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Enclosure (1) to [illegible]

WOODS HOLE OCEANOGRAPHIC INSTITUTION

Woods Hole, Massachusetts

STI

Reference No. 51-43

UNATTENDED INSTRUMENTS

400 Day Ocean Current Recorder

by

Arthur A. Klebba

Technical Report
Submitted to the Office of Naval Research
Under Contract No. N6onr-27701
NR-083-004

June, 1951

APPROVED FOR DISTRIBUTION _____
Director

Preface

This report describes a current recording instrument designed and developed under Contract N6onr-277, Task Order One, with the Office of Naval Research.

The need has long been felt for an instrument that could be set at a particular location in the ocean to continuously record the net flow of water over a long period of time. This instrument was designed and built using several unique ideas in means of measurement and construction.

Arthur A. Klebba

June 1, 1951

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Principle of Operation

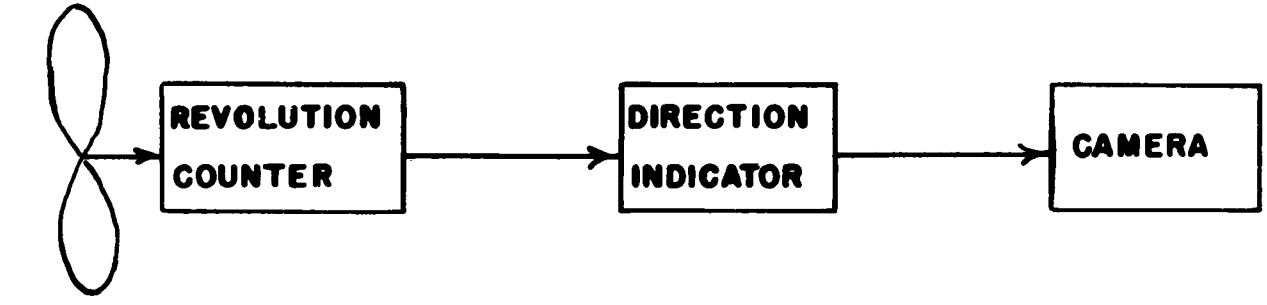
This instrument was designed to record and retain approximately one year of ocean current data. The recording is on 16 millimeter motion picture film with small photographs of the compass face indicating the direction of the instrument. A direction vane is provided so that alignment of the instrument with the current takes place readily. Each picture indicates the passage of 500 turns of the propeller. In order that the full surface of the film be used, the pictures are placed vertically as well as on the horizontal time axis. Figure one illustrates a block diagram of the instrument and the method of utilizing the complete surface of the film.

Method of Recording

Referring to the block diagram, the revolution counter sends an electrical signal to the compass assembly resulting in a timed illumination of the compass face. The camera lens is placed about ten inches from the compass and forms a small image of the compass face on the film. The film moves at the rate of one eighth inch per hour, and the same clockwork used for the film movement is used to oscillate the lens crosswise on the film. The result of this lens motion is to displace the image formed by the lens. The lens is constructed to move slowly down, as indicated by the dark lines and arrows at the lower part of the figure. Actually the movement of the lens is vertical but movement of the film in the meantime makes the obvious slant movement represented by the heavy lines.

Each hour the lens is made to traverse in the opposite direction in a fraction of a second, as denoted by the fine line and arrow. Insignificant film movement takes place in this interval.

For illustration: a synthetic section of record is sketched on the same page, with the path from picture to picture indicated. Regardless of the vertical position on the film, the horizontal distance between each picture can be converted to the time interval between successive pictures. A scale can be used to convert the distance directly into the value of current when the record is projected on a viewing screen.


