

CATALOG and MANUAL
C-81

The
LOGAN-LILLY
HOIST CONTROLLER
Gravity-Electric

HEREIN REFERRED TO AND POPULARLY KNOWN AS LILLY CONTROLLER

— MODEL C —

AND

AUXILIARY EQUIPMENT

FOR

MINE HOISTS — ELECTRIC,
STEAM, and AIR OPERATED

Engineered and Manufactured by

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FOREWORD

The purpose of this manual is to explain and emphasize the importance of automatic safety equipment for mine hoists, — to describe the Model C Logan-Lilly Controller (herein referred to and popularly known as the LILLY Controller) and auxiliary equipment—and to give instructions for installing and adjusting.

Our standard equipment* is illustrated and described, and at each illustration there is a reference to the paragraphs describing that equipment, all paragraphs being numbered.

There are three sections. The first describes Model C Logan-Lilly Hoist Controllers and auxiliary equipment.

The second contains illustrations of typical installations on mine hoists.

The third section contains instructions for the installation, adjustment, and maintenance of Model C Logan-Lilly Controllers and auxiliary equipment.

Typical electrical diagrams are shown, including schematic diagrams, which should simplify working out the circuits and connections for any installation.

We are always glad to assist those desiring further detailed information concerning the selection, installation, adjustment or maintenance of the equipment that we manufacture.

See "Instructions for ordering" on page 28.

*It is also sometimes necessary to furnish special equipment for unusual conditions, many of which are not herein illustrated.

To Insure Safety In Hoist Operation

- (A) The brakes must be capable of meeting the maximum demands and be responsive to the control of the hoistman.
- (B) Suitable automatic safety equipment must be selected and carefully installed.
- (C) Correct adjustment of the brakes, the control mechanism, and the automatic safety equipment must be maintained.
- (D) Careful inspection of these features must be made regularly by a responsible person who thoroughly understands the equipment, and a written report should be made and retained as a matter of record.

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THE IMPORTANCE OF AUTOMATIC SAFETY EQUIPMENT ON MINE HOISTS

1. Mine hoists are liable to have accidents of various kinds, some of which are beyond the control of the hoistman. These accidents, which are not uncommon among hoists without adequate safety protection, have frequently been accompanied by injuries or fatalities. All hoists should therefore be protected by dependable automatic safety equipment.
2. Hoist accidents may be caused by —
 - a — Starting the hoist in the wrong direction when at or near the limit of travel.
 - b — Running the hoist too fast without warning for the proper speed limit.
 - c — Failure to commence retarding at a sufficient distance from the end of travel to permit the cage or skip to be stopped within the normal limits.
 - d — Failure to continue retardation at the proper rate.
 - e — Failure to stop the hoist when the normal limit of travel has been reached.
 - f — Mistaking the marks on the indicator or drum.
 - g — Lowering with the brake, and allowing the drum to run away.
 - h — Releasing the brake from a free drum while the clutch is disengaged, or disengaging the clutch while the brake is released.
 - i — Forgetting that both cages or skips of a double-drum hoist with one or both drums clutch driven, may be at the top or bottom at the same time, engaging the clutch and starting in either direction.
 - j — Cutting off power at an intermediate position and omitting to set the brake.
 - k — Electric power failure, or steam being shut off from the line while the hoist is in motion, without the brake being set to hold the load.
 - l — Clutch breaking, allowing a drum to run away.
 - m — Breaking the drive pinion or gear, or a key coming out.
 - n — Breaking or shearing bolts in the drive gear.
 - o — Breaking the drive coupling between the motor and the hoist.
 - p — Breaking the connection between the hoistman's lever and the brake mechanism or the brake engine.
 - q — Hand lever slipping out of its notch, and releasing the brake.
 - r — Indicator drive failing, due to the loss of a key — friction drive being improperly tightened — chain worn out of pitch and climbing on sprockets — chain coming off — or gears working out of mesh.
 - s — Hoist being operated by an inexperienced or unauthorized person.
 - t — Running too fast with men, and having no overspeed warning to inform the hoistman of over-speeding.
 - u — Hoisting men above the man-landing, and possibly dumping them in a bin or chute.
 - v — Lowering men into the sump.
 - w — Absent mindedness on the part of the hoistman for a moment — falling asleep — fainting — being struck by lightning — being incapacitated or killed by a rope breaking, a pipe bursting, or a gasket blowing out, or dropping dead from natural causes.
3. Accidents resulting from some of these potential causes are comparatively rare, while others have been common, and all possible contingencies should be considered when selecting, installing and adjusting the safety equipment.

SUMMARY OF PROTECTION AFFORDED BY A LILLY HOIST CONTROLLER

4. *It is assumed that the control apparatus, the brake mechanism, and the Lilly Controller are properly installed, adjusted, and maintained.*

It will:

5. — prevent overspeeding in hoisting and lowering.
6. — sound an alarm when the normal speed is exceeded, and will stop the hoist if the hoistman fails to respond to the alarm.
7. — warn the hoistman when to commence retarding the hoist for the top or bottom of the shaft, and will stop the hoist if the warning is not heeded.
8. — warn the hoistman if the retardation of the hoist is not properly conducted within the pre-determined limits of safety, and will stop the hoist if he fails to respond.
9. — prevent the cages or skips from being hoisted or lowered beyond the limits for which the Lilly Controller is adjusted.
10. — cut off the power and apply the brake if the hoist is started in the wrong direction from the top or bottom, and when used with a back-out switch on an electric hoist, it prevents the power from being applied in the wrong direction after a limit switch is opened.
11. — immediately apply the brake (of an electric hoist) in case of power failure.
12. — regulate the speed of applying the brake in case of an emergency stop due to overspeed, failure to stop at the limits, current failure, or the hoistman pushing the stop-button, thus eliminating the dangers due to sudden and violent emergency application at full speed, and also causing the quickest possible brake application at the ends of cage travel where the hoist speed must be low.
13. If a free drum is accidentally unclutched with the brake released, or if the brake is accidentally released with the drum unclutched, or if the clutch should break, allowing the drum to run away, —as soon as the speed increases above normal the alarm bell will ring, and the Lilly Controller will apply the brake to stop the drum if the speed increases further.
14. A stop-button or safety switch should be placed within reach of the hoistman to enable him to stop the hoist thru the Lilly Controller equipment in case that any of his controls fail to respond, or in case of conditions that might endanger his life were he to remain at his post to bring the hoist to rest in the usual way.

MAN-SAFETY EQUIPMENT

15. Hoists handling men to and from the surface, and hoisting the mine production to a higher point, such as the head-frame or tibble, should have the automatic safety equipment arranged to function at will for men or material, especially when it would be possible without special protection to dump the men in the bin or chute.
16. Man-safety equipment is available as an extra feature to guard against overrunning the man-landings at the top and bottom, and to prevent hoisting or lowering men at higher speeds than those consistent with safety.
17. The Man-Safety is usually engaged and disengaged by a hand lever placed within reach of the hoistman, or by air-electric or hydraulic-electric operators. Switches within the Man-Safety unit provide means of indicating the position by a series of lights in the engine room and at the man loading points.
18. When engaged, the Model C cam dials are shifted to adjustable advanced positions for earlier actuation of the warning, overspeed, retardation, and limit functions.
19. The Man-safety will prevent the man-speed from being exceeded,—will compel a gradual approach to the top and bottom man-landings, —and will prevent hoisting or lowering men beyond those landings.

THE LILLY HOIST CONTROLLER — PRINCIPLE OF OPERATION

(See Fig. 58)

20. The fundamental principle of operation of the Lilly Controllers is based upon the co-ordinated movements of a governor and cams, the governor following the hoist speed, and the cams following the relative position of the mine cage, providing a pattern for the correct speeds at all points of travel including retardation.
21. When the hoist speed slightly exceeds the predetermined safe maximum, or if it is not decreased in conformity with the profile of the retarding cam when approaching the end of travel, an electrical contact closes a circuit to ring a bell or buzzer to warn the hoistman. If he fails to respond promptly, and permits a slight further increase in speed, or if a retarding cam engages the cam roller without the hoist being retarded, the overspeed switch in the Lilly Controller will open the safety circuit, thereby cutting off the power and setting the brake.
22. There are also two cam-operated selective limit switches independent of governor action, one for each end of travel. Each limit switch will be opened by the corresponding cam if the hoist is not stopped within the normal limit of travel, or if it is started in the wrong direction from the end of travel.

NO INTERFERENCE WITH NORMAL OPERATING OF THE HOIST

23. Lilly controllers do not interfere with the normal operating of a hoist within the predetermined bounds of speed and travel, and the hoist may be stopped at any place and started with full torque in either direction except at the limits of travel, where it may be operated only in the return direction.

SWITCH CONTACTS

24. The Overspeed Switch and the Two Limit Switches are ruggedly constructed and are, as standard, fitted with silver faced contacts for A.C., battery, or direct current.
25. The switches and contacts are insulated for the usual voltages of 110 to 550 volts for A.C. and 110 to 250 volts D.C.

GEAR COMBINATIONS

(See pages 13 and 25)

26. Thirteen standard gear combinations adapt the Model C Lilly Controllers to conditions where speed and depths vary, and each controller is furnished with the proper gears to suit the hoisting speed and travel. The gear combination can be changed in the field if necessary, to suit changes in the hoisting conditions, or off-standard combinations can be furnished where required.

BRAKE REGULATING

27. The Lilly Controller can regulate the speed of setting the brakes when they are automatically applied in an emergency. This is necessary to prevent them from applying too severely while the rope speed is high, and to apply them as quickly as possible at the ends of cage travel. The speed of application within the retarding zone is graduated by cam action.
28. It should be understood that in either slow or fast emergency application of the hoist brake by the Lilly Controller it is applied fully, and not partially, because regulating the brake simply varies the time consumed in tightening it, and not the amount of tightening.

BRAKE CONTROL FOR UNBALANCED SLOPE HOISTS

29. For flat or irregular slopes where an upcoming load will run a long distance by its momentum after the power is shut off, the brake should not be applied in the same manner as for vertical shaft, except when the drum is revolving in the lowering direction.
30. A "Brake Control" can be furnished that prevents the brake from applying automatically except while the drum is revolving in the lowering direction, or very near the top for an upcoming load.
31. This prevents danger due to suddenly stopping the drum and allowing an upcoming load to overrun the rope, and then to run back and possibly break it.

The brake control is covered by a separate bulletin, "Slope Brake Control."

OVERSPEED WARNING

32. A warning bell, buzzer, or light warns the hoistman in case of overspeeding or failure to retard properly, to give him a chance to act before the Lilly Controller takes control of the hoist.
(The contacts to operate the warning are included in the Lilly Controller, but the bell, buzzer, or light should be provided by the customer, unless ordered extra.)

RETARDING WARNING

33. A single stroke gong or optional electric contacts on the Lilly Controller warns the hoistman when the retarding zone is approached, and should be set to operate just before entering that zone.

SOURCE OF ELECTRIC CURRENT FOR THE OVERSPEED ALARM BELL

34. Low voltage current (6 to 12 volts) for the overspeed alarm bell is usually supplied by a bell-ringing transformer for A.C. electric hoists, or for D.C. and steam hoists when an A.C. light or power circuit is available. Otherwise the bell may be operated from a D.C. circuit thru a resistor to give 8 to 12 volts, and for steam hoists a battery may be used.

THE ELECTRO - MAGNETIC HOLDING SYSTEM

35. An outstanding advantage of the Lilly Controller is its instantaneous performance accomplished through the electrical holding system. This electrical holding system may include a solenoid, magnetic contactor, or magnetic latch. When the safety circuit is interrupted by the Lilly Controller, an emergency push-button, track limit switches, or current failure, the holding system immediately releases the means to stop the hoist.
36. The electrical system also facilitates the use of track limit switches at the shaft, which produce immediate action in the engine room even if quite distant. This action is not affected by weather conditions or lost motion, such as would render mechanical means inoperative or inefficient.

AUXILIARY UNITS

37. This catalog illustrates and describes Lilly Controller auxiliary units for hoists of the usual types. These units are used by several hoist builders for new hoists, and they are particularly adaptable for equipping hoists in the field. Many large hoists have corresponding auxiliary equipment built in and arranged to be actuated and regulated by the Lilly Controller.

NUMBER OF CONTROLLERS REQUIRED

38. A single-drum hoist, or a hoist having two or more drums keyed to the drum shaft, or geared to each other and never operated independently, requires only one hoist controller, regardless of the number of ropes involved.

39. A double-drum hoist having one or both drums clutch driven, and arranged so that either or both may be operated independently, requires two hoist controllers, one geared to each drum.

INSTALLATIONS ON ELECTRIC HOISTS

40. The simplest Lilly controller installations are those on Electric Hoists, where the Lilly Controller operates on a relay circuit, usually the retaining circuit of the "Undervoltage Protective Contactor." This contactor opens the retaining circuit for the primary contactors, thereby cutting the power off the hoist motor, and de-energizing the coil of a solenoid or electromagnetic latch, to set the brake.

INSTALLATIONS ON ELECTRIC HOISTS WITH WARD-LEONARD CONTROL

41. When Lilly Controllers are installed on Ward-Leonard controlled hoists, the mechanical brakes are operated in the usual manner. When the hoist is equipped with decelerating contactors, dynamic braking may be utilized together with mechanical braking for emergency purposes by having the Lilly Controller open the control circuit, and the decelerating contactors will control the dynamic braking. When the installation is on a Ward-Leonard Hoist that is not equipped with decelerating contactors, dynamic braking can be utilized for emergency purposes by installing special electrical apparatus operating in conjunction with the Lilly Controller.
42. Dynamic braking should be utilized when possible to provide double means of stopping the hoist in an emergency.

INSTALLATIONS ON STEAM HOISTS

43. The safety equipment for steam hoists must comprise mechanical means to close the throttle in addition to operating the brakes, and several units are available for the purpose.
- For a steam hoist with gravity brakes, a Brake and Throttle Operator together with a Brake Regulator, is generally used. Further information can be supplied for steam hoist applications on request.

SLOW SPEED SWITCH

44. A Slow Speed Signal Switch (Loss of Motion), formerly optional, has been made standard for all Model C Logan-Lilly controllers with either single or Duplex governors for Serial Number 5282 and later, as well as all machines being factory rebuilt from that time. The switch operates below governor minimum speed, and is useful in signalling possible drive failure from the drum to the Controller and other auxiliaries. See Fig. 7 and 8 and 24

TRACK LIMIT SWITCHES

45. Where the clearance at the limits of travel is very little, especially if a great length of rope must be wound, or where there are several layers, it is desirable to use track limit switches in the head-frame, shaft house, or tippie, to insure an accurate stop at the limit. They do not need to be readjusted after being set at the proper place, and they compensate for rope stretch and uncertain position of the cage in relation to the position of the drum (due to varying loads). "Electric Eyes" have been used successfully at some mines for track limit switches and under suitable conditions they have a number of advantages.
- 45a. Track limit switches, without a hoist controller, will not likely stop a hoist within the available clearance if the speed is not reduced, and they cannot prevent overspeed or runaways, but by using track limit switches in conjunction with a Lilly Controller, maximum protection is assured.

46. The Lilly Controller without a track limit switch will stop a hoist drum at the limit for which it is adjusted, but no device geared to the drum can compensate for variations in the position of a cage due to varying loads, especially with a long rope where the variation in cage position sometimes amounts to several feet with relation to the position of the drum.

BRAKE ENGINES

47. When Lilly Controllers are to be installed on hoists having hand or foot operated brakes requiring a large amount of energy to apply, we recommend that "gravity brake engines" be installed, making it easier for the hoistman to operate the brakes, and eliminating delay in restarting after an emergency stop.
48. Where heavy emergency weights must be reset manually, time is lost in resetting, and the heavy lift may overtax the strength of the hoistman. Weights of 100 to 150 lbs. may usually be reset by hand without great difficulty, and a 200 lb. weight is about the limit for a man to reset. Lifting that amount directly is usually not desirable from the standpoint of the hoistman's welfare.

HOISTS HAVING A MAIN MOTOR AND AN AUXILIARY MOTOR

49. Hoists having a main motor, and a smaller auxiliary motor to operate at lower drum speed, can be equipped with a Lilly Controller arranged so that when the large motor is engaged, the hoist may be operated at full speed, but when the small motor is clutched in, the drum speed is automatically held to that suitable for the small motor.

FRICTION HOISTS

50. When safety controllers are installed on friction type hoists, the Controllers, as well as depth indicators and other travel sensitive equipment, must be periodically resynchronized with the conveyance end position to correct for rope creep and slippage on the rope driving pulley.
51. Resynchronizing switches can be installed on the Model C Logan-Lilly Controller for either or both cam dials, and consist of two limit type switches operated by additional adjustable cams on the cam dial.
52. For standard Controllers, the Controller is raised 5/8 inches to accommodate a base plate under the machine for switch support, and the drive shaft height must be increased to allow for the base plate.
53. On Long-RangeCam Dial Drive machines, the resynchronizing switch supports are from the Long-Range base structure, and the drive shaft height is not affected for that model.

THE MODEL C LOGAN-LILLY HOIST CONTROLLER

54. Model C Logan-Lilly Hoist Controllers comprise a complete, versatile, and efficient equipment line for large fast hoists, and wherever conditions demand the best possible safety control.
55. The design and construction of the Model C Controller is rugged, yet it is extremely sensitive to speed changes, and insures accuracy of control for long periods of time without attention other than oiling and adjusting for rope stretch, although it is recommended that regular inspections be effected and logged to ascertain that adjustments remain proper.

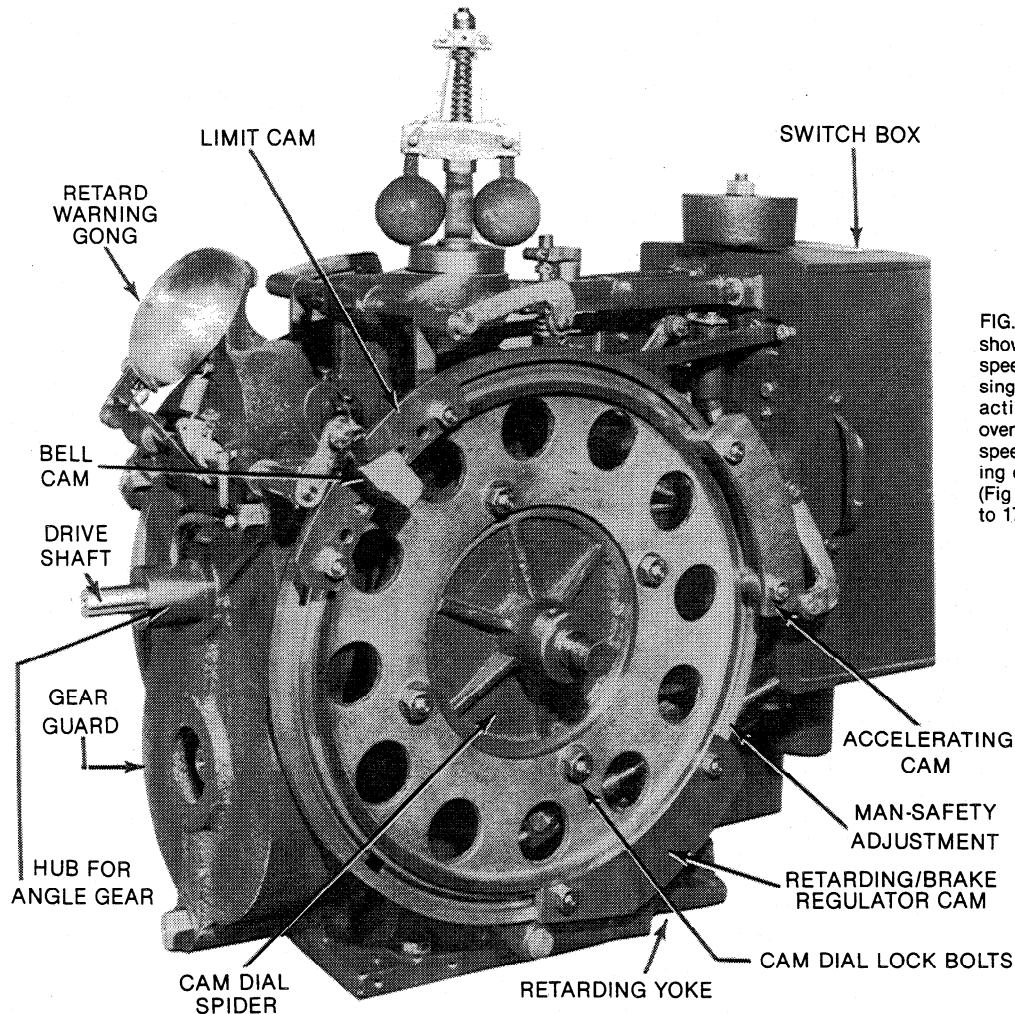


FIG. 1—Lilly Hoist Controller, Model C, shown with Man-safety Equipment. The speed range of this controller with a single governor is 6, so that the governor action is sufficient to open the overspeed switch at one sixth of full speed when the full height of the retarding cam is over the roller. See drawing, (Fig 9, and paragraphs 54 to 85 and 133 to 170).

GOVERNORS

56. The Model C Controller can be equipped with a single governor for moderate hoisting conditions, or with duplex governors for an extremely long speed range. The speed range with a single governor correctly adjusted is 6 or better, and with duplex governors, 12 or better. Therefore a single governor assures speed protection for all speeds down to within one-sixth or $16\frac{2}{3}\%$ of full speed, and with duplex governors to within one-twelfth or $8\frac{1}{3}\%$ of full speed.
57. Optional gearing for the duplex Governor can provide a 16 to 1 range, or governor action to within 6.5% of full speed.
- 57a. Governor guards are available. See Figs. 26 and 27.

THE ACCELERATING FEATURE

58. The Model C Controller has a feature known as the "Accelerating Feature," which permits a hoist to accelerate to full speed within a shorter distance than that through which it retards. This is desirable for many installations, particularly where the conditions at the dump or tipple necessitate a slow approach, or where a cage must be landed on a solid bottom, yet where acceleration in the opposite direction may be rapid. Without the accelerating feature, the profile of the retarding cams might have to be altered to permit the hoist to accelerate in a normal way, with consequent loss of a part of the protection that the cams should provide for approaching the travel limits.

REVERSING SWITCH

59. The Accelerating Feature is directionally controlled to be operative only when leaving the limit of travel. If the hoist motor control is at any time "plugged" to assist the braking function when approaching the limit, false accelerating solenoid operation might result. Under those circumstances, a reversing switch can be incorporated into the controller and be responsive only to actual direction of movement. See Fig. 25.

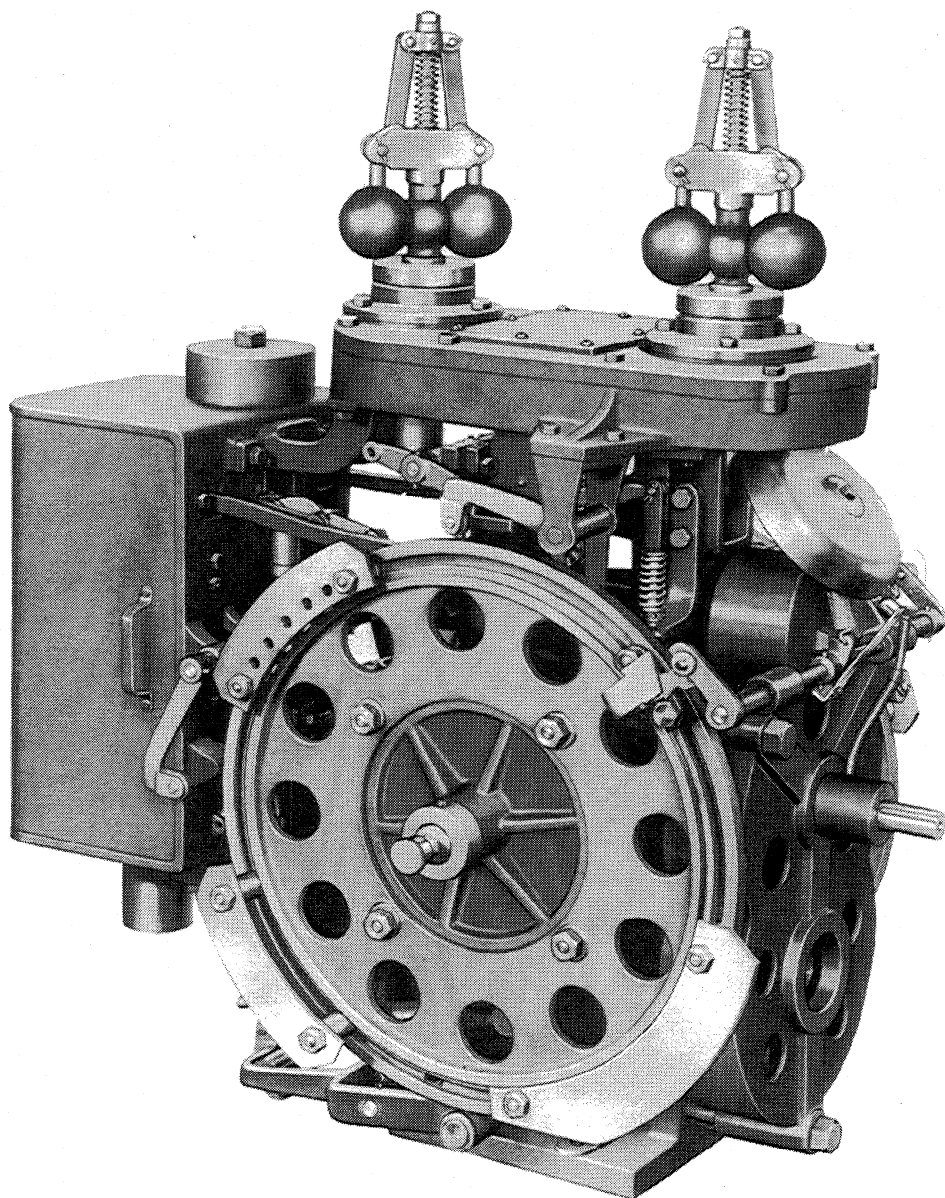


FIG. 2—Lilly Hoist Controller, Model C, with Duplex Governors. Note the adjustment including a spring and plunger with an adjusting screw in the foreground above the dial. The duplex head can be installed on any Model C Lilly Controller if it is desirable to increase the speed range from that of a single governor. The speed range of this controller with duplex governors is 12, so that the governor action is sufficient to open the overspeed switch at one twelfth of full speed when the full height of the retarding cam is over the roller. See drawings, Fig. 10 and Fig. 60 and paragraphs 56 and 171 to 179.
*16:1 governor range is also available as an option.

CAM DIALS

60. The Model C Lilly Controller has two cam dials, the cams for one direction of drum rotation being carried by one of the dials, and the cams for the opposite direction being carried by the other dial. Each cam dial mounts on a flange to which it is secured by four bolts disposed in a circular T-slot near the outer edge of the flange, permitting rotation of the dial on the flange, and clamping in any desired position.
61. After the cams have been correctly adjusted on the dial, resetting is accomplished by slackening the nuts on the four bolts, and advancing or retarding the dial, thus resetting all cams at a single operation. This feature is a great convenience and time saver.

CAM DIAL DRIVES

62. There are three types of drives for the cam dials, Regular, Long-Range, and Variable Depth, in all of which worm gearing is used. For the regular drive, used for shallow or moderate depth shafts, the cam dials travel in synchronism with the hoist drum, whenever the drum moves. With the Long-Range Dial Drive, the cam dials, while remaining in synchronism, move relatively fast in the retarding zones and remain stationary throughout most of the hoist travel, thus making possible the use of relatively long retarding cams. In deep shafts, where the profile of the retarding cam may thus be as much as six times the length of the cam if the regular drive were used, greater accuracy of the cam is obtained with better retarding protection.
63. The Variable Depth drive, either standard or Long-Range type, provides protection quickly adjustable for multi-level operations. See Fig. 38 and 39

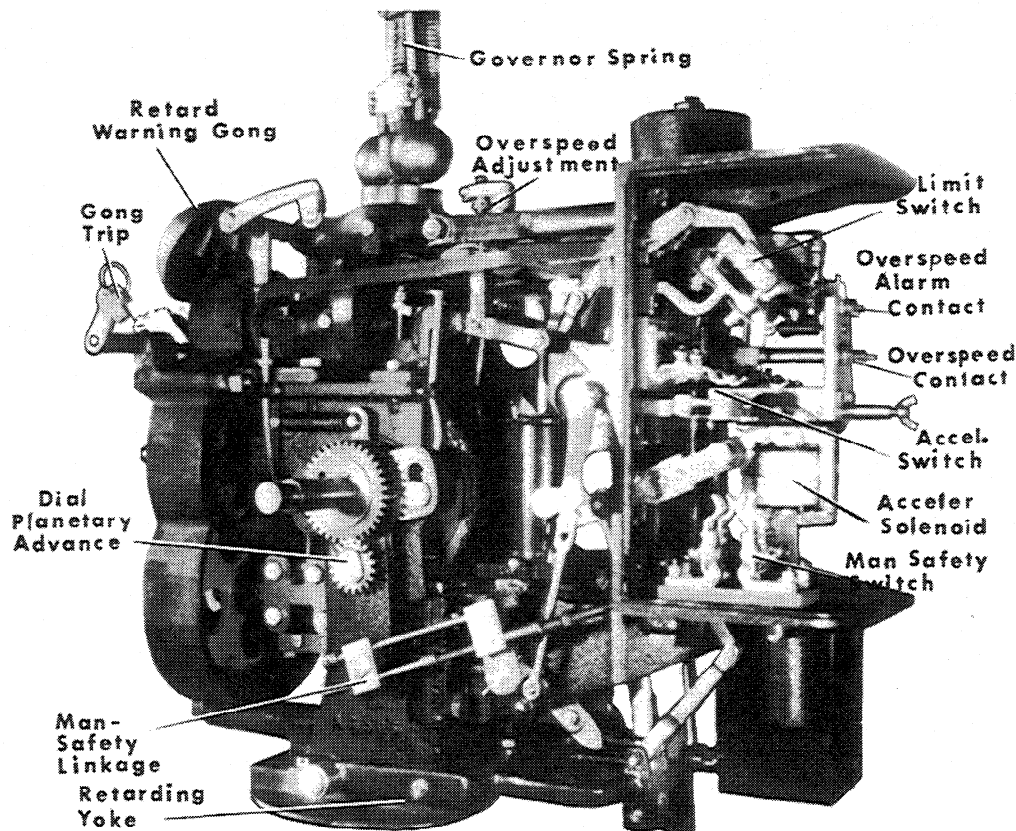


FIG. 3—Lilly Hoist Controller, Model C, with Man-safety Equipment. One cam dial together with dial flange and internal gear has been removed to show the planetary drive for standard Man-safety. The switch-box cover also has been removed to show the switches and the accelerating solenoid.

MAN-SAFETY EQUIPMENT

64. In the regular Model C Controller without Man-safety Equipment, the cam dial flanges are keyed to the dial shaft, but when the controller is equipped with Man-safety, these flanges are free on the dial shaft, and driven by planetary gears, each idler of which is mounted on a movable arm. To engage the Man-safety, the hoistman moves a small lever connected with the movable arm, which thru the planetary gears advances the dials the necessary amount to stop the cage at the man landings.

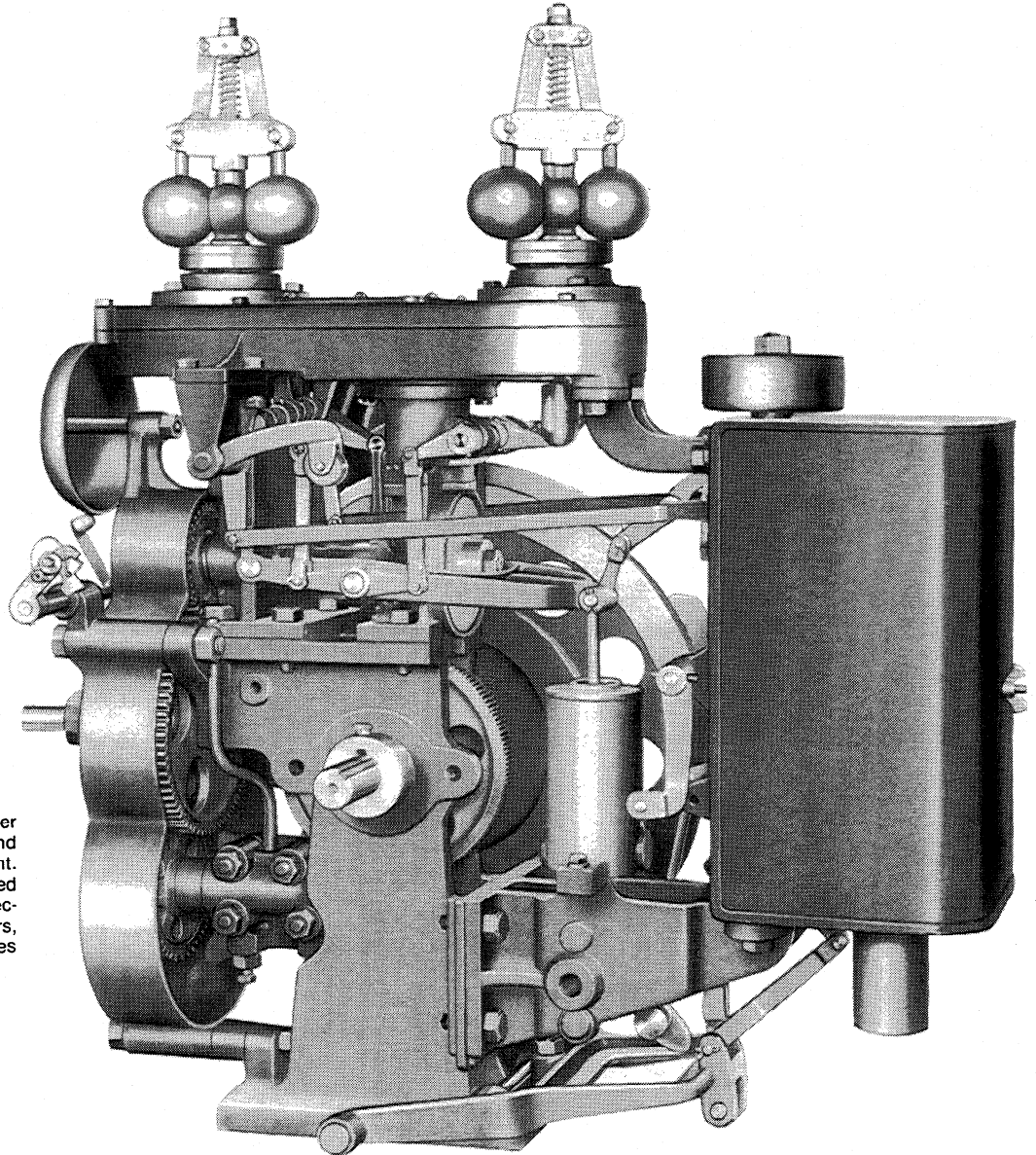


FIG. 4—Model C Lilly Controller with Duplex Governors, and without Man-safety Equipment. One cam dial has been removed to expose the equalizing connections of the Duplex Governors, which are simpler at both sides of the controller.

