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# THE B.I.O. LEBUS - SPOOL WINCH

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by

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# THE B.I.O. LEBUS - SPOOL WINCH

## General Description

The unit consists of a Lebus-Grooved spool holding 21,000 ft. of 3/8" dia. wire rope, a Lebus Fleet-Angle Compensator, 23 Horsepower 220 v.D.C. Compound-Wound Motor with electric brake and reduction gear-box, and a chain drive between the gear-box and the Drum. All of these items are mounted on a common frame.

The motor is controlled, when used with 220 v.D.C. supply, with a semi-automatic controller. The resistance box associated with the controller is completely conventional, but the relay/contactor box and portable manual control box are specially designed.

## Unit Details

The Lebus Grooving system and Fleet-angle compensator are proprietary devices, described in the appendix. The wire rope used is precisely controlled in diameter, and only the correct size of wire may be used, diameter of 0.385" ± .005". The gear-box is a conventional unit, oil-filled, with straight-toothed gears, with a ratio of 6 to 1. The chain is a standard 2" pitch chain, with 1 1/4" face, and an 11-tooth pinion is used with a 60-tooth gear. The entire cable reel can be moved to adjust the chain tension. The electric brake is normally held on by a spring; when power is applied the solenoid energises and releases the brake.

The motor is a standard compound-wound four-pole motor with interpole windings. When the motor is run in reverse the shunt winding is reversed, and the series winding is short-circuited. The magnetic field, measured with the armature shorted and mechanically locked, varies linearly with current. The shunt field is 9,000 gauss at 220 v., the series field adds a further 1,800 gauss at 90 amps. The interpole field is approximately 15,000 gauss at 90 amps. The circuit for the motor is shown in Figure 1.

Torque tests on the motor were made using a 3 ft. lever arm, (with the motor armature stalled) and the motor operating in the "hoist" mode -- i.e. motor turning clockwise when viewed from the shaft end. With controller on step A (i.e. motor armature shunted by 0.8 ohm, 2.10 ohms in series), total current is 100 amps, and torque is 150 ft. lbs. With controller on step B, motor with 2.10 ohms in series, the current is 95 amps, and torque is 180 ft. lbs. With the controller on step B, and motor with 1.05 ohs in series the current is 180 amps and torque is 300 ft. lbs. In all cases, the current was measured with a panel meter of unknown accuracy, so that great reliance should not be placed on these measurements.

Overall line-tension measurements were made with the complete winch. Stalled line-tension at various ohm diameters are shown in Figure 2, and also the tension due to the dead-weight load of a 1,200 lb. cover plus wire; the stalled tension is measured under conditions where the motor is attempting to start under full tension.

The circuit of the motor and controller is shown in Figures 1, 3, & 4. Figure 5 is a sketch of the layout of relays and contactors etc. in the Relay/Contactor Box. A description of the operation of the controller follows.

The forward (lifting) & reverse operations are basically similar, and the following description applied to the forward steps.

a) The first step is the lowest speed, "inching" position. Line pull is not particularly high in this position, which is used for manoeuvring when the corer is close to the block, etc.

b) The second step is the basic starting step, having low speed and high line pull.

c) - e) The next steps give progressively higher speeds, e) going the normal running speed.

f) This is the first overspeed step; in this position the speed is 50% above normal speed, and the line pull is 2/3 normal.

g) The highest speed, twice normal speed, with line pull of half normal.

The controller is automatic in action, and is arranged so that the highest speed will be selected which does not overload the motor or whatever speed is desired by the operator. If the control is moved right over to "high" immediately from stop, the control will start the winch and bring up the speed, step by step, without drawing excessively high current, until the speed matches the load. On the two "overspeeds", if the load subsequently increases, the controller will shift to the normal speed to prevent overloading the motor.

Step a) Forward. Relay RLB is energised via the hand controller, and in turn operates Contactors CTB and CTF via RLB/3 and RLB/3-RLC/1 respectively. (see Fig. 3). The main supply is then connected via the Trip coil, 60A relay, 100A relay, CTB/1, R1, R2, & R3 to the motor armature, and hense through the series field winding to negative supply; at the same time R4 is connected via CTF/1 in parallel with the armature. The supply to the field is connected from CTB/1 via the fuse, RLJ/3 & RLK/3 (both normally closed) to the change-over switch RLA & RLD and so through the field to ground (-ve.) At the same time the brake winding is energised from CTB/1 via the fuse.

Step b) Relay. RLC is energised, and so RLC/1 opens and breaks the supply to CTF, which in turn removes the shunt resistance R4 from the motor armature. Otherwise the circuit is unchanged from (a).

Step c) When the motor current drops to 100A, the relay 100A is released so that the contacts close and RLD is energised. As RLC/2 is closed, RLF is then energised and remains energised via RLF/1 & RLC/2 even though RLD/1 opens as the motor current rises above 100 Amps. RLF/2 excites CTC, which reduces the resistance in series with the armature to R2 + R3, by short circuiting R1 by CTC/1.

Step d) As in step (c), when the motor current drops below 100 Amps, RLG is energised and R2 is short-circuited by CTD/1.

Step e) As in steps (c) & (d), when the motor current drops below 100 Amps RLH is energised and R1 is short circuited by CTE/1. The motor armature, in series with the series field, is now connected directly across the line; the motor field is also connected directly across the line so that the motor runs at full speed.

Step f) When the motor current drops below 60 Amps, RLE is energised. RLJ is then energised via RLD/4 (closed as current less then 100 a), RLE/1 and RLH/3. As soon as RLJ operates, RLJ/1 holds the circuit even though RLE becomes de-energised as the current rises above 60 amps. The current will remain below 100 amps so long as the load remains constant, so that RLD/4 will not open and break the circuit. RLJ/3 opens, so that a series resistance of 150 ohms is connected between the supply and motor field winding, increasing the speed by about 50%. If the load increases, so that the motor current exceeds 100 amps, RLD is de-energised, and RLD/4 opens; if RLK is not closed, then RLJ is de-energised and the resistance is removed from the field winding, so that the motor is operating at full normal speed.

Step g) This step is similar to step (f), adding a further 50% over-speed when RLK is operated.

It will be noted that the relays sequence in series, each relay being operable only when the previous step is complete. The capacitors across the relay coils show the actions of the relays so that steady sequencing takes place.

Diodes are fitted to most coils to reduce arcing at contacts. Diodes D1-D5 provide arc-suppression when switching the motor field winding; D1 to D4 when the field is switched off and D5 when the series resistances are connected. Diodes used in association with the relays and contactors may be omitted without great harm, in case of failure. If diodes D1-D5 are omitted considerable arcing will take place at RLA/1 & 2 and RLB/1 & 2, probably destroying the contacts after a few dozen operations. Diodes included in the spare parts (GE type A10N) may be used to replace any of the diodes in the system.

## OPERATING INSTRUCTIONS

The hand controller is fitted with a gate mechanism to prevent accidental movement from forward to reverse. The control should always be left at "stop" for 3 seconds between a forward to reverse change. DAMAGE MAY OCCUR IF THIS INSTRUCTION IS IGNORED.

At "stop", the centre position, the motor brake is applied. The controller has similar speeds, forward or reverse. At the first step the cable runs slowly; this step is for "inching" control. DO NOT RUN THE WINCH FOR MORE THAN FIVE MINUTES LIKE THIS OR THE RESISTANCE BOX MAY OVERHEAT.

At the second step, the motor will come up to normal speed automatically. If the cable is taut when the winch is started, the maximum tension available is that shown in Fig. 1. If the motor comes up to speed before the cable becomes fully tight, the maximum cable tension may be considerably more than that shown, and it is easy to break the cable at any drum diameter. The third & fourth steps are "high speed" steps, which will only come into operation if the load permits.