REVOLUTION
COUNTER
DIRECTION
INDICATOR
CAMERA
PROPELLER

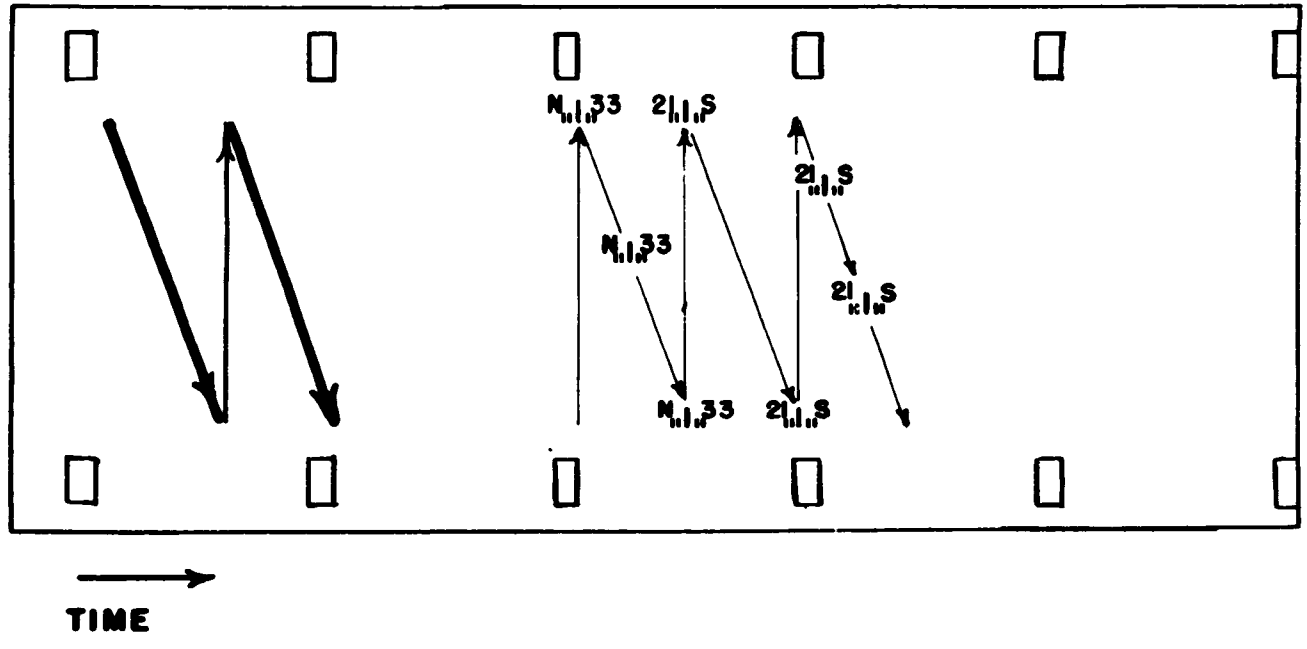

TIME

FIGURE 1

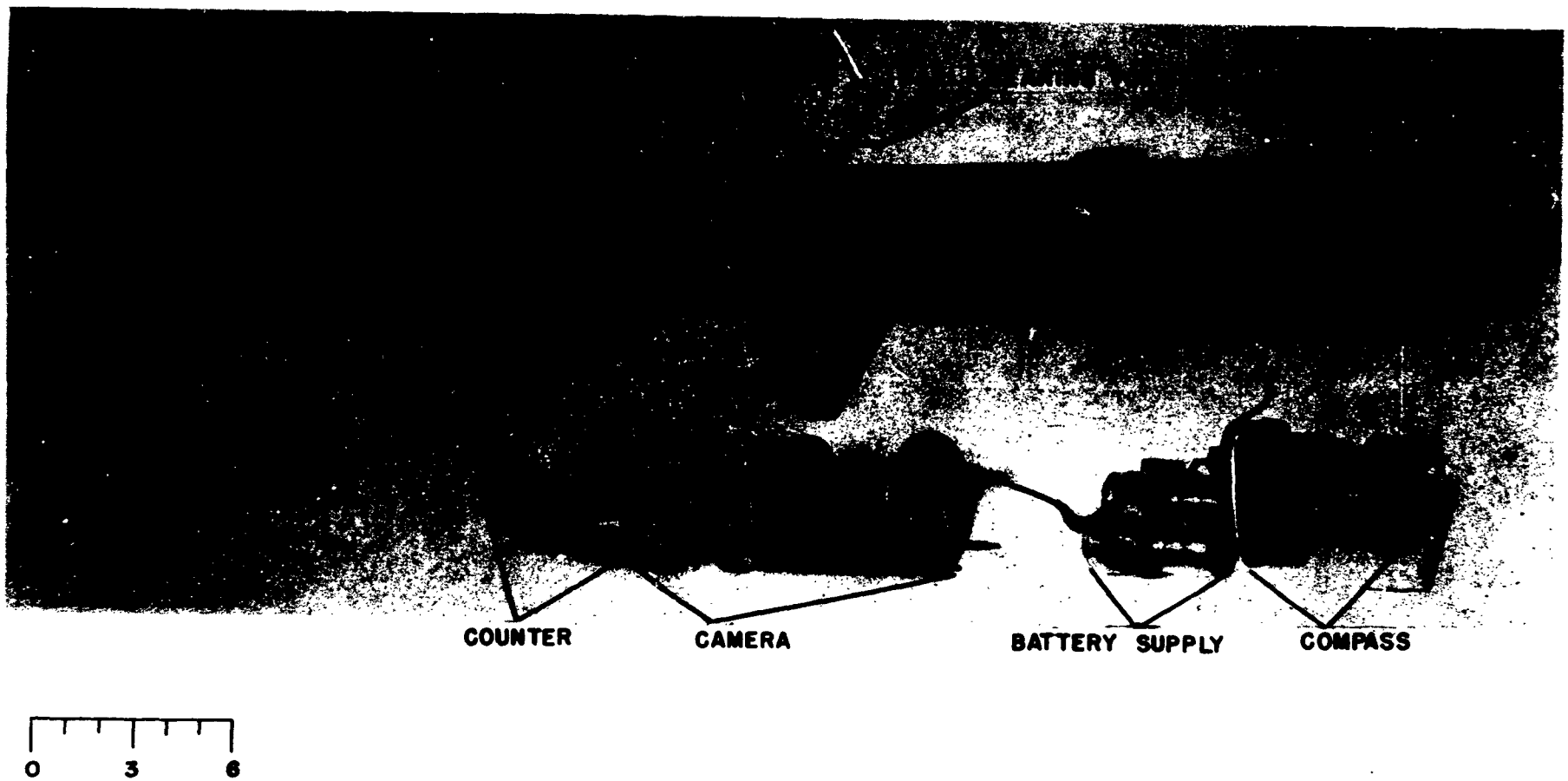


FIGURE 2

General Appearance

Figure two illustrates an outer view of the instrument with the inner parts shown in the relative positions they occupy in the case. The camera case has been removed and is not shown. The upper ball bearing swivel is shown. The lower swivel is usually bolted to the bottom of the yoke which is attached to the instrument body at two ball bearing races. Monel balls are used in the swivels as at the yoke support points. The ball races are bronze, but an Everdur casting is intended to replace this construction.

Figure three shows an outline view and the parts lay-out, with some parts shown in section.

Compass

Figure four illustrates the compass used in the current recorder. It is a standard Bendix B16 aircraft compass. The usual means of illuminating the face is inadequate for photography and is removed. A Formica block forms a mounting for an assembly of six "grain of wheat" lamp bulbs. These are connected in a series parallel circuit so that each lamp receives three volts. If one lamp burns out, the two lamps near it burn slightly brighter than before the burnout occurred. The compass has EW and NS compensations which are accessible when the light assembly is removed.

All magnets and magnetic materials are located at the other end of the instrument, and adjustment of the compass is easily accomplished before installation in the instrument.

Revolution Counter

This portion of the instrument is intended to provide an electrical signal of fixed duration for each 500 revolutions of the propeller. An enclosed ring magnet attached to the propeller is coupled magnetically to a similar magnet inside the case which is shown in Figure five.

Energy from the propeller is used to trip a switch and this amount of energy required is distributed over 500 propeller revolutions. The ring shaped magnet inside the case and on this assembly, is mounted on its symmetric axis with a shaft using two ball bearings. Attached to this shaft is a small 6 tooth spur pinion. The pinion engages a 60 tooth spur gear which is connected to a single thread worm. The worm drives a 50 tooth worm gear upon which is mounted a spiral cam. A micro switch is installed so that its lever engages the cam and is spring loaded to allow the switch to be in a normally open position. The shaft supporting the micro switch is connected to a gear sector which engages a ratio gear and in turn a gear with an inertia wheel. This set of gears acts as an escapement.