65. While the Man-safety Equipment limits the cage travel within its full normal distance, it can also limit the allowable man-speed by means of a simple tappet back of the switch box, which can be adjusted for the maximum speed desired. See C, Fig. 58.

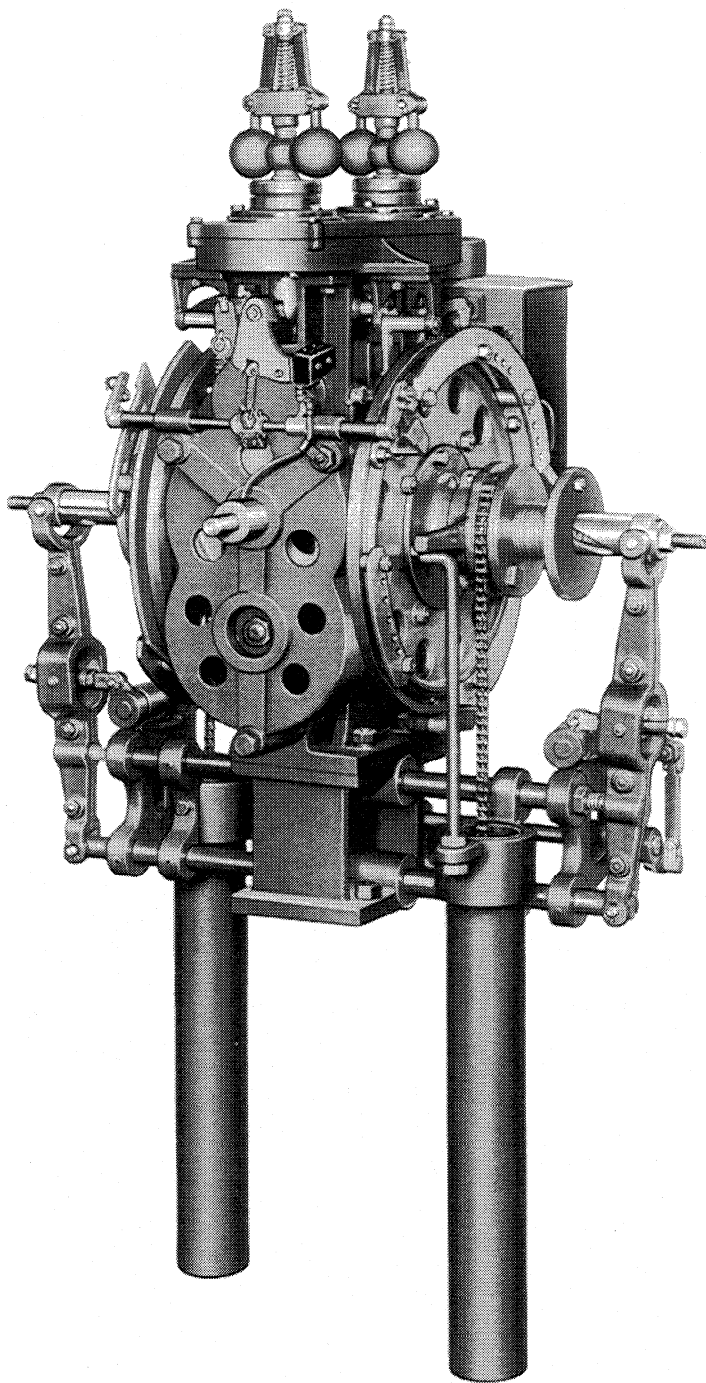


FIG. 5—Lilly Hoist Controller, Model C, with Duplex Governors, Long-range Dial Drive, and Man-safety Equipment. The Long-range Dial drive may be used with a single governor or with duplex governors, and with or without Man-safety equipment. This controller has electric contacts instead of a gong for the warning alarm. This feature can be furnished instead of the gong for remote warning, when preferred. See drawings, Figs. 11 and 14, and paragraphs 62, 66, 67 and 180-194.

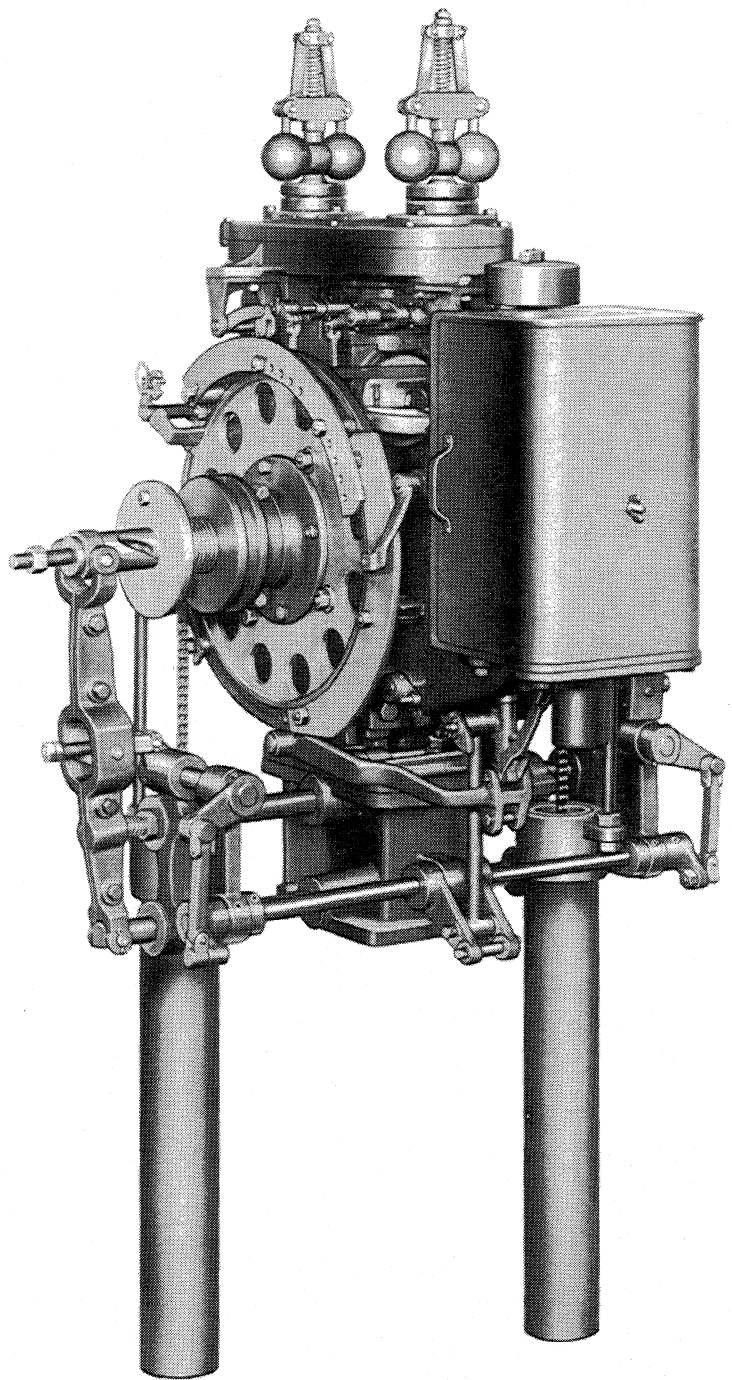
THE LONG-RANGE DIAL DRIVE

66. When the controller is equipped with a Long-range Dial Drive, the cam-dial flanges are free on the dial shaft, and each is driven for the retarding zone by a pair of hardened steel dogs, one of which is secured in the hub attached to the cam dial flange, and the other in the flange of a threaded and flanged sleeve screwed into the hub and driven by the dial shaft, which has a long key at each end. As the retarding zone is reached, the revolving driving dog of the flanged sleeve engages the corresponding lug of the dial flange, rotating the dial and cams until the end of the trip is reached. As the hoist drum revolves in the opposite direction for the return trip, each cam dial in turn is rotated away from the end of travel, by a weight and roller chain, the weight keeping the cam dial pulled against the driving dogs until stopped by a finger on the dial flange hub coming in contact with a fixed post attached to the controller frame. The cam dial then remains stationary, while the threaded flanged sleeve unscrews the amount necessary to complete the trip, the first turn of the sleeve carrying it outward a sufficient distance to permit the driving dog to pass its mate without interfering. In the meantime the threaded sleeve at the opposite side of the controller screws inward until the driving dogs engage, when the cam dial on that side is driven in the proper direction to the end of the trip. On the return trip the whole process is repeated in the opposite direction by the dials and cams. Regardless of the hoisting distance, the profile of the retarding cams with this type of drive can be relatively long.

MAN-SAFETY EQUIPMENT USED WITH LONG-RANGE DIAL DRIVE

67. When Man-safety Equipment is used with the Long-range Dial Drive, the general form of drive is the same, but instead of driving the fleeting nuts directly from the dial shaft, there is a hardened sleeve interposed between the shaft and the

fleeting nut. In the outside of this sleeve there is a long key or feather, and the fleeting nut is made larger in diameter to accommodate the sleeve. Instead of keys in the dial shaft, there is a hardened driving pin fastened through the shaft near each end, and in each of the hardened sleeves there are two opposite spiral slots engaging the pin. By moving the sleeve axially on the dial shaft, it is rotated in proportion to the amount of axial movement, thereby advancing the cam dial the desired amount. The reason for using this method of cam advance with the Long-range Dial Drive is because the planetary drive would not provide a sufficient amount of angular advance for this type of drive, which involves a relatively large angular movement of the dial and cams as compared with the rope travel within the retarding zone.



HAND LEVERS FOR MAN-SAFETY EQUIPMENT

68. Two types of hand levers are used to operate the Man-safety, as shown in Figs. 12 and 13. The former is used for the regular Man-safety, and the latter for long-range Man-safety, which requires a greater effort to engage, and therefore the long-range levers are made more rugged.

FIG. 6—Lilly Hoist Controller, Model C, with Duplex Governors, Long-range Dial Drive, and Man-safety Equipment. The man-safety can be operated with a single connection in the center as shown, to protect a single cage, or with an individual connection to each arm where two cages are handled by one drum.

MAN-SAFETY OPERATORS

69. Man-Safety operating mechanisms, other than hand levers, can be air-electric or hydraulic-electric as shown in Figs. 36 and 37, whereby the Man-Safety features can be engaged by remote electrical push button or switch. Double solenoid valves are generally used for positive engagement or disengagement.

VARIABLE DEPTH EQUIPMENT

70. The Variable Depth Equipment, when added to the Controller, permits selecting, at will, any one of up to eight levels above the maximum depth and operating to those levels with complete overspeed, retardation, limit and accelerating protection.
71. This feature is of value when spill doors, knees, or other encroachments are introduced into the shaft space below the selected operating level, and full protection is desired to prevent lowering into the obstruction. Signal interlocking switches are incorporated into the Variable Depth Selector to provide means of locking out operation unless the equipment is properly set above the location of any obstruction introduced into the shaft space.
72. A Long-Range version of the equipment is also available. Request "Variable Depth Bulletin" where applicable.

GEAR COMBINATIONS

73. There are thirteen standard gear combinations to adapt the controllers to different hoisting speeds and depths, so that while maintaining the maximum normal governor speed for the maximum normal hoist speed, the greatest available portion of the cam dial will be used for a full trip. (See instructions and table, Pages 25 and 26.)

ELECTRICAL FEATURES

74. The electric switches and other electrical features are enclosed in the switch box at the end opposite from the drive, and an opening in the bottom of the switch box accommodates a conduit connection for the wires.
75. A terminal board can be furnished as an option where it will be of value in making connections and where it will not interfere with accessibility in machine adjustments and maintenance. See Fig. 29.

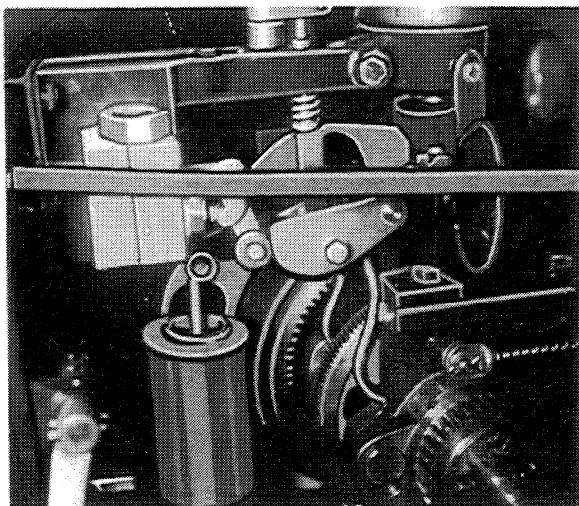


FIG. 7—Slow Speed Signal Switch
Single Governor
See paragraph 44.

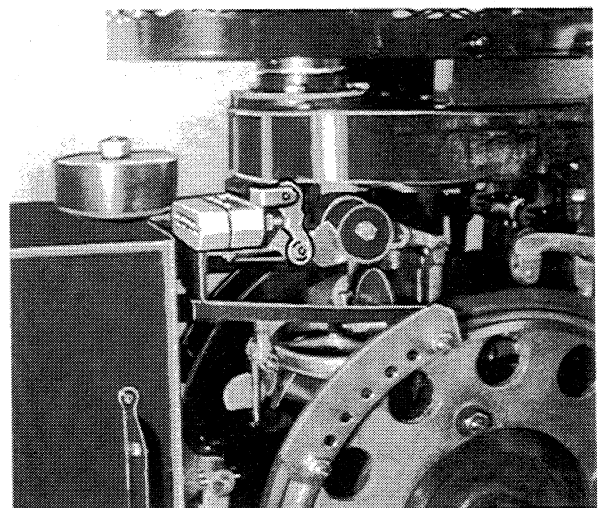


FIG. 8—Slow Speed Signal Switch
Duplex Governor
See paragraph 44.

THE OVERSPEED SWITCH, AND THE OVERSPEED WARNING CONTACTS

76. The overspeed switch, which is of the double-break single-pole type, and normally closed, is located in the center of the switch box, near the top. It is actuated by the combined action of the governor and the retarding cams, so that it will open if the maximum normal speed is exceeded, and within the retarding zones it will open if the speed at any given distance from the end of travel is higher than the safe predetermined speed for that point as represented by the profile of the retarding cam.

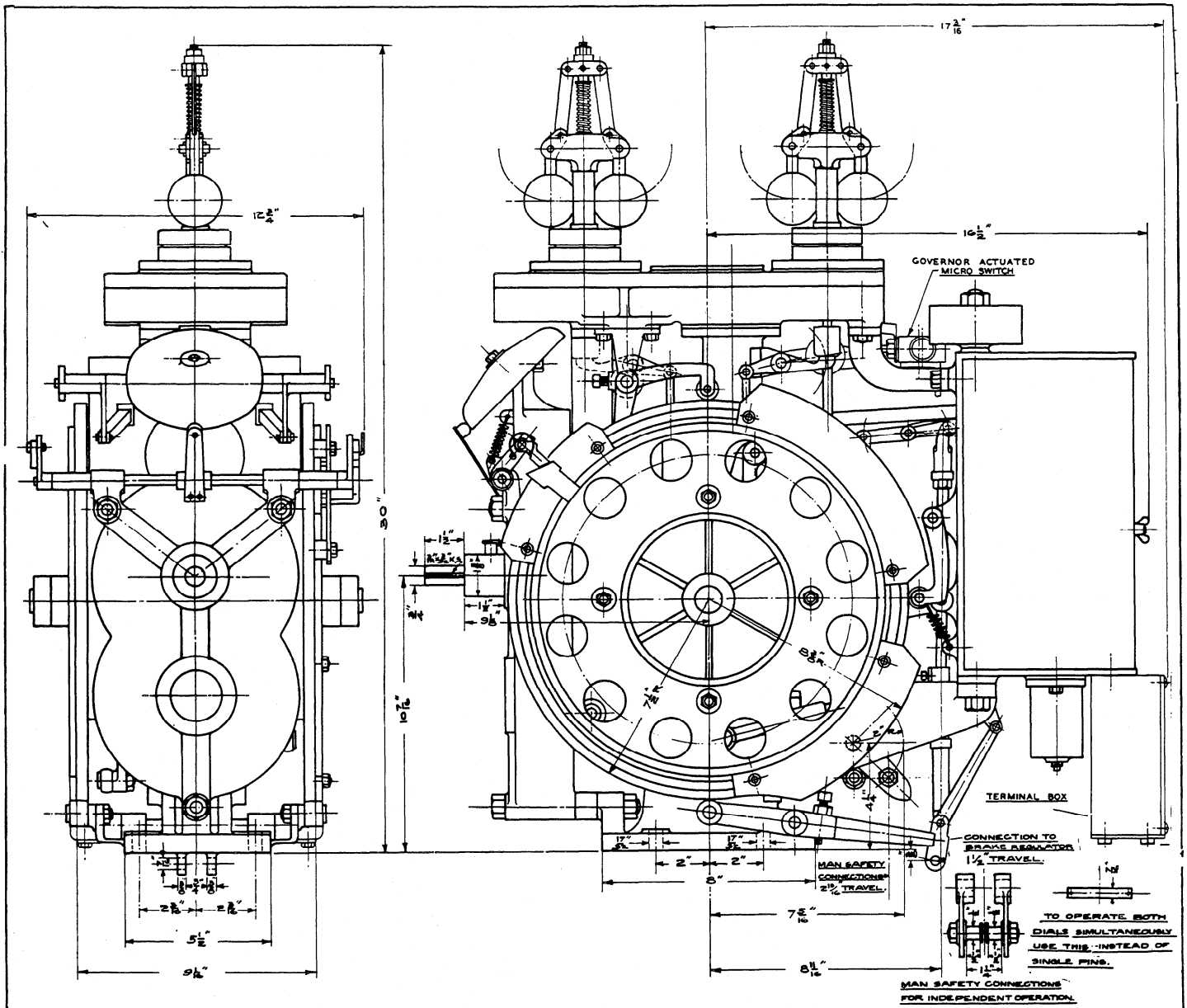


FIG. 10—Drawing of a Model C Lilly Hoist Controller, with Duplex Governors and Man-safety Equipment. See Figs. 2 and 4. Scale of drawing 1" = 6".

77. The overspeed switch includes overspeed warning contacts, so that before the overspeed switch will open, the warning contacts must engage, and additional speed is necessary to open the switch for overspeed, thus warning the hoistman before stopping the hoist.
78. The two lower terminals of the overspeed switch panel are for the safety circuit, and the upper terminal is for the low-voltage warning circuit. See diagrams, Figs. 65 to 67.
79. In some cases double sets of overspeed contacts can be supplied to open in adjustable sequence for two values of overspeed. See Fig. 31.

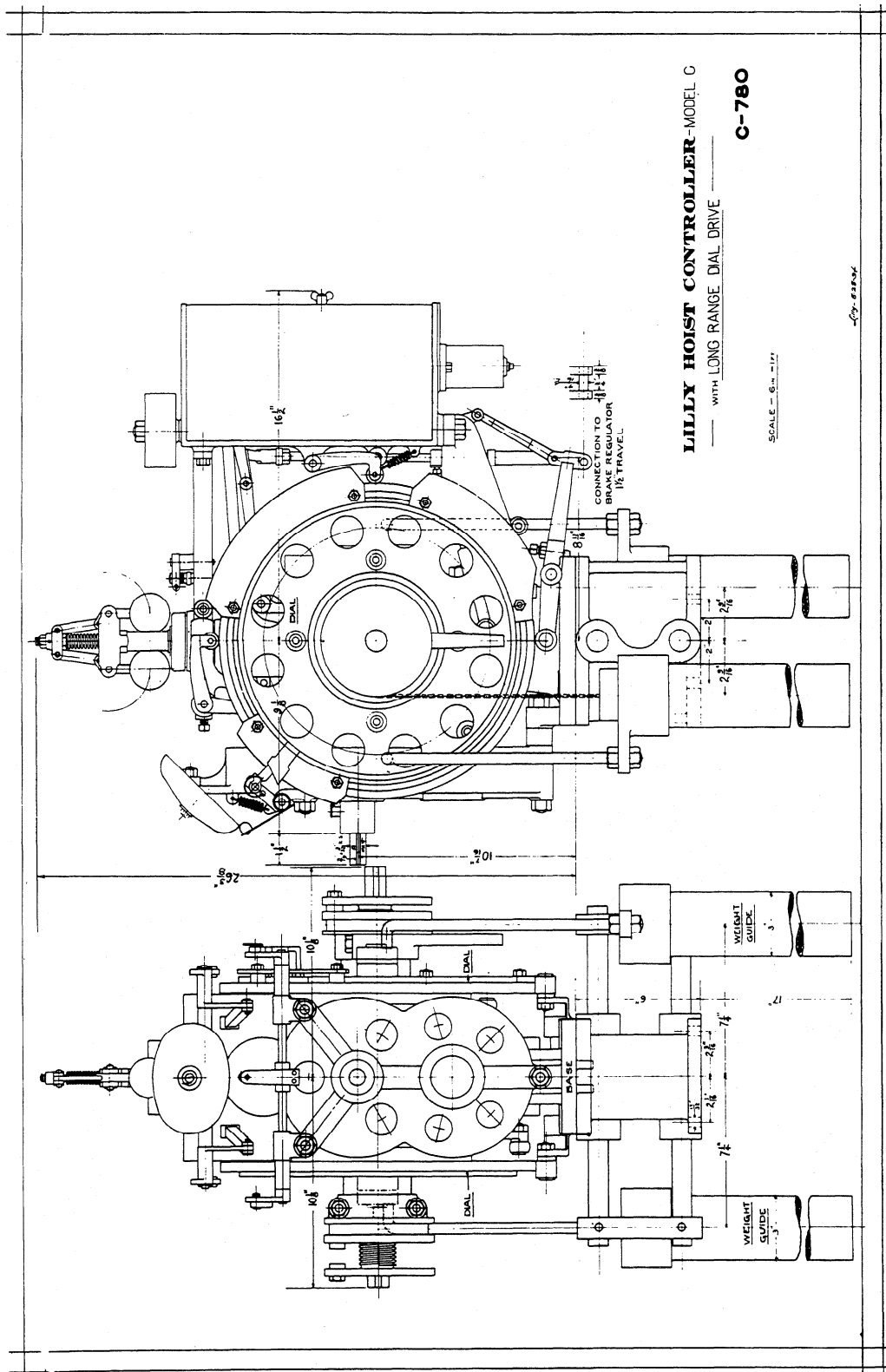


FIG. 11—Drawing of a Model C Lilly Hoist Controller with a Single Governor and Long-range Dial Drive, without Man-safety Equipment. See Figs. 5 and 6 for pictures showing Long-range Dial Drive with Man-Safety and Duplex Governors. Scale of drawing 1" = 8".

THE LIMIT SWITCHES

80. There are two limit switches of the double-break single-pole type, normally closed, which are located in the switch box near the top, one at each side. Each of these switches is actuated by a limit cam only, and speed has no influence on them. See diagram, Fig. 58.
81. Additional limit switches can be mounted per Fig. 33 and 34 for signalling or for interlocking and can be used for resynchronizing purposes when on friction drive hoists.

THE ACCELERATING SOLENOID

82. This solenoid is located in the center of the switch box below the overspeed switch. Its function is to raise the fulcrum point of the actuating arm of the overspeed switch while the hoist is accelerating from either limit of travel, to prevent the hoist from being stopped by the retarding cams in case the speed at any point while accelerating might be higher than at the same point while retarding. This solenoid is actuated by the accelerating switches in conjunction with other elements that determine the direction of drum rotation, such as directional contacts in the master electrical control, or from a directional reversing switch on the Logan-Lilly controller. See diagram, Fig. 68 for electric hoists.
83. The accelerating solenoid is controlled by an air dash-pot attached under the bottom of the switch box. When the solenoid is energized or de-energized, the piston in the air dash-pot compels the armature to move smoothly and without a hammer blow, while the air above and below the piston enters and leaves the cylinder thru very small holes in the cylinder wall.

THE ACCELERATING SWITCHES

84. There are two accelerating switches, one below each of the limit switches. They are of the double-break single-pole type, and normally open. These switches are actuated by the accelerating cams, one switch being closed for each retarding zone. See diagram, Fig. 68 and 69.

THE MAN-SAFETY INDICATING LIGHT SWITCHES

85. These switches are of the double-pole, sliding contact type, and located in the bottom of the switch box. Where the Man-safety protects a single cage, only one light switch is required, and it may be at either side. Where there are two cages to be protected by a controller, it will be necessary to have two light switches, one at each side. See diagrams, Fig. 70 and 71

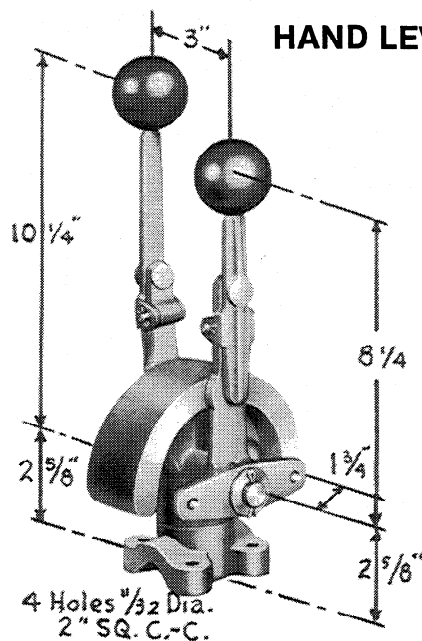


FIG. 12—Man-safety Levers with base and quadrant for the regular Model C Controllers. These units can be furnished with either one or two levers on a base. The quadrant can be swiveled to any angle on the base and tightened there. It can also be doweled in place. See Fig. 59 for connections, and paragraphs 15 to 19 and 163 to 169.

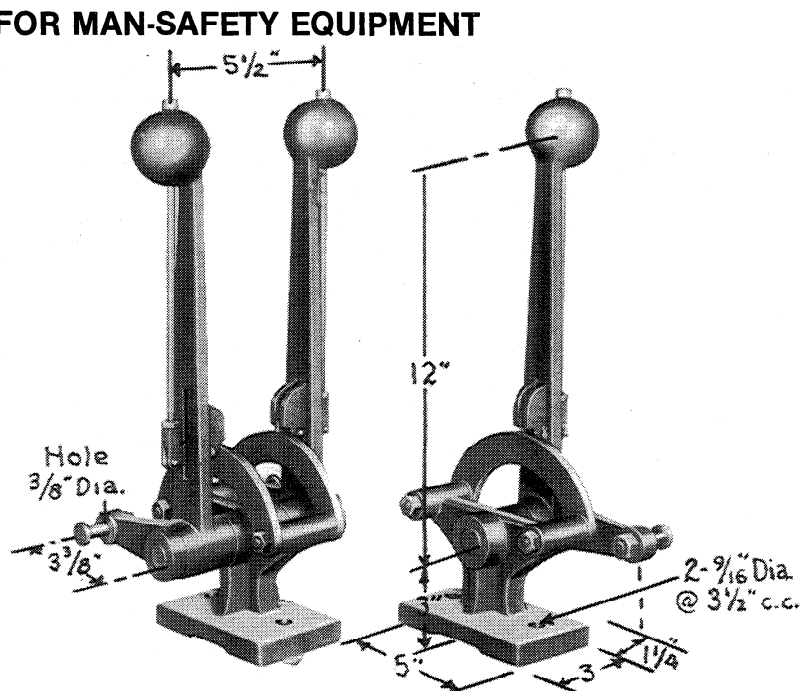


FIG. 13—Heavy duty Hand Levers with Base and Quadrant for Model C Lilly Hoist Controllers with Long-range Dial Drive. These units can be furnished with either one or two levers on a base. Fig. 59 for connections, and paragraphs 15 to 19 and 163 to 169.

SOLENOID VALVE EQUIPMENT FOR ELECTRIC HOISTS WITH OIL OPERATED GRAVITY BRAKES

86. The solenoid valve unit comprises a pedestal for carrying a Model C Lilly controller and a balanced valve and solenoid to control the oil supply to the brake engine, together with mechanism to control the speed of applying the brakes when the solenoid is de-energized.

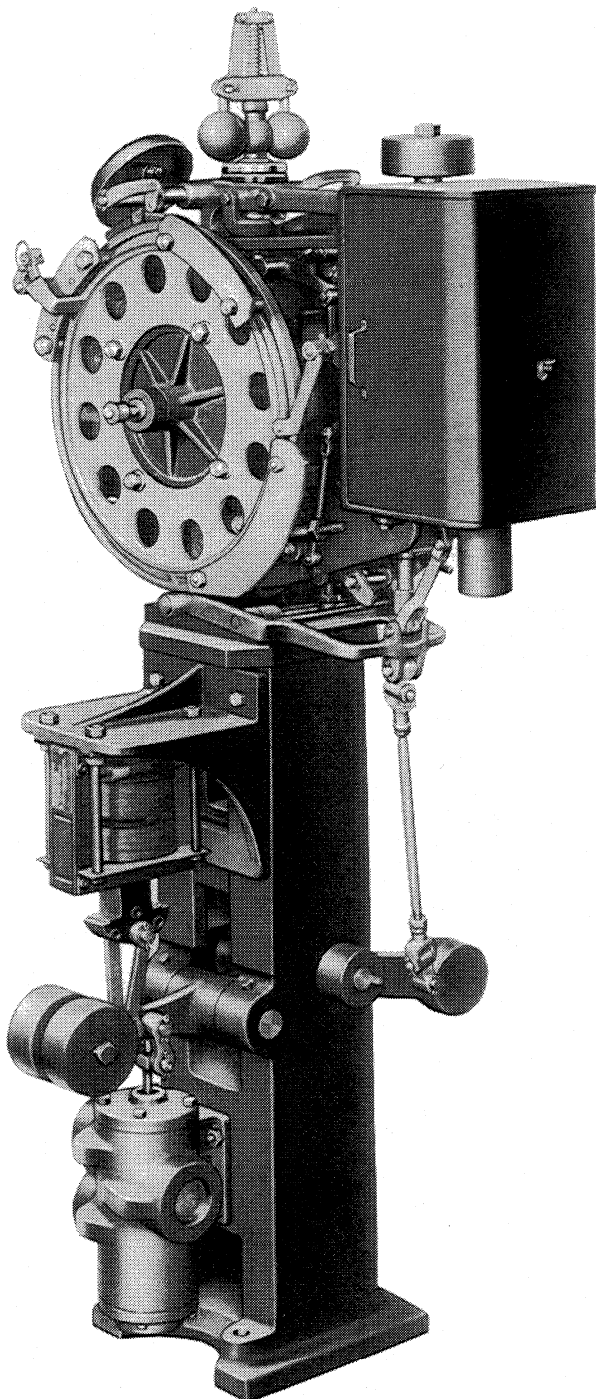


FIG. 15—Solenoid Valve Unit for electric hoist with oil operated gravity brakes. The valve is a balanced piston valve, made in three sizes for 1", 1½" or 2" standard pipe. The 1" standard pipe, the 1" and 1½" valves can be bushed for ¾" and 1¼" pipe respectively. There is no option as to right or left hand valves, as the 1" and the 1½" valves are made with the outlets as shown in this view, and the 2" size as shown with flange connections Fig. 16. See Fig. 62 for connections, and paragraphs 86, 87, and 215 to 217.

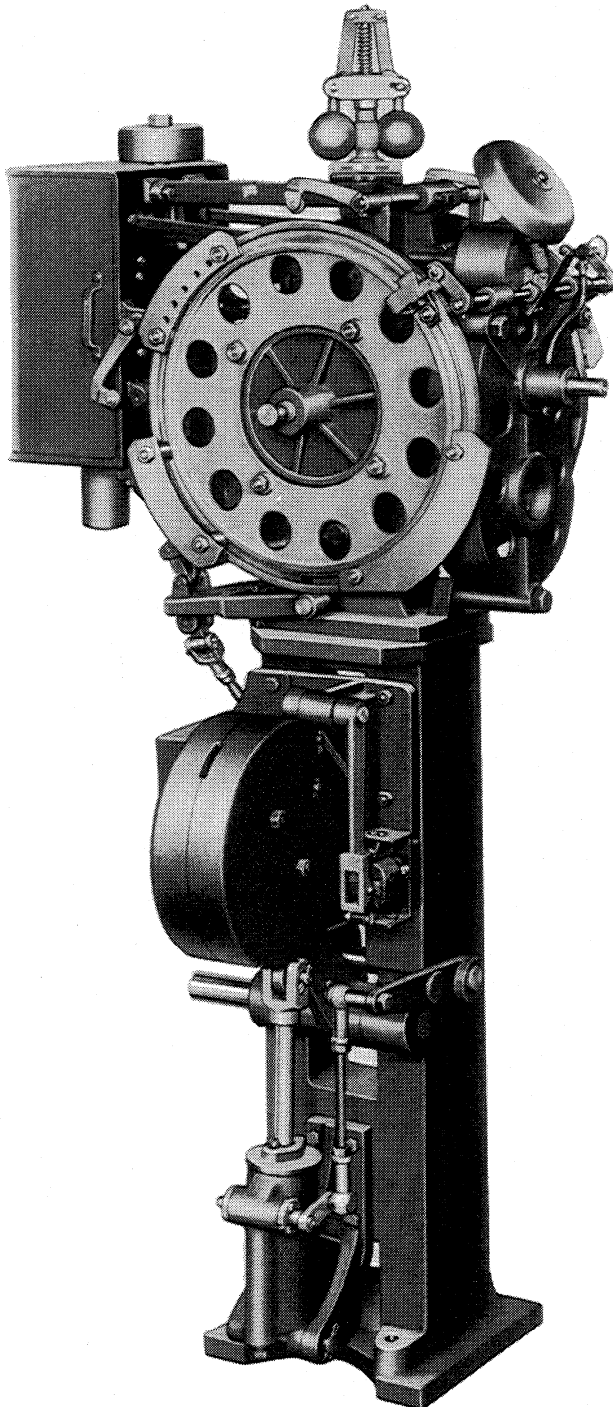
87. While the hoist operates normally, the solenoid holds the valve plunger up, permitting oil to flow from the accumulator to the brake engine valve. In case of an emergency, the solenoid core and the valve plunger drops, cutting off the oil supply* and opening a release from the brake engine cylinder to the oil sump to set the brake. The brake regulator which is actuated by the Lilly Controller regulates the amount the valve opens, and consequently the speed at which the brake will apply. The hoistman may hasten the setting of the brake if necessary, but he cannot prevent it from setting.