The control may be put into any position immediately on starting, if desired. The automatic features will select the appropriate maximum speed. If, whilst on the 3rd or 4th step, contactors come in and out as the ship rolls, etc., so that the speed is going up & down, come back a step at a time until the speed remains steady on either the 2nd or 3rd step.

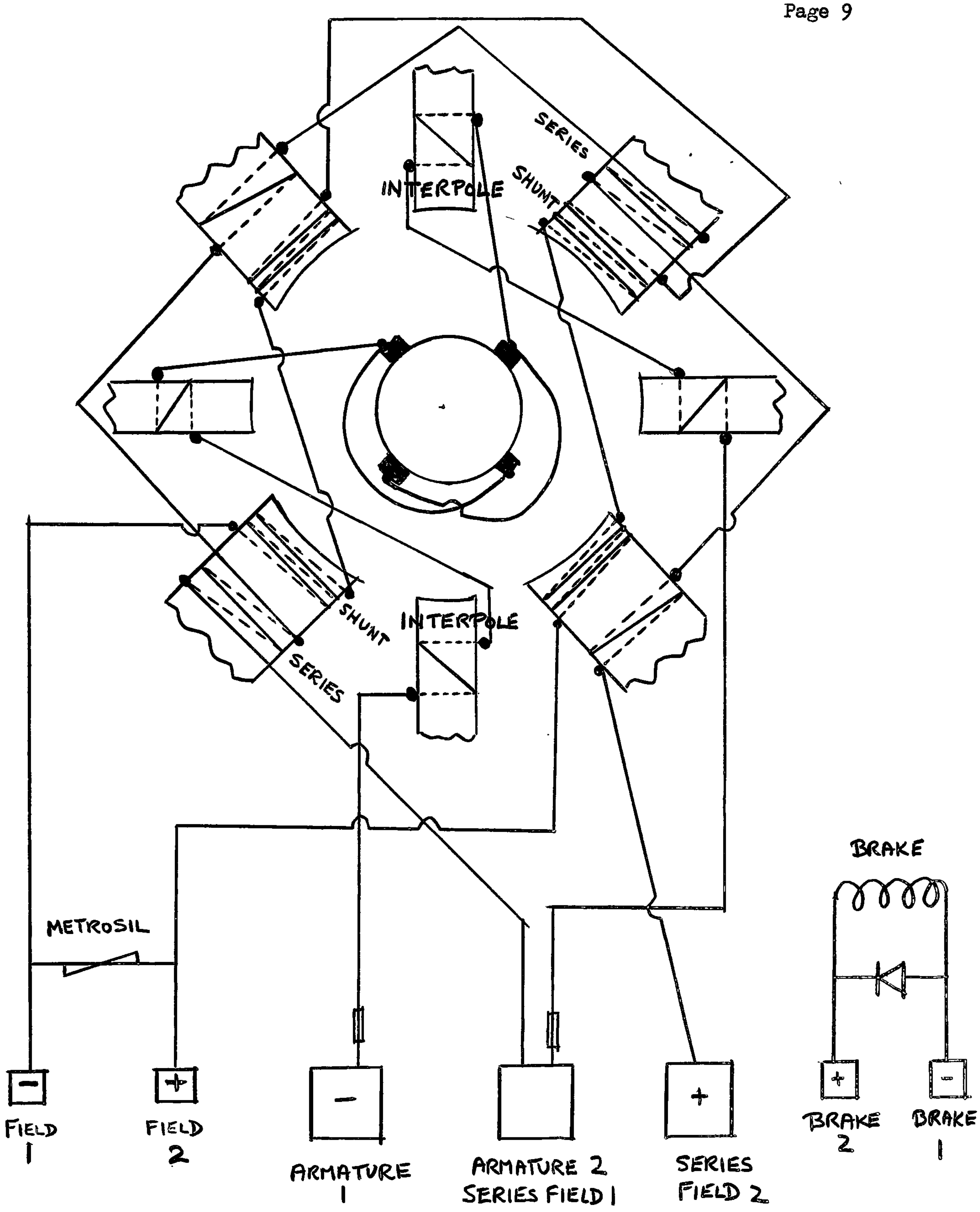

SERIES
SHUNT
INTERPOLE
INTERPOLE
SHUNT
SERIES
BRAKE
METROSIL
FIELD 1
FIELD 2
ARMATURE 1
ARMATURE 2 SERIES FIELD 1
SERIES FIELD 2
BRAKE 2
BRAKE 1

FIGURE 1

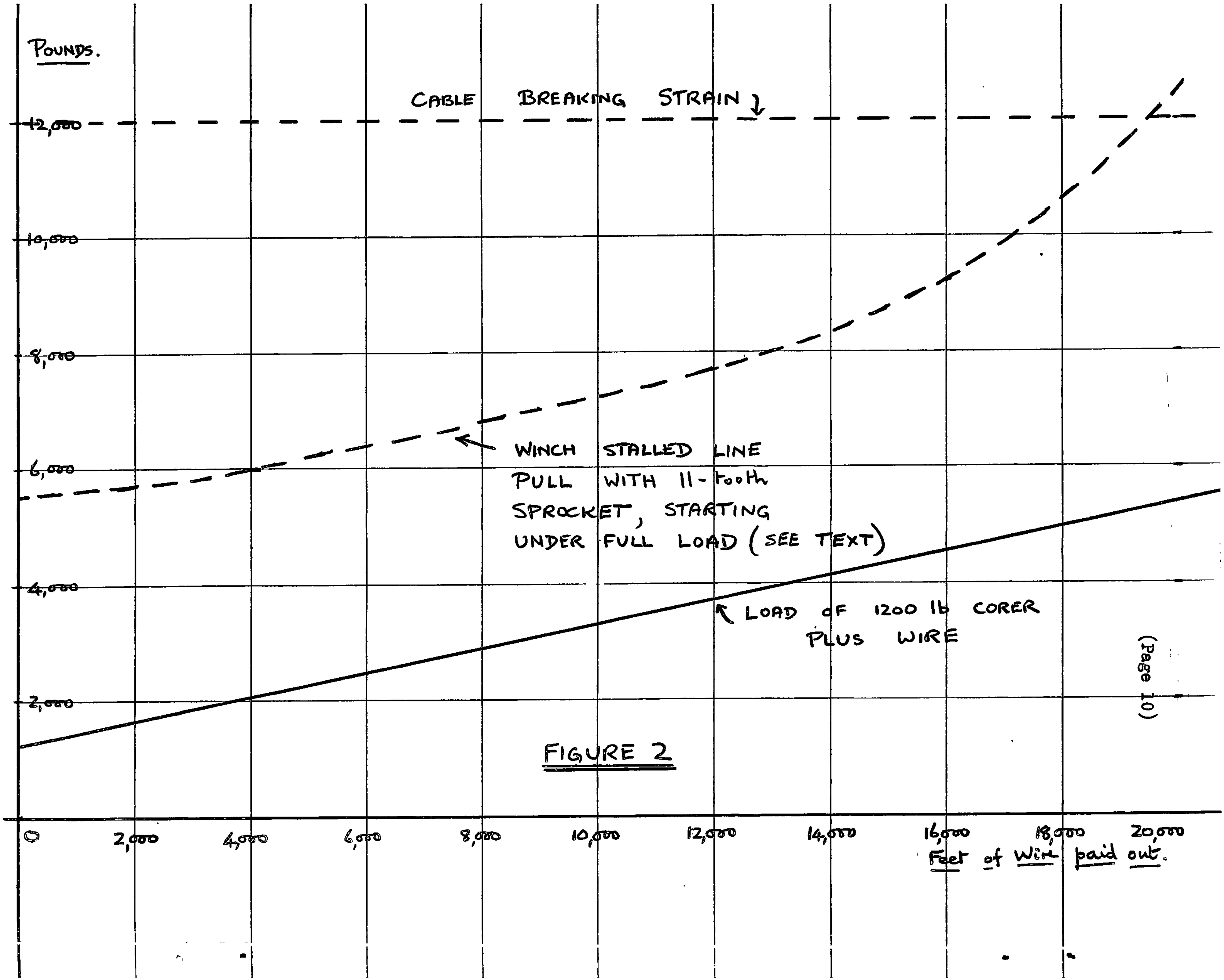

POUNDS.
CABLE BREAKING STRAIN
12,000
10,000
8,000
6,000
4,000
2,000
WINCH STALLED LINE PULL WITH 11-tooth SPROCKET, STARTING UNDER FULL LOAD (SEE TEXT)
LOAD OF 1200 lb CORER PLUS WIRE
0
2,000
4,000
6,000
8,000
10,000
12,000
14,000
16,000
18,000
20,000
Feet of Wire paid out.