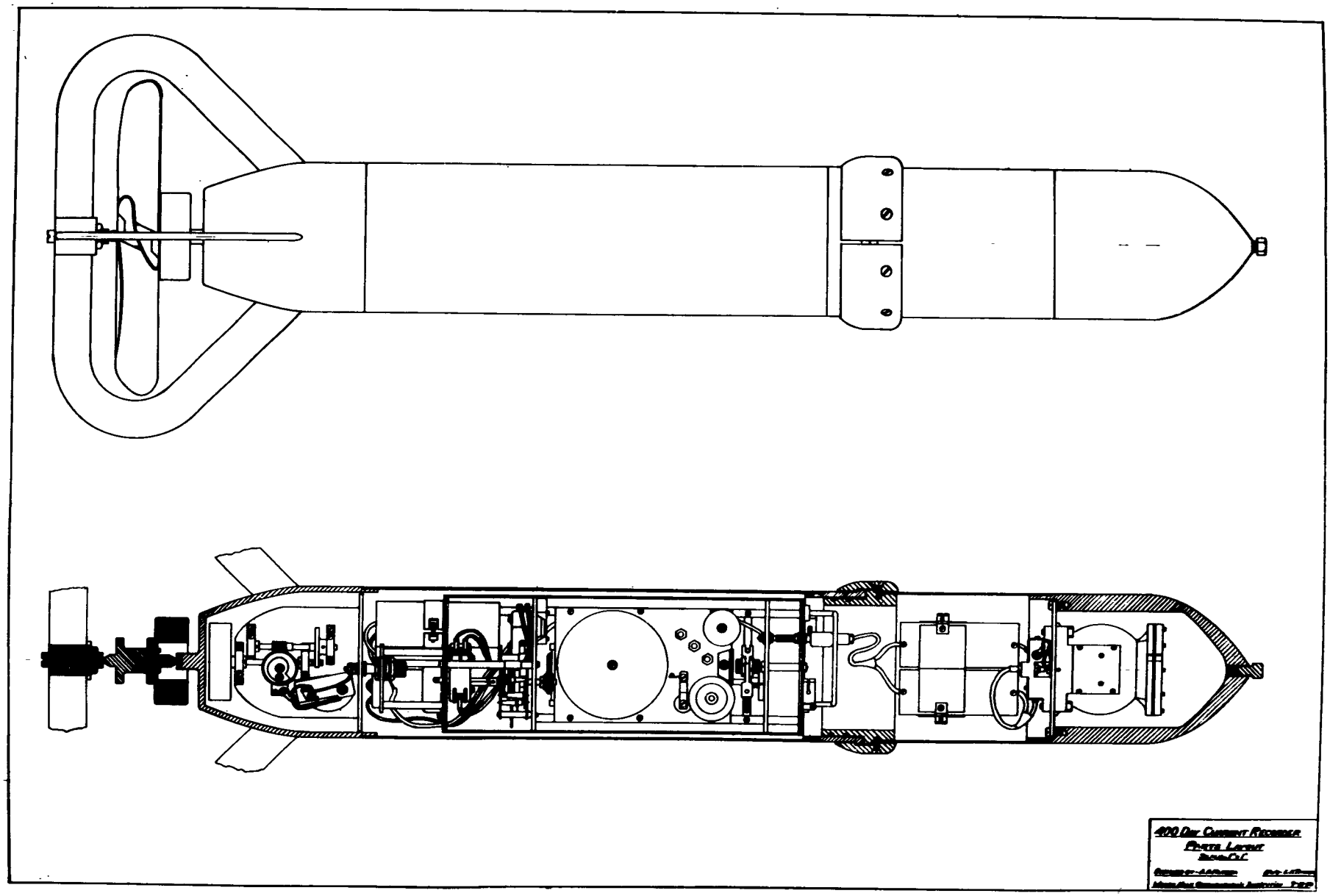