* The oil supply should be cut off to prevent draining the accumulator and also to prevent interference with setting the brakes.

WEIGHT EQUIPMENT FOR ELECTRIC HOISTS WITH AIR OPERATED GRAVITY BRAKES

(See Figs. 17 to 20)

88. Air operated gravity brake engines usually have an oil cataract cylinder in tandem with the air cylinder, and in order to set the brake it is necessary to permit the transfer of oil from one side of the piston to the other by means of a valve operated in synchronism with the brake engine air valve.
89. A considerable amount of energy is usually required to operate these valves, and if solenoid-operated for emergency, a relatively large solenoid is required.



90. The weight unit C-547, illustrated in Figs. 17 and 18, designed to operate these valves, comprises a pedestal for carrying a Model C Lilly Controller, and a weighted arm with a magnetic latch for holding the weight in reserve. It also has a dashpot to prevent the weight from dropping too rapidly, and a regulating stop arranged to be actuated by the Lilly Controller to regulate the distance that the weight is permitted to drop when released by the latch, thereby setting the brakes at the required speed. This unit must operate the brake engine valves direct, and not thru a floating lever. See B, Fig. 63.

91. Another weight unit C-578, illustrated in Figs. 19 and 20 similar to C-547, has an oil regulating cylinder instead of a dash-pot and regulating stop.

The regulating cylinder has an automatically controlled valve of the Corliss type in the oil bypass to regulate the speed at which the weight will drop to actuate the brake engine at the predetermined speed desired.

92. This unit must operate the brake engine thru the floating arm just as it would be operated by the hoistman, as illustrated in C Fig. 63.

FIG. 17—Weight Equipment for an Electric Hoist with Air Operated Gravity Brake. A 52-lb. weight on an arm at a 10" radius is held up by the magnetic latch shown beside the weight, and when the electric circuit is opened, the weight drops until stopped by the brake regulating stop in the pedestal, moving the valves of the brake engine to set the brake at a speed governed by the position of the cage in the shaft. See Fig. 18 for dimensions, Fig. 63 for connections, and paragraphs 88 to 95 and 220 to 230. This unit moves the brake operating valve directly.

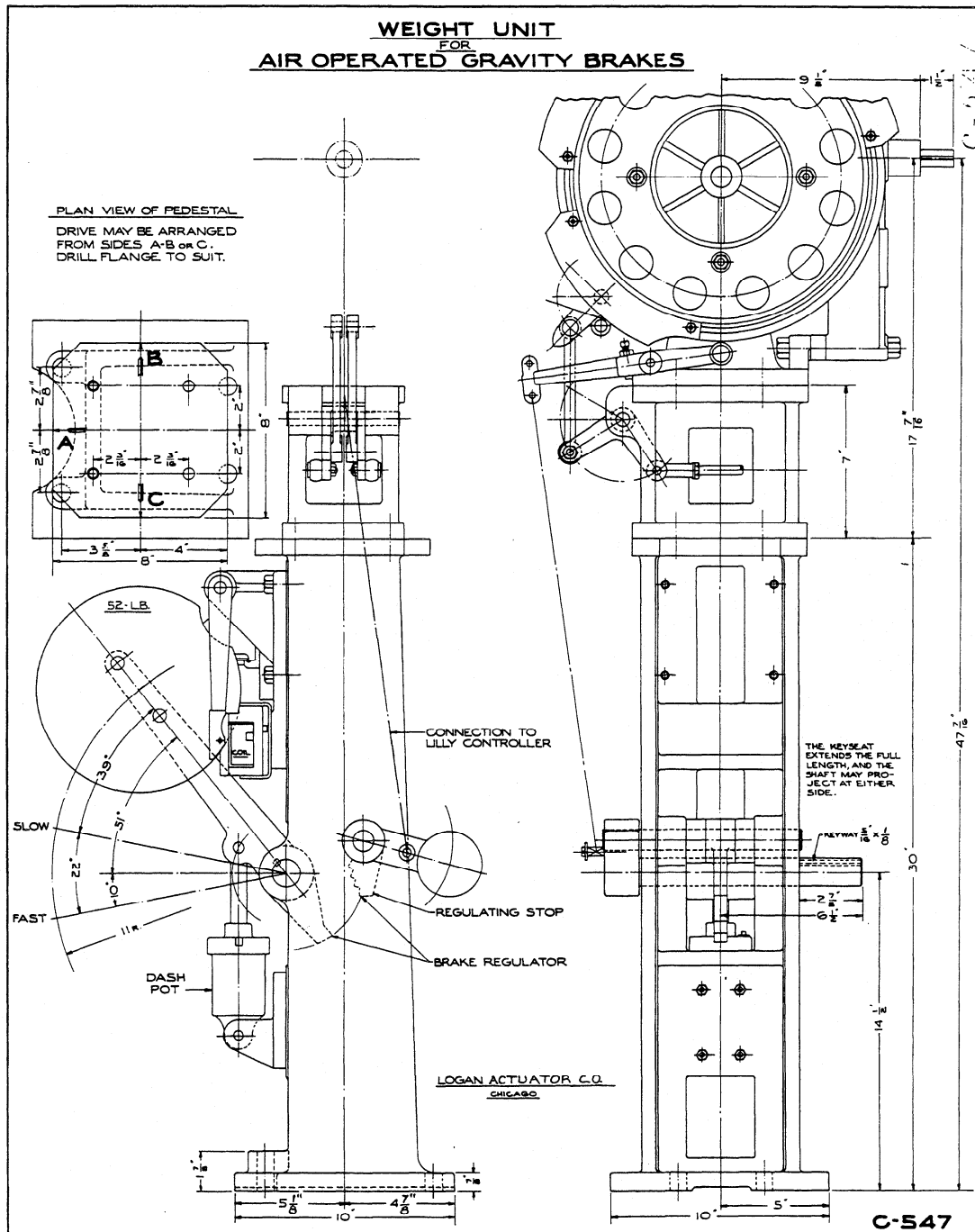


FIG. 18—Drawing of Unit shown in Fig. 17 (with Lilly Controller indicated). Scale of drawing 1" = 8".

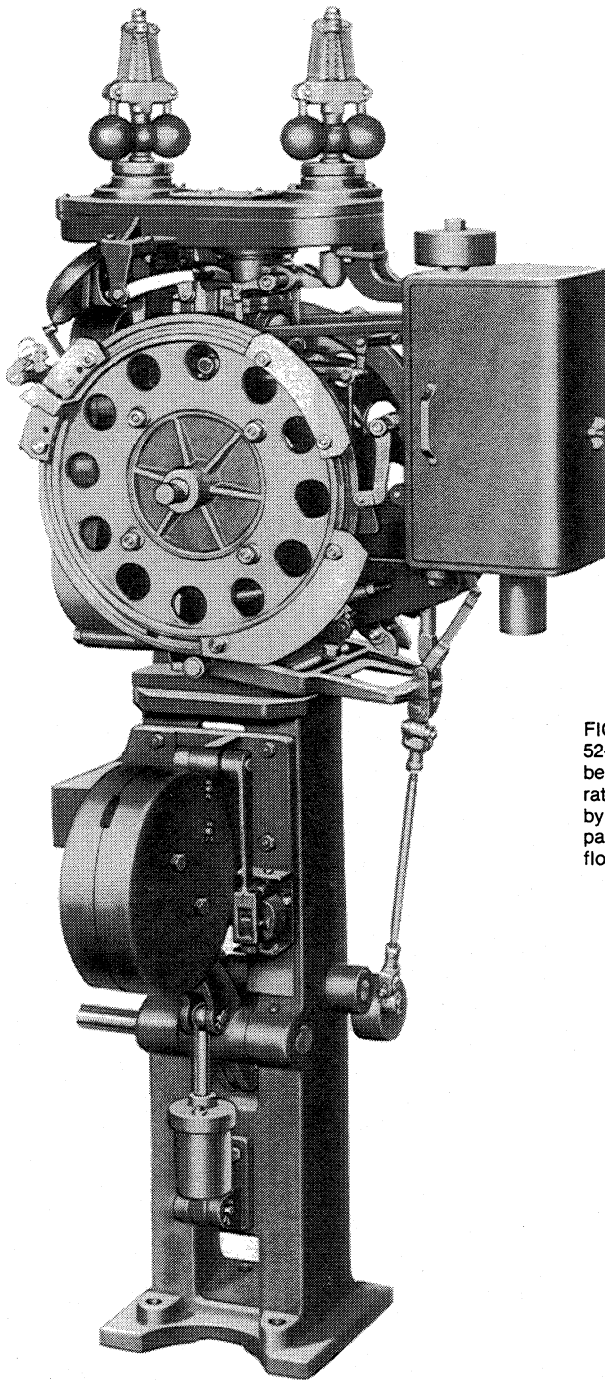


FIG. 19—Weight Unit for an Electric Hoist with Air Operated Gravity Brake. A 52-lb. weight on an arm at a 10" radius is held up by the magnetic latch shown beside the weight, and when the electric circuit is opened, the weight drops at a rate controlled by the rate regulating cylinder, the by-pass of which is actuated by the Lilly Controller. See Fig. 20 for dimensions, Fig. 63 for connections, and paragraphs 88 to 95. This unit moves the brake operating lever connection, or floating lever.

THE WEIGHT, SHAFT, AND MAGNETIC LATCH OF THE WEIGHT UNITS SHOWN IN FIGS. 17 TO 20

93. The weight provides the energy equivalent to that of a very large solenoid, yet a very small amount of current is sufficient to hold the magnetic latch, and it releases instantly when the circuit is opened.
94. Provision should be made to raise the weight by a lever placed near the hoistman, this lever being arranged so that it cannot accidentally prevent the weight from dropping in an emergency. It is desirable to have the weight re-setting lever interlocked with the brake lever when possible, to insure that the brake lever will be in the brake setting position before the emergency weight can be raised. An electrical interlock switch is located beside the weight, and it may be connected in any suitable manner.

95. A shaft projects from the side of the pedestal to which an arm should be keyed to actuate the brake engine valves, and slotted rod heads or their equivalent may be used for the weight connection and the hoistman's connection to permit the brake to be applied by either without interference from the other. When the hoistman's control is through a slotted connection, it is necessary to arrange a latch or other device to release the brake, unless it is permissible to have the safety device move the hoistman's lever.

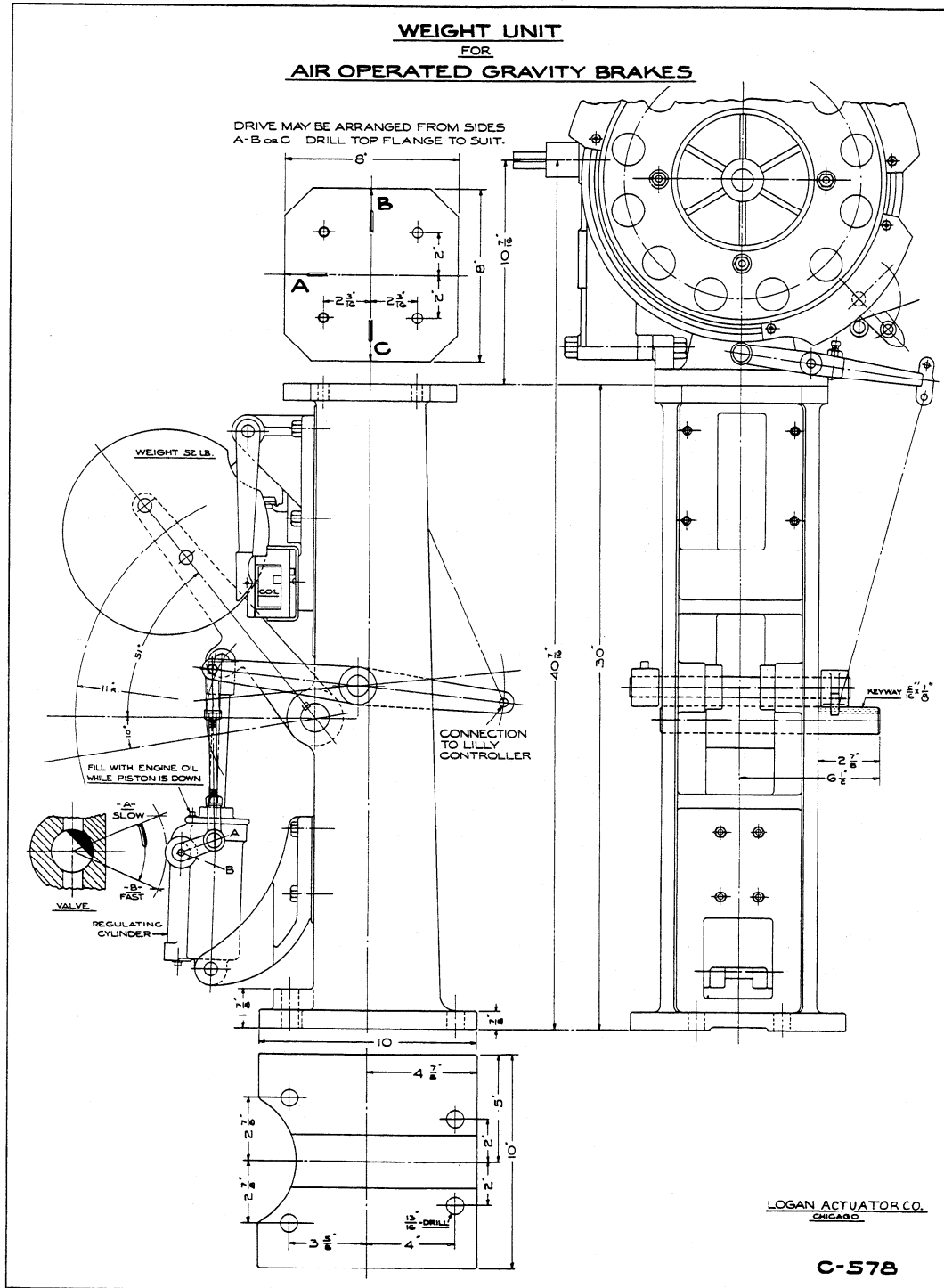


FIG. 20—Drawing of Unit shown in Fig. 19 (with Lilly Controller indicated). Scale of drawing $1" = 8"$.

GEAR COMBINATIONS AND METHOD OF SELECTING

96. In order that the governor may be driven at the proper speed for full hoist speed, and the largest available portion of the cam dial will be used for the complete trip, it is necessary to provide gearing within the Lilly Controller to suit the conditions under which it is to operate, and thirteen standard combinations of gears are available for the purpose. These are tabulated, and by the use of a simple formula the proper gear combination may be quickly determined to suit any given conditions.
97. The information necessary to determine the proper gear combination may be given in either of two ways. (In either case allow for deepening the shaft, should that be likely at a future time.)
- (a) Maximum R.P.M. of drum, and total number of turns or revolutions per trip, or
 - (b) Maximum rope speed, and total amount of rope to be wound.

(A) Divide the number of revolutions per trip (r), by the max. R.P.M. = $\frac{r}{\text{RPM}} = T.$

— OR —

(B) Divide the total amount of rope to be wound (feet "f") by the max. rope speed (feet per min.) =

$$\frac{f}{\text{FPM}} = T.$$

98. Referring to the gear table, glance down the second column until the number is found that is as great as, or the next greater than "T." This will indicate the correct gear combination to be selected, and its number will be found opposite in the third column. The correct drive speed for any combination will be found in the first column, opposite the number of the combination. The controller should be geared to the hoist so that at the maximum normal hoist speed the controller will be driven at approximately the speed specified, but not faster.

TABLE OF GEAR COMBINATIONS FOR MODEL C CONTROLLER

99. The worm wheel with 144 teeth and the worm are single thread for all machines (including the Long Range machines) without the planetary type Man-Safety cam dial drive. The standard Man-Safety machine with the planetary cam dial drive utilizes double thread worm and worm wheel to compensate for the planetary reduction. (For Variable Depth or Long Range Variable Depth machines, see the Variable Depth bulletin.)

Drive Speed r.p.m.	Time in Min. "T" for 116 Rev. of Worm	Combination Number	G E A R S			
			Governor Shaft	Drive Shaft	Drive Shaft	Worm Shaft
90	.36	00	36	72	84	24
	.49	0	36	72	78	30
	.64	1	36	72	72	36
	.82	2	36	72	66	42
	1.03	3	36	72	60	48
	1.28	4	36	72	54	54
	1.61	5	36	72	48	60
	2.02	6	36	72	42	66
	2.57	7	36	72	36	72
	3.35	8	36	72	30	78
	4.51	9	36	72	24	84
51.4	5.86	10	24	84	30	78
	7.89	11	24	84	24	84

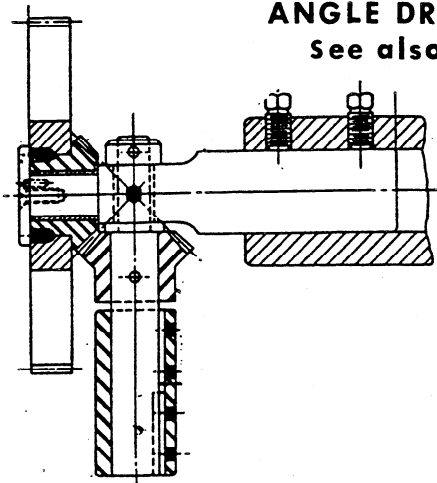
100. Example No. 1 — Select gear combination for 1620 Ft. of rope winding at 3000 ft. per minute.
 $T = \frac{1620}{3000} = 0.54$ Min. use G.C. #1 with "T" @ 0.64 Mins.
 Drive Speed = 90 R.P.M.
101. Example No. 2 — Select gear combination for 240 revolutions of the drum at drum speed of 50 R.P.M.
 $T = \frac{240}{50} = 4.8$ Minutes Use G.C. #10 with "T" = 5.86 Mins
 Drive speed = 51.4 R.P.M.
102. "Try to keep within 2% of the listed drive speed to avoid special controller gearing which would be extra cost."

GEAR COMBINATIONS FOR LONG RANGE DIAL DRIVE

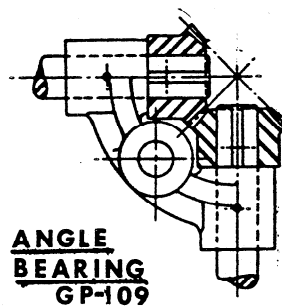
103. For the Long-Range Dial Drive, calculations should be made to provide the desired length of the retarding cam profile.
 Example: assume 4600 Ft. travel at 2,000 Ft./min. rope speed. Retarding distance 200 Ft., and desire a 5" retarding cam profile.
- | | |
|--|-----------------------------------|
| H = Hoisting distance, Ft. | C = Retarding cam length, Inches |
| R = Rope speed, Ft./Min. | G_D = Gear teeth on drive shaft |
| r = Retarding distance, Ft. | G_W = Gear teeth on worm shaft |
| T = Travel time, minutes actual | D = Drive shaft speed, R.P.M. |
| T' = Recalculated value to select gears for longer cam | L = Revolutions of cam dial shaft |
104. For the standard drive, 116 rev. of the worm represents 290° or 37.96" on the 15" dia. cam dial for the full "T" as listed in the Gear Combination table.
 $T = \frac{H}{R} = \frac{4600 \text{ Ft.}}{2000 \text{ Ft./min.}} = 2.3 \text{ Min.}$ G.C. #7 has T = 2.57 min.
- If G.C. #7 is used, total dial travel = $\frac{2.3}{2.5} \times 37.96" = 34.92"$
- Retarding travel will then be $\frac{200}{4600} \times 34.92" = 1.52"$
- If we desire a 5" cam, the cam dial must be speeded up
 by $\frac{5}{1.52} = 3.29$ Factor. "T" for G.C. #7 is 2.5 min.
- Desired T' = $\frac{2.5}{3.29} = 0.76 \text{ min.}$
- Select G.C. #2, which has T = 0.82
- The resulting cam profile will be $\frac{0.76}{0.82} \times 5" = 4.63"$ long.
105. The cam length can also be calculated by, $C = \frac{G_D r D}{3.06 G_W R}$, inches.
 For the example and selected G.C. #2,
 $C = \frac{66 \times 200 \times 90}{3.06 \times 42 \times 2000} = 4.62"$
- Total cam dial shaft rotation = $L = \frac{A_{\text{actual}} \times T' \times D \times G_D}{144 \times G_W}$, Revol.
- $L = \frac{2.3 \times 90 \times 66}{144 \times 42} = 2.25 \text{ Revolutions}$
106. The Long Range Drive will accomodate up to seven revolutions of the cam dial shaft plus 60° for cam dial movement at the end of travel, or 2580° total dial shaft rotation. This is almost nine times the allowable 290° rotation with the standard drives as listed in the Gear Combination Table.
107. The cam dial should not move more than 90° in the slow down zone, and there is seldom much advantage in rotating the cam dial more than 60° in the refarding zone.

ANGLE DRIVES FOR HOIST CONTROLLERS

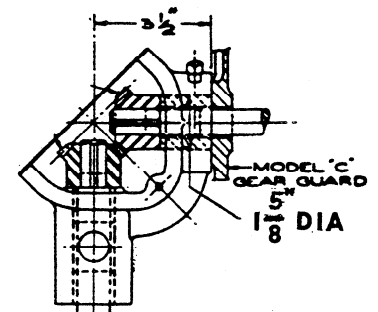
See also Fig.57 and Bulletin 810104



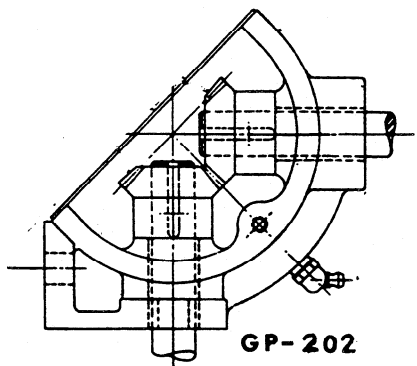
SPUR AND BEVEL GEAR DRIVE
GP-112



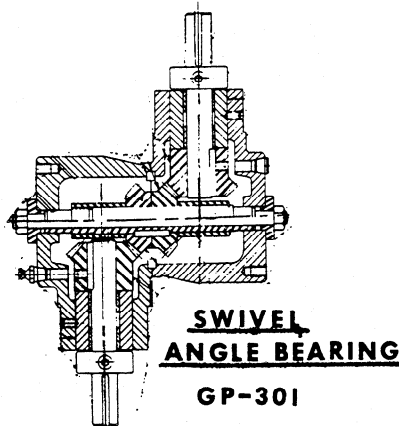
ANGLE
BEARING
GP-109



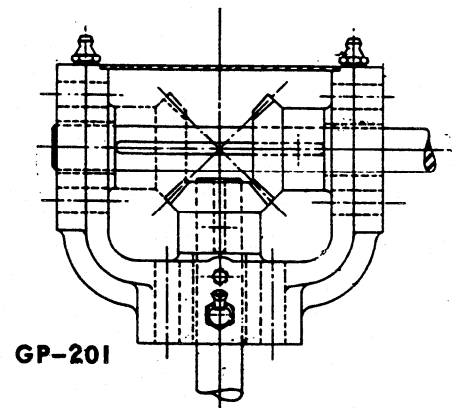
ANGLE BEARING
FOR
MODEL "C" LILLY HOIST CONTROLLER
GP-104



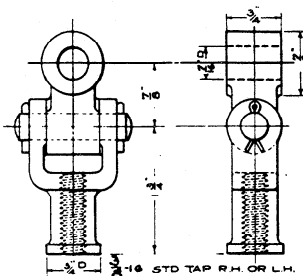
GP-202



SWIVEL
ANGLE BEARING
GP-301

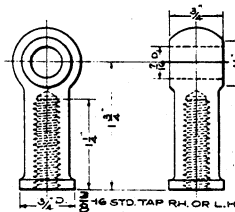


GP-201

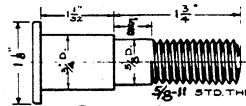


GP-414 R.H. GP-415 L.H.
UNIVERSAL HEADS

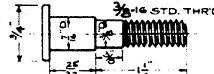
ROD HEADS, ENDS, ETC.



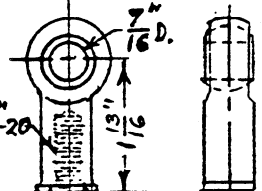
GP-412, 413
HEADS



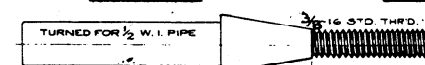
GP-409
GP-416
PINS



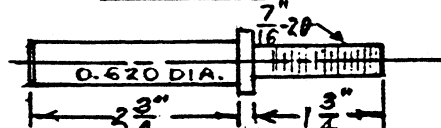
GP-426 R.H. GP-427 L.H.



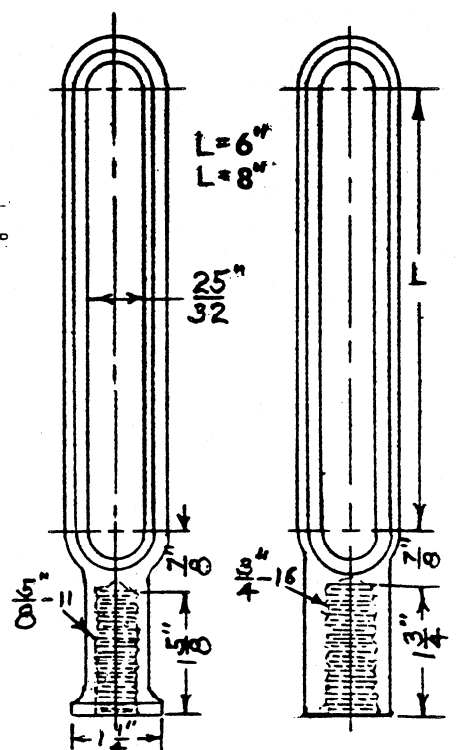
BALL TYPE
UNIVERSAL HEAD



GP-417 R.H. GP-418 L.H.
ROD ENDS



GP-432 R.H. GP-433 L.H.



SLOTTED HEADS

INSTRUCTIONS FOR ORDERING MODEL C LILLY CONTROLLERS AND EQUIPMENT

108. Please specify the applicable information from the following check list when ordering the Controller and equipment.
109. Are Single Governor or Duplex Governor required?
110. Gear Combination — Or, the rope speed and depth to be wound, or — Drum R.P.M. and number of turns of the drum.
111. Whether Long Range Cam Dial Drive is required. If not ordered, it will be assumed that the standard drive is desired.
112. Whether electrical retardation contacts are wanted instead of the standard retarding warning gong.
113. Whether Man-Safety equipment is wanted, and whether for a drum handling one cage or two cages in balance. Give man speed and travel compared to main limits.
114. Whether man safety levers, or pneumatic, or hydraulic operators are wanted. Give voltage for operator valves.
115. Current characteristics for the accelerating solenoid.
116. If multiple levels require protection for retardation and travel limits because of obstructions, spill doors, etc., introduced into the shaft space. (Possible variable depth requirements.)
117. If auxiliary equipment is desired. Refer to by number as illustrated or to meet special requirements, and whether right hand or left hand, if applicable.
118. Whether Resynchronizing Switches, Reversing Directional Switches, Terminal Board, Governor Guard, Housings, etc. are required.
119. Are angle gears, bearings, rod heads and ends required. See Bulletin 810104, and Fig. 21.

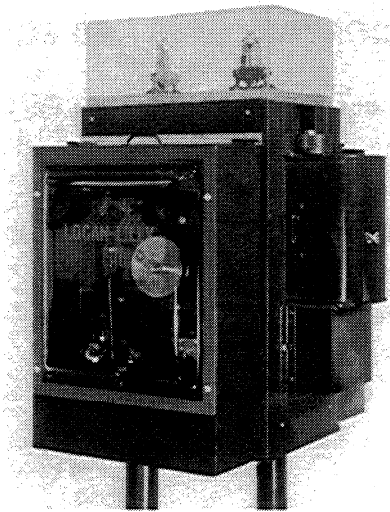


FIG. 22 SECTIONAL ENCLOSURE
C-1555 as shown for long range.
C-1600 w/o side boxes for standard machine.

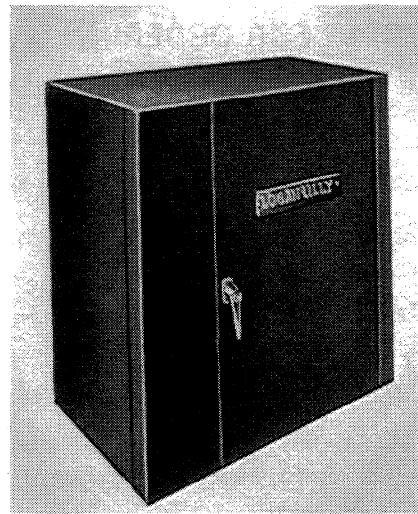
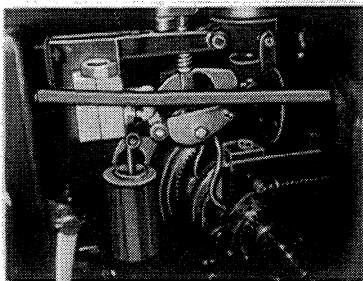
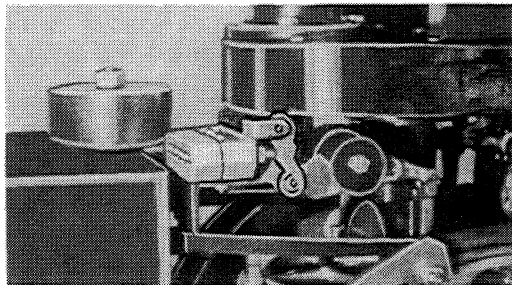


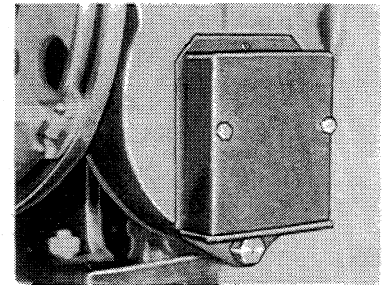
FIG. 23 STEEL CABINET
M-768 with doors and panels.



SINGLE GOVERNOR

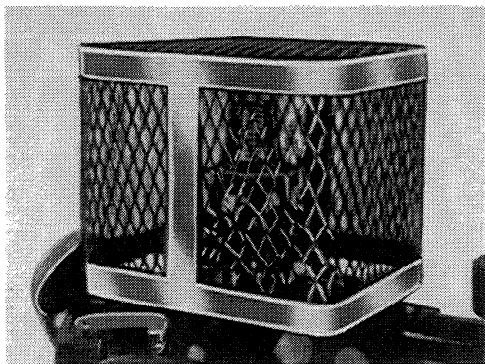


DUPLEX GOVERNOR

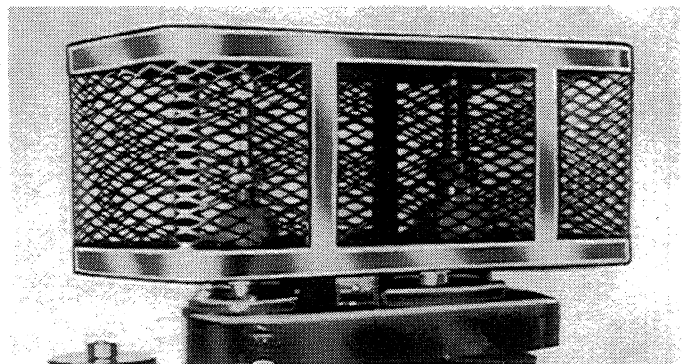


C-1472 Reversing
Directional Switch
FIG. 25

FIG. 24 Rotation Sensing Switch



C-1729 SINGLE GOVERNOR
FIG. 26



C-1745 DUPLEX GOVERNOR
FIG. 27

GOVERNOR GUARDS

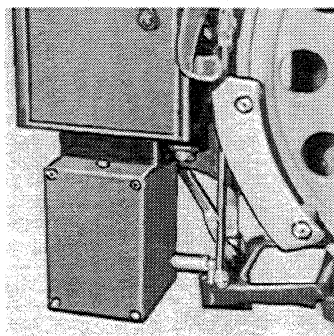


FIG. 28 Reduced Speed Mechanism

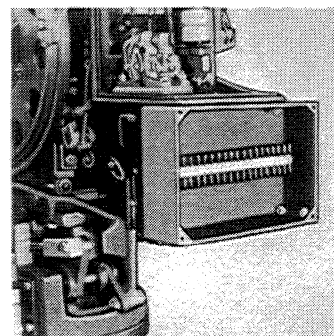


FIG. 29 Terminal Board

OPTIONAL FEATURES

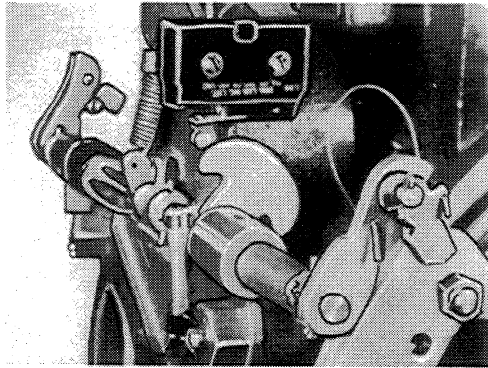


FIG. 30 Electric Retard Warning
Contacts in lieu of Gong.