FIGURE 2

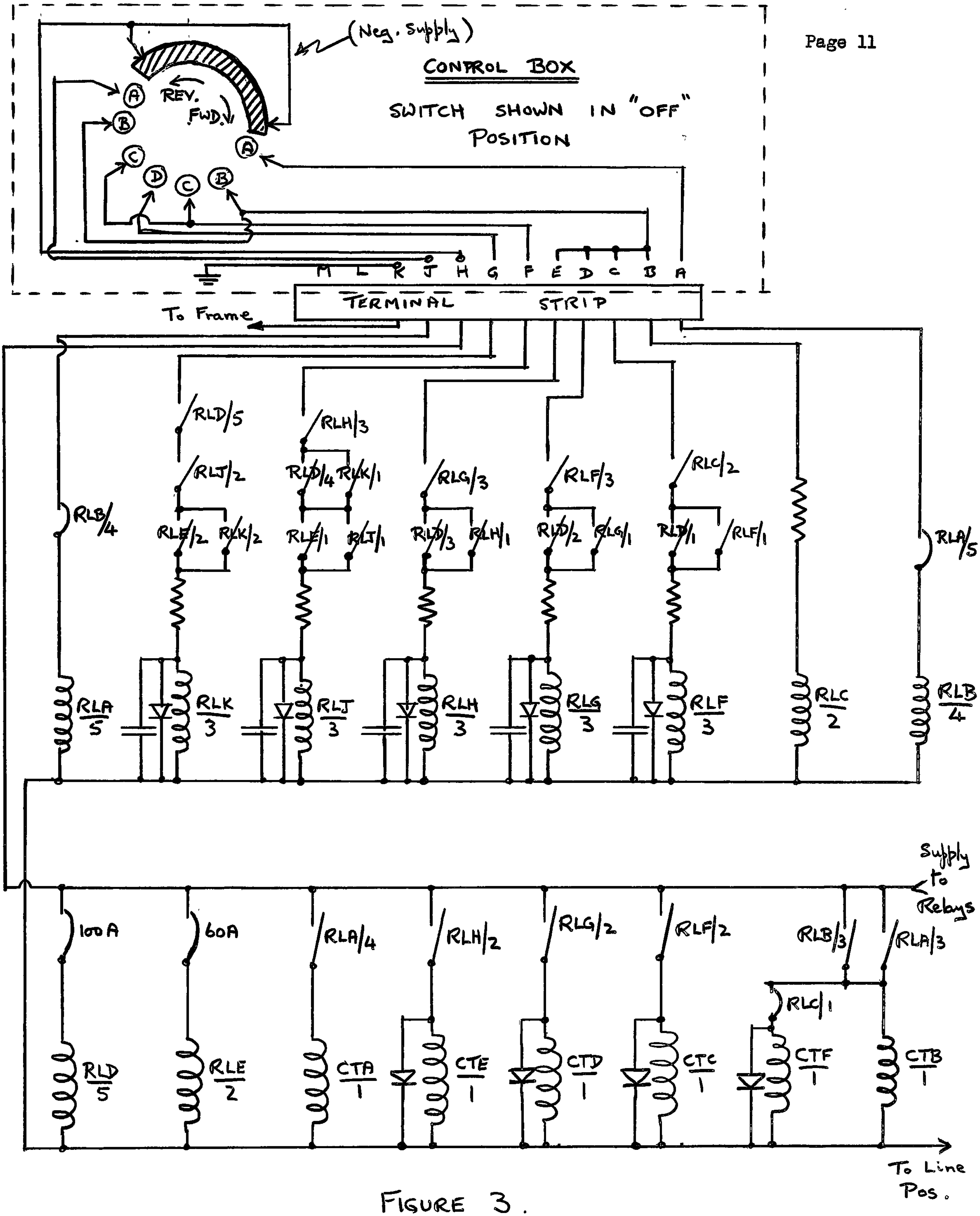
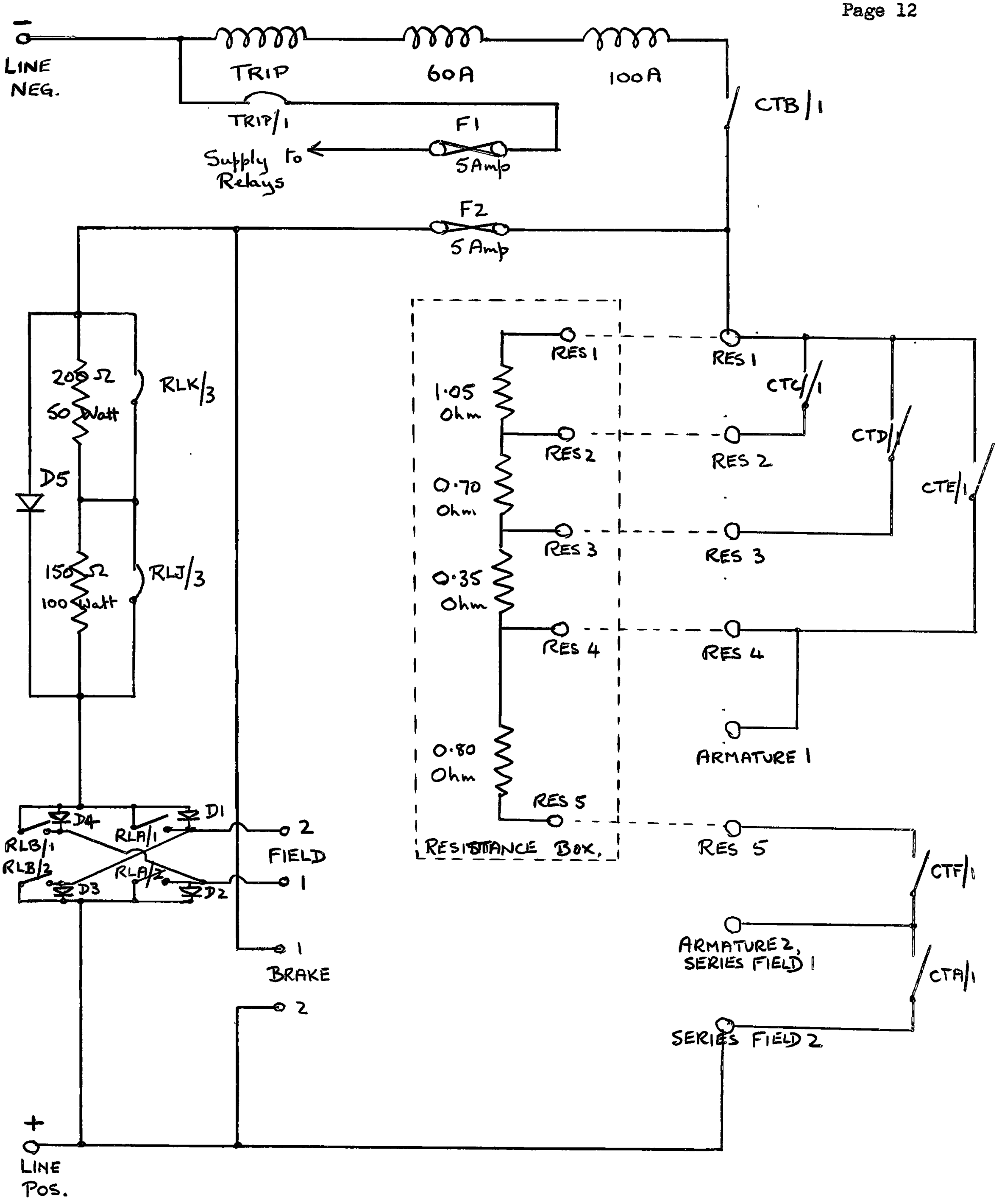

