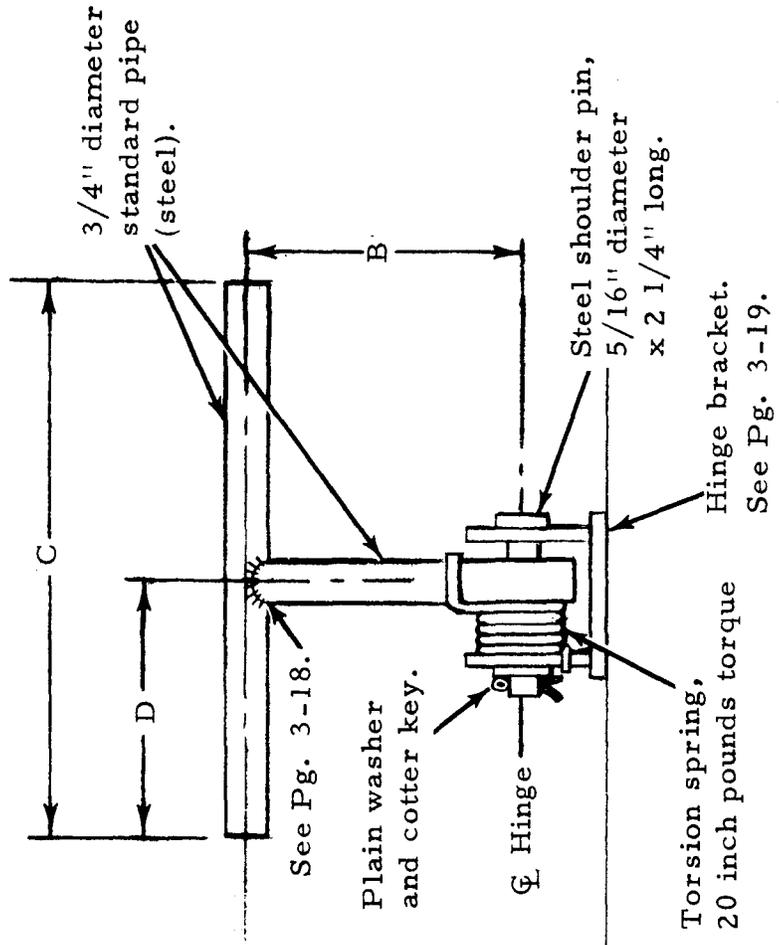
Note: Make from SAE 1020 carbon steel plate, bar or equivalent

Type 4 Panic Bar - Hinge Bracket

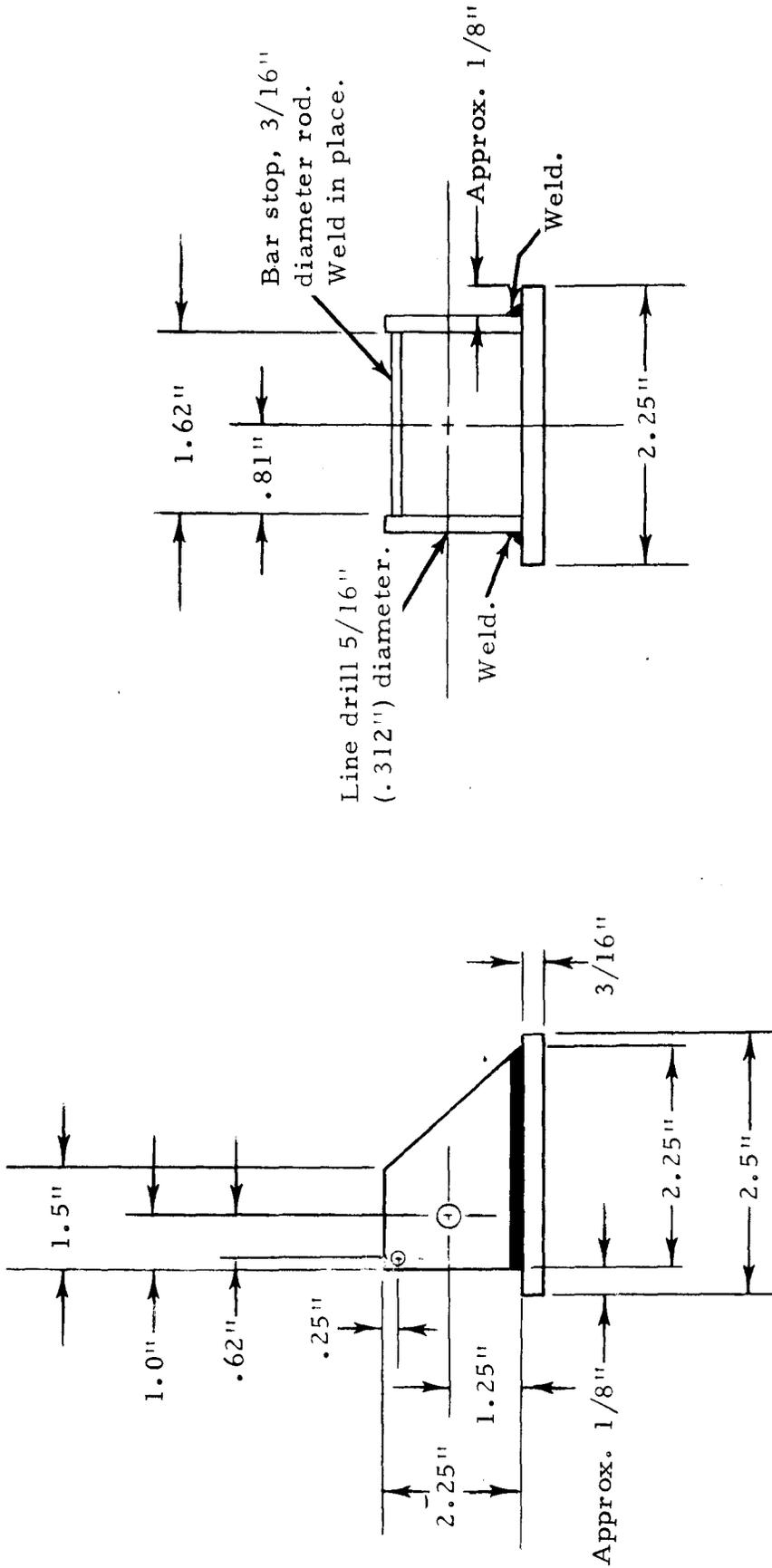
Plane of attachment,
hinge up.