FIGURE 7

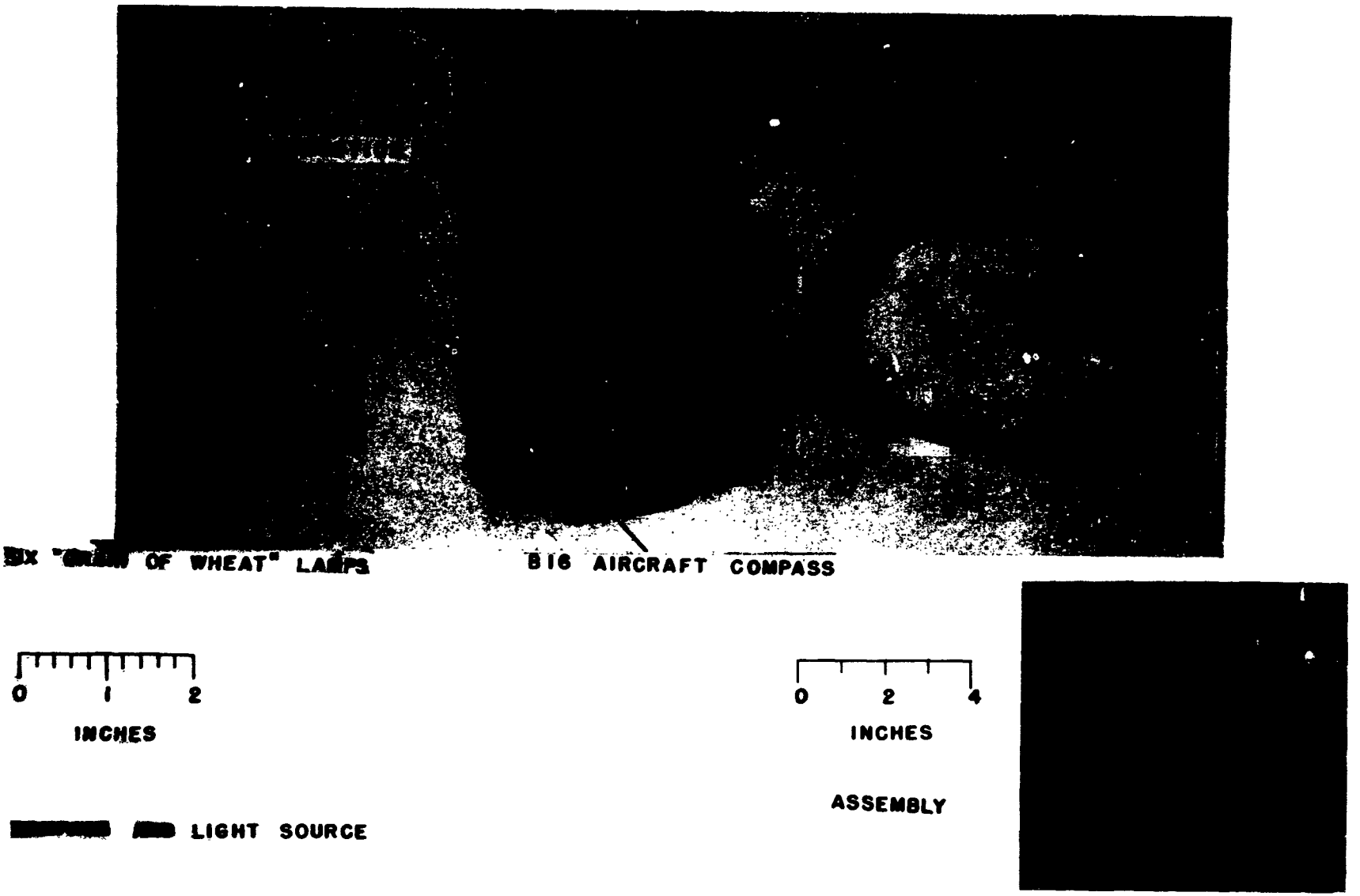