(Neg. Supply)
CONTROL BOX
SWITCH SHOWN IN "OFF" POSITION
REV.
FWD.
M L K J H G F E D C B A
TERMINAL STRIP
To Frame
RLD/5
RLJ/2
RLE/2
RLK/2
RLH/3
RLD/4
RLK/1
RLE/1
RLJ/1
RLG/3
RLD/3
RLH/1
RLF/3
RLD/2
RLG/1
RLC/2
RLD/1
RLF/1
RLB/4
RLA/5
RLA 5
RLK 3
RLJ 3
RLH 3
RLG 3
RLF 3
RLC 2
RLB 4
Supply to Relays
100A
60A
RLA/4
RLH/2
RLG/2
RLF/2
RLB/3
RLA/3
RLC/1
RLD 5
RLE 2
CTA 1
CTE 1
CTD 1
CTC 1
CTF 1
CTB 1
To Line Pos.

FIGURE 3.



−
LINE NEG.
TRIP
60A
100A
CTB/1
TRIP/1
F1
5Amp
Supply to Relays
F2
5 Amp
200 Ω
50 Watt
RLK/3
D5
150 Ω
100 Watt
RLJ/3
RES 1
1·05 Ohm
RES 2
0·70 Ohm
RES 3
0·35 Ohm
RES 4
0·80 Ohm
RES 5
RESISTANCE BOX.
RES 1
CTC/1
RES 2
CTD/1
RES 3
CTE/1
RES 4
ARMATURE 1
RES 5
CTF/1
ARMATURE 2, SERIES FIELD 1
CTA/1
SERIES FIELD 2
D4
D1
RLB/1
RLA/1
RLB/2
RLA/2
D3
D2
2
FIELD
1
1
BRAKE
2
+
LINE POS.


FIGURE 4.

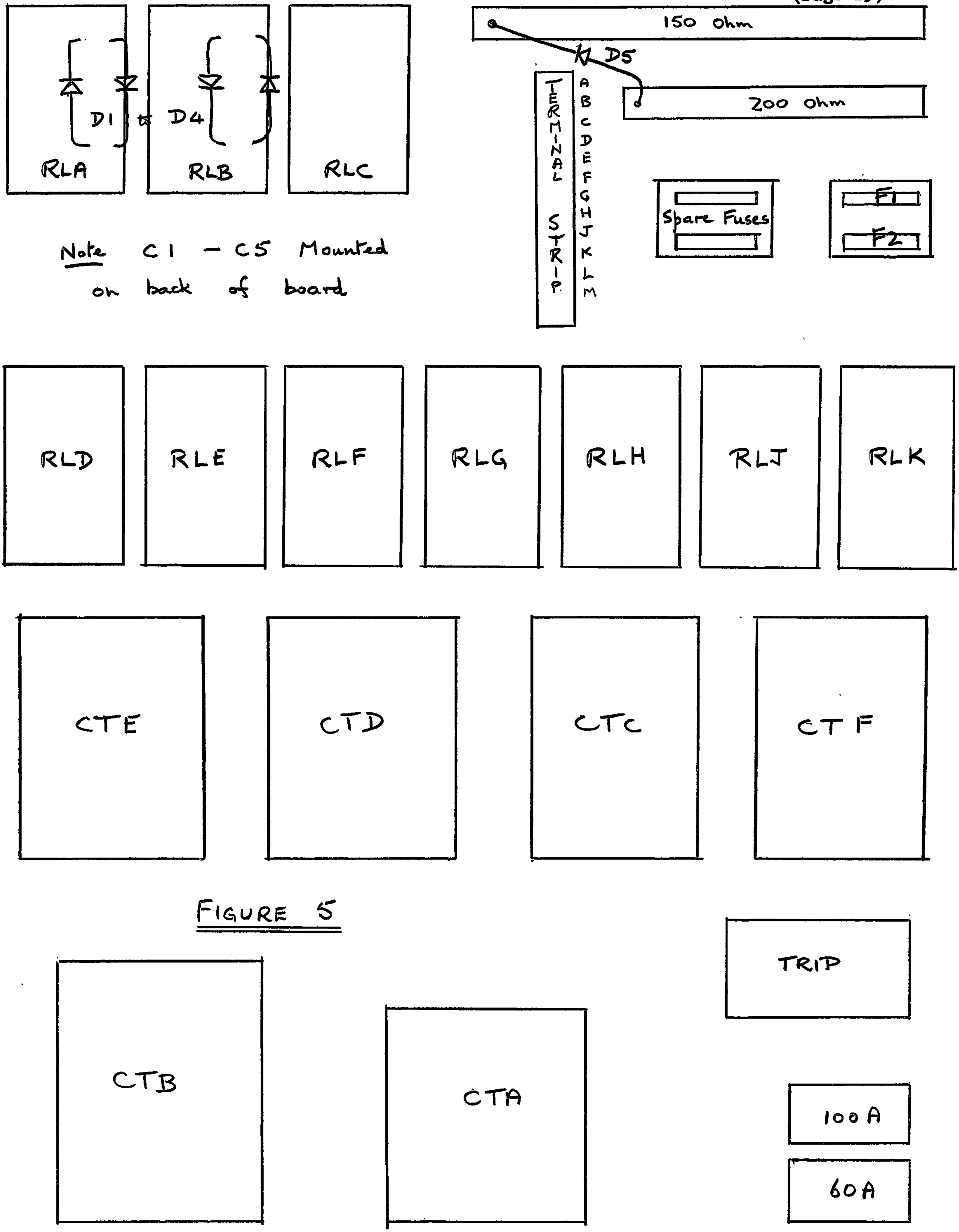
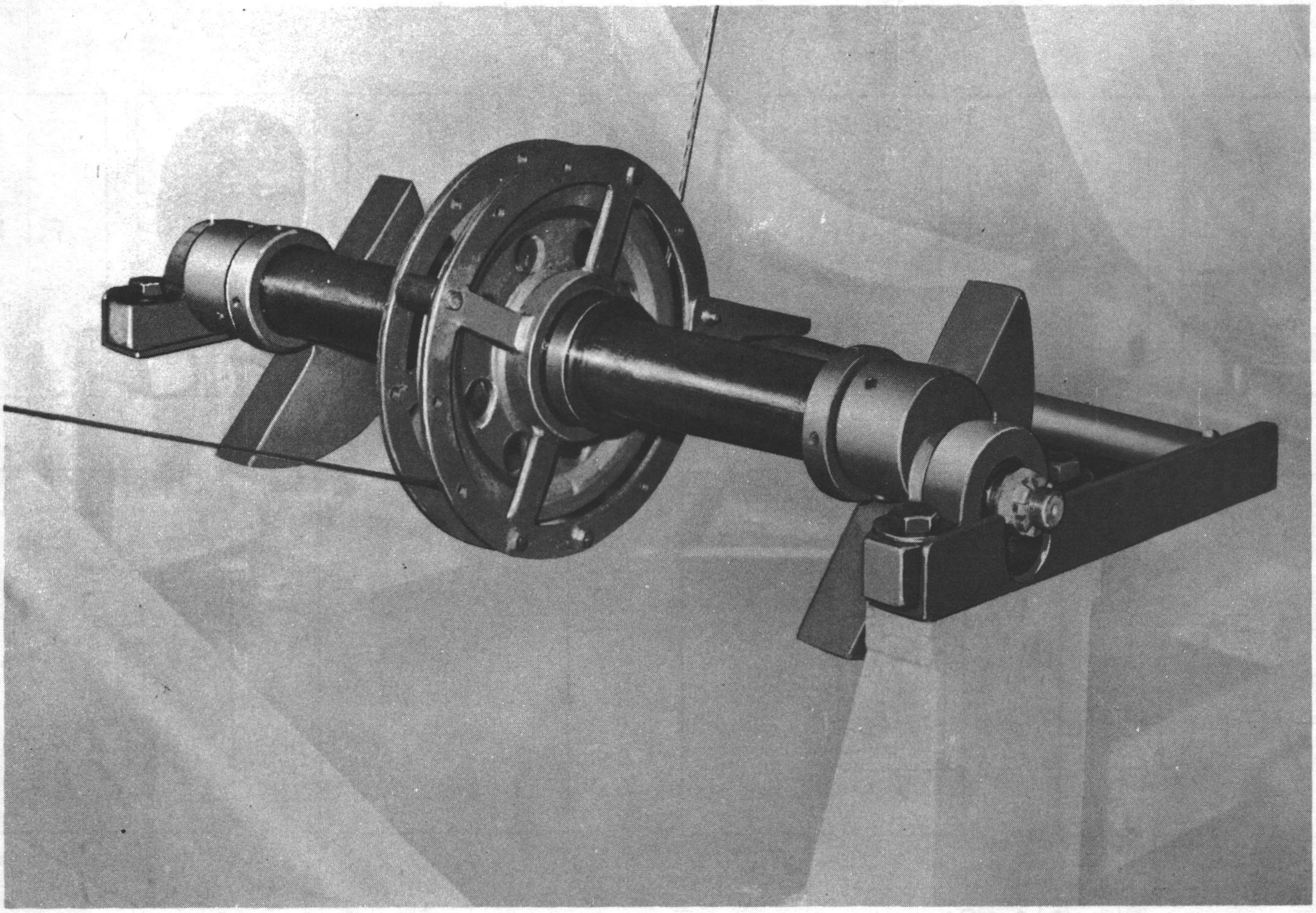