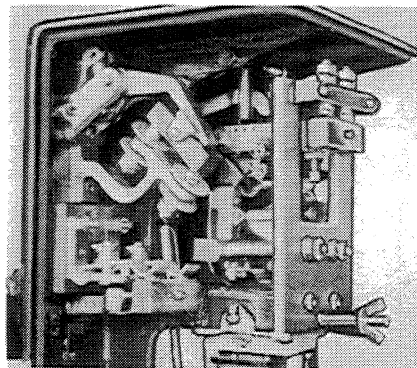


FIG. 31 Double
Overspeed Contacts

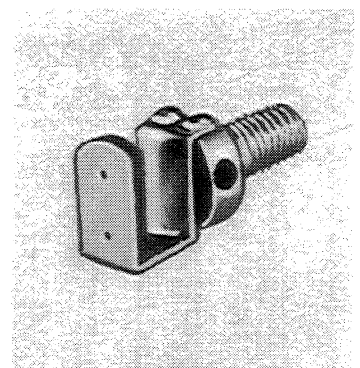


FIG. 32
Cam Profile Marker

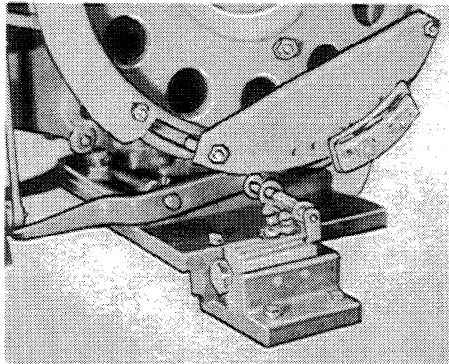


FIG. 33 Standard Machine

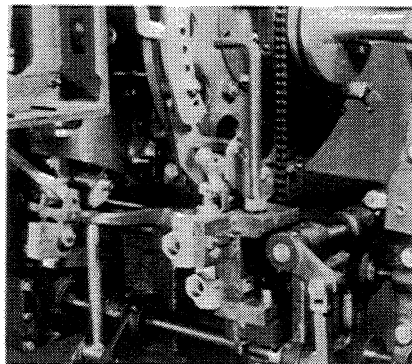


FIG. 34 Long Range Machine

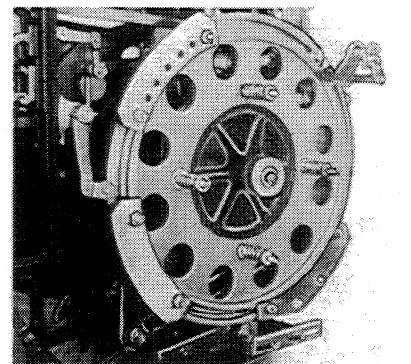


FIG. 35 Cam Dial
Friction Driven

RESYNCHRONIZING SWITCHES

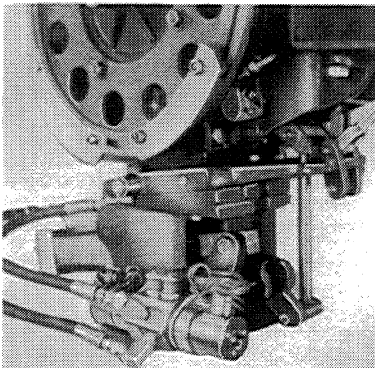


FIG. 36
Standard Machine

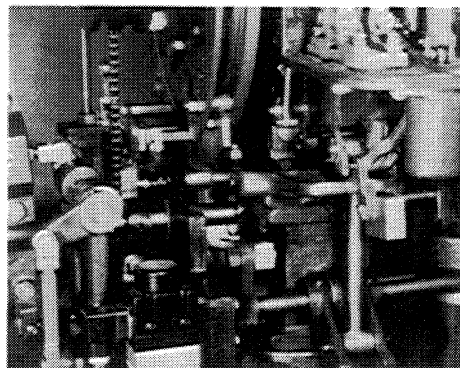


FIG. 37
Long Range Machine

Man-Safety
Operators
Pneumatic/Electric
or
Hydraulic/Electric
Single or Double

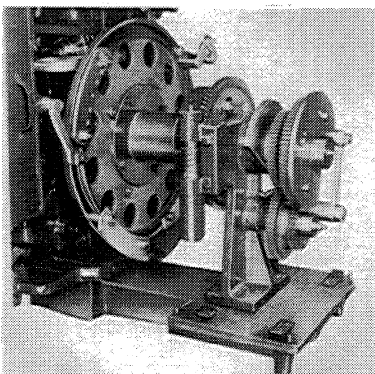


FIG. 38 Variable Depth Machine

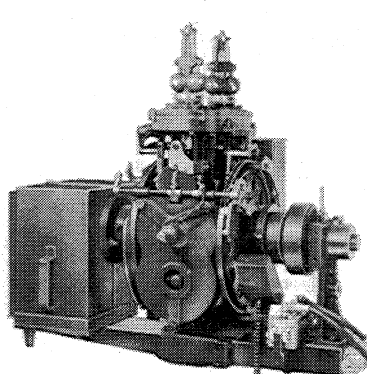


FIG. 39 Long-Range Variable
Depth Machine

Variable-Depth
or
Long-Range Variable
Depth Machine.
(Covered by
Separate Bulletin)

TABLES

FEET OR METERS

Per Second	Per Minute	Per Second	Per Minute	Per Second	Per Minute	Per Second	Per Minute
1	60	21	1260	41	2460	61	3660
2	120	22	1320	42	2520	62	3720
3	180	23	1380	43	2580	63	3780
4	240	24	1440	44	2640	64	3840
5	300	25	1500	45	2700	65	3900
6	360	26	1560	46	2760	66	3960
7	420	27	1620	47	2820	67	4020
8	480	28	1680	48	2880	68	4080
9	540	29	1740	49	2940	69	4140
10	600	30	1800	50	3000	70	4200
11	660	31	1860	51	3060	71	4260
12	720	32	1920	52	3120	72	4320
13	780	33	1980	53	3180	73	4380
14	840	34	2040	54	3240	74	4440
15	900	35	2100	55	3300	75	4500
16	960	36	2160	56	3360	76	4560
17	1020	37	2220	57	3420	77	4620
18	1080	38	2280	58	3480	78	4680
19	1140	39	2340	59	3540	79	4740
20	1200	40	2400	60	3600	80	4800

Table A. Equivalent Speed in Feet or Meters per second and per minute.

DRUM DIAMETER IN METERS	CIRCUM-FERENCE IN METERS	EQUIVALENT DIAMETER IN FEET	CIRCUM-FERENCE IN FEET
1	3.14	3.28	10.30
1.5	4.71	4.92	15.46
2	6.28	6.56	20.61
2.5	7.85	8.20	25.76
3	9.42	9.84	30.91
3.5	11.00	11.48	36.07
4	12.57	13.12	41.22
4.5	14.14	14.76	46.37
5	15.71	16.40	51.52
5.5	17.28	18.04	56.67
6	18.85	19.68	61.83
7	21.99	22.97	72.16
8	25.13	26.25	82.47
9	28.27	29.53	92.77
10	31.42	32.81	103.08
11	34.56	36.09	113.38
12	37.70	39.37	123.68
13	40.84	42.65	133.99
14	43.98	45.93	144.29

Table B. Conversion Table. Drum Diameters and Circumferences in Meters and Feet.

DRUM DIAMETER IN FEET	DRUM CIRCUM-FERENCE IN FEET	EQUIVALENT DRUM DIAMETER IN METERS	DRUM CIRCUM-FERENCE IN METERS	DRUM DIAMETER IN FEET	DRUM CIRCUM-FERENCE IN FEET	EQUIVALENT DRUM DIAMETER IN METERS	DRUM CIRCUM-FERENCE IN METERS
1	3.14	.31	.96	19	59.69	5.80	18.18
1.5	4.71	.46	1.44	20	62.83	6.10	19.13
2	6.28	.61	1.91	21	65.97	6.40	20.09
2.5	7.85	.76	2.39	22	69.12	6.71	21.05
3	9.42	.92	2.87	23	72.26	7.02	22.00
3.5	11.00	1.07	3.35	24	75.40	7.33	22.96
4	12.57	1.22	3.83	25	78.54	7.63	23.92
4.5	14.14	1.37	4.31	26	81.68	7.93	24.87
5	15.71	1.52	4.78	27	84.82	8.24	25.83
5.5	17.28	1.68	5.27	28	87.97	8.54	26.79
6	18.85	1.83	5.74	29	91.11	8.84	27.74
7	21.99	2.13	6.70	30	94.25	9.15	28.70
8	25.13	2.44	7.65	31	97.39	9.45	29.66
9	28.27	2.74	8.61	32	100.53	9.76	30.61
10	31.42	3.05	9.56	33	103.67	10.06	31.57
11	34.56	3.36	10.52	34	106.81	10.36	32.53
12	37.70	3.66	11.48	35	109.96	10.68	33.48
13	40.84	3.97	12.44	36	113.10	10.97	34.44
14	43.98	4.27	13.39	37	116.24	11.27	35.40
15	47.12	4.57	14.35	38	119.38	11.58	36.35
16	50.27	4.87	15.31	39	122.52	11.88	37.31
17	53.41	5.18	16.26	40	125.66	12.20	38.27
18	56.55	5.49	17.22				

Table C. Conversion Table. Drum Diameters and Circumferences in Feet and Meters.

HOISTING ROPES SAFETY FACTOR FOR VARIOUS DEPTHS OF SHAFTS	MINIMUM SAFETY FACTOR FOR NEW ROPE	MINIMUM SAFETY FACTOR WHEN ROPE MUST BE DISCARDED	PERCENTAGE REDUCTION
500 Ft. or Less	8	6.4	20
500 to 1000 Ft.	7	5.6	17
1000 to 2000 Ft.	6	4.8	16½
2000 to 3000 Ft.	5	4.0	14
3000 and over	4	3.6	10

The above factors are based upon an actual safety factor of four, and are made greater for shallower shafts because there the acceleration stresses are normally greater and in deep shafts the elasticity of the rope acts to minimize the shock of starting and the stresses of accelerating.

Table D. Safety Factor for Hoisting Ropes.

Diameter, Inches	Approx. Circumference, Inches	Weight per Foot, Lbs.	Iron			Crucible Steel			Extra Strong Crucible Steel		Plow Steel		Crucible and Plow Steel, Min. Size of Sheave, Feet	Monitor Plow Steel		
			Breaking Strength, Tons, (2000 Lbs.)	Safe Working Load, Tons	Minimum Size of Sheave, Feet	Breaking Strength, Tons, (2000 Lbs.)	Safe Working Load, Tons	Minimum Size of Sheave, Feet	Breaking Strength, Tons, (2000 Lbs.)	Safe Working Load, Tons	Breaking Strength, Tons, (2000 Lbs.)	Safe Working Load, Tons		Breaking Strength, Tons, (2000 Lbs.)	Safe Working Load, Tons	Minimum Size of Sheave, Feet
2¼	7½	8.00	72.0	14.4	14.0	133.0	26.6	9.0	160.0	32.0	186.0	37.0	9.0	210.0	42.0	9.0
2	6¾	6.30	55.0	11.0	12.0	106.0	21.2	8.0	123.0	24.6	140.0	28.0	8.0	166.0	33.0	8.0
1¾	5¾	5.55	50.0	10.0	12.0	96.0	19.0	8.0	112.0	22.4	127.0	25.0	8.0	150.0	30.0	8.0
1½	5½	4.85	44.0	8.8	11.0	85.0	17.0	7.0	99.0	19.8	112.0	22.0	7.0	133.0	27.0	7.0
1¼	5	4.15	38.0	7.6	10.0	72.0	14.4	6.5	83.0	16.6	94.0	19.0	6.5	110.0	22.0	6.5
1½	4¾	3.55	33.0	6.6	9.0	64.0	12.8	6.0	73.0	14.6	82.0	16.0	6.0	98.0	20.0	6.0
1¾	4¼	3.00	28.0	5.6	8.5	56.0	11.2	5.5	64.0	12.8	72.0	14.0	5.5	84.0	17.0	5.5
1¼	4	2.45	22.8	4.6	7.5	47.0	9.4	5.0	53.0	10.6	58.0	12.0	5.0	69.0	14.0	5.0
1½	3½	2.00	18.6	3.7	7.0	38.0	7.6	4.5	43.0	8.6	47.0	9.4	4.5	56.0	11.0	4.5
1	3	1.58	14.5	2.9	6.0	30.0	6.0	4.0	34.0	6.8	38.0	7.6	4.0	45.0	9.0	4.0
¾	2¾	1.20	11.8	2.4	5.5	23.0	4.6	3.5	26.0	5.2	29.0	5.8	3.5	35.0	7.0	3.5
¾	2¼	0.89	8.5	1.7	4.5	17.5	3.5	3.0	20.2	4.0	23.0	4.6	3.0	26.3	5.3	3.0
½	2	0.62	6.0	1.2	4.0	12.5	2.5	2.5	14.0	2.8	15.5	3.1	2.5	19.0	3.8	2.5
½	1½	0.39	3.9	0.78	3.0	8.4	1.68	2.0	9.2	1.84	10.0	2.0	2.0	12.1	2.4	2.0

Table E. Strength of rope and minimum size of sheave.

Tables D and E are based upon data that we believe to be reliable. The other tables are simply mathematical and are close enough for ordinary calculations.

METRIC EQUIVALENTS

LENGTH			
1 Centimeter	=	.3937 Inch	
1 Meter	=	39.37 Inches	
1 Meter	=	3.28 Feet	
1 Meter	=	1.094 Yards	
1 Kilometer	=	.621 Mile	
1 Inch	=	2.54 Centimeters	
1 Inch	=	.0254 Meter	
1 Foot	=	.3048 Meter	
1 Yard	=	.9144 Meter	
1 Mile	=	1.61 Kilometers	
WEIGHT			
1 Gram	=	15.432 Grains	
1 Gram	=	.0353 Ounce	
1 Kilogram	=	2.2046 Lbs.	
1 Kilogram	=	.0011 Ton (Short)	
1 Metric Ton	=	1.1023 Tons (Short)	
1 Grain	=	.0648 Gram	
1 Ounce	=	28.35 Grams	
1 Lb.	=	.454 Kilogram	
1 Ton (Short) 2000 Lb.	=	907.20 Kilograms	
1 Ton (Short)	=	.907 Metric Ton	
1 Ton (Long) (2240 Lb.)	=	1016.04 Kilograms	
1 Ton (Long)	=	1.016 Metric Tons	

Table F. Metric and English Equivalents.

INCLINE TABLE

DEGREES	INCLINE PER 100 FT. OR %	DEGREES	INCLINE PER 100 FT. OR %
1	1.745	24	40.674
2	3.490	25	42.262
3	5.234	26	43.837
4	6.976	27	45.399
5	8.715	28	46.947
6	10.453	29	48.481
7	12.187	30	50.000
8	13.917	31	51.504
9	15.643	32	52.992
10	17.365	33	54.464
11	19.081	34	55.919
12	20.791	35	57.358
13	22.495	36	58.778
14	24.192	37	60.181
15	25.882	38	61.566
16	27.564	39	62.932
17	29.237	40	64.279
18	30.902	41	65.606
19	32.557	42	66.913
20	34.202	43	68.200
21	35.837	44	69.466
22	37.461	45	70.711
23	39.073		

Table G. Incline Table.

CONVERSION TABLES

English to Metric

To Convert	To	Multiply By
INCHES	CENTIMETERS	2.54
FEET	METERS	0.3048
YARDS	METERS	0.9144
MILES	KILOMETERS	1.60935
SQUARE INCHES	SQUARE CENTIMETERS	6.4516
SQUARE FEET	SQUARE METERS	0.0929
SQUARE MILES	SQUARE KILOMETERS	2.58899
ACRES	SQUARE KILOMETERS	0.004047
CUBIC INCHES	CUBIC CENTIMETERS	16.3934
CUBIC FEET	CUBIC METERS	0.02834
GALLONS (U.S.)	LITRES	3.785
GALLONS (Imperial)	LITRES	4.5431
POUNDS (Avoirdupois)	KILOGRAMS	0.4536
TONS (Short, 2000 Lb.)	KILOGRAMS	905.79
TONS (Long, 2240 Lb.)	KILOGRAMS	1014.4848
Metric to English		
CENTIMETERS	INCHES	.3937
METERS	FEET	3.2808
METERS	YARDS	1.09361
KILOMETERS	MILES	0.62137
SQUARE CENTIMETERS	SQUARE INCHES	0.1550
SQUARE METERS	SQUARE FEET	10.7641
SQUARE KILOMETERS	SQUARE MILES	0.38611
SQUARE KILOMETERS	ACRES	247.114
CUBIC CENTIMETERS	CUBIC INCHES	0.0610
CUBIC METERS	CUBIC FEET	35.3140
LITRES	GALLONS (U.S.)	0.2642
LITRES	GALLONS (Imperial)	0.2201
KILOGRAMS	POUNDS (Avoirdupois)	2.20462
KILOGRAMS	TONS (Short, 2000 Lb.)	0.001102
KILOGRAMS	TONS (Long, 2240 Lb.)	0.000984

Table H. Conversion Table. English to Metric and Metric to English.

TENSION ON ROPE FOR INCLINE PLANES

ANGLE DEGREES	TENSION FOR 2000 LB. LOAD
90	2,000
80	1,970
70	1,880
60	1,732
50	1,552
45	1,414
42.5	1,350
40	1,286
37.5	1,216
35	1,148
32.5	1,074
30	1,000
27.5	922
25	846
22.5	764
20	684
17.5	600
15	518
12.5	432
10	348
8	278
7	242
6	208
5	174
4	138
3	104
2	70
1	34

Table I. Tension on rope for incline.

WEIGHT OF WATER

at 62°F.

Volume	Weight
1 CU. FOOT	62.355 LB.
1 CU. INCH	.036 LB.
1 CU. INCH	.576 OZ.
1 GALLON (U.S.)	8.33 LB.
1 GALLON (IMP.)	9.998 LB.
12004 GALLON (U.S.)	1.00 LB.
12.0048 GALLONS (U.S.)	100.00 LB.
240.096 GALLONS (U.S.)	1 SHORT TON (2000 LB.)
268.908 GALLONS (IMP.)	1 LONG TON (2240 LB.)
1 LITRE	2.201 LB.

Table J. Weight of Water.

Short and Long Tons. U. S. and Imp. Gallons.

CONVERSION TABLE

To Convert	To	Multiply By
SHORT TONS (2000 Lb.)	LONG TONS (2240 Lb.)	.893
LONG TONS	SHORT TONS	1.12
U. S. GALLONS (231 Cu. In.)	IMPERIAL GALLONS (277.274 Cu. In.)	.8331
IMPERIAL GALLONS	U. S. GALLONS	1.2003

Table K. Conversion Table. Short and Long Tons. U. S. and Imp. Gals.

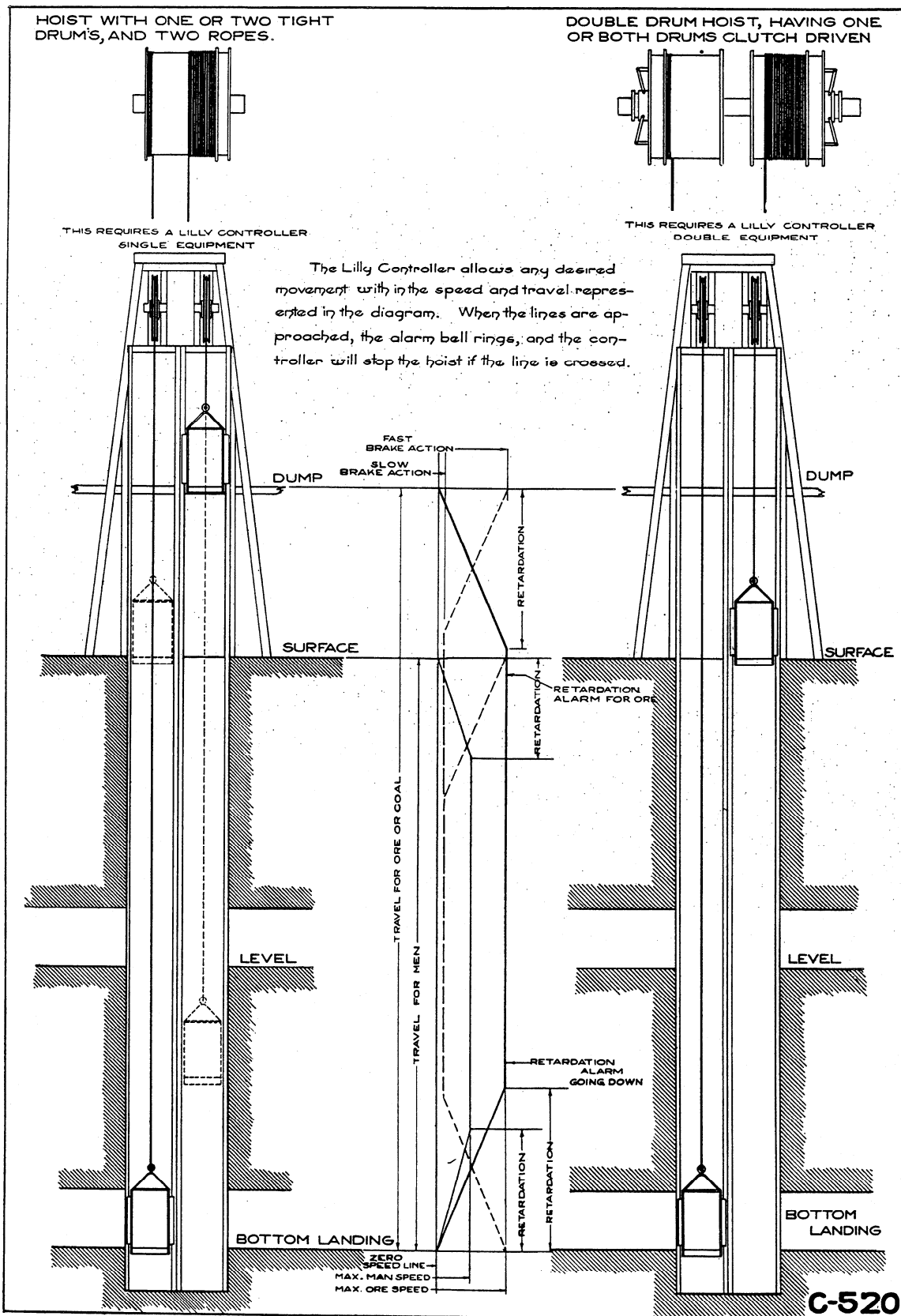


FIG. 40—This diagram shows the relative positions of the cages when handling men, both for a single-drum with two ropes; and for double-drums, either or both being clutch driven. It also indicates the theoretical limit of speed and travel permitted by the Lilly Controller, both for men and for ore or coal, and shows how the brake action is gradually quickened as the speed is reduced near the ends of travel.

TYPICAL INSTALLATIONS†°

The hoists illustrated on the following pages include the largest electric and steam hoists in the world, and the general data pertaining to these hoists are given as far as it is available.

Although representing relatively few of the Model C Lilly Controller installations, the selection includes hoists of many designs and sizes, together with various types of installations, all of which should be of interest.

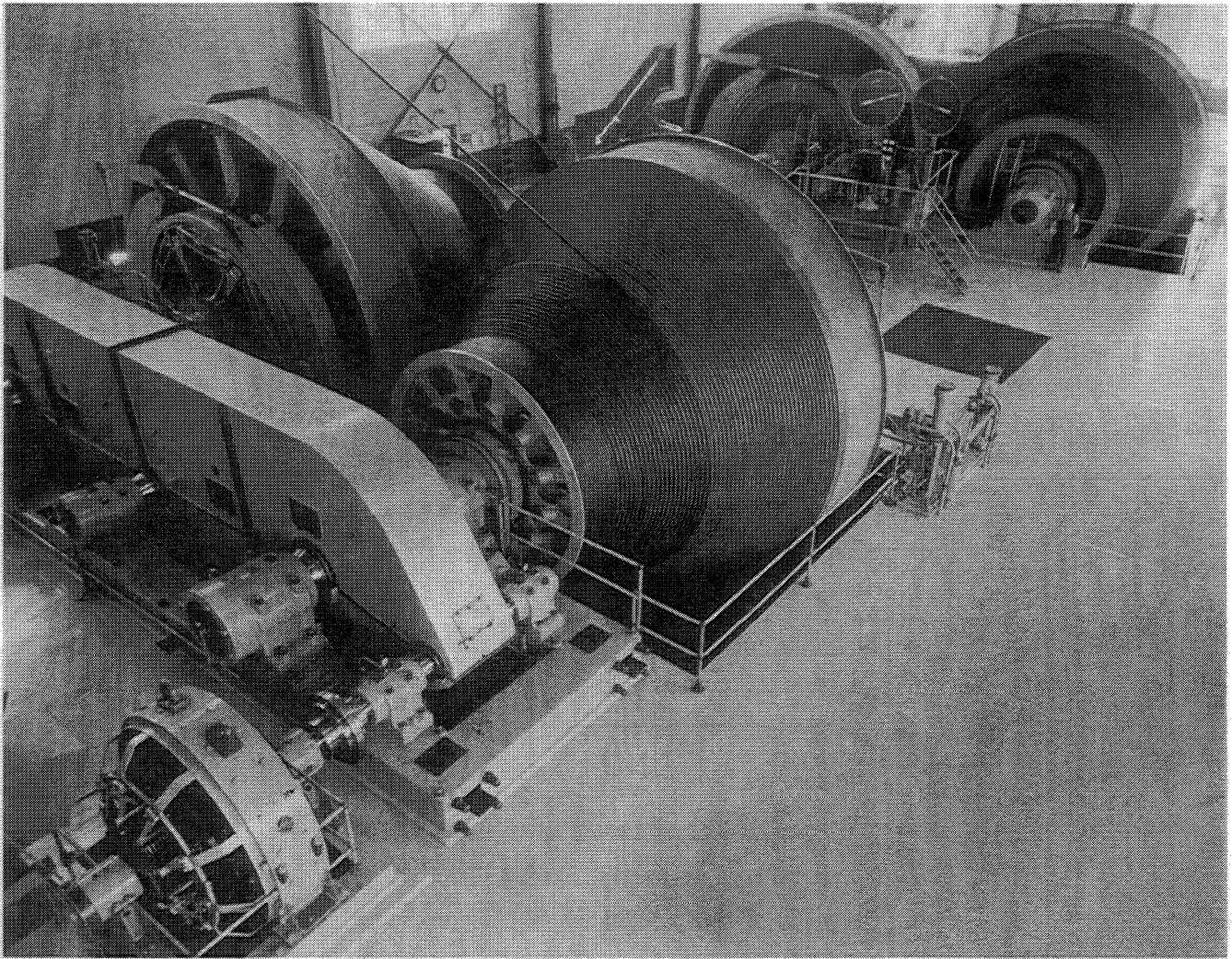


FIG. 41—Two of the four large Nordberg electric hoists at Lead, South Dakota, with 25 ft. diameter drums winding 5000 ft. of rope. All are equipped with Model C Lilly Controllers with Duplex Governors and Long Range Dial Drives.

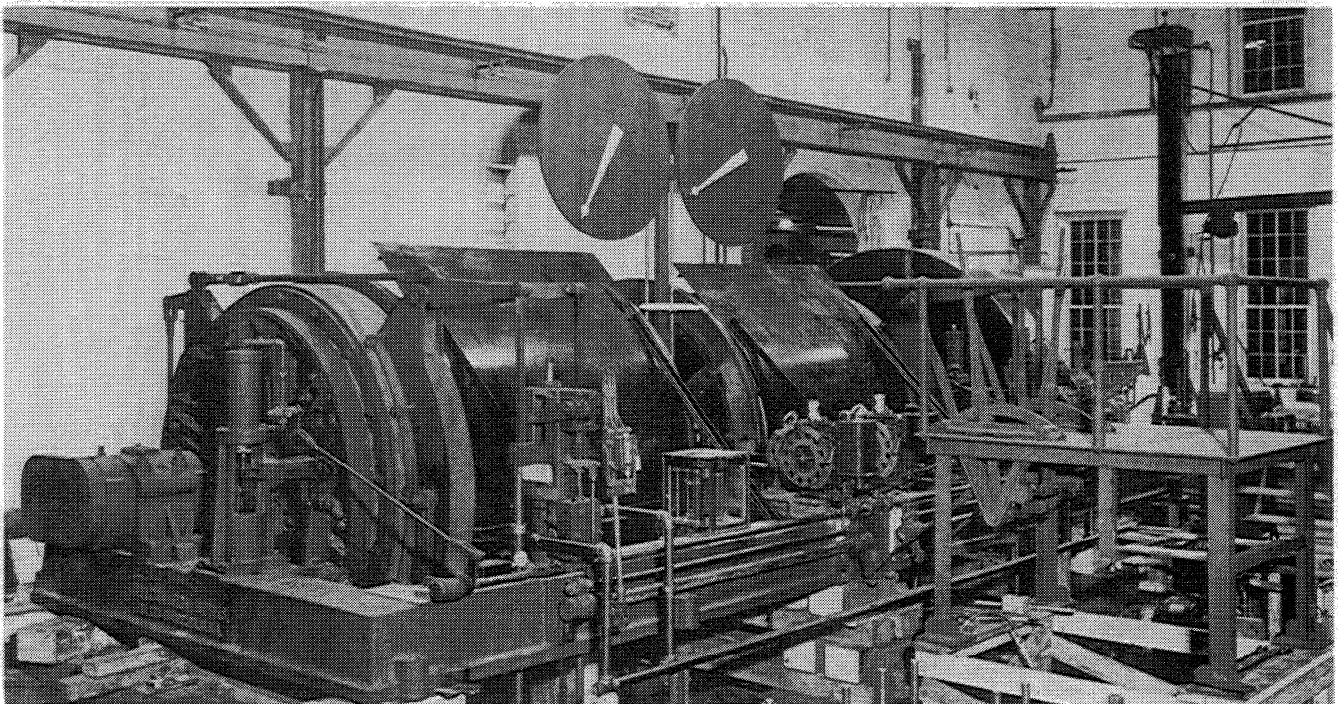


FIG. 42—A Vulcan Iron Works (Wilkes-Barre, Pa.) double-drum electric hoist, (shop picture). Two Model C Lilly Controllers are installed on the bedplate in front of the platform.

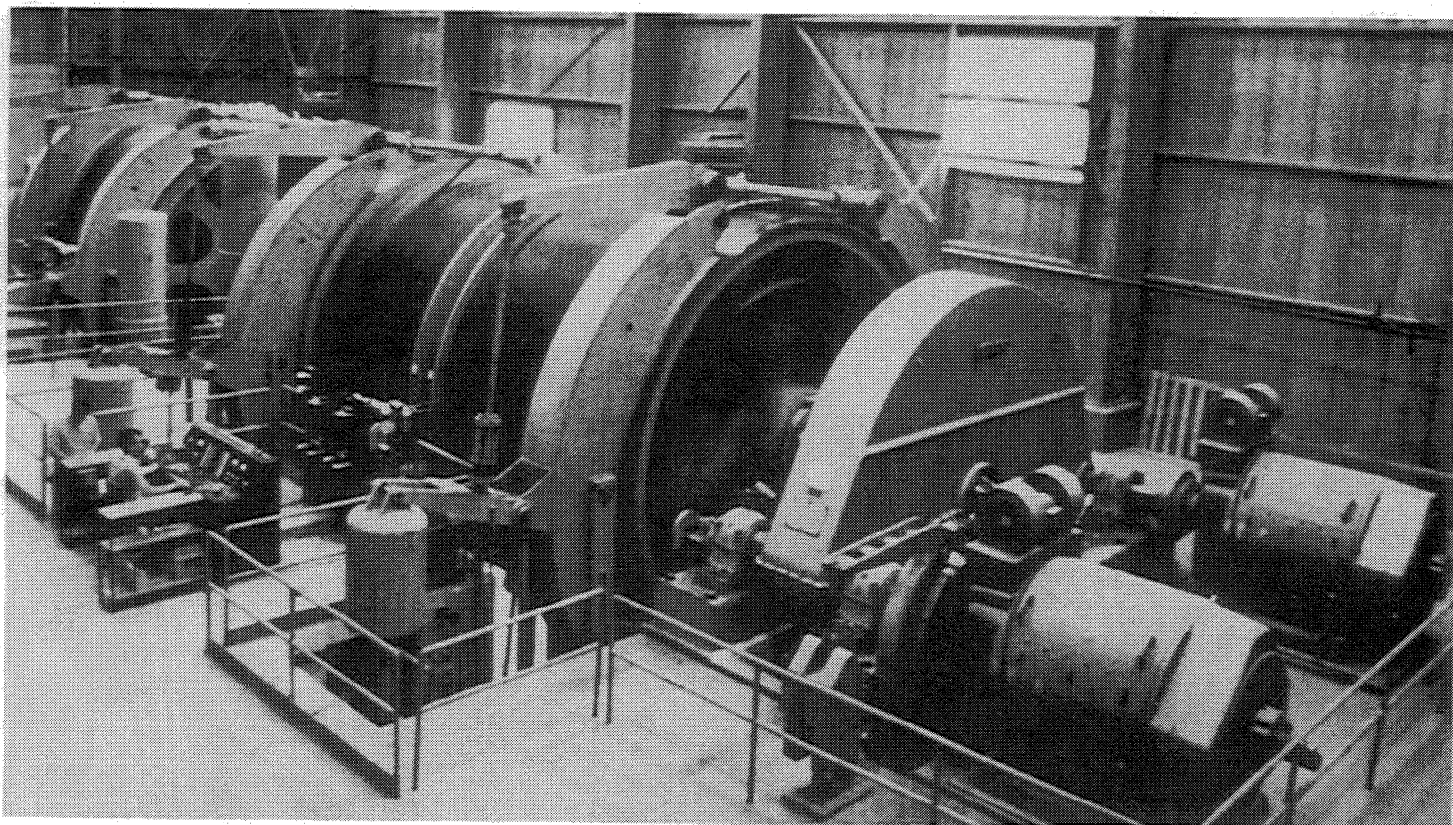


Fig. 43—Two fifteen-foot diameter double drum Nordberg hoists in a western U.S.A. molybdenum mine, each with two Logan-Lilly Model C Controllers.