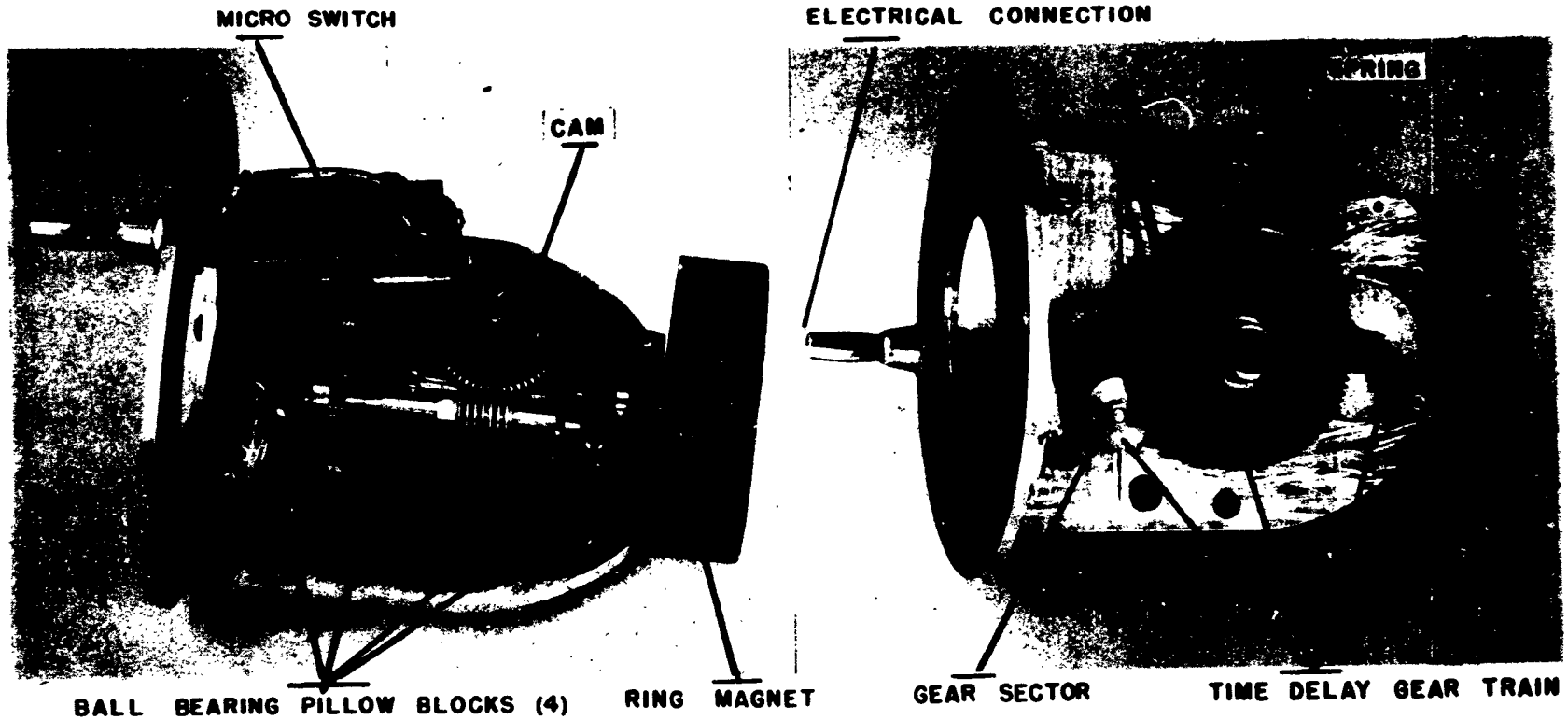