RLA
RLB
RLC
D1 to D4
150 ohm
D5
200 ohm
TERMINAL STRIP
A
B
C
D
E
F
G
H
J
K
L
M
Spare Fuses
F1
F2
Note C1 – C5 Mounted on back of board
RLD
RLE
RLF
RLG
RLH
RLJ
RLK
CTE
CTD
CTC
CT F
TRIP
CTB
CTA
100 A
60 A

FIGURE 5

# APPENDIX



# LEBUS AUTOMATIC fleet angle COMPENSATOR

# Why use a Fleet Angle Compensator?

A Fleet Angle Compensator is necessary for the proper spooling of wire rope on a hoisting drum if the fleet angle is greater than 1½ degrees or less than ¼ degrees. When the fleet angle is less than 1½ degrees, a Fleet Angle Compensator will also improve wire rope life by reducing scrubbing at the crossovers. The fleet angle can be defined as the included angle between the wire rope, in its position of greatest travel across the drum, and a rope drawn normal to the drum shaft, passing through the center line of the lead sheave. (See Figure 1.)

The fleet angle has an important bearing upon the change from one layer to the next. If it is too great, the tendency will be for the wire rope to pull away from the flange too rapidly, leaving gaps into which the rope on the next layer will fall. If the fleet angle is too small, the rope may not pull away from the flange soon enough. In this event, it would tend to pile up on itself adjacent to the flange, for perhaps two or three wraps, and then drop down with considerable force. The resulting impact would be harmful not only to the rope, but to the equipment on which it operates. Without a Fleet Angle Compensator, the fleet angle should vary between a maximum of 1½ degrees to a minimum of ¼ degrees for good spooling.

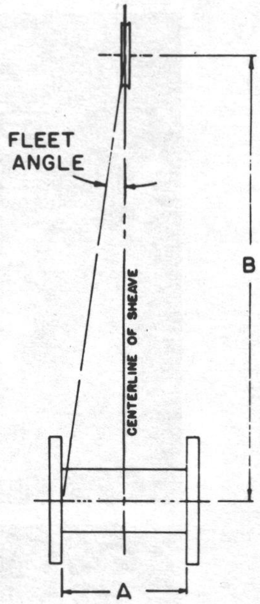



FIG. 1
A = Distance between flanges
B = Distance from drums to sheave

## LeBus Automatic Fleet Angle Compensator solves most fleet angle problems

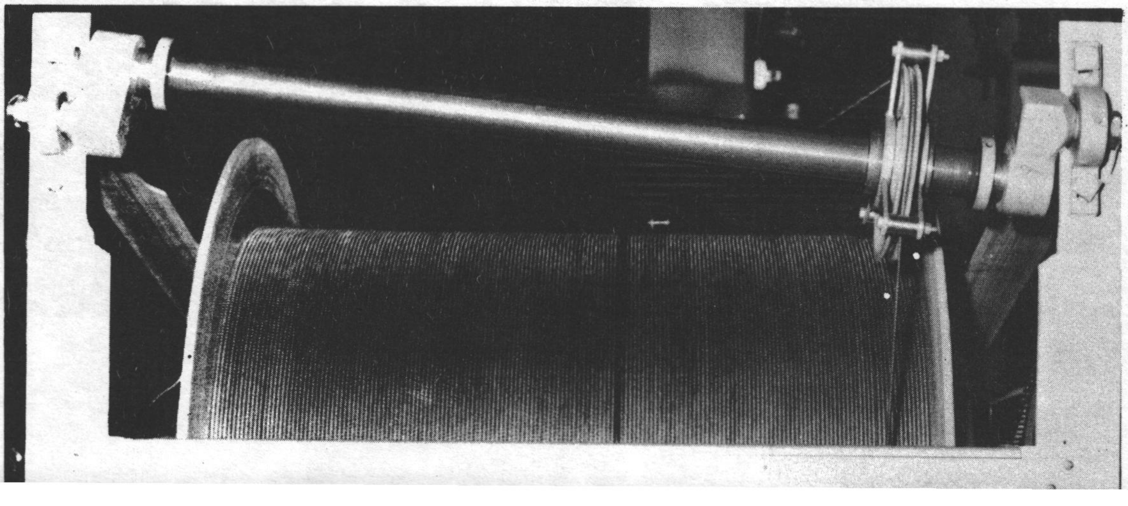
The LeBus Fleet Angle Compensator has the following limitations:

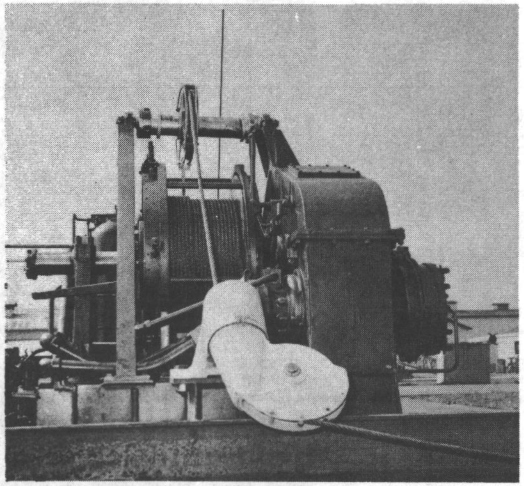
1. The cable must go from the drum over the compensator to a fixed point such as a fairlead or fixed sheave.
2. The drum must have controlled spooling comparable to LeBus Grooving.
3. There must be tension in the cable during the spooling operation.

The LeBus Fleet Angle Compensator is capable of reducing excessive fleet angles so that the resulting fleet angles are kept within even narrower limits than those above. The LeBus Fleet Angle Compensator tends to keep the wire rope spooling onto the drum practically perpendicular at all times except at the flanges where a small fleet angle is needed to prevent the rope from piling up on itself as stated previously.