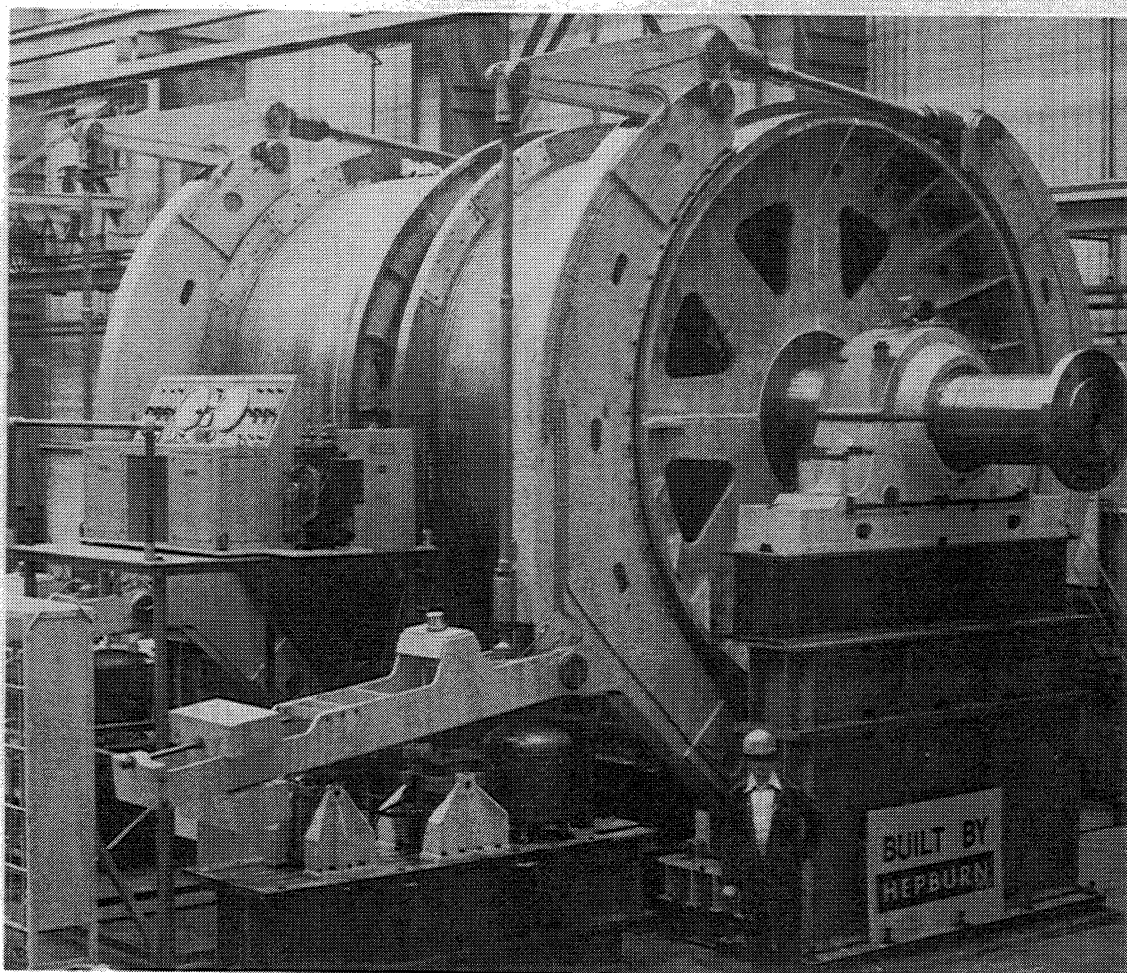


Fig. 44—Shop photo of John T. Hepburn double drum hoist with 14-ft. diameter drums for an Elliot Lake, Ontario mine, showing accessible locations for the two Duplex Governor Model C Controllers.

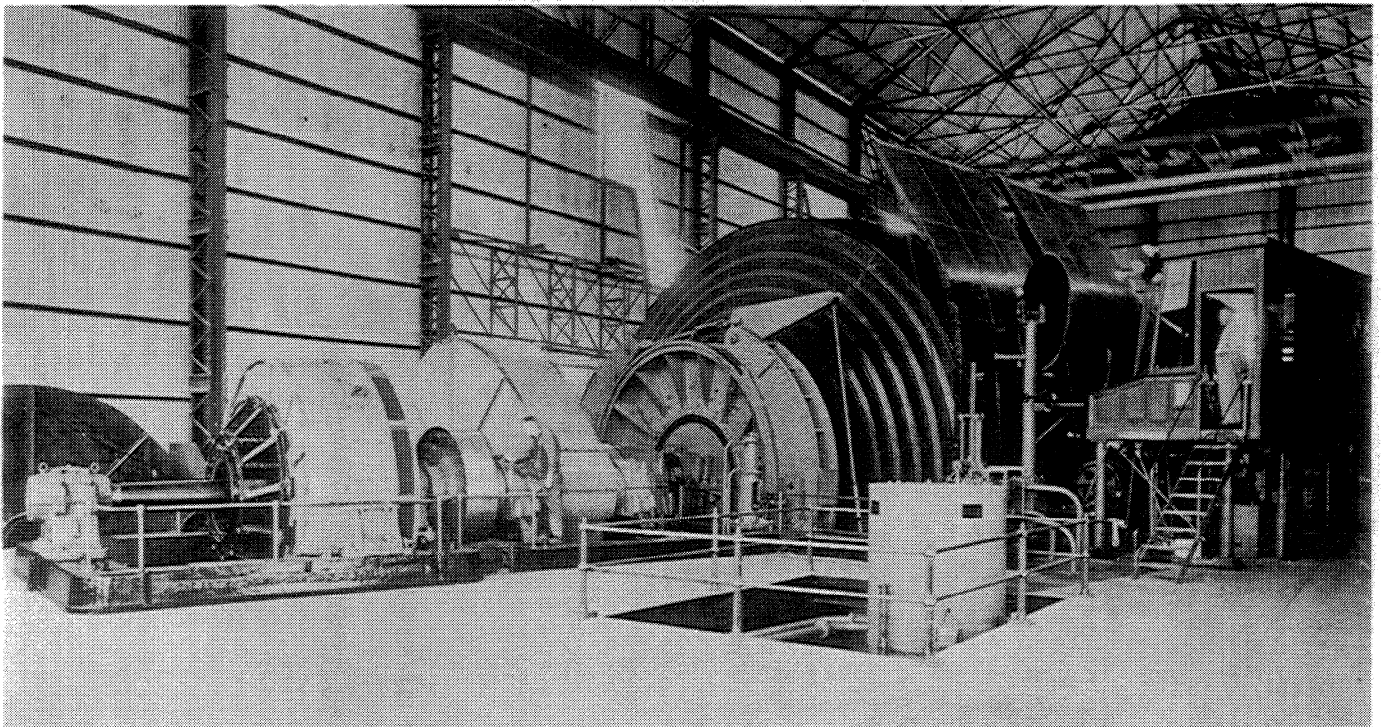


FIG. 45—One of the two large Fullerton, Hodgart & Barclay double-drum electric hoists at a gold mine in South Africa. The drums are 36 ft. in diameter, driven by a single motor of 5157 peak horsepower, with Ward-Leonard control, and wind 6000 ft. of 2 inch rope at 3000 ft. per minute.

Two Model C Lilly Controllers are installed under the platform, but they are not shown in the picture.

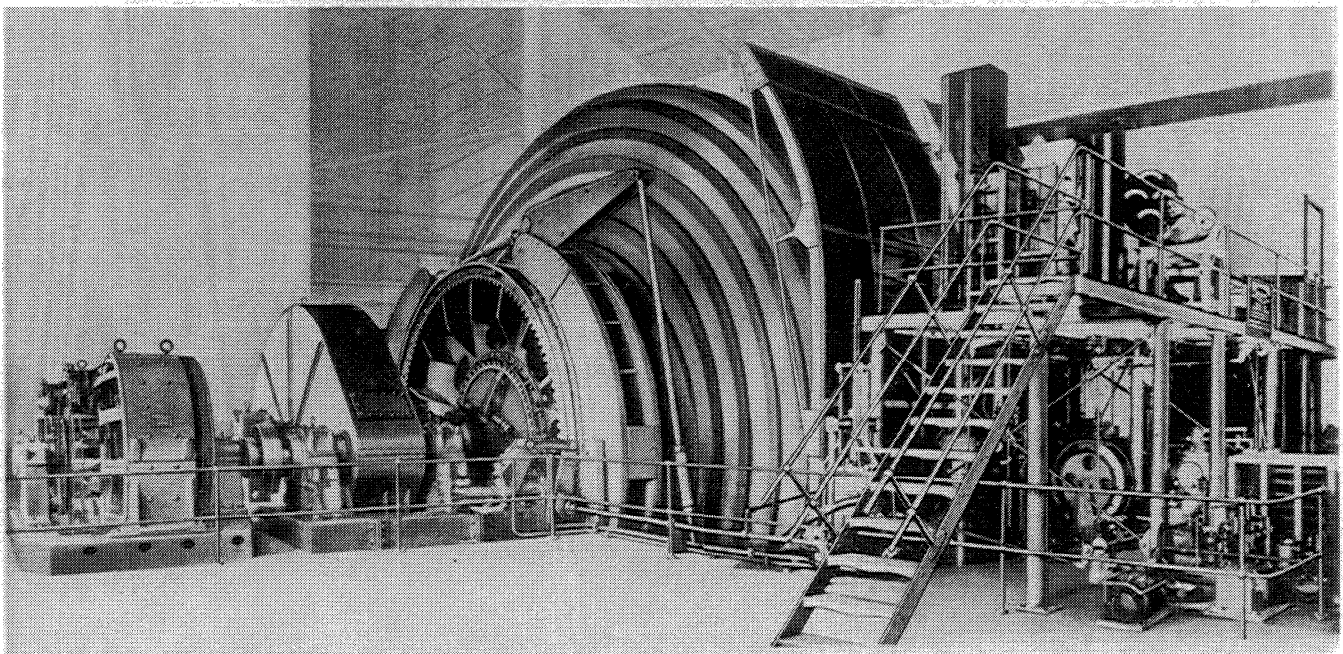


FIG. 46—A large double-drum electric hoist with twin D.C. motors having a total of 5000 H.P. and Ward-Leonard control, at a gold mine in India. It hoists a 10,000 lb. load at 3000 ft. per minute from a depth of 6600 ft.

Two Model C Lilly Controllers with Duplex Governors and long range dial drive are installed under the platform, one of them just visible back of the stairs. This installation was made by the Metropolitan-Vickers Electrical Co., Ltd., Manchester, England.

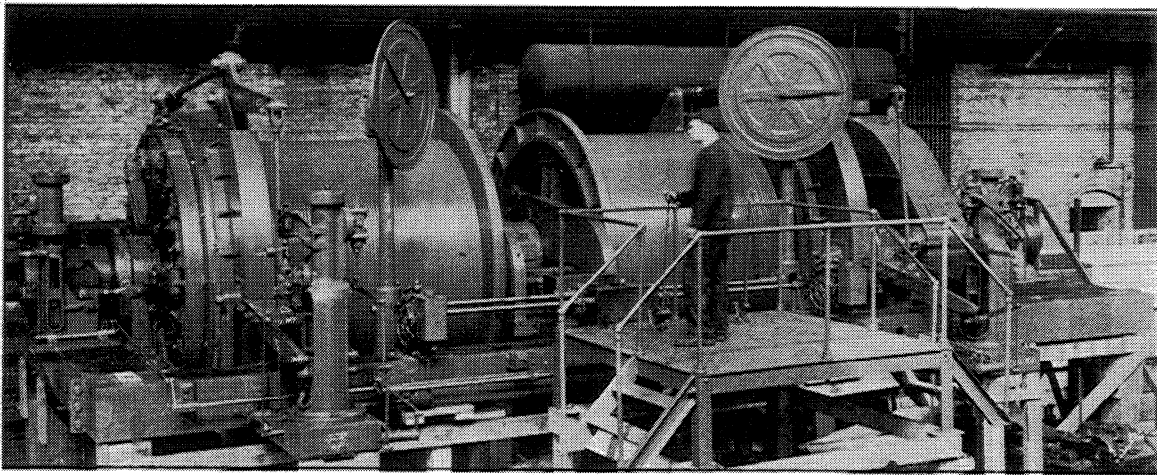


FIG. 47—A double-drum Allis-Chalmers electric hoist, (shop picture) for a Michigan iron mine. Two Model C Lilly Controllers are installed on the bedplate near the depth indicators.

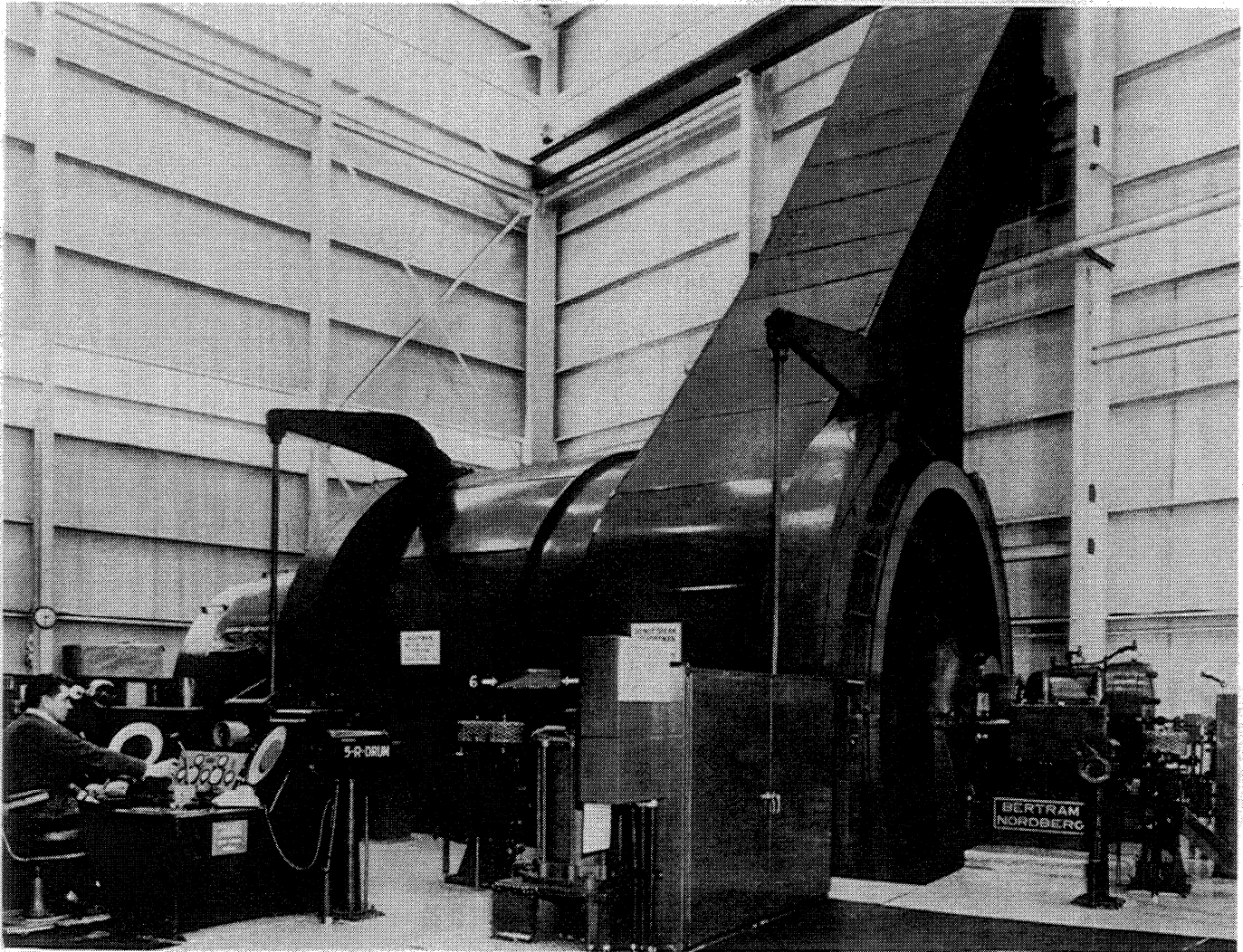


Fig. 48—Bertram/Nordberg (Orenstein & Koppel) sixteen-foot six-inch double drum hoist equipped with Variable Depth Model C Logan-Lilly Controllers.

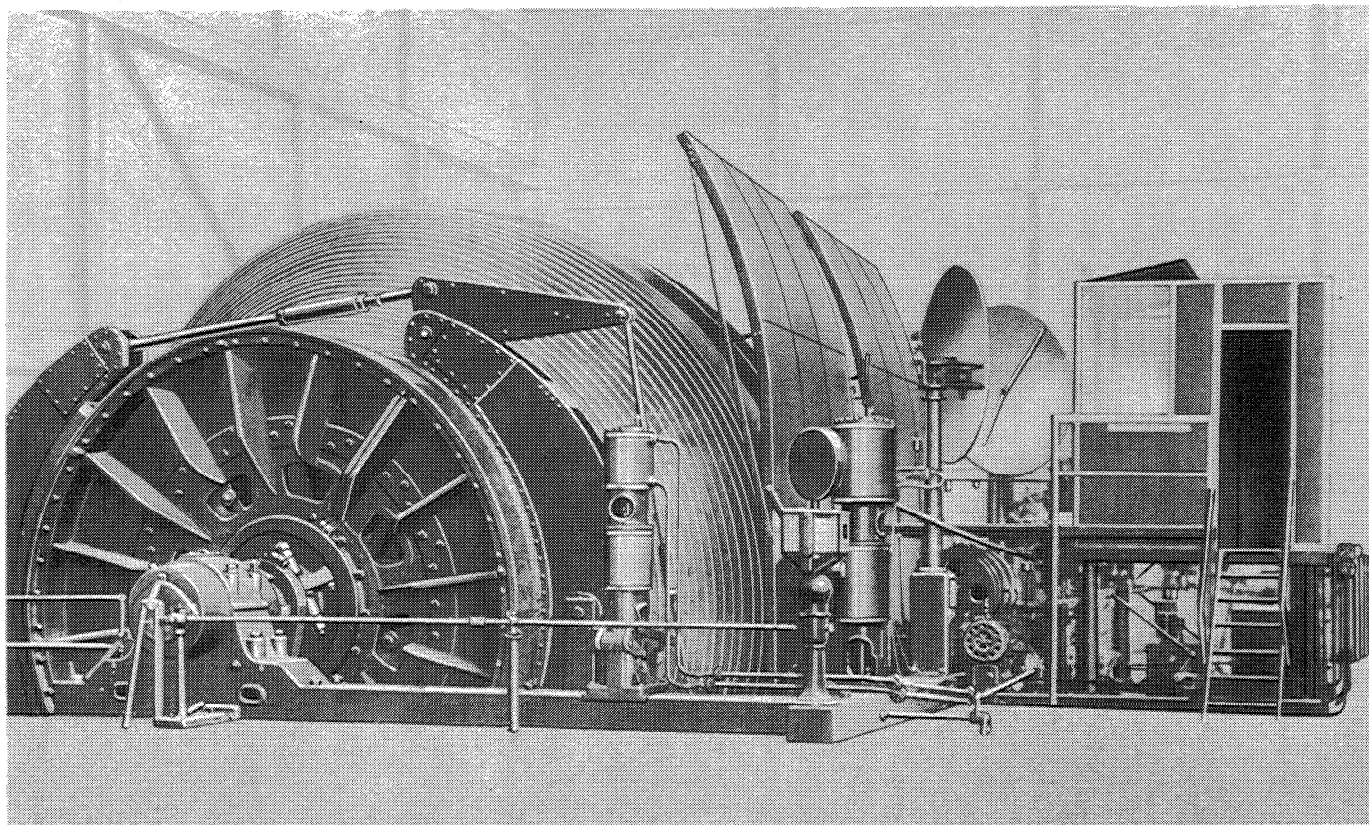


FIG. 49—One of two large Fullerton, Hodgart & Barclay double-drum electric hoists with twin motors, each of 2600 peak H.P. The drums are 26 ft. in diameter, and wind 4000 ft. of 1 1/4" rope at 3520 ft. per minute. Two Model C Lilly Controllers are installed, one of which can be seen in the foreground near the depth indicator.

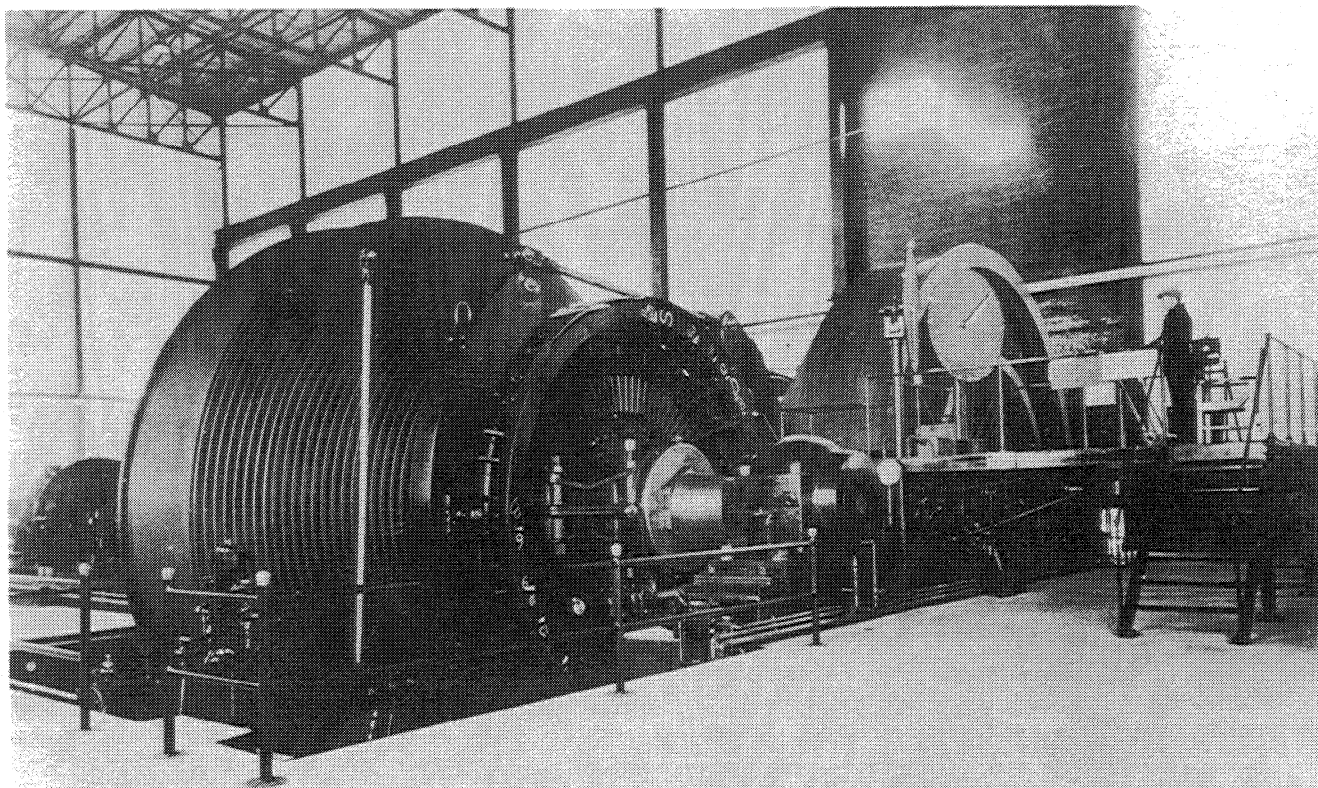


FIG. 50—A large Canadian Allis-Chalmers Co., double drum electric hoist installed at a nickel mine, near Copper Cliff, Ontario. This hoist, which is one of the largest in Canada, has drums 25 ft. in diameter. Two Model C Lilly Controllers are installed, one at the left of the nearer drum, and the other in a corresponding position beyond the other drum.

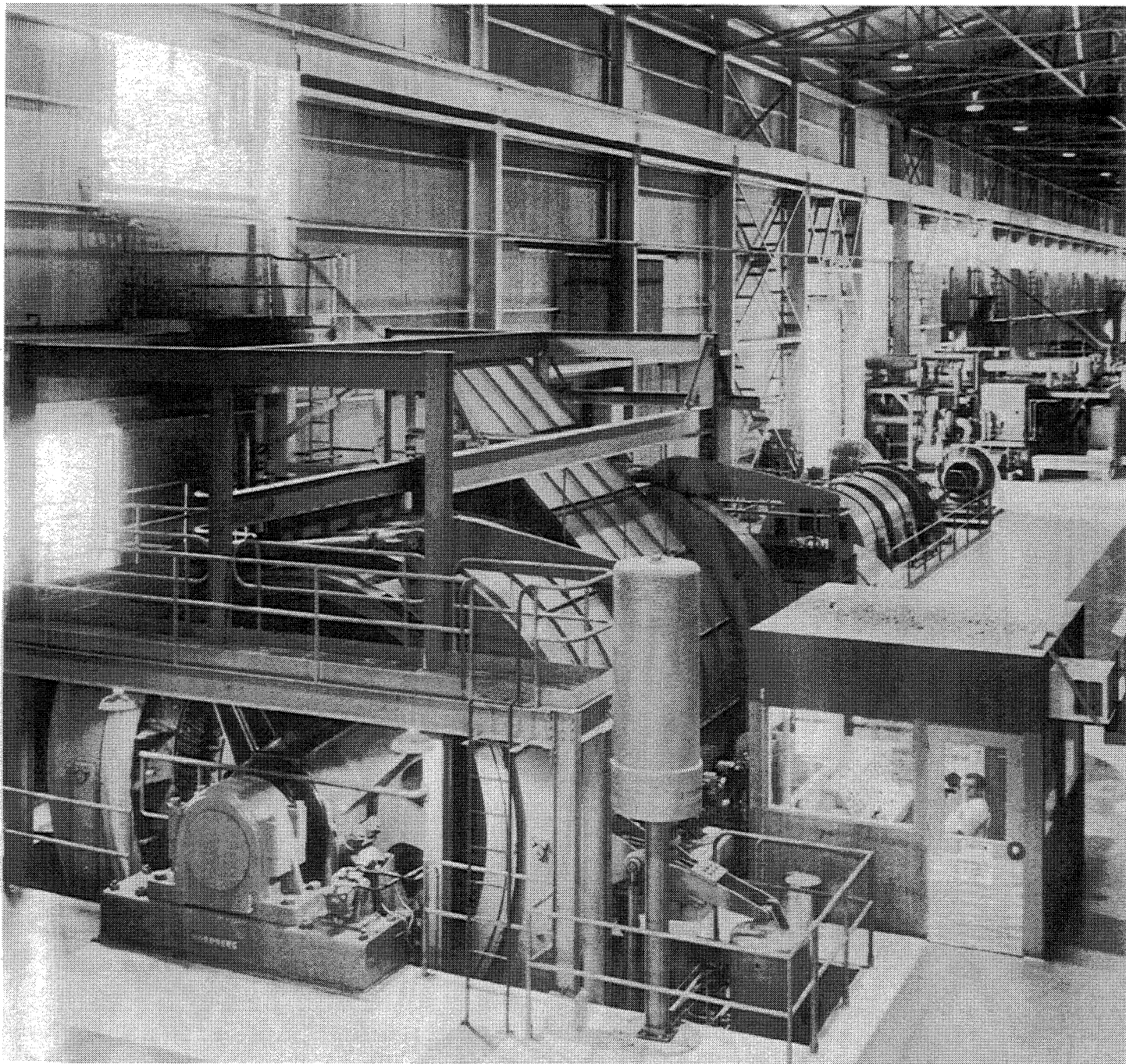


Fig. 51—Portion of hoist house at a western U.S.A. copper mine containing five Nordberg double drum hoists, each equipped with Duplex Governor Model C Logan-Lilly Controllers.

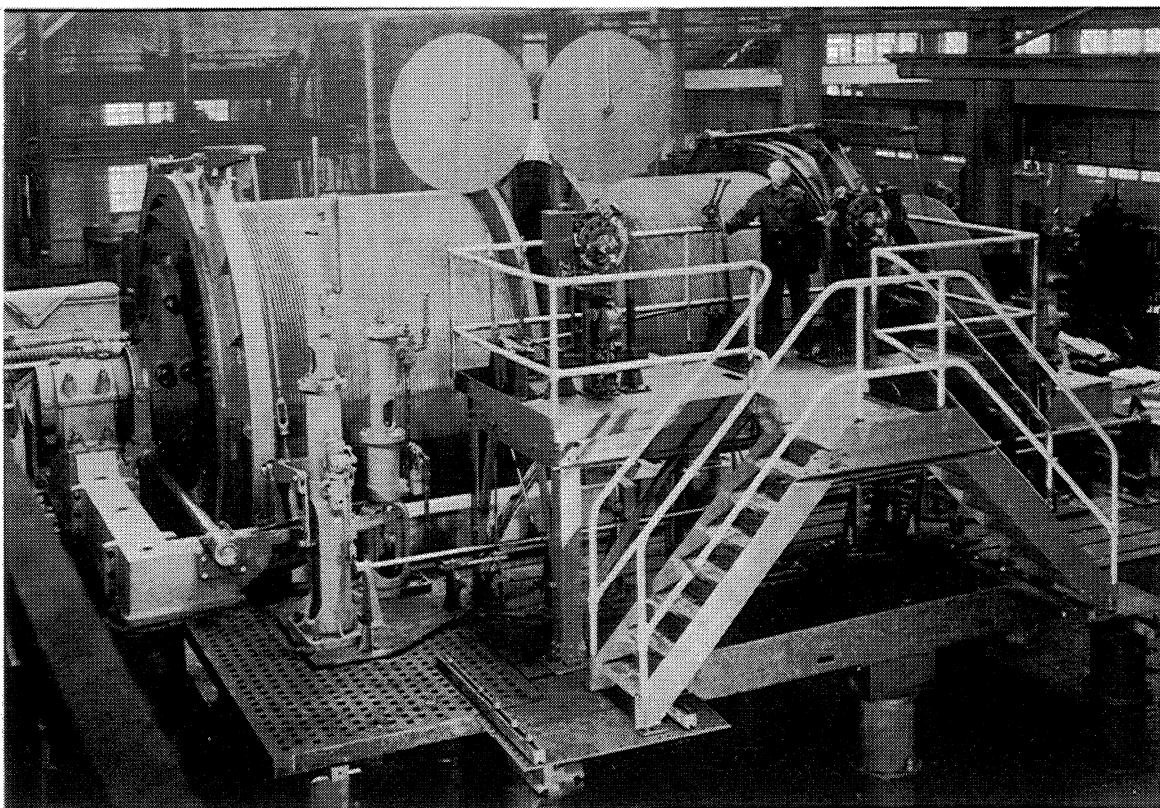


FIG. 52—A large Wellman Engineering Co. double-drum electric hoist, (shop picture) for an iron mine at Wabana, Newfoundland. Two Model C Lilly Controllers and Weight Units are shown the platform in a very accessible position.

The hand levers for the man-safety are in view on the railing of the platform, in front of the hoist-man's position.

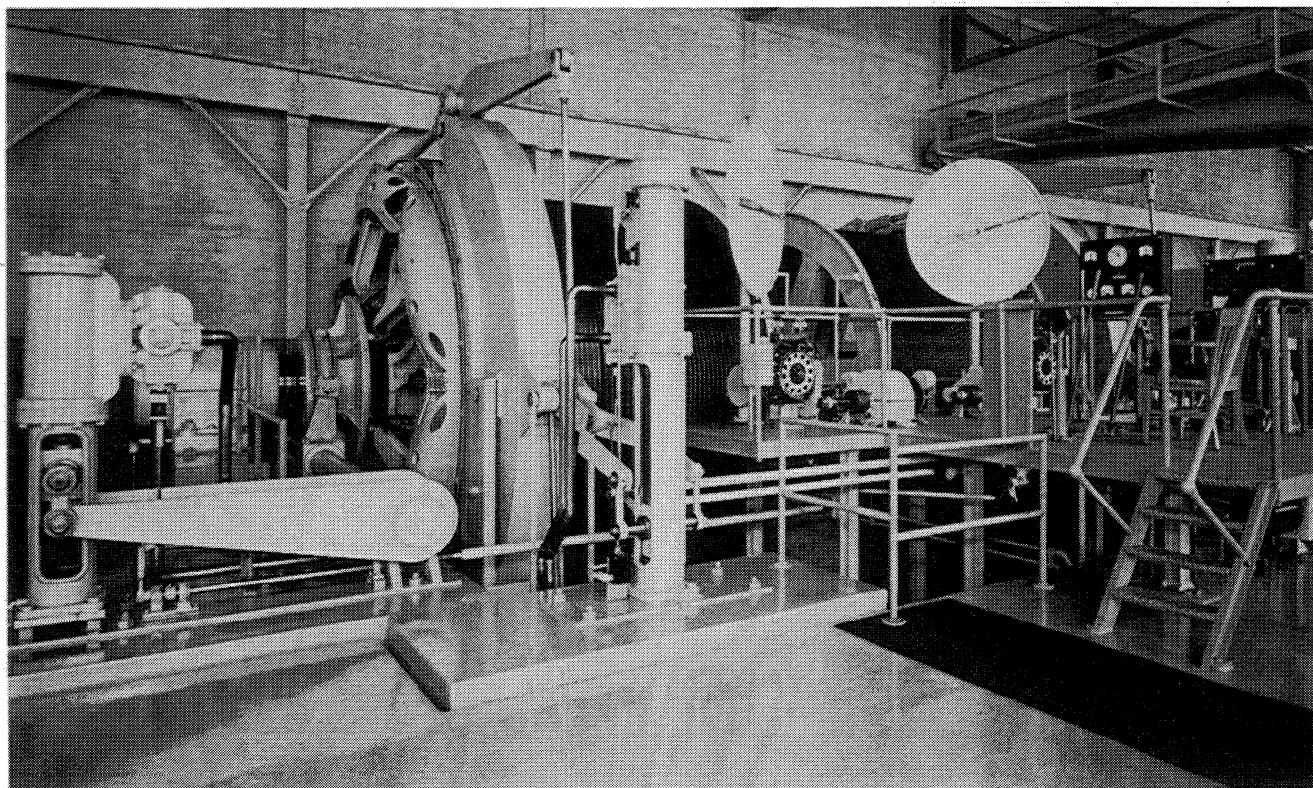


Fig. 53—A double drum hoist built by Lake Shore Engineering Company with two Duplex Governor Model C Logan-Lilly Controllers visible on the platform with easy access for maintenance and adjustment.