OF WHEAT" LAMPS
B16 AIRCRAFT COMPASS
0 1 2
INCHES
LIGHT SOURCE
0 2 4
INCHES
ASSEMBLY

FIGURE 4



REVOLUTION COUNTER

FIGURE 5

In operation, the spiral cam rotates proportionally to the propeller speed and slowly moves the switch lever and switch cam, causing the escapement gears to turn. As the cam reaches the maximum deflection the switch lever drops. The gears attached to the switch must return to their initial position because of their spring loading. The lever of the switch is in the closed position during the interval of return and voltage is applied to the compass lights for this time.

Camera

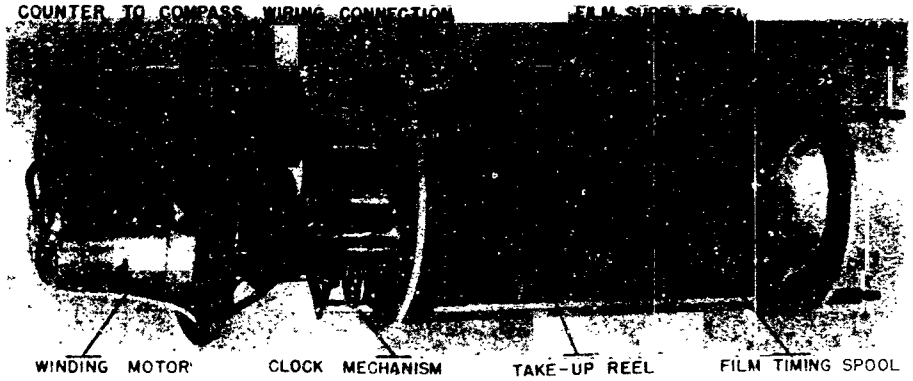
Figure six illustrates four views of the camera assembly. The basic timer used is an electrically wound clock movement. Originally it was driven by a 48 hour spring, but this has been removed in addition to all parts transmitting spring torque to the hour wheel.

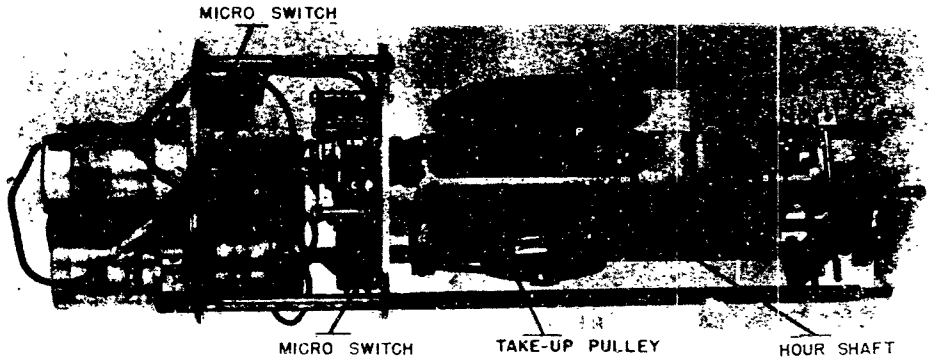
Clock Movement

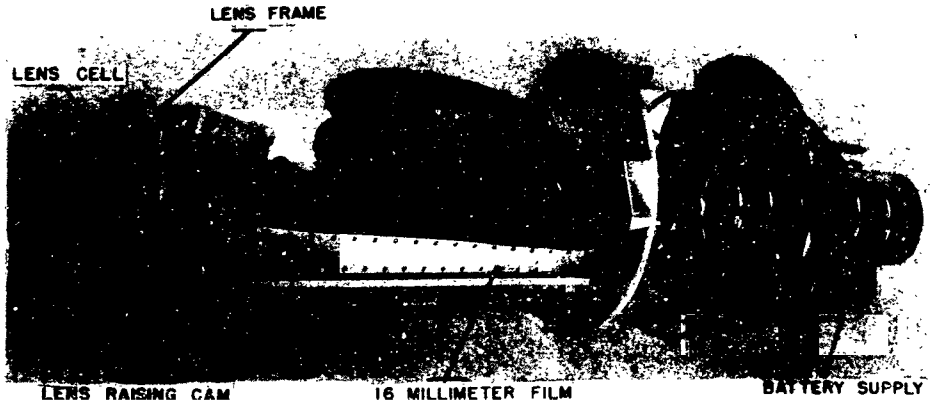
A new main spring and spring barrel are used in the timer. A small six volt DC geared motor has its output shaft connected to the main spring with the outer end of the spring anchored to the hour gear. The hour gear meshes with a similar gear which has a cam mounted to raise a micro switch lever 50 percent of the time, and lower the switch 50 percent of the time. A similar cam and micro switch are installed on the motor shaft. Initially it is wound a few turns. The two micro switches are single pole, double throw, and are connected in the usual double switch manner. That is, if either switch is thrown when the motor is off the motor will run, and if either switch is thrown when the motor is running it will stop. In this manner the hour wheel will throw the lever either up or down, and the motor will run until its cam has done the opposite movement to its micro switch. This winding operation occurs each half hour, and 200 milliamperes is drawn for two seconds from the battery supply each winding period. The rate of the clock is set by a stroboscopic light source which illuminates the balance wheel at the rate of 112 times per minute.