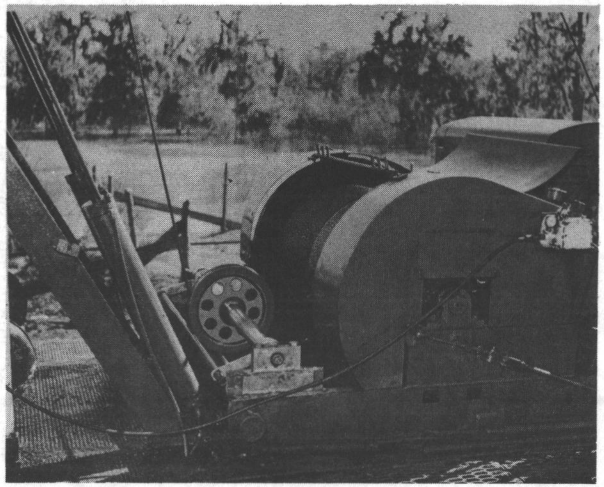
In operation, the LeBus Fleet Angle Compensator is COMPLETELY AUTOMATIC and after the initial adjustments are made at the time of installation, only a minimum amount of inspection is necessary. During the winding or unwinding of the rope the fleet angle compensator shaft will slowly oscillate, allowing the sheave to float across the shaft in the path of an arc. There is no mechanical hook-up between the LeBus Fleet Angle Compensator and the drum.

Sheave rotates and slides along eccentric oscillating shaft to keep wire rope perpendicular to the axis of the drum core. The sheave is actuated only by the cable spooling onto the drum.

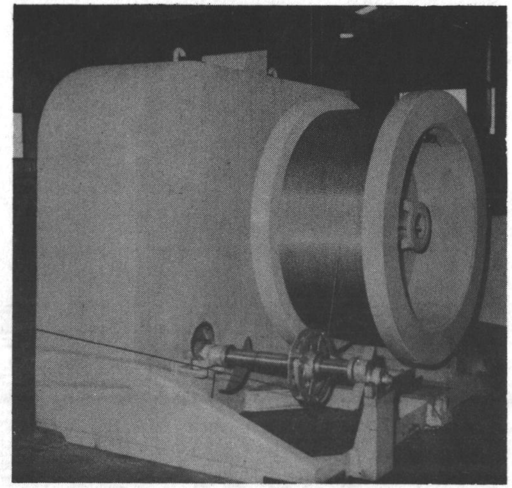




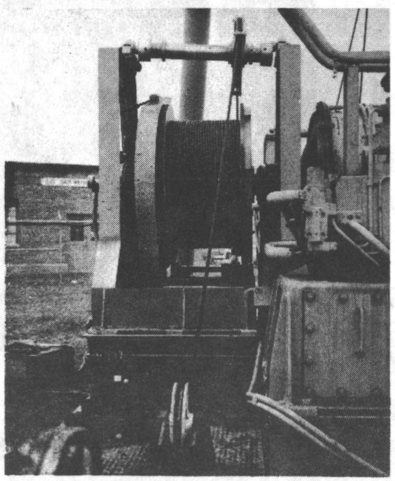
Constant tension winch for shipboard use equipped with LeBus Grooved Drum, LeBus Automatic Fleet Angle Compensator and a LeBus Swiveling Fairlead.



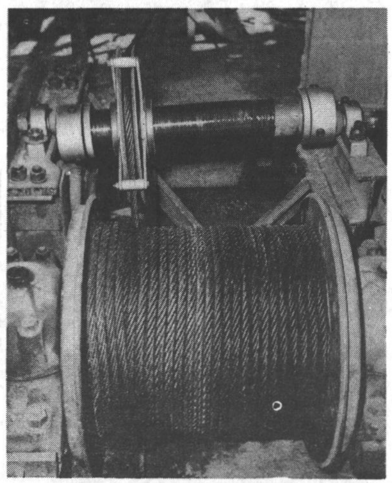
Oilfield swabbing unit with LeBus Grooved Drum and LeBus Automatic Fleet Angle Compensator.



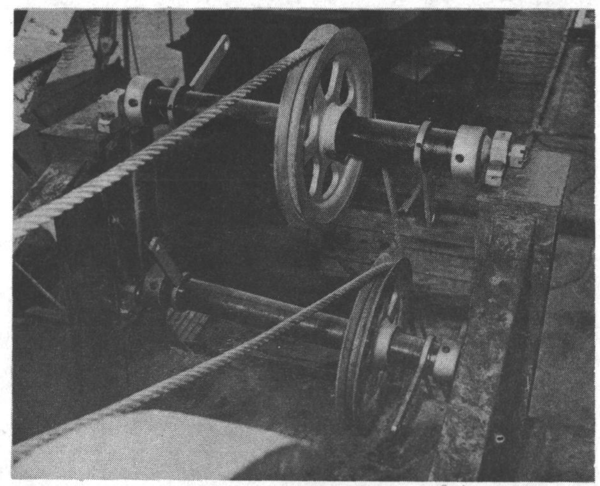
Oceanographic winch with 30,000 feet of 5/32" line on LeBus Grooved Drum with LeBus Automatic Fleet Angle Compensator.



Utility winch, note extreme fleet angle corrected by LeBus Automatic Fleet Angle Compensator.

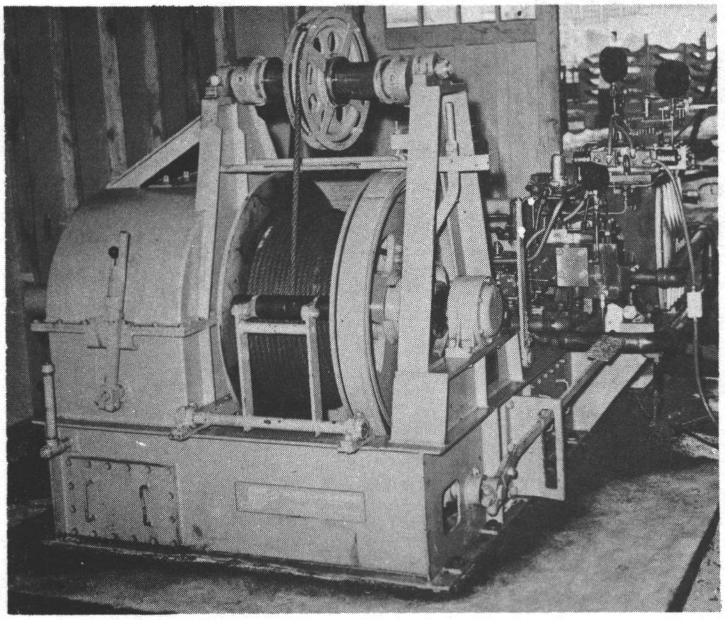


Sand and gravel barge spotter with LeBus Grooved Drum and LeBus Automatic Fleet Angle Compensator.

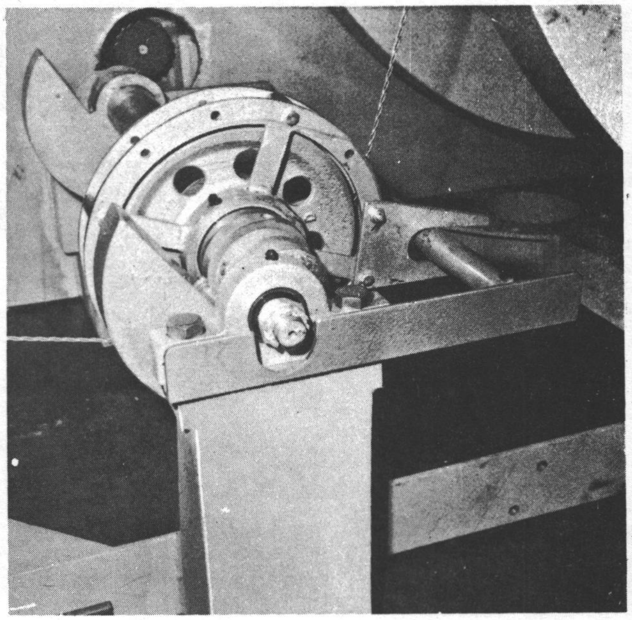


1" cable on double drum anchor winches on pipe-laying barge with two LeBus Automatic Fleet Angle Compensators.