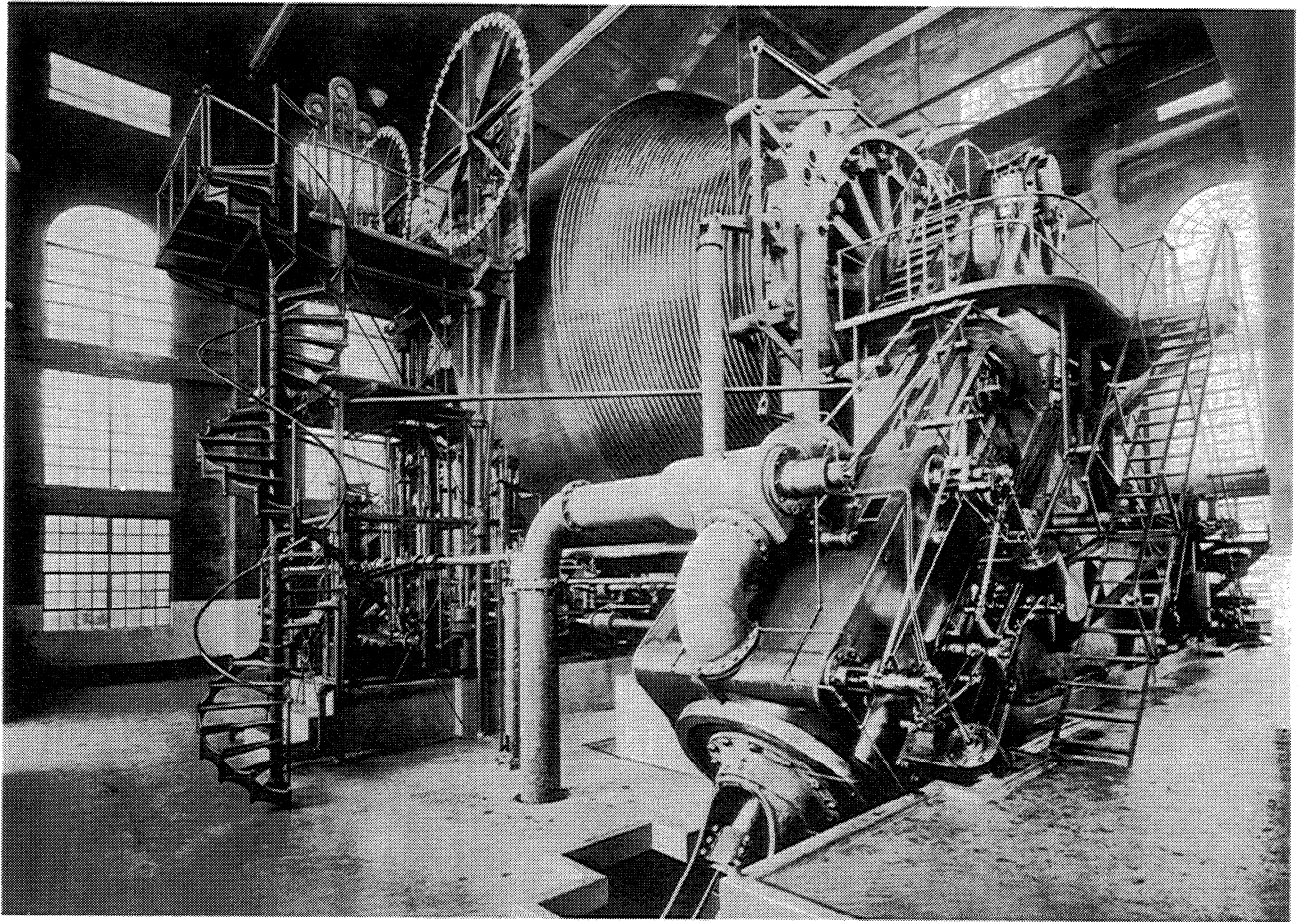


FIG. 54 (Above) — A large Nordberg single-drum steam hoist at a copper mine at Hancock, Michigan. This hoist is now on exhibit and said to be the largest steam hoist in the world. It has a cylindro-conical drum 30 ft. in diameter, with capacity to wind 10,000 ft. of rope to serve an incline shaft. A Model C Lilly Controller (not shown) is installed below the drum.

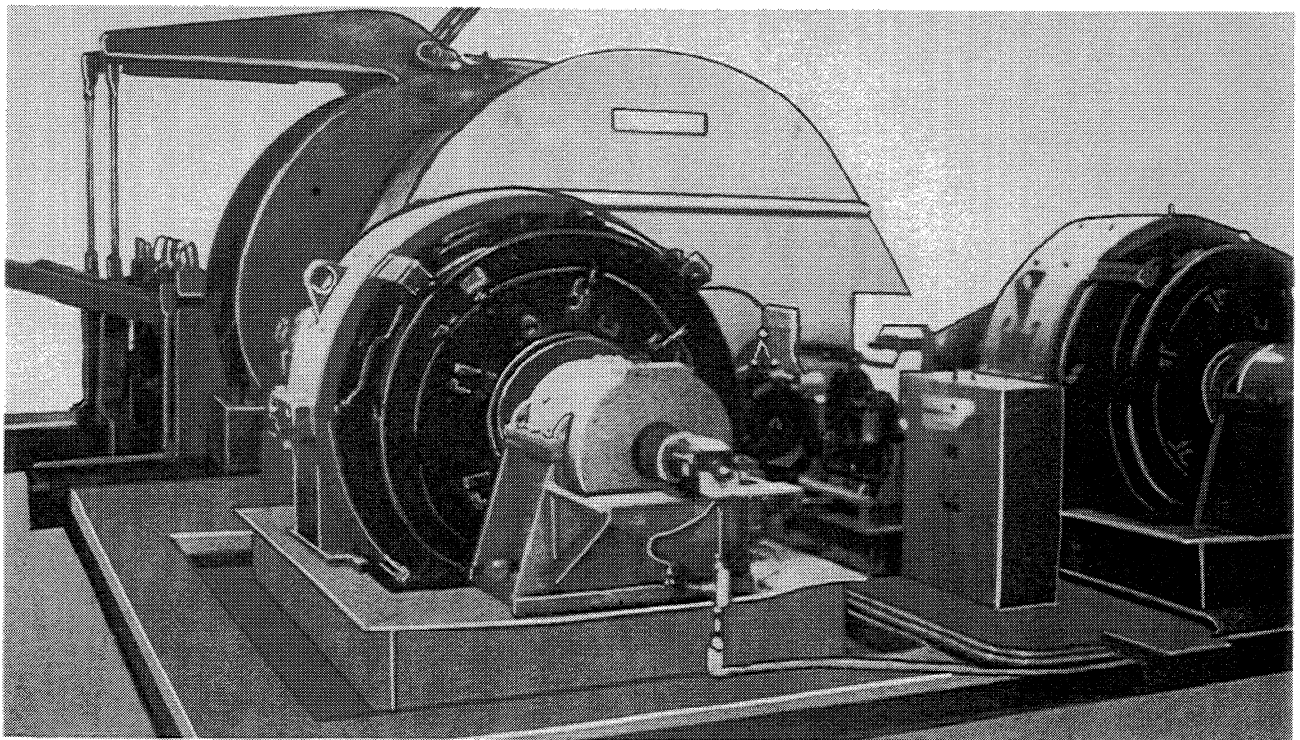
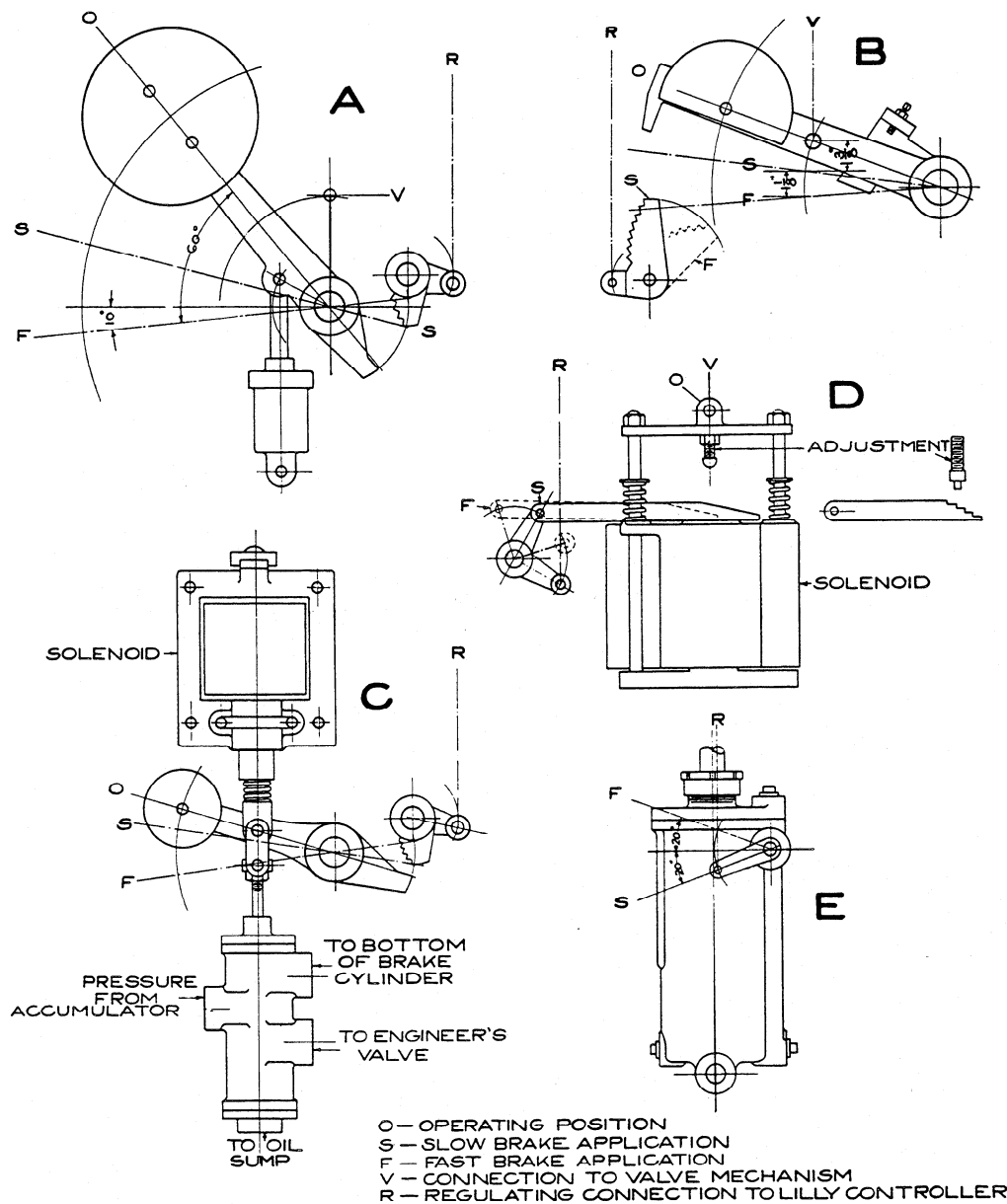


Fig. 55—A Nordberg ten-foot diameter, four rope, ground mounted friction hoist in a southeastern U.S.A. coal mine, with Model C Logan-Lilly Hoist Controller.



- A** — BRAKE REGULATING STOP FOR AIR OPERATED GRAVITY BRAKE EQUIPMENT
B — BRAKE REGULATING STOP AS USED WITH EQUIPMENT FOR STEAM HOISTS.
C — BRAKE REGULATING STOP AS USED WITH EQUIPMENT FOR OIL OPERATED GRAVITY BRAKES
D — ANOTHER METHOD. BRAKE REGULATING WEDGE AND STOP.
E — REGULATING CYLINDER. VALVE OPENS UPWARD IN STANDARD EQUIPMENT FOR "HAND OPERATED BRAKE" HOISTS. MAY BE ARRANGED TO OPEN IN EITHER DIRECTION.

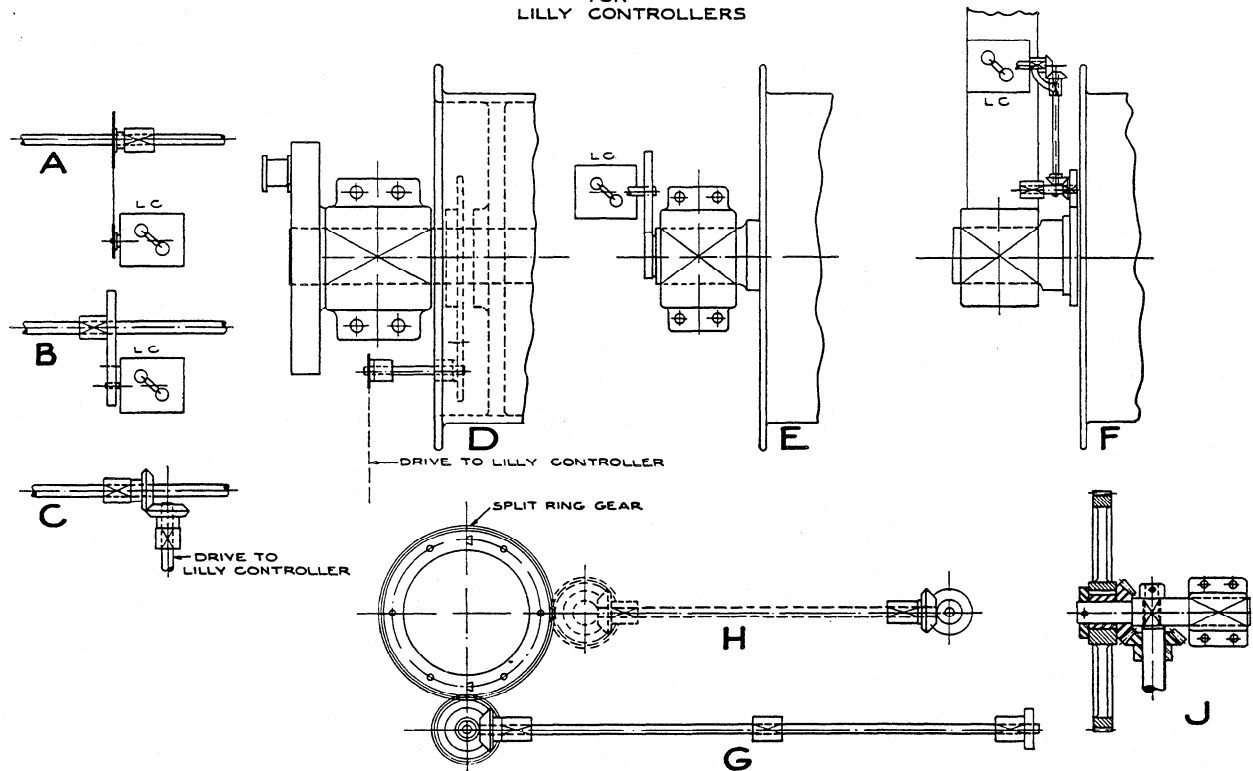
BRAKE REGULATING DIAGRAMS FOR LILLY HOIST CONTROLLERS

C-522

FIG. 56—Various forms of brake regulating means used with Lilly Hoist Controllers.

INSTRUCTIONS

STANDARD METHODS OF DRIVE FOR LILLY CONTROLLERS



THREE METHODS OF DRIVE
FROM INDICATOR SHAFT

- A** CHAIN AND SPROCKETS
- B** SPUR GEARS
- C** BEVEL GEARS

- D** CHAIN DRIVE WHERE DRUM OVERHANGS
- E** SPUR GEAR DRIVE FROM END OF SHAFT
- F** SPUR AND BEVEL GEAR DRIVE FROM INSIDE OF BEARING

G-H-J SPUR AND BEVEL GEAR DRIVE FROM
LOOSE DRUM (WORM DRIVE NOT SUITABLE)
PROVIDE ALL BEARINGS WITH GREASE CUPS

C-528

FIG. 57—Usual methods of driving Lilly Hoist Controllers. See paragraphs 120 to 132.

THE LOCATION OF A LOGAN-LILLY CONTROLLER ON A HOIST

120. The Lilly Controller and auxiliary equipment should be so located on a hoist, that it will be accessible, and well protected against water, oil or tar from the ropes, and mechanical injury, which might be caused by a rope breaking, or when repairing or adjusting the brakes. Protection against damage, and accessibility for oiling, adjusting and inspecting are of prime importance, and should not be overlooked. See Governor Guards, Fig. 26 and 27 if required.
121. The drive for the Lilly Controller, and the connections to the brake mechanism and all other control elements should receive careful thought, and a location for the controller should be selected that will make possible the simplest and most economical installation.
122. Where there is danger of the Lilly Controller being damaged by water, oil or tar from the ropes, or excessive dust and grit, a guard or case should be provided for its protection. See Fig. 22 or 23.
123. Lilly Controller should *never be installed on the floor or in inaccessible corners*, or where an attendant inspecting, oiling or adjusting them would be endangered by other moving parts.
124. By placing the controllers in desirable locations and at a convenient height, the inspecting, oiling, and adjusting are greatly facilitated, and they are less likely to be neglected.

THE DRIVE FOR THE LILLY CONTROLLER

(See Fig. 57)

125. The Lilly Controller must be positively driven in ratio with the hoist drum (or reel) by cut gears or by roller chain and cut sprockets.
126. It is frequently possible and convenient to obtain a drive from the end of the drum shaft of a single drum hoist having a tight drum. In many cases, however, it is preferred to arrange a drive from another part of the drum shaft, and where the depth indicator is driven by rugged gearing, it may provide a suitable drive for the Lilly Controller.
127. Some specifications, however, call for completely independent drives for the depth indicators and the Lilly Controllers, so that if either drive should go out of order it will not interfere with the performance of the other.
128. The drive from a free drum is usually transmitted by means of a ring gear attached to the drum hub, and both the depth indicator and the Lilly Controller are driven from the ring gear, either by a single gear or by an independent gear for each.
129. Drives should in all cases be arranged so that they will not be affected by lateral motion of the drum. Some forms of worm gear drives for depth indicators, and some bevel gear drives are affected by lateral motion of the drum, rendering them unsuitable for driving a governor or a travel limit device. Spur gears or steel roller chain and cut steel sprockets permit lateral motion of the drum to take place without affecting the drive, and they are recommended for that reason.
130. Where the Lilly Controller is installed at a considerable distance from the hoist drum, it is usually best to transmit the drive from the spur gears at the drum through a shaft with bevel gears at one or both ends.
131. In some of the old hoists, it is not possible to use a gear drive or a shaft drive from the drum, and chain and sprockets must be used. In some other installations it is desirable to use chain drive where a gear drive would be expensive or hard to install. Provision should always be made to take up slack as the chain wears, and very long chains should not be used.
132. Only gears or sprockets with machined teeth, and steel roller chain should be used to drive a controller, and all gears, chains, and sprockets should be guarded.

EXPLANATION OF THE MODEL C LILLY CONTROLLER ACTION

(Referring to Fig. 58)

133. A—Shows the arrangement of the cams in their correct relationship on the dial as they would be when the hoist has reached one of its limits of travel, the dial approaching that limit running in the direction of the arrow.
134. It will be observed that the cam for the retarding alarm gong has passed the bell trip, having sounded the gong before reaching the retarding zone. Then the accelerating cam closes the accelerating switch, after which the retarding cam comes in contact with the roller of the retarding yoke, moving it downward as the hoist proceeds toward the end of travel. If a stop is not made when the limit of travel is reached, the limit cam shown above the dial, engages with a limit switch roller and opens the limit switch.
135. B—Shows the limit switch with connection for operation by the cam.
136. C—Shows the connection from the governor to one end of a floating arm, and the connection from the retarding yoke to the other end, while the floating arm is carried in a fork of the contact arm. It will be observed that action by the governor or the cam, or by both combined, operates the contact arm, and when the alarm contacts engage, the overspeed alarm bell will ring. Further movement causes the overspeed switch to open.
137. When Man-safety equipment is used, if it is desired to limit the man speed below full hoist speed, a tappet engaged by the cam-arms No. 190 (See Fig. 9 and 58) carries the retarding rod upward when the man-safety is engaged, to bring the alarm contacts to the correct relative position for the desired man speed. In the diagram the alarm contacts have already been brought nearly together by the action of the retarding cam, and in practice the tappet would be set higher than where it is shown. In any case the retarding cam will raise the retarding rod as soon as the point in the retarding zone is reached where the safe speed is lower than the man speed, and from that point to the end of the trip the tappet will be raised clear of the lifting cam.
138. Referring to "D"—the function of the accelerating solenoid and associated members, is to separate the overspeed contacts a small amount each time the hoist accelerates when leaving the end of travel until the retarding cam clears its roller. By referring to the electrical diagram in Figs. 68 & 69 the action will be more clearly understood, and only the mechanical action will be explained here.
139. When at the end of travel, the roller being at the full height of the retarding cam, the fulcrum point Y of the solenoid floating arm is raised to the position shown. When the solenoid is energized, lifting the core and the end of the floating arm to which it is attached, it raises the fulcrum point X of the contact arm and separates the contacts.
140. As soon as the hoist drum commences revolving away from the limit of travel, the retarding yoke gradually moves to the position indicated by the broken line, carrying the link and arms to a corresponding position, so that the fulcrum point X of the contact arm is gradually brought back to near its normal position as the retarding zone is cleared, and when the cam releases the accelerating switch, and the solenoid core drops, it brings the contact arm fulcrum X to its normal position, and withdraws the solenoid lifting rod a short distance in the upper telescopic connection, then the solenoid remains inactive until the hoist again commences to accelerate from one of its limits of travel.
141. The warning gong is sounded by a striker operated by a spring and a cam for each direction of hoist travel, so that the gong rings only when the hoist approaches the retarding zone, but not when leaving.

ADJUSTING A MODEL C CONTROLLER

142. See that all switch contacts are clean, and that the governor dash-pot is filled to near the top with a medium or light engine oil.
143. When the governor is inactive at the ends of travel, and the roller against the highest part of a retarding cam, the alarm contacts should be a short distance apart. (Usually about 1/32".)
144. This adjustment should be right when the controller leaves the factory, and should seldom need adjusting in the field, except to take up wear after a period of time.
145. (a) Disconnect the brake regulating rod, leaving the regulating stop in position for slow brake application.
146. (b) Remove the retarding cams from each dial, and put the nuts back on the bolts so that they cannot back out through the entering hole and become jammed by the movement of the dial.

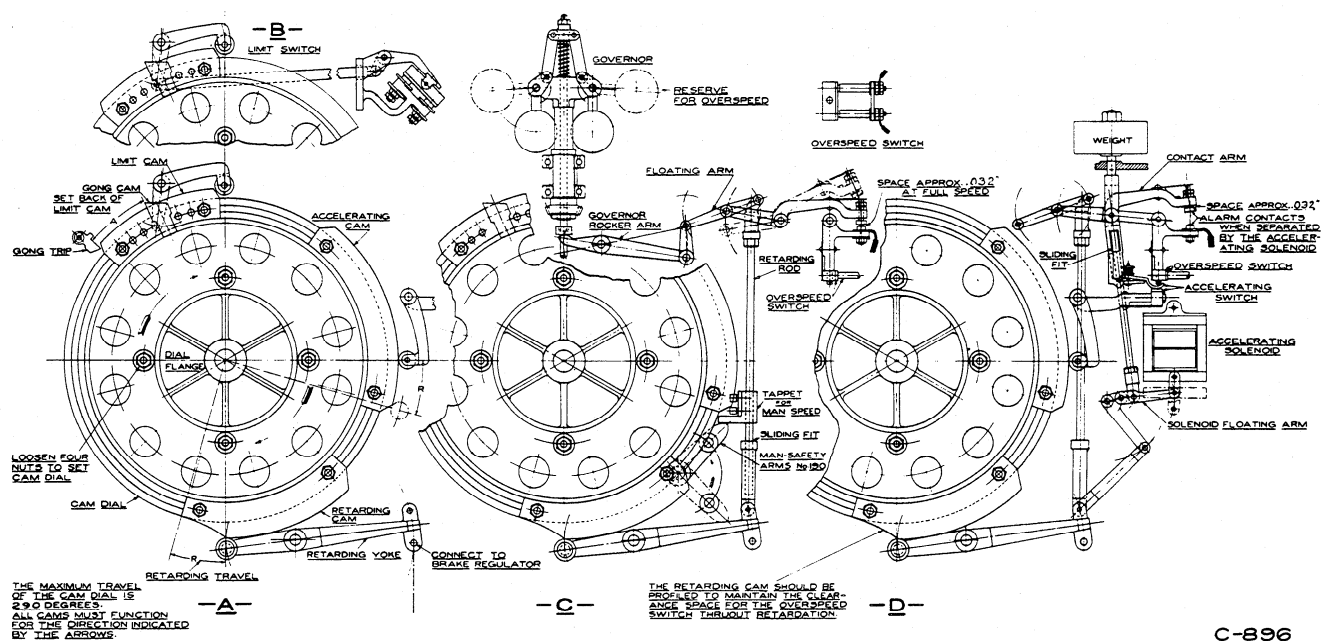


FIG. 58—Elements and adjustments of a Model C Lilly Hoist Controller. See paragraphs 133 to 170.

147. (c) Set the alarm cams to ring the gong just before reaching the retarding point, when approaching the end of travel.
148. (d) Set the limit cams to open the limit switches at their respective ends of travel slightly beyond the normal stopping point. The circuits may then be connected through these switches to protect the hoist against over-travel, or starting in the wrong direction at the end of travel.
149. (e) Set the accelerating cams so that each accelerating switch will close just before reaching the retarding zone for its respective side.
150. (f) Connect the circuit for the overspeed alarm bell. (Top and center of switch box panel.)

151. While operating the hoist in the usual way at full normal speed, note the distance between the overspeed alarm contacts in the switch box, and adjust the governor adjusting spring so the contacts will be separated about 1/32" while the speed is maintained. If unable to get sufficient variation by the adjusting spring, a weaker or stronger governor spring should be used, and the adjustment completed with the adjusting spring. Governor springs are furnished in five different strengths, and adjusting springs in four different strengths.
152. (h) Mark on the cam dial with a lead or soapstone pencil the amount the dial travels during normal retardation, and cut the retarding cam to a wedge shape, starting from the rim of the dial, and reaching the top of the cam at a distance around the dial to correspond with the pencil marks, but curving the wedge somewhat to conform to the curve of the dial rim. Bolt one cam in place on the dial and note the action of the contacts during retardation. The contacts should remain approximately the same distance apart throughout retardation as during full speed. If during normal retardation as conducted from the same point each time, the contacts are too open or too close at certain parts of the profile, the cam should be fitted to correct the action and to give an even curve that will follow closely the movement of the governor and maintain the opening between the contacts approximately the same throughout full speed and retardation. See also Par. 195 to 198.
153. If a jumper is used across the overspeed contacts while profiling the cams, attach a large noticeable streamer so the jumper will be removed when going away from the Controller. Do not leave the Controller if the jumper is still in place.
154. The alarm bell assists to correctly profile the cams, and by listening to the bell and marking the cams when the bell rings, the correct profile is readily developed.
155. As both cams are usually alike, the first cam profiled may be used as a pattern for the other, after which each cam may be bolted in place on its dial, to take care of retardation at both ends of travel.
156. The Cam Marker C-1711 (fig. 32) can help in marking the cams while the retarding yoke is manually positioned to the proper contact gap while approaching in the retarding zones.
157. Connect the overspeed and accelerating circuits to actuate the accelerating solenoid and prevent interference by the overspeed contacts during the acceleration period. If the proper connections are made, the contacts will automatically separate when the hoist accelerates while leaving the end of travel, and they will remain in normal relationship while approaching the end of travel. If the opposite results are obtained at first, reverse the wires. Each accelerating cam should function for the retarding cam on the same dial.
158. See that all nuts and bolts are tight, and re-connect the brake regulating rod, after which the equipment is ready for testing.
159. When all speed adjustments have been made, see that the governor has sufficient reserve action to function for overspeed, because if adjusted to the limit for normal speed, there would be no action to take care of overspeed.
160. If, after a period of time, adjustments are necessary, start with paragraph 142 to adjust the contacts so they will come to the the 1/32" gap while the governor is at rest and the roller on the highest part of the retarding cam.
161. To adjust these contacts, loosen the lock-nut on the vertical rod, back of the switch box, and turn the rod in the proper direction to obtain the necessary adjustment, and lock the nut, or adjust the weight above the switch-box. The latter is usually simpler.
162. Then follow with the adjustments for overspeed as per paragraph 151.

ADJUSTING THE MAN SAFETY EQUIPMENT OF A MODEL C CONTROLLER

(See Page 65 for Long-Range Man-safety)

163. (a) With the man-safety arms in the Lilly Controller connected to the hoistman's man-safety levers, see that the proper movement is obtained when the levers are placed in position for full speed, and also for man-speed. See Fig. 59. The arms No. 190 in the controller should move the full distance between the stops.
164. Pneumatic/electric or hydraulic/electric Man-Safety Operators are available. See Fig. 36 and 37.

165. (b) If the weight of the hand lever is not sufficient to positively hold the man-safety in engagement, drill holes in the quadrant for the lock pin of the lever to hold it in place when engaged.
166. (c) After the retarding cams are set for the extreme limits for the dump or tippie, with the man-safety disengaged, run the hoist to the position where it should be stopped for men, and move the lever to engage the man-safety. Then adjust the dial advancing rod to rotate the dial the necessary amount to bring the limit cam close to the roller, so that further movement would open the limit switch. Lock the adjustment by the nut, and proceed to adjust the other dial the same way to take care of the travel for men at the opposite side.

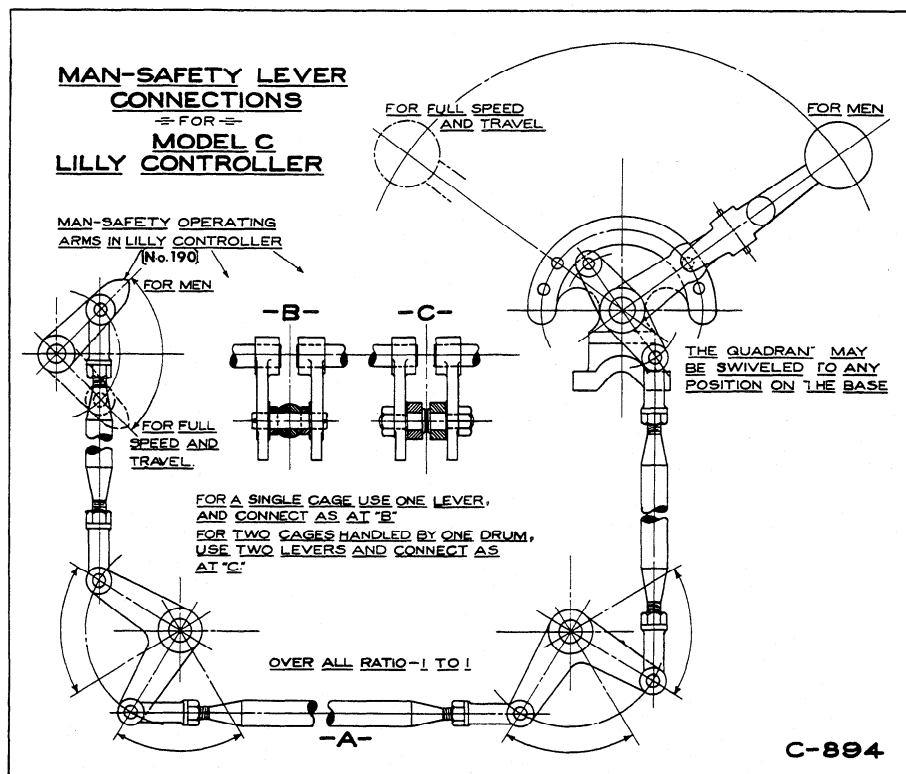


FIG. 59—Connections for Man-safety levers. See paragraphs 15, 64 to 69 and 163 to 169.

167. (d) Run the hoist at the man-speed, and note the distance the vertical rod back of the switch box must be raised to ring the bell. Stop the hoist, and place the man-safety lever in the position for handling men, and set the tappet on the rod so that the tips of arms No. 190, will hold the rod up to bring the overspeed contacts approximately 1/32" apart while the hoist is run at the man speed. Test the setting by running the hoist at the man-speed, noting the distance between the alarm contacts, and readjust the tappet if necessary.
168. (e) Check the light circuit and see that the lights indicate correctly in the engine room and at the shaft, the engagement and disengagement of the man-safety equipment, and the cage being protected.
169. (f) The necessary tests to prove the efficiency of the man-safety equipment for speed and stopping points may now be made.

STOP PINS FOR MAN-SAFETY QUADRANT

170. After the man-safety levers have their movement checked and approved, a hole should be drilled in the quadrant just outside of each extreme position, and a 3/8" pin driven in, as a stop for the lever, to enable the hoistman to find the stopping point easily and quickly, and also to prevent straining the connections by forcing the levers beyond their normal limits of travel.