Note: Panic bar may be oriented hinge up on hinge down, depending on installation requirements.



Type 5 Panic Bar

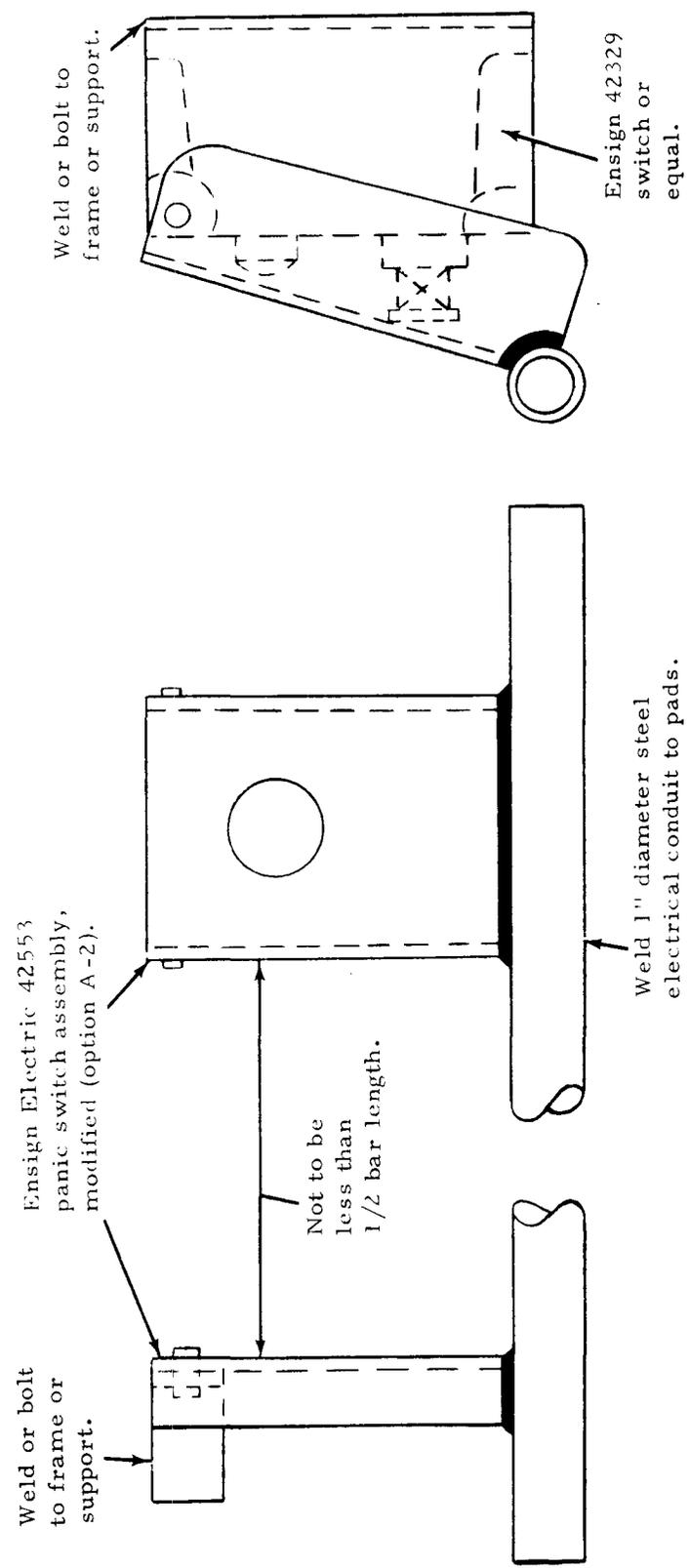


Note: Make from SAE 1020 carbon steel plate, bar or equivalent

Type 5 Panic Bar - Hinge Bracket

Notes:

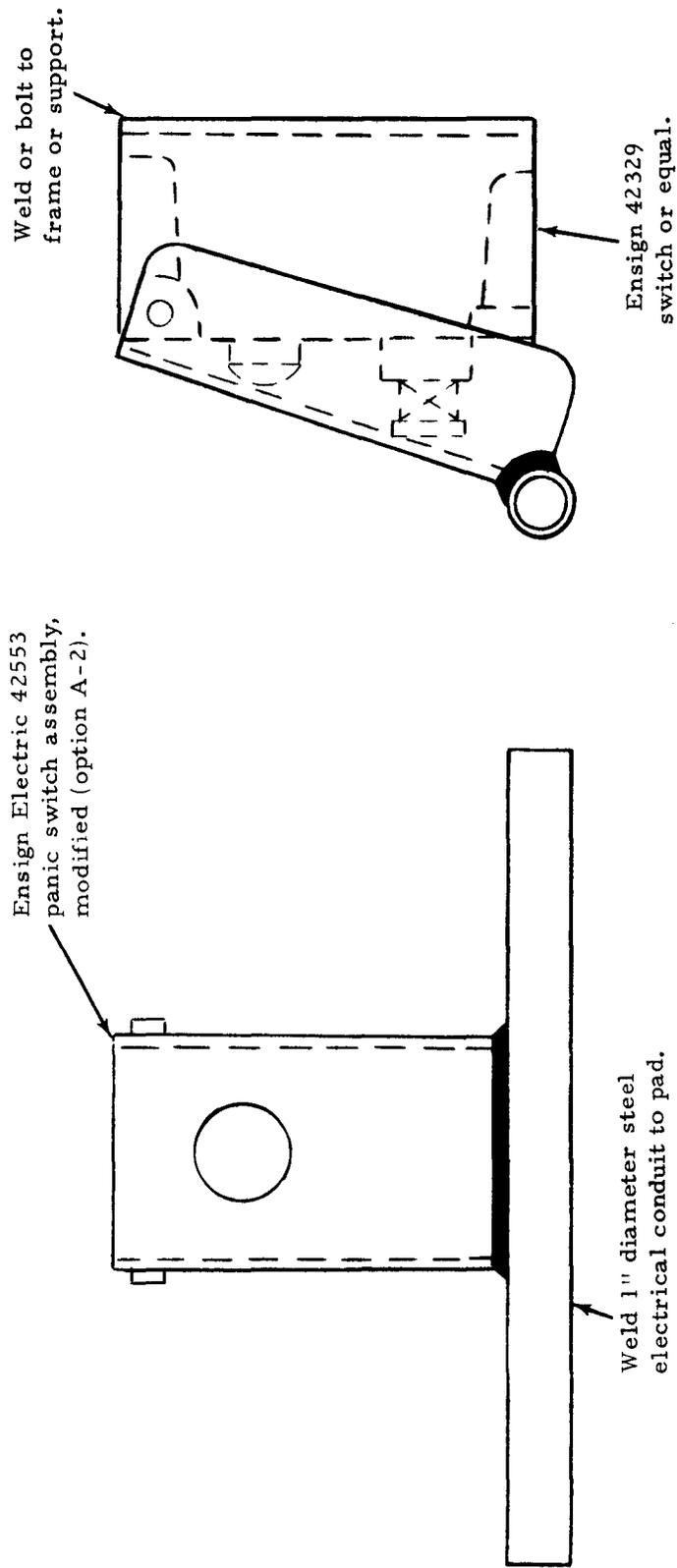
1. When the assembly drawing calls out a Type 6 panic bar with switch option A-2, order part numbers 42553 and 42329.
2. When the assembly drawing calls out a Type 6 panic bar without switch option A-2, order part number 42553.