# LeBus Automatic Fleet Angle Compensator



Another shipboard winch with LeBus Grooved Drum, LeBus Automatic Fleet Angle Compensator, LeBus Pressure Roller, and LeBus Swiveling Fairlead.



Detailed view of Fleet Angle Compensator showing line guard. Counter weights and line guard yoke.

## Advantages of LeBus Automatic Fleet Angle Compensator

- Compensates for excessive fleet angles to provide proper fleet angle for proper spooling on LeBus Grooved Drums or on grooved drums comparable to LeBus Grooving.
- Equipment is simple, rugged and fully automatic, with no periodic adjustments required.
- No special synchronizing drive trains and controls required.
- Wear on rope is no greater than that from a simple sheave.
- The only maintenance requirements are proper lubrication of shaft and bearings.
- Can be mounted in any position around the drum.

## The following is information required by LeBus to engineer your requirements:

1. Plan or elevational view of winch or hoisting equipment and location of first fixed sheave or fairlead.
2. Drum dimensions.
3. Rope or Cable size.
4. Is slack rope or cable involved in the operation?
5. Approximate weight of hook and/or block (pulley).
6. Minimum and maximum loads to be hoisted.

**SPECIAL NOTE:**

It is recommended that the LeBus Automatic Fleet Angle Compensator be used only in conjunction with LeBus Grooved Drums or grooved drums comparable to LeBus.

## Initial Adjustments:

After installation, the Fleet Angle Compensator must be adjusted before proper operation is obtained. Preliminary calculations were used to design the Fleet Angle Compensator as to length of shaft, end cap throws, etc., but a final adjustment under actual spooling operations is needed. There are two types of adjustments required. The adjustable end cap may be rotated on the shaft to provide a number of different degree settings. These different degree settings determine the distance the sheave will travel back and forth along the shaft.

Note:

The Fleet Angle Compensator has two end caps. One is called the zero degree end cap because the zero degree mark on the end cap is always aligned with the mark on the shaft. This end cap is pinned at the factory and is never adjusted. All end cap adjustments are made on the other end cap which is called the adjustable end cap.

The other adjustment required is the positioning of the set collars. The set collars limit the travel of the sheave along the shaft so the fleet angle is never smaller than 1/2 degree.

The adjustable end cap is adjusted first. In Figure 2 you will note that the end cap is marked with a 0 degree mark at the top or adjacent to the bearing journal and other degree markings either to the right or left are placed around the end cap. To adjust the end cap, the three jam nuts and set screws are loosened and the end cap is rotated until the desired degree mark is aligned with the mark on the shaft. The set screws and jam nuts are then tightened.

To begin the actual adjustment of the Fleet Angle Compensator, the adjustable end cap is set to the 100 degree mark, either right or left. If improper spooling occurs at this setting, then the end cap will be readjusted for another spooling try. Several settings may be tried before the correct one is found.

Note:

Adjusting the end cap while there is tension in the wire rope is extremely difficult, therefore plan to make these adjustments while there is no tension in the rope.

In some instances, a Fleet Angle Compensator will be installed on a drum that already contains misspooled wire rope. Before the compensator can be adjusted, it will be necessary to unwind the drum until every wrap is in its proper position.

If there is no rope on the drum, proceed to spool the first layer of rope on the drum under sufficient tension making sure that every wrap is in its proper place. The decision whether the compensator is in adjustment or not is determined by observing the spooling or action of the wire rope. In most cases, if the corrector is out of adjustment, the wire rope will misspool as it rises from one layer to the next at the flanges. The most critical area on a drum for spooling is that area next to the flange. When the first layer is completed, the wire rope will rise to the second layer. At this point if the wire rope pulls away from the adjacent wrap leaving a gap, you may assume the end cap setting was not large enough. If on the other hand, the rope spools nicely to the flange, rises as it should, and then the next wrap or two the rope piles upon itself adjacent to the flange, the assumption is that the end cap setting is too large. In short, misspooling will be recognized by the wire rope either pulling away from the adjacent wrap leaving a gap, or by piling upon itself. Excessive scrubbing of adjacent wraps may also be classified as poor spooling which may be reduced by setting the end cap to a larger degree setting.

As soon as misspooling occurs while winding the rope on the drum, the drum should be reversed so as to unwind the bad spooling from the drum and then the tension in the rope removed. By analyzing the observation of the action created by the rope, the adjustable end cap is readjusted about 10 degrees either larger or smaller. The winding procedure is commenced again for another try.

After finding the correct end cap setting which will allow the wire rope to travel over the the flange completing the first layer, rising as it should to the second layer, the rope is allowed to continue spooling toward the opposite flange. The spooling condition at the second flange must also be observed and the end cap adjusted again if necessary. In the majority of cases, the adjustment required for good spooling at one flange will be the correct adjustment for the other flange. Assuming this to be the case, the spooling operation is continued for several layers. At this time the set collars may be positioned on the shaft and set. The set collar is positioned so that when the sheave is adjacent to the set collar, the wire rope will have a fleet angle with the flange of about 1/2 degree. This will prevent the rope from piling upon itself at the flange.

The set collars are most important when spooling at both flanges cannot be accomplished by the end cap settings. This condition usually means that the Fleet Angle Compensator is not in proper alignment with the drum or the first fixed sheave is not in the exact center of the drum. To solve this problem, the end caps are adjusted so as to have good spooling on one flange and a piling up tendency occurs on the other flange. Then, as stated previously, the piling up tendency is corrected by the proper positioning of the set collar at that flange.

So, a tendency of the wire rope to pull away is corrected by end cap adjustments only. Also, a tendency to pile up at <u>both</u> flanges is corrected by end cap adjustments. Piling up at <u>one</u> flange must be corrected by the set collar at that flange if the other flange has good spooling because adjusting the end cap to correct the piling up would only cause the good spooling to misspool by pulling away.

Always adjust the end cap first, then position the set collars. Adjustment of the end cap is less difficult when the end cap is adjusted before set collars are positioned because the natural tendency of the sheave at the flange gives an indication to the correct end cap setting.

In severe cases, the wire rope may pull away or pile up in the center of the drum. Figure 3 is a chart that summarizes most troubles stated above and which are likely to occur while adjusting the Fleet Angle Compensator. To read the chart, decide first when the trouble started, then next, what happened to cause the misspooling. The most likely cause will be at the intersection of these two columns.

After the fleet angle has been adjusted, the adjustable end cap and set collars are pinned with the locking pins provided. The end of the shaft must be drilled with a 5/16 drill to a depth of 1-1/2" after the end cap has been adjusted. The set collars are also pinned by drilling the shaft with a 3/16 drill through the hole provided in the set collar. Leave about 1/4" of the locking pin in the set collar protruding for removal. The locking pin in the end cap must be flush with the surface.

## LEBUS FLEET ANGLE COMPENSATOR

## END CAP ADJUSTMENT CHART

1. First decide where bad spooling occurred.
2. Then decide if wire rope broke away from its adjacent wrap or piled upon itself.