ADJUSTING DUPLEX GOVERNORS

171. The high-speed governor for the standard 12:1 ratio governor or for the optional 16:1 Range should become active at the lowest hoist speed possible, and its action should continue beyond half speed, at which point this governor reaches the limit of its action.
172. Before the high-speed governor reaches its limit of action, the low-speed governor becomes active, and its action continues up to full hoist speed, with a reserve for overspeed. Through the floating arms the combined action of the two governors blends into a smooth continuous action with a total range more than twice that of a single governor.
173. The high-speed governor must be very sensitive to provide protection for low hoist speeds to insure that the hoist cannot reach the limits of travel without adequate retardation. It is furnished with a light governor spring which should normally not be changed.

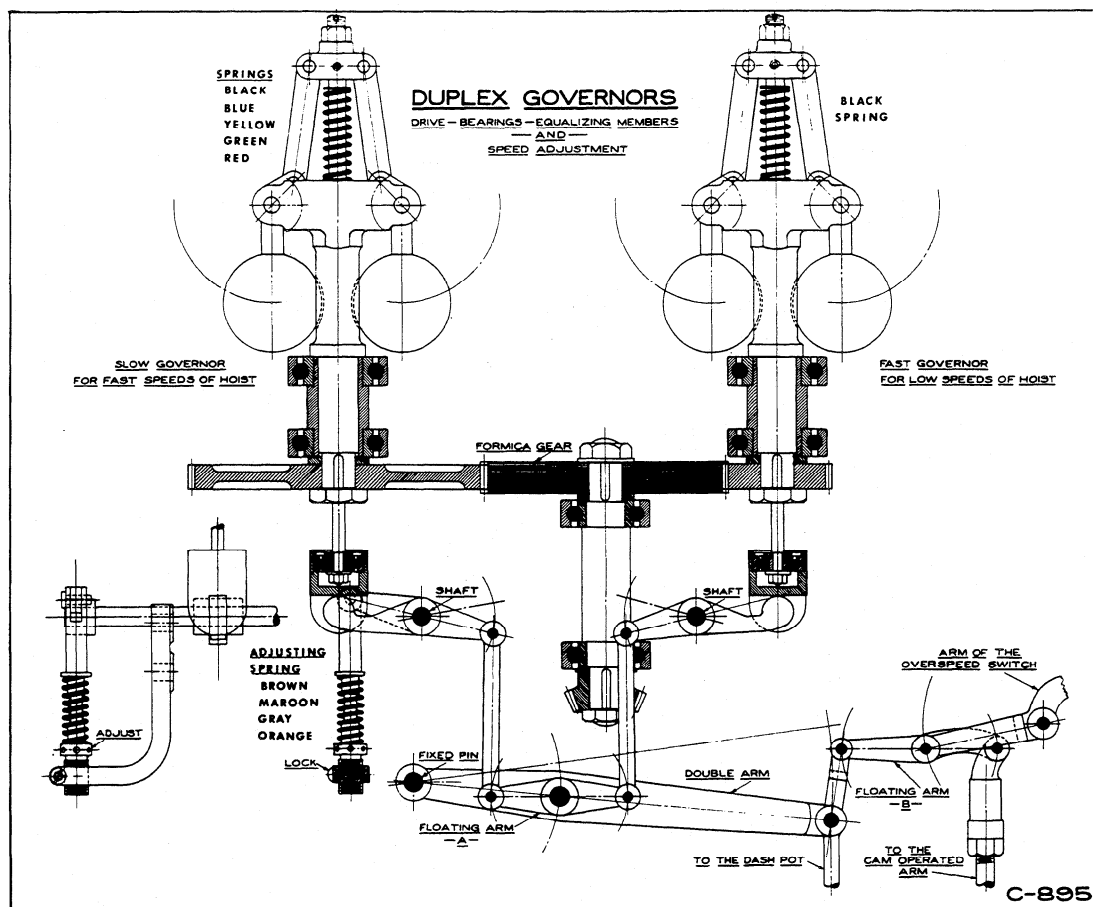


FIG. 60—Arrangement of the drive, bearings, equalizing members and speed adjustment for Duplex Governors. It will be noted that all movements of both governors and the movement of the cam operated rod are co-ordinated through floating arms A and B to produce a resultant in the movement of the arm for operating the overspeed switch. See paragraphs 56, and 171 to 179.

174. All speed adjustments act on the low-speed governor, which guards against overspeeding for intermediate positions in the trip. Adjustment for this governor is provided by five interchangeable springs for the governor spindle, and four shorter interchangeable screw adjusted springs below and alongside the governor.
175. If the controller is driven at the listed speed, the springs with which it is equipped at the factory should be satisfactory, but if the driving speed should be slightly different, the springs on the governor and if necessary on the side adjustment should be changed to bring the overspeed contacts to approximately 1/32" from each other, completing the adjustment by the adjusting screw, which should be at an intermediate position until the correct springs have been selected.
176. Governor springs are color coded BLACK, BLUE, YELLOW, GREEN, RED in order of increasing strength.
177. Adjusting springs are color coded BROWN, MAROON, GREY, ORANGE in order of increasing strength.

178. One or two extra washers may be used under the governor spring if desired, to permit higher speed, especially where the next heavier spring may be stronger than necessary, but the slack above the spring in the governor should not all be taken up, as there should be a minimum *clearance* of 1/32" at the end to *insure overspeed trip allowance, which should be checked.*
179. When the correct adjustment has been made, the adjusting screw should be locked by the pinch screw in the bracket.

ADJUSTING THE LONG-RANGE DIAL DRIVE

180. Before connecting the drive from the hoist drum to a Lilly Controller with a Long-range Dial Drive, disconnect both weight chains, and turn the stop posts around so they will not interfere with the stop finger if the cam dial should be revolved a full revolution.
181. Run the hoist to one extreme end of travel, and observe which cam dial will protect the hoist for that direction of travel. Revolve that cam dial by hand in the opposite direction from that in which it will revolve when driven by the hoist, screwing the dial hub over the threaded sleeve until the driving dogs engage. Set the limit cam so that if the hoist should move closer to the limit of travel, the limit switch will be opened. Run the hoist away from the limit of travel to a distance below the point where retardation should commence. Stop the hoist, and then return to the retarding point, thus taking up any slack that may be in the drive to the Lilly Controller.
182. Slacken the clamp screws of the stop finger, and also swing the stop post around to engage the stop finger, while keeping the driving dogs engaged. Tighten the finger clamp while the stop finger is in contact with the top of the stop post.
183. Connect the weight chain to the stop finger to pull the latter against the stop post.
184. The accelerating cam may now be set in place on the dial so that it will have just closed the corresponding accelerating switch at this point approaching the limit of travel while operating normally.
185. The gong trip may be tentatively set so that the gong will sound shortly before reaching the retarding zone.
186. The only cam remaining to be set is the retarding cam, and it should be profiled as explained in Paragraphs 195 to 198 and then set on the dial as shown in Fig. 58.
187. Run the hoist to the other end of travel, the threaded sleeve already adjusted unscrewing from the dial hub, and keeping in synchronism for the return trip.
188. Proceed to adjust the other cam dial in the same manner.
189. When the Lilly Controller has man-safety equipment, the main adjustments should be made in the same manner as directed, and then the hoist should be stopped at a man-stop, and the man-safety engaged.
190. See that the long setscrews in the ends of the dial shaft are withdrawn so that they will not interfere while making the adjustments.
191. Tighten the nut outside of the rocker-arm crosshead, thereby moving the spiral sleeve inward to rotate the cam dial until the limit cam is brought close to the limit switch roller.
192. Tighten the nut against the inside of the crosshead, and then the two lock nuts.
193. Finally tighten the stop screws, one in each spiral sleeve, to prevent the sleeves from throwing too far if the hand levers should be moved quickly.
194. Adjust the other cam dial in the same manner, and then set the tappet back of the switch box to control the man speed if it is desired to limit it below the regular full speed of the hoist.

CAM PROFILES

195. Fig. 61 shows six cams, each of which is profiled in the field to suit different conditions. The dotted outline shows the shape of the cams as they are furnished from the factory, and the full line shows the finished profile after being fitted at the hoist. The letter "R" indicates the "Rétardation Travel," and each cam is shown in the position with relation to the roller that it should always occupy when at the limit of travel.
196. The profile of the cams as furnished may be very nearly right, but they usually have to be fitted on the job to suit the operating conditions, and may then resemble one of the following illustrated operating profiles.

"A" shows a very common cam profile, and indicates that the period of retardation is relatively small as compared with the dial movement, such as hoisting at average speed from a fairly deep shaft.

"B" shows a cam profile that indicates a long and very gradual retardation as compared with the depth of the shaft. In balanced hoisting when the power is shut off early and the hoist allowed to coast to the end of travel, the cam will frequently have a profile similar to this.

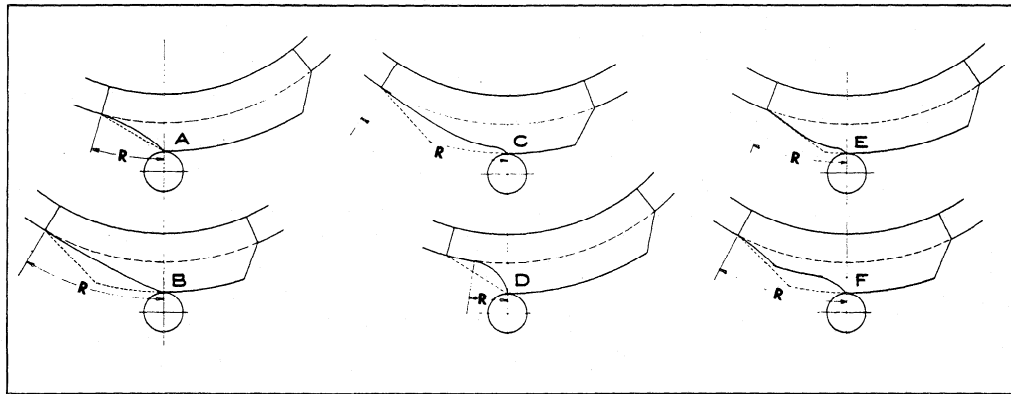


FIG. 61—Cam Profiles. See paragraphs 195 to 198.

"C" shows a cam similar to "B," but it indicates that a higher speed is carried near to the limit, and the action of dumping or the application of the brakes brings the hoist quickly to rest.

"D" shows a profile that indicates slow hoisting from considerable depth, or hoisting at average speed from a very great depth where the retardation travel is small as compared with the full travel.

"E" shows a profile that indicates normal retardation to about quarter speed, then more gradual, and finally a quick stop. This shape of cam frequently results from local conditions in the dump or tippie.

"F" shows a profile that may be used for the top or bottom of a shaft when using a single rope on the drum. The object of this shape is to compel the slowing of the hoist at a distance from the limit, and to proceed within that speed toward the limit, finally retarding to the stopping point. Such cams are sometimes necessary because of conditions in the shaft or in the head frame.

197. The cams as furnished are longer than generally required, so that there is ample material to profile them to suit almost any conditions. In case the cams prove to be longer than necessary, preventing sufficient movement of the controller dial, they may be shortened, but in doing so the back end should be cut with a bevel like the original shape in order to avoid danger of jamming against the roller if the cam should happen to be reset at the wrong side of the roller. If longer cams are necessary, they can be furnished.
198. A cam marker device is available to assist in the initial profile marking in the field by insertion in lieu of the retard cam roller and manually positioning the retarding yoke while entering the retarding zone. See Fig. 32.

BRAKES—ADJUSTING THE AUTOMATIC BRAKE OPERATING MECHANISM

(See Fig. 62 and A, B, C, D, E, Fig. 63)

199. The brake applying mechanism should always be adjusted while the hoist is standing in an intermediate position, and it is well to make these adjustments before adjusting the Lilly Controller. Do not attempt to adjust the brake control mechanism with the hoist in motion. Observe the speed at which the hoistman applies the brake when the hoist is running at full speed, to stop it without severe shock, and adjust the automatic mechanism to apply the brake in a similar manner when the solenoid or magnet circuit is opened.
200. (a) A single drum hoist with two ropes may usually be balanced at an intermediate position, so that the drum will stand with the brake released. With the brake regulating means in position for slow brake action, open the circuit so that the Lilly Controller auxiliary equipment will apply the brake, and observe the speed at which it applies. If not right, adjust the valve movement until the desired brake action is obtained, testing the brake from time to time by alternately releasing and then applying it.

(b) Each brake of a double-drum hoist may be operated in turn and the brake control mechanism adjusted independently while alternately having the opposite brake hold the hoist.
201. On hoists with deceleration regulators, the brake regulating valve positioned by the Lilly Controller, must be adjusted to properly set the brakes if the deceleration regulator fails to act within its adjusted time, taking into account possible drum speedup as a result of the delay in action.

THE AUXILIARY WEIGHT UNITS WITH REGULATING STOP TO OPERATE GRAVITY BRAKE ENGINES

(Figs. 17 to 20)

202. The Lilly Controller auxiliary weight units with regulating stop operate the brake engine valves direct, and not thru a floating mechanism, for the latter would bring the valves to central position before the brake could set fully, preventing further brake travel, whereas moving the valves direct, and holding them in the brake applying position causes full application, the speed of brake setting being governed by the amount of valve opening. When this is done, the floating lever takes care of itself, the movement being taken in a slot or collapsing means when same is provided, or by moving the hoistman's lever when neither slip connection or collapsing means are used.
203. The hoistman's lever should not be moved by the automatic application of the brakes when it moves toward the hoistman to apply the brakes, as it is liable to cause injury. For installations on new hoists, it is an easy matter to provide slotted connections or their equivalent, so that either the hoistman or the automatic safety equipment can apply the brakes without interference from each other. In many cases, especially with oil operated gravity brakes, the hoistman's lever is not affected by the automatic application of the brakes, but in order to reset after an emergency stop, the lever must be placed in the brake applying position before the solenoid will pick up, this feature usually being provided by an electrical interlock. An adjustment must be provided so that the valve opening may be varied as desired, to give the correct speed of brake application. The high part of the regulating stop should check the movement of the auxiliary weight when it drops for intermediate positions in the shaft, but at the limits of cage travel the lowest part of the stop should engage. Between these two extremes of action, the speed of brake application in an emergency will be gradually slower going away from the end of travel, and faster when approaching.

204. The steps of the regulating stop may be altered when necessary, to quicken the brake action at a greater or less distance from the end of travel, relative to the retarding cams, and in some cases the brake action should be quickened to full speed application at the beginning of retardation, while in others it should remain slow to near the end of travel. Usually, however, the brake regulating stop as furnished is satisfactory without changes.
205. If the arm lengths and connections have been correctly designed and the mechanism adjusted for slow brake action, the fast action will be right. It is a good plan, however, to move one of the retarding cams on the dial to the position for quick brake action. Then open the circuit, and observe if the brake applies as fast as necessary.
206. The brakes should act quickly at the ends of travel, in order to stop the drum within the available clearance.
207. *The Lilly Controller prevents approach to the limits except at relatively low speed.*
208. Valve mechanism is sometimes found in which the valves bounce ahead of the position to which they are moved by the Lilly Controller auxiliary weight, thereby tending to set the brakes too fast, and making the operation irregular and unreliable. This can usually be corrected by cams, friction members, dash-pots, springs, or other means of balancing the mechanism.
209. In the design of some brake engines the valves are operated by a vertical sliding rod balanced by a spring, the tension of which may be adjusted by a set collar. This collar should be set so that the spring tends to bring the rod to neutral position, and when it is forced downward by the action of the Lilly controller, the spring prevents the rod from bouncing ahead of the position to which the emergency weight has moved it, setting the brakes in the proper manner.

AUXILIARY WEIGHTS UNITS USING AN OIL REGULATING CYLINDER

210. Auxiliary weight units using an oil regulating cylinder to control the movement of the brake weight should for hand operated brakes be connected to the mechanism direct, and for power operated brakes, they should be connected to operate thru the hoistman's controls and the floating mechanism. See C, D, E, Fig. 63

ADJUSTING THE REGULATING CYLINDER

211. If the action of the regulating cylinder is too slow with the valve closed (the cylinder being nearly full of oil) the adjustment may be changed to keep the valve partially open, and if necessary the hole in the piston may be enlarged, or the valve removed and a leakage groove filed around it to connect with the by-pass, allowing a small amount of oil to pass thru when the piston moves down in the cylinder. If the action is too fast with the valve closed, heavier oil should be used, or the hole in the piston should be partly closed, which can be done by peening the metal around it.
212. If the brake action is not fast enough at the limits of cage travel with the valve open, the passage thru the valves may be enlarged, or lighter oil may be used.
213. The cylinder should not be filled while the piston is up, as the displacement of the rod must be provided for, to permit the weight to fall. Hence it is best to fill the cylinder when the weight is at its lowest position, and let a small amount of oil out, to permit a margin of travel.
214. Where the temperature varies considerably, transformer oil may be used in the regulating cylinder, as temperature changes affect it less than lubricating oil, and its action from day to day will be more uniform.

ADJUSTING THE PISTON VALVE

(For Oil Operated Gravity Brakes Shown in Figs. 15, 16, and 62)

215. The piston-valve plunger has notches extending across both sides at the top, and when the valve is opened the necessary distance for slow brake application, the release of oil from the brake cylinder takes place thru these notches. If the brake action is too slow, the stem should be screwed downward to lower the plunger slightly, and if too fast, the plunger should be raised. If much faster action is desired, it is advisable to remove the plunger from the valve body, and widen the notches across the top, or cut additional notches to allow the oil to flow thru more rapidly.
216. The purpose of the notches to release the oil for slow brake action instead of releasing around the entire circle, is because if there should be a slight difference in movement due to lost motion it has less effect upon the operation, and therefore it is easier to control. The pipes must be carefully fitted and flushed out before connecting to the valve, as chips or cuttings might lodge in the valve and prevent it from operating, or score it so as to cause a leak. If the valve plunger is removed from the body, care should be taken to prevent damaging it, and it must be assembled free from dust or grit, and be perfectly free in all positions, as a sticky valve would not be dependable for emergency use. The valve should be tested after the pipes are screwed in, to check for possible distortion.
217. The steps of the brake regulating stop may be altered if necessary to bring about quickened brake action at a faster or slower rate when approaching the limits of travel.

SAFETY EQUIPMENT FOR HAND OPERATED BRAKES

218. The Controllers and equipment shown in D and E, Fig. 63* are usually easy to install. An arm should be keyed to the shaft as shown in D and E, the arm usually being set at an angle of about 90 degrees from the direction of pull with the weight up, so that the slack in the brake connections is quickly taken up by the movement of the weight where its leverage is least, and the intensity of the pull to the brakes increases to a maximum at the tightening point. This makes it possible to provide for the necessary brake pull with a minimum amount of weight, and therefore facilitates resetting the weight after it operates in an emergency.
219. For steam hoists a throttle closing auxiliary arm on the safety equipment may be connected to the throttle in any convenient way, and usually a slotted connection is used, so that when the weight is latched in the reserve position, the hoistman may open or close the throttle at will. (See "Steam" bulletin)

SAFETY EQUIPMENT FOR AIR OR STEAM OPERATED GRAVITY BRAKE ENGINES WITH OIL CYLINDER CONTROL, AND SYNCHRONIZING VALVES FOR THE AIR (OR STEAM) CYLINDER AND THE OIL CYLINDER

220. There are a number of engineering problems involved in correctly controlling the automatic operating of the brakes with this type of brake engine.
221. Three typical arrangements are shown in Fig. 63 as follows:
 - A — A Brake Regulator as used for Steam Hoists, connected with the valve gear of a standard and well known type of brake engine.
 - B — A Weight Unit (C-547, Figs. 17 and 18) connected to the same brake engine for an electric hoist.
 - C — A Weight Unit (C-578, Figs. 19 and 20) connected to the controls of the same brake engine.

* Because Model C Lilly Controllers are seldom if ever installed on hoists with hand brakes, the weight unit (B-279) shown diagrammatically at D and E, Fig. 63, is not illustrated or described in this catalog, but if required it may be found in Figs. 8 to 11, in Catalog D-75.

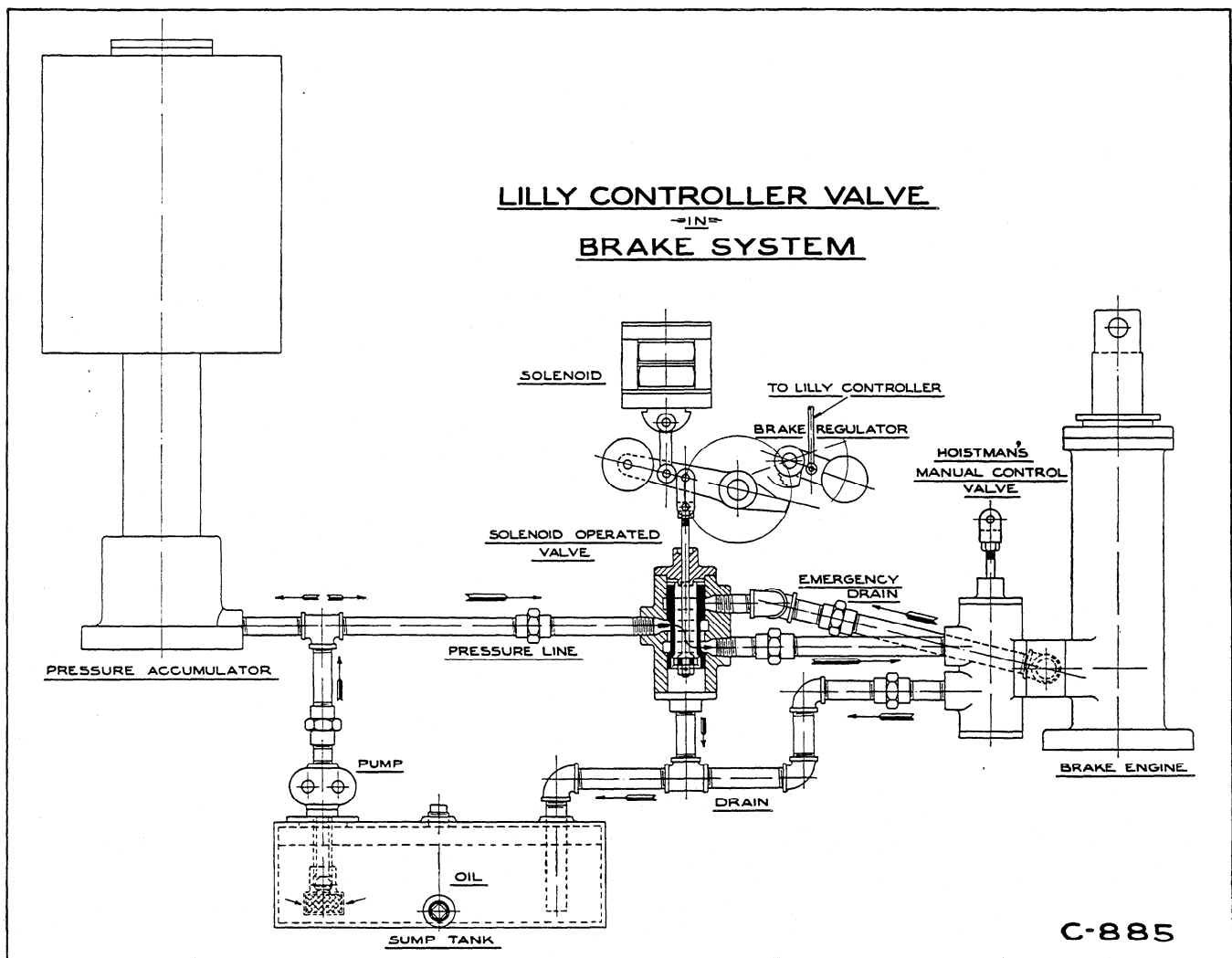


FIG. 62—Hydraulic Connections for Solenoid Valve Unit shown in Figs. 15 and 16. See paragraphs 86, 87, and 215 to 217.

222. It will be observed that the arrangement shown in "A" and "B" involves the direct operation of the brake engine valves, the speed of setting the brakes being controlled by a regulating stop. (See instructions for adjusting Pars. 202 to 209.)
223. The arrangement shown at "C" includes a regulating cylinder to control the speed of applying the brakes, and the brake engine valves are operated in emergency through the floating lever, just as they are applied by the hoistman.
224. An advantage of the equipment and arrangement shown in "A" and "B" is that the valves are operated directly, thereby eliminating danger from possible breakage or disconnections between the hoistman's lever and the brake engine.
225. The equipment and arrangement shown in "C" is usually easier to install, especially for hoists in the field, and altho more expensive than the equipment using a regulating stop, it is frequently preferred.
226. In all of these arrangements as shown, the brake lever will be moved when the safety device functions, but where the lever moves away from the hoistman to set the brake, it is usually quite satisfactory. Various methods have been used to disconnect the control from the hoistman's lever when the emergency weight drops, so as not to move the lever, but in any arrangement of this kind, the hoistman should not be deprived of his means to set the brake faster if he so desires, although he may be deprived of his means of releasing the brake until the safety equipment is reset.

BRAKE CONNECTIONS

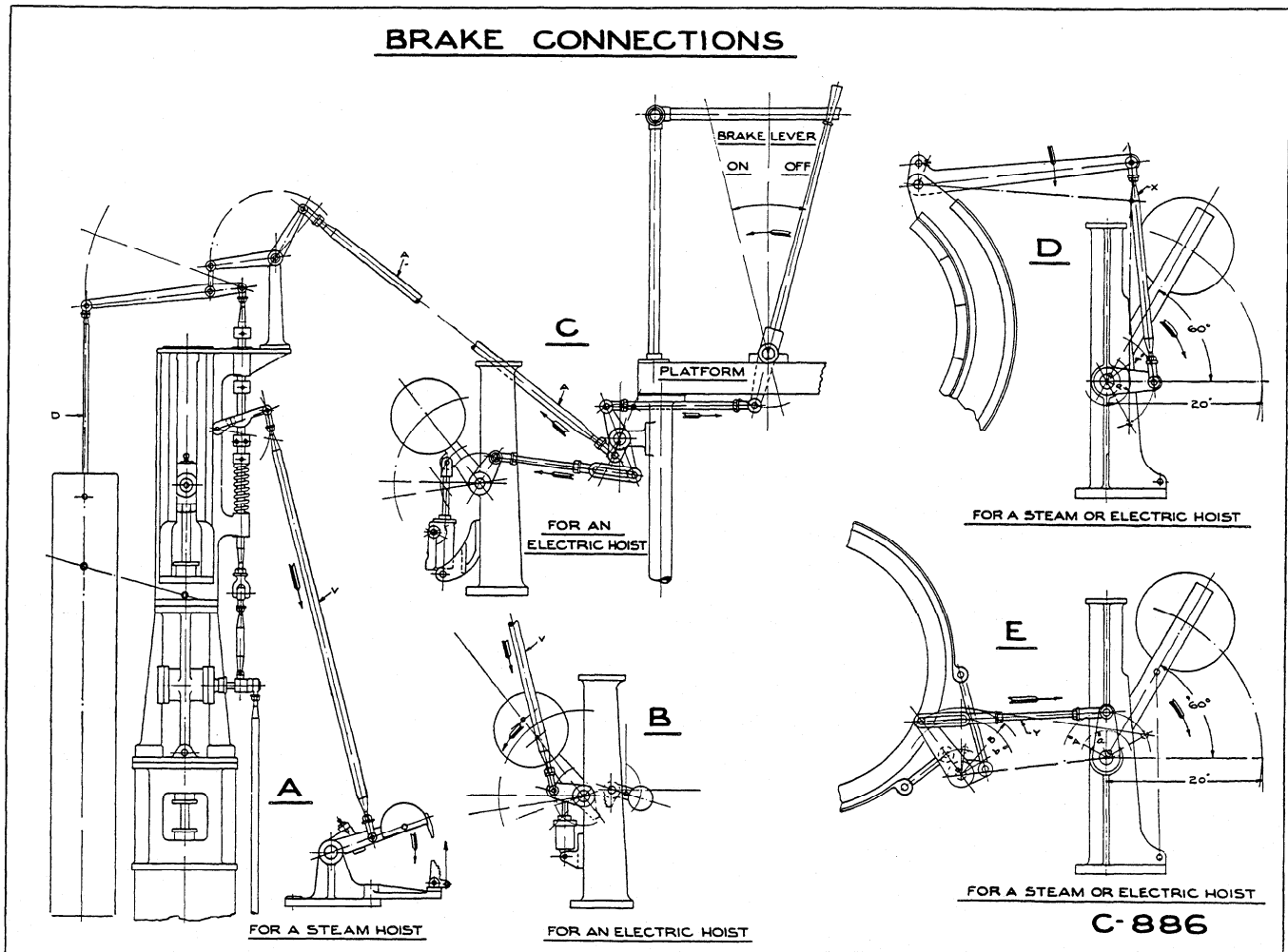


FIG. 63—Connections for various brake operating units. "A" shows a very practical method of operating the valves of a brake engine by a Brake Regulator. "B" shows a similar connection for a C-547 Weight Unit Fig. 17. "C" shows a typical connection to the brake mechanism, for a C-578 Weight Unit. Fig. 19. "D" shows a connection for a brake used exclusively for the safety device. If also used by the hoistman, the rod must have a slotted head at one end. "E" shows a typical connection for a hand operated band brake. See Figs. 17 to 20. Also Pars. 88 to 95 and 220 to 230.

227. Some air operated gravity brake engines are provided with auxiliary valves for emergency operation, in which the safety equipment does not connect with the main valves. With this arrangement the automatic mechanism must prevent the transfer of oil through the hoistman's valve during an emergency setting of the brake, except when his lever is moved to brake-setting position. Otherwise the oil valve being opened backward by the floating mechanism will cause the brakes to set at an accelerating rate, which is the reverse of what is desired.
228. In order to retain the automatic control of the brakes and not interfere with the hoistman's means of increasing the speed of setting them if he should desire to do so when the safety device acts, a three ported valve may be used in the oil manifold, one port being common to the up and down movement of the brake engine, and an independent port and passage for the up, and another for the down movement.
229. A shut-off valve may be placed in the brake releasing passage and closed by the safety equipment simultaneously with opening the release valve in the auxiliary by-pass, thereby preventing the regular control valve from interfering with the speed of setting the brakes as controlled by the auxiliary by-pass valve.
230. Should the hoistman desire to increase the speed of setting the brakes, he may do so in the usual way, because the by-pass is available through which the hoistman's valve permits the oil to transfer from the lower to the upper end of the oil cylinder.

STOP-BUTTON

231. A rugged type stop-button should be placed within easy reach of the hoistman, and connected in the Lilly Controller circuit, enabling the hoistman to stop the hoist in case the manual controls of the hoist fail. Stop-buttons may also be placed at remote points such as at the top and bottom of the shaft, to enable attendants to stop the hoist quickly in an emergency.

PUTTING THE LILLY CONTROLLER IN SERVICE, AND TESTING

232. (a) Do not attempt to adjust the Lilly Controller with all electrical circuits connected thru the controller. Leave the operspeed connections off or short-circuited until the mechanical adjustments are completed.
233. (b) See that the brake operating mechanism is in good working order, and properly adjusted. (See paragraphs 199 to 230.)
234. (c) Connect the Lilly Controller drive, and proceed to adjust the controller in accordance with detailed instructions. (See paragraphs 142 to 194.)
235. (d) When the mechanical adjustments have been completed, the electrical circuits may be connected in accordance with the instructions and diagram.
236. (e) To test the controller adjustments (the brake regulator having been adjusted) start the hoist away from the end of travel, at low speed, and then push the stop-button, or raise the governor beam by hand. If the mechanism functions properly, repeat the test a number of times, at a higher speed each time until the hoist is stopped from full speed. This permits the test to be conducted so as to avoid severe shock or other danger that might arise if the hoist were first stopped by the controller from high speed. Usually the action will be satisfactory if proper care has been taken with all details.
237. (f) It is advisable to advance the cams to stop the hoist at an intermediate point in the shaft, and run into them at various speeds, noting where the hoist is stopped. If the stop in each case is made within the distance on the cam that would indicate a safe stop at the limits, the cams may then be moved to their proper places and tightened there.
238. (g) Care must be exercised in making all tests, as success depends upon the brakes and the hoist controls, as well as upon the Lilly Controller, and needless risk should be avoided. There is no danger of causing damage in making tests, if reasonable care and judgment are used.

WIRING DIAGRAMS

- 239. The wiring diagrams shown in Figs. 64 to 71 are typical, but not necessarily correct for all installations. The purpose in showing these is to convey the general scheme, and obviously a diagram should be arranged to suit each individual installation.
- 240. Each Lilly Controller has three main switches,—an overspeed switch, and two selective limit switches. These three switches should be wired in series, and for electric hoists, connections thru a standard backout switch should be arranged to short-circuit either limit switch at will if held open by overtravel, at the same time opening a circuit in the control to prevent the hoist from being operated farther in the wrong direction.
- 241. The Lilly Controller switches are usually connected in the retaining circuit of the undervoltage contactor, and in case of a double installation involving two Lilly Controllers, the six switches (3 in each controller) will be connected in series.
- 242. Accelerating Switches — These are connected so the accelerating solenoid will be energized when leaving the travel limits. If the solenoid is energized when approaching the limits, check first that the proper accelerating cam is engaged, and if so then interchange the directional control connections for proper operation.
- 243. On some hoists, such as with D.C. control, plugging although undesirable, might be used to help slow the hoist when approaching the travel limits, and as a result the motor directional control circuits are unreliable as a signal of actual directional rotation. In that set of circumstances, a directional switch installed on the Model C Controller will signal the actual direction of rotation and will coordinate the accelerating solenoid with the proper accelerating switches for outward movement only. See Fig. 25
- 244. No. 14 wire may be used for connections, but No. 12 is sometimes preferred because of its greater mechanical strength.
- 245. All wiring should be done in a first class manner, running the wires in conduit, and properly protected to prevent short circuits, loose connections, and mechanical damage.