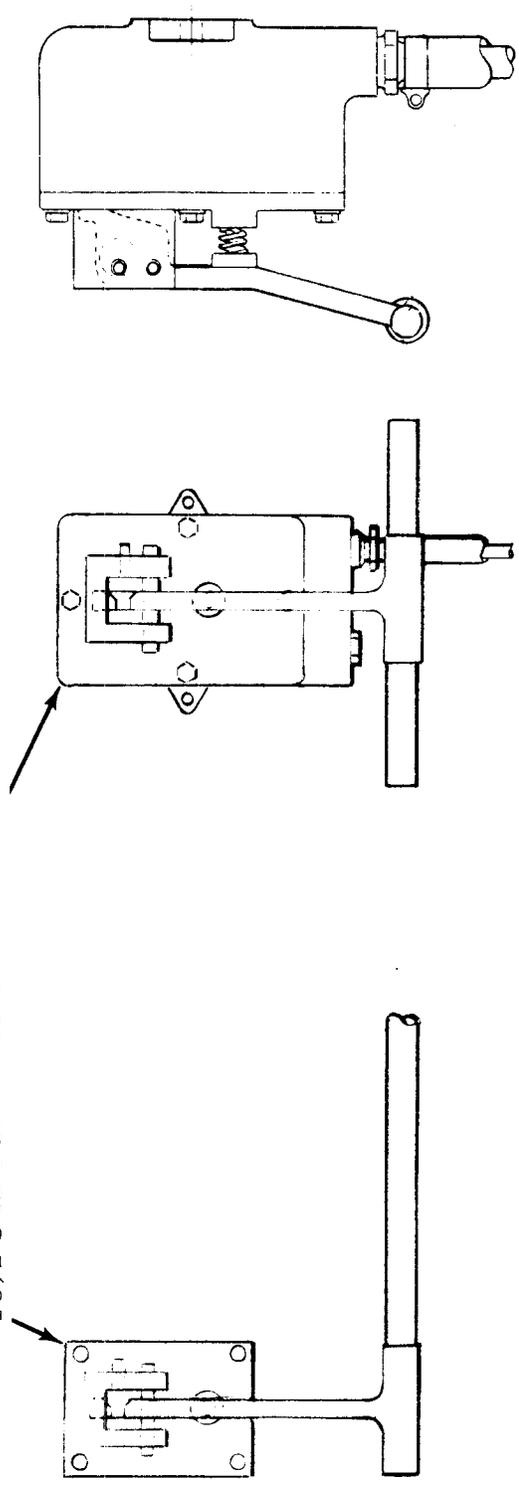
Type 6 Panic Bar

Notes:

1. When the assembly drawing calls out a Type 7 panic bar with switch option A-2, order part numbers 42553 and 42329.
2. When the assembly drawing calls out a Type 7 panic bar without switch option A-2, order part number 42553.

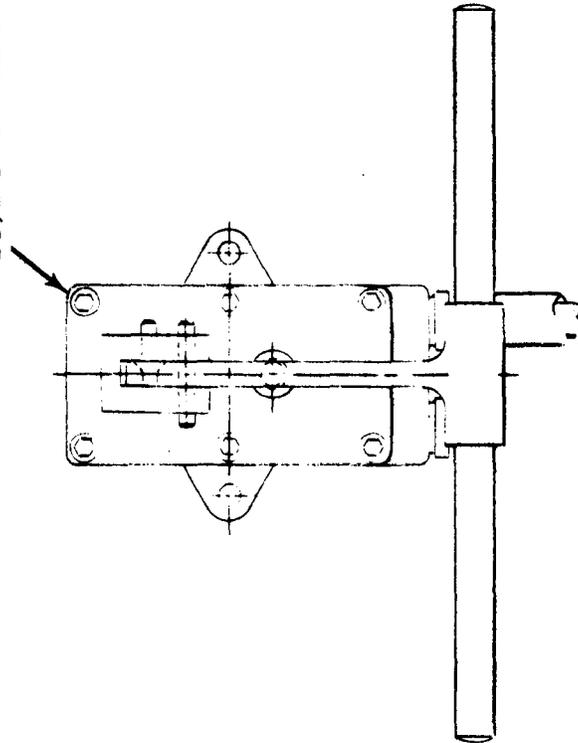
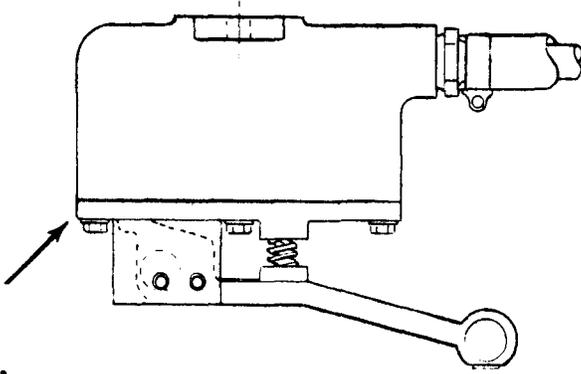


Jeffrey Mining Machinery Company
189FO42 Panic Bar Switch Kit.



Type 8 Panic Bar

Jeffrey Mining Machinery Company
189FO42 Panic Bar Switch Kit.



Type 9 Panic Bar