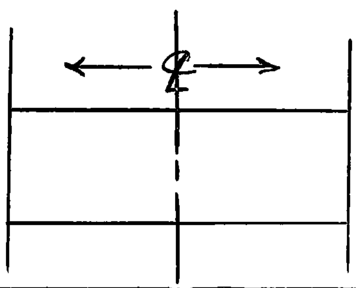
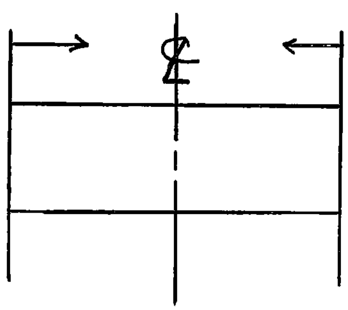
| If bad spooling occurred when | Wire rope breaks away from adjacent wrap. | Wire rope piles upon itself or excessive scrubbing. |
| --- | --- | --- |
| Spooling from center of drum toward flange.  | End cap setting is too large. Reduce setting about 10 degrees for another trial. | End cap setting is too small. Increase setting about 10 degrees for another trial. |
| Spooling from flange toward center of drum  | End cap setting too small. Increase setting about 10 degrees for another trial. | End cap setting is too large. Reduce setting about 10 degrees for another trial. |

FIGURE 3

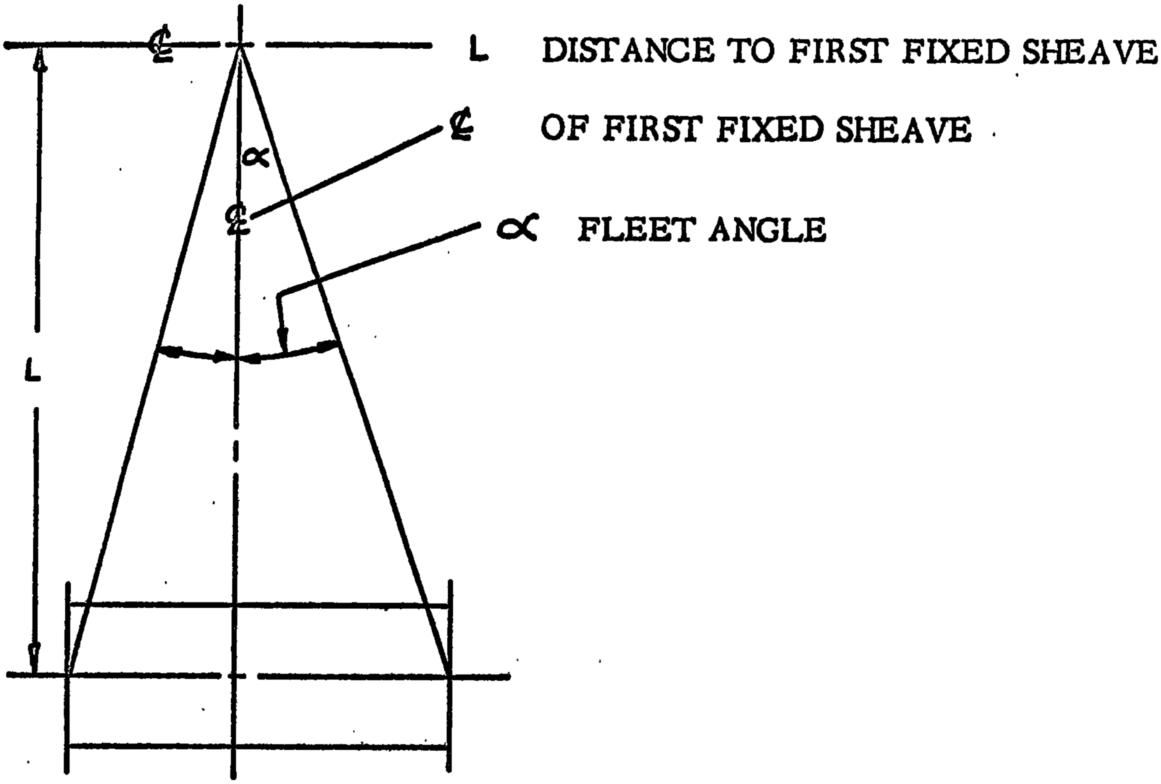

L
DISTANCE TO FIRST FIXED SHEAVE
℄
OF FIRST FIXED SHEAVE
α
FLEET ANGLE
α
℄
℄
L

FIG. 1

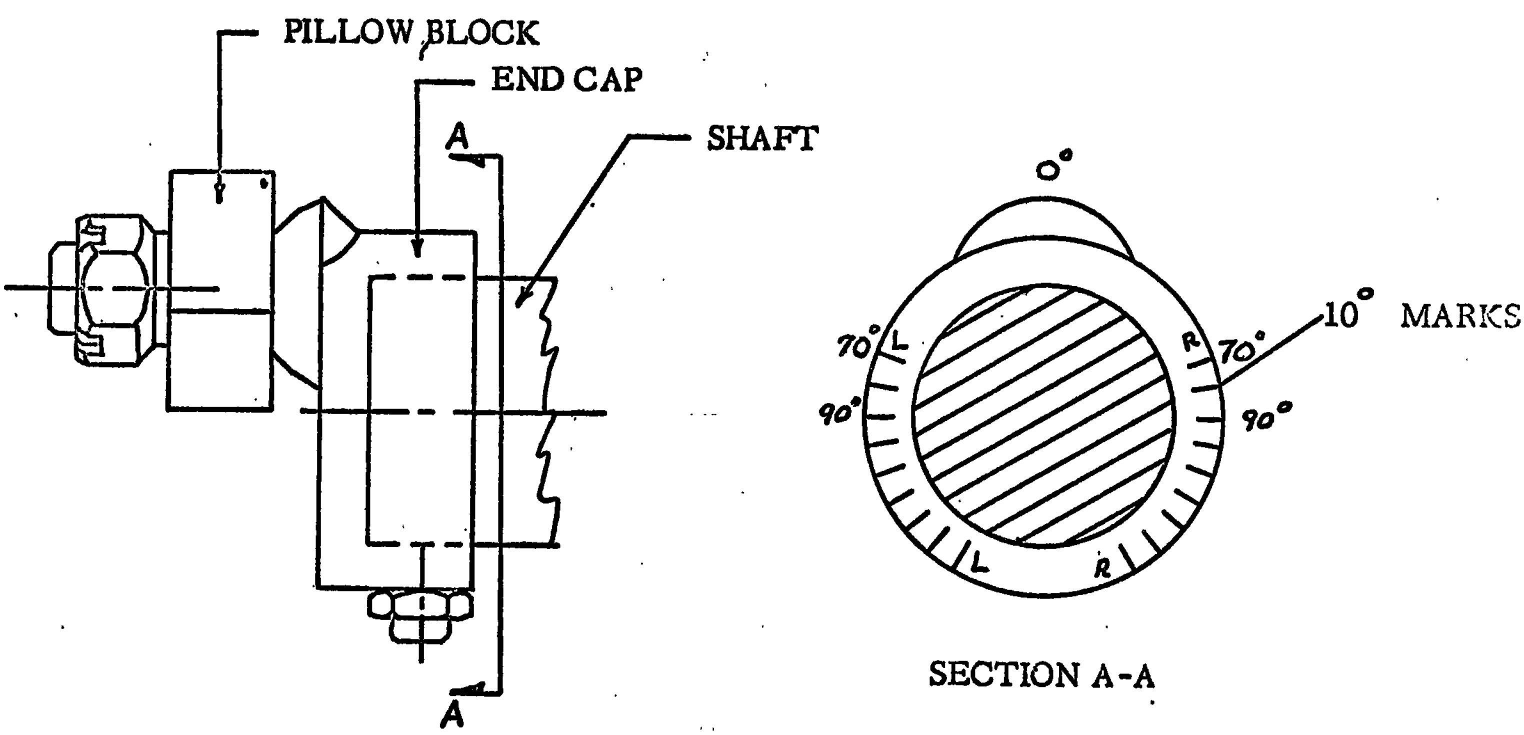

PILLOW BLOCK
END CAP
A
SHAFT
A
0°
70°
L
R
70°
10° MARKS
90°
90°
L
R
SECTION A-A

FIG. 2