ELECTRICAL TROUBLES AND REMEDIES

- 246. If a hoist is occasionally stopped by the safety equipment without apparent reason, it is evident that there is a loose connection, a defective conductor, or poor contact at a push-button or at one of the switches.
- 247. The switches should be scraped clean, and their springs checked to make sure that they close the switches properly, and yet are not so strong as to interfere with normal opening in case of an emergency.
- 248. See that the overspeed switch makes good contact at each side. If it tends to touch one side before the other, or does not have sufficient "rock" on the hinge pin or clearance between the fixed fingers, enlarge the hole at each end, and file the finger so as to allow it to rock sufficiently to engage both of its two electrical contacts equally.
- 249. If track limit switches are used, they should be tested in case of an open circuit, as they may stick in an open position.
- 250. If the holding coil is "dead," a test should be made around the coil, as it may be burned out, and if found to be defective it must be replaced. If there is current at the source, but not in the circuit, and the switches and terminals are apparently all right, the circuit should be traced to locate the break, keeping in mind that an insulated wire that appears to be intact may be broken inside of the insulation.
- 251. When Controllers are installed on hoists that are subject to excessive vibration, the standard switch springs may not have sufficient strength to hold the switches closed firmly, and they may have to be shortened, or stronger springs installed.
- 252. If a stronger overspeed switch spring is ever used, it should not be so strong that the accelerating weight rises before the overspeed contacts open.

MAINTENANCE RECOMMENDATIONS

- 253. (a) The retarding cams must not open the overspeed switch without governor action, because that would make it necessary to short-circuit the overspeed switch before the hoist could be backed out of over-travel, which would eliminate a very important feature of protection. The overspeed switch must be connected in the emergency circuit so that it will not be short-circuited under any conditions.
- 254. (b) See that the cams are set at the correct position on the dial to function properly during the retarding period and at the limits of travel.
- 255. (c) The respective cam dials and limits should be selected to approach the limits in a clockwise direction.
- 256. (d) When the hoist is at the end of travel, with a retarding cam on top of the roller, see that the overspeed switch contact is set so that the warning contacts are .015" to .032" apart. See C, Fig. 58.
- 257. (e) In the position described in (d) raise the governor balls slightly by hand and the alarm bell should ring. Raise slightly higher and the overspeed switch should open. (See footnote *)
- 258. (f) When the hoist is at rest, at an intermediate point, with the retarding cams NOT on the roller, raise the governor balls, by hand, to a point slightly above the angle at which they operate at full normal hoisting speed, and the alarm bell should ring. Raise them slightly higher and the overspeed switch should open. (See footnote *)
- 259. (g) When the hoist is running at full normal speed, see that the governor arms have a margin of movement (below the horizontal) for overspeed.
- 260. See that all pins, linkages, spur gears, bevel gears, worm gears and shafts are in good condition and have not developed lost motion.
- 261. See that the brake operating and regulating mechanism is correctly adjusted and functioning properly. Be sure that when the overspeed switch or either one of the limit switches is opened, the power will be immediately cut off and the brakes applied.

THE HOIST BRAKES

- 262. Remember that a great deal depends upon the brakes, and they should be kept in first-class condition and adjustment.
- 263. For gravity applied brakes, care should be taken to maintain the adjustments so that the full force of the brake weight will act on the drum, and that part of it is not lost by a piston striking the bottom of the brake engine cylinder, or by any interference with the free movement of the weight.
- 264. Hand brakes should be adjusted so that the lever does not operate to the end of its quadrant, so as to have a reserve in case of the brakes heating, or the linings wearing.
- 265. The brakes should respond properly during manual operation, and retard the drum smoothly, at a fast or slow rate as may be desired, for otherwise it is not likely that the safety device can operate them satisfactorily.
- 266. If the brakes are efficient and responsive for manual operating, they can be operated in the proper manner by a Lilly Controller.

* For Duplex Governors, raising the balls of either governor should cause the overspeed bell to ring under the conditions described in paragraph 257, but under the conditions described in paragraph 258, it will be necessary to raise the governor balls of the fast running governor to a position near horizontal, and while holding them in that position have someone raise the governor balls of the slow running governor to a position beyond 45 degrees, to make the overspeed bell ring. As long as the governor bell rings while the slow running governor balls are well below a horizontal position, it can be depended upon to function for overspeed.

ELECTRICAL DIAGRAMS

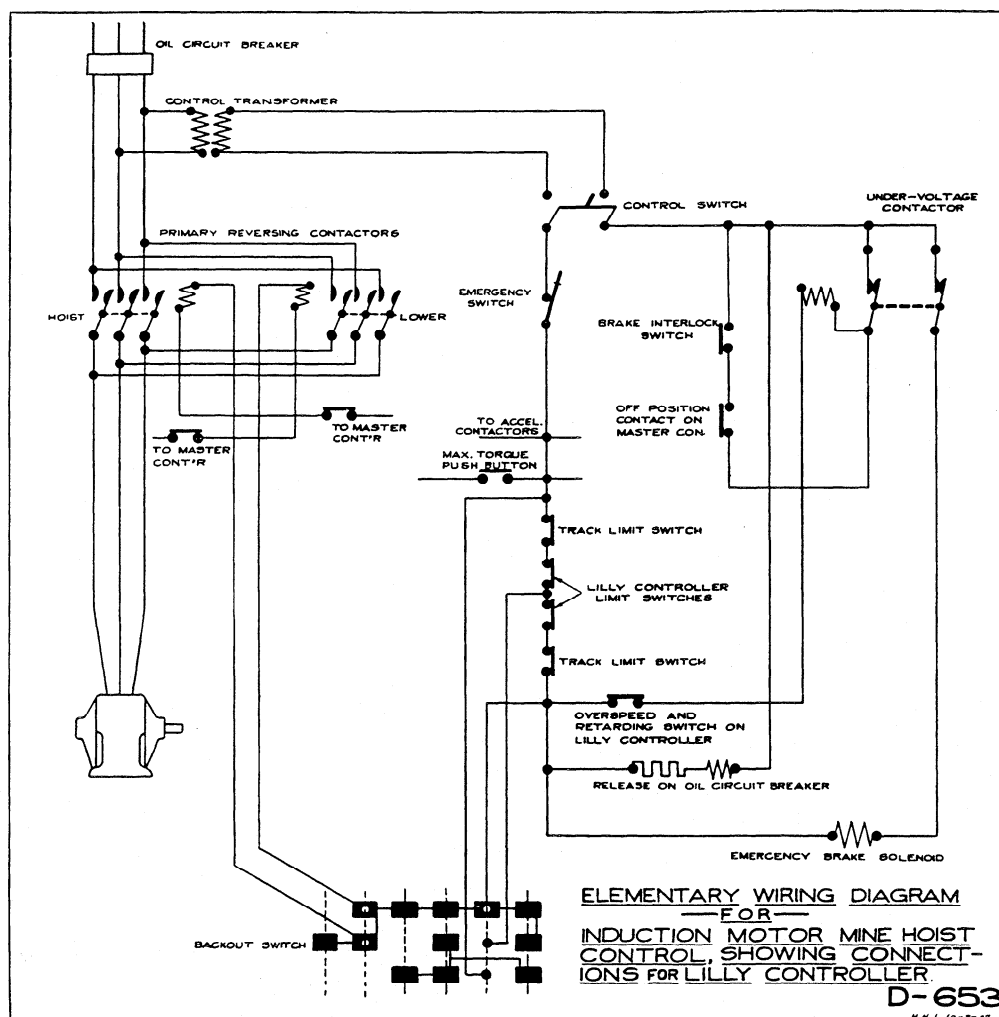


FIG. 64—Lilly Controller elementary electrical diagram for a single-drum electric hoist.

THE DIAGRAMS FOR ELECTRIC HOISTS

267. The elementary diagram in Fig. 64 shows the Lilly Controller contacts carrying the current for the brake solenoids and the coil of the oil circuit breaker, as well as the coil of the undervoltage contactor.

This arrangement is ideal in some cases, but where there is a large solenoid, or two solenoids as in the case of double drum hoists, there may be too much current for the contacts of the Lilly Controllers, which were designed to handle a control circuit only. The contacts may carry the current without trouble, but there will be more arcing, which with a slow break has a tendency to burn the contacts.

268. The diagrams on the following pages show the Lilly Controllers carrying the current of the under-voltage contactor coil only, which has proven to be good practice. This enables the hoistman to re-start easily after the hoist has been stopped by the safety device.
269. Where the brakes are operated by a solenoid valve, it is only necessary to bring the control lever to neutral and apply the brake lever, and then re-start the hoist without leaving the platform after an emergency stop by the Lilly Controllers.
270. Where weighted equipment and a magnetic latch are used to set the brakes, and sometimes also to close a throttle, the weight must be re-set before re-starting the hoist, as the magnetic latch simply holds the weight in the reserve position, but it cannot raise the weight.
271. Many new installations have two undervoltage contactors connected in the control circuit in series and with their coils in parallel, to eliminate possible danger of a single contactor sticking and failing to open when the retaining circuit is interrupted. The arrangement is shown in the diagrams Figs. 66 and 67.
272. Double undervoltage contactors are recommended, and a second U.V. contactor may easily be installed on a panel that was originally equipped with only one.

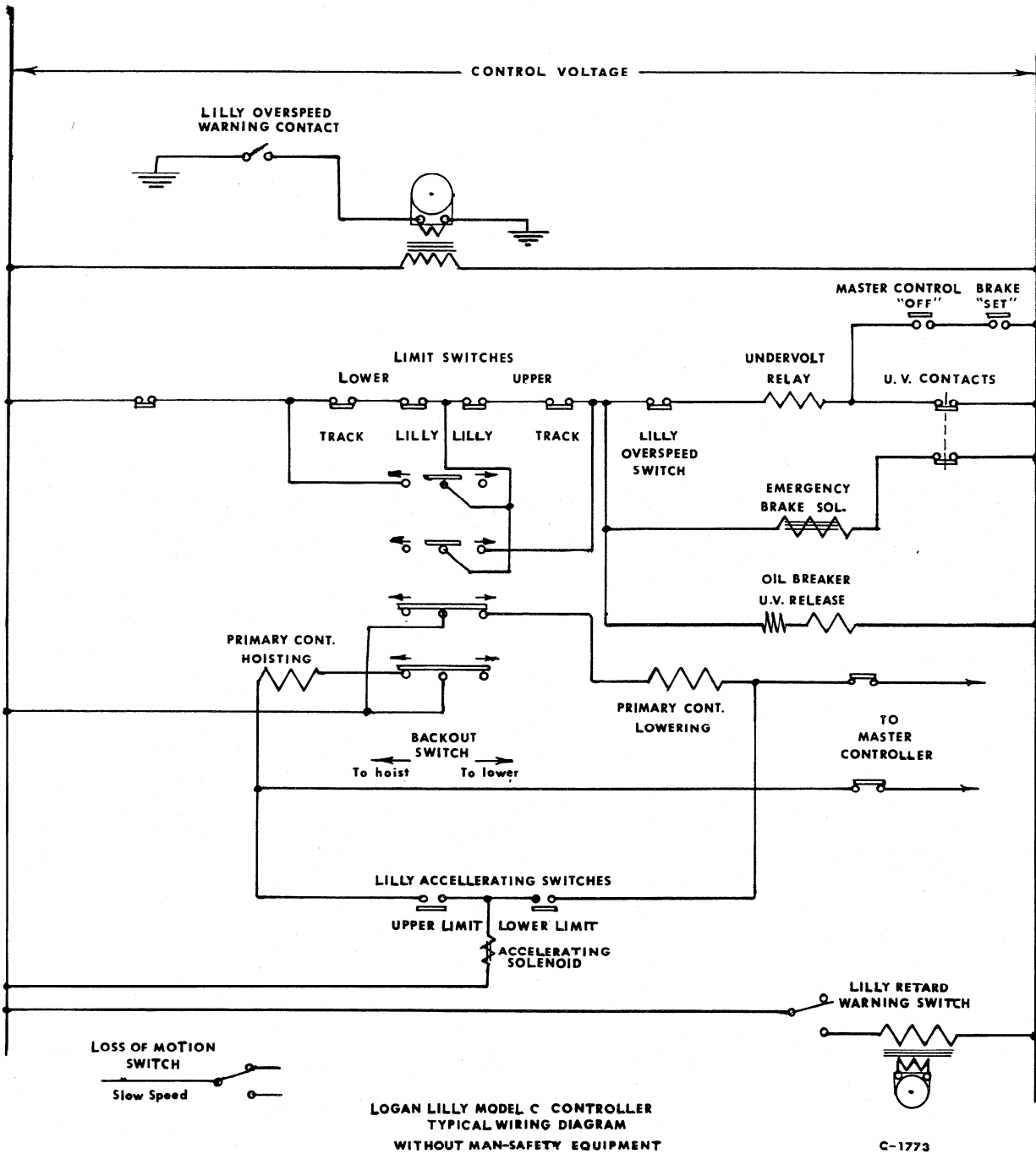


FIG. 65

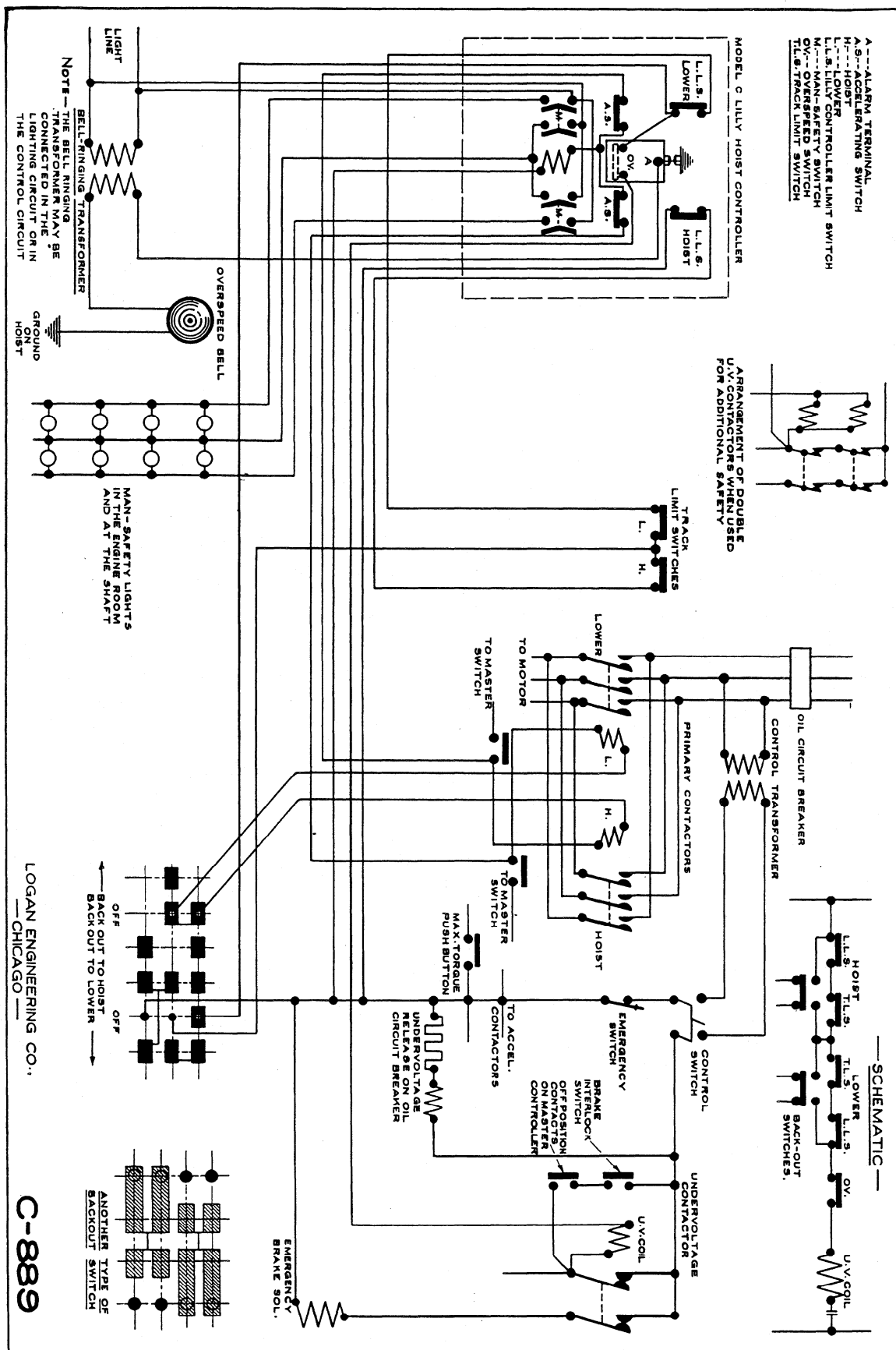


FIG. 66—A typical electrical diagram for a Model C Lilly Hoist Controller with Man-safety Equipment installed on an electric hoist with an A.C. motor and controls.

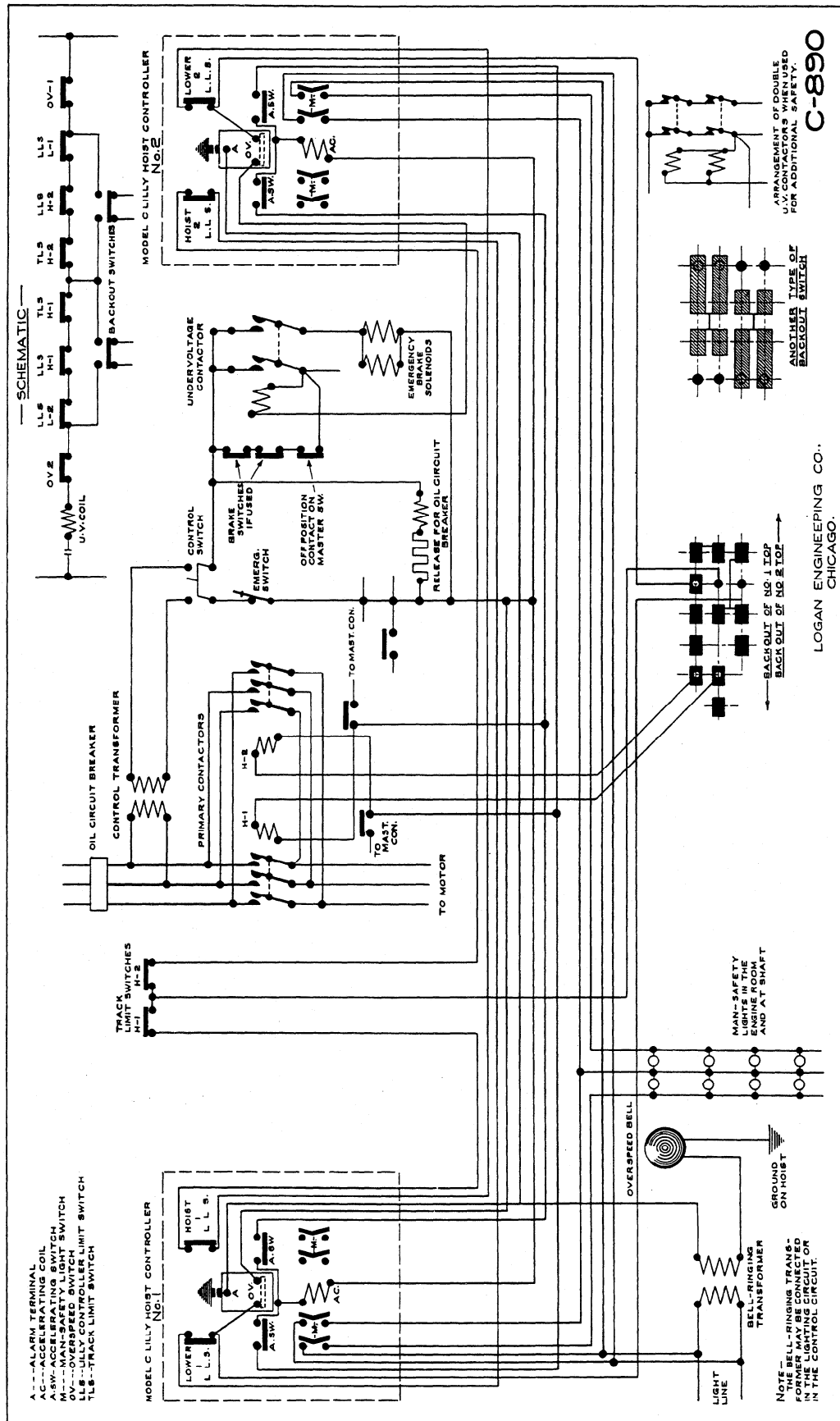


FIG. 67—A typical diagram for two Model C Lilly Hoist Controllers with Man-safety Equipment, installed on a double-drum electric hoist with an A.C. Motor and Controls.

THE ACCELERATING CIRCUIT

273. The purpose of the accelerating circuit is to automatically move the fulcrum point of the overspeed switch arm so as to separate the overspeed contacts while the hoist is accelerating after leaving the limits of travel, to prevent the retarding cam from interfering if the speed at any point in the retarding zone should be higher during acceleration than at the same point during retardation, thus permitting the retarding cams to be correctly profiled to secure the utmost protection thruout retardation, and avoiding the need to sacrifice any part of that protection for the benefit of acceleration.
274. To accomplish this, it is necessary to utilize two positive elements, one controlled by the relative position of the cage in the shaft, and the other by the direction of rotation of the drum.
275. The elements functioning for cage position are the accelerating switches operated by the accelerating cams.
276. The elements functioning for direction of drum rotation vary with the type of hoist.
277. For electric hoists the energizing circuit for the directional primary contactors is generally utilized as the source for the accelerating circuit, altho extra contacts in the master controller may be used for the purpose if preferred. In fact, any source of current may be used that will automatically indicate the direction of drum rotation.
278. If necessary to prevent the accelerating solenoid from functioning until a considerable portion of the power is applied, the circuits may be connected thru contactors that will not close until the predetermined conditions are realized, instead of having it function whenever the power is applied. This has been desirable in some cases, particularly where it is necessary to "plug" the hoist to retard at the limits of travel.

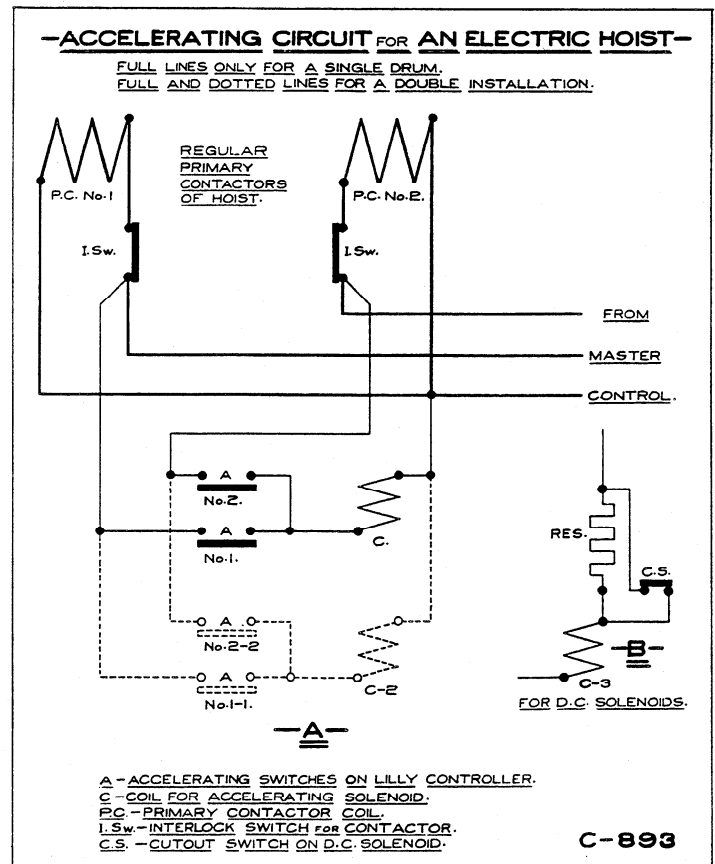
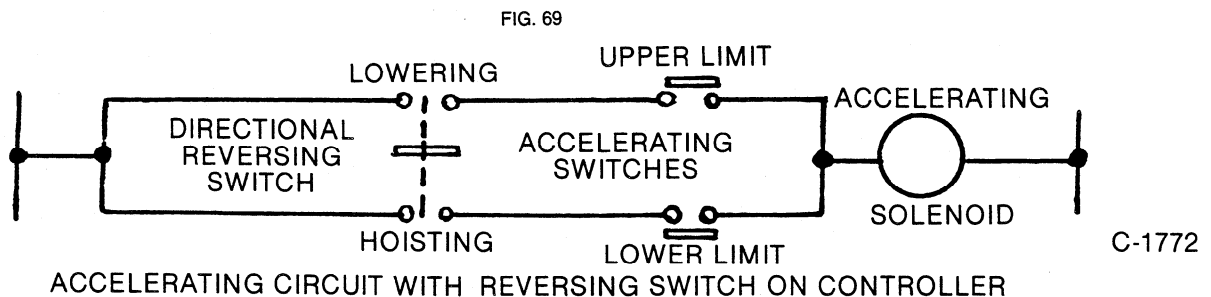


FIG. 68—Accelerating circuit for electric hoist. The accelerating switches "A", No. 1 and 2, and the accelerating solenoid "C" are in the Lilly Controller. The primary contactors and interlock switches are part of the regular electrical equipment of the hoist. See paragraphs 273 to 278.



279. As previously mentioned, either a desire for self contained circuitry, or "plugging" situations, may make use of the Reversing Directional Switch (Fig. 25) advantageous.
280. Where the Reversing Switch is on the Lilly Controller, the circuit to the accelerating solenoid is completed only when the hoist reverses out from the limits, regardless of motor control settings.

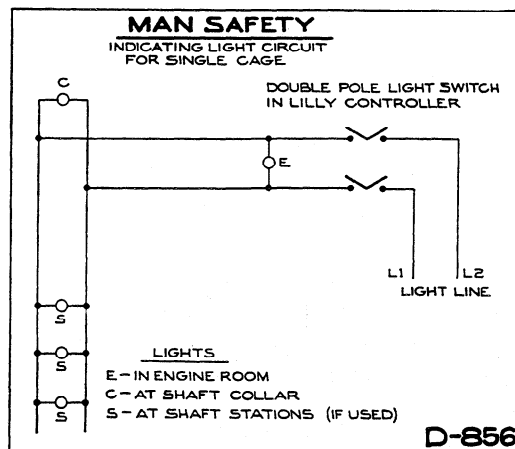


FIG. 70—A man-safety light circuit for a Lilly Hoist Controller for a single cage.

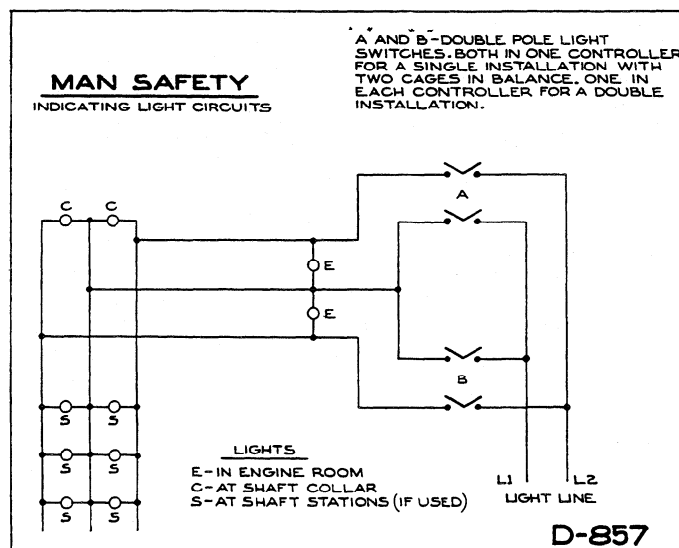
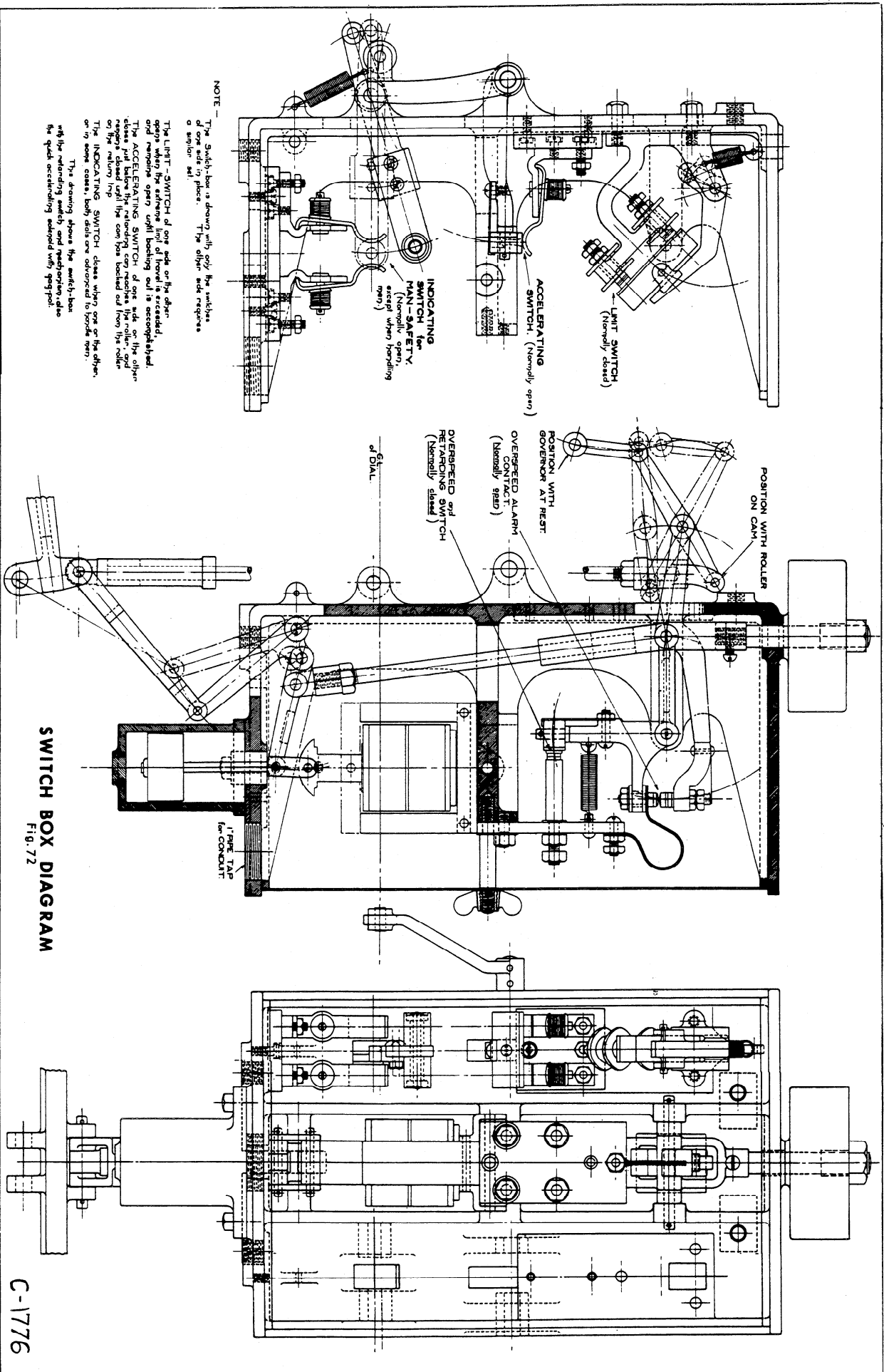


FIG. 71—A man-safety light circuit for a single or a double Lilly Controller installation for two cages.



ADDENDUM TO CATALOG/MANUAL C-81

Effective as of Serial Number 5390 (Dec., 1983) the Model C Logan-Lilly Controller will be furnished with Teflon main cam dial shaft bearings, and all other main shafts will be ball-bearing mounted, including the drive shafts.

Variations from the illustrations in Catalog/Manual C-81 will be:

- 1.) The drive shaft hub in the gear guard will be 2" diameter by 1.450" extension instead of the 1-5/8" diameter by 1 1/2" extension, as shown in the catalog.
- 2.) The drive shaft, worm shaft, and governor shafts will be ball bearing mounted.
- 3.) The cam dial shaft bearings will be replaceable Teflon type.

The lubrication requirements will thus be greatly simplified. The gearing and linkage points should still receive attention, and regular inspection and adjustment schedules should still be strictly maintained.

Machines, being returned for rebuilding, can have the new features incorporated while at the factory.

Drive Shaft -- New style requires gear guard and main frame machining.

Cam Dial Shaft -- Teflon hub units require machining the frame.

Worm Shaft -- New assembly is interchangeable with old plain bearing assembly.

Governor Shaft -- New shafts and bracket assemblies are interchangeable with old assemblies.

Note: Interchangeable assemblies are also field interchangeable.

The increased diameter of the gear guard hub is called to attention in case angle bearings would require boring to 2" inside diameter for mounting on the hub.

The Teflon dial shaft bearing hubs are retained by socket head screws, and can be removed from either side to simplify cam dial shaft removal with the worm wheel key when worm wheel changes are being made. The Teflon hubs are replaceable if ever damaged.

The new applicable parts sheets numbers are:

- | | |
|--------------------|------------------------------|
| 831001, 2, 3, 4 | - Frame and Overspeed Switch |
| 831007 | - Drive |
| 831009 | - Single Governor |
| 831013, 14, 15, 16 | - Duplex Governor |
| 840306, 7 | - Angle Bearings and Drives |

CONTROLLER LUBRICATION

The Logan-Lilly® and Simplex Hoist Controllers should be inspected at least once a week by qualified personnel to check on adjustments and mechanical integrity, in addition to the regular hoist operator's limit checks. At the time of the inspection, lubrication can be performed.

OIL: SUS Viscosity 284-347, Non-detergent, Equiv. SAE-20W

Plain bearing shafts, Oil Cups or Oil Holes etc.	Several Drops
--	---------------

Pin Connections	Several Drops
-----------------	---------------

Worm Bath	Keep Filled
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Governor Dash Pot	Keep 3/4 Full
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Note: This is for dampening action only,
In cold temperatures, may be thinned with kerosene

GREASE: General Purpose NLGI #2 Worked penetration 265-295 Med. Soft

Gears	Liberal Coat
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Grease Cups or Pressure Fittings	Keep filled
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The Ball Bearings are factory packed and will not require lubrication unless washed out by solvents during maintenance or repairs

**The Accelerating Dash Pot, under the Switch Box on the Model C, is for
AIR ONLY. Do not fill with oil of any sort.**