Battery Supply

Two banks each of six series connected cells are used in parallel to drive the motor for rewinding. The cells are of the mercury type and the total capacity of the bank is 6400 milliampere hours. These cells have a shelf life of several years. A similar set of cells is used to supply power for the compass lighting.







CAMERA ASSEMBLY

0 1 2
INCHES

FIGURE 6

Lens Motion

A shaft rotating once per hour runs from the clock movement to the lens and is termed the "Hour Shaft". It turns a single thread worm which engages the 30 tooth worm gear connected to the film timing spool. At the extreme end of the shaft a spiral cam is mounted which is called the "Lens raising cam". The purpose of this cam is to move the lens crosswise to the film as previously described. It is a linear spiral cam rotating to raise the lens mount assembly evenly during the hour and drop it quickly. In reading the film it appears that the image slowly lowers and then raises quickly, due to the fact that an inverted image results on the film.

Film Timing Spool

The spool is used instead of a sprocket to obtain smooth film travel. It turns once each 30 hours and moves the film one-eighth inch per hour. Two grooves in the spool contain "O" rings which provide traction on the film. The assembly turns on a spring loaded ball bearing so no irregular movements can occur once the slack is taken up on the worm gear. A spring loaded roller bears on the film, holding it well against the "O" rings.

Film Take-up

Power for the film take-up is provided by the motor shaft which projects through the clock movement and terminates in a small pulley made of a grooved hub with two "O" rings to provide traction on a spring belt. The belt connects this pulley to a larger one which is at the lower end of the shaft which passes through the film reels and turns the lower reel. The top reel, which is the supply reel, uses this shaft to rotate upon, but does not turn with it. For each winding period the motor shaft turns one half revolution and the spring belt slips on a larger pulley for over travel. During the interval of film transport the "spring" in the belt serves to take up one sixteenth inch of film sent through by the film timing spool.

Film

Eastman Kodak Linagraph Ortho film has been found satisfactory for this recording. It can be used with a red light in the darkroom and offers excellent contrast for the image of the compass face. It has been found possible to use other 16 mm films that are available with standard photographic development. The cost of the Linagraph film is less and does not include factory development. A negative image is formed, black image on a light background.

Film Magazines

These are standard 100 foot open reels. Light exclusion is dependent upon the camera case. All film threading must be done in the darkroom with the camera and case. The top reel is the supply reel and the line of film is brought to base plate level by passing it through an inclined stirrup. The take-up reel is engaged to the shaft passing through the center of both reels.

Lens

Three inexpensive plano convex lens elements are used to obtain the short focal length necessary for photographing the compass face. Image quality is sufficient when the lenses are used at small fixed aperture. Details of construction are outlined in the appended drawings.

Propeller

This unit consists of five Everdur blades soldered with Eutectic 1806 solder to an Everdur hub. The hub has 60 degree cones on each end which form the pivot. Five sapphire balls are used in races of rectangular cross section. The blades are made by cutting trapezoidal sections and then rerolling the blades in a sheet metal roller. The axis of the roller is inclined from the central axis of the blade. The present construction is described in the drawings of the appendix. Other angles of displacement and curvature could be constructed for numerous degrees sensitivity of the instrument. The propeller assembly can be removed and another put in its place in a few minutes.

Ring Magnet

The magnetic coupling of the propeller and revolution counter is accomplished by mounting one magnet on the propeller outside the case, and one inside the case. Alnico VI is used, and the direction of the magnetization is across the diameter of the magnet. This particular grade of Alnico is intended for large air gap use, and lends itself very well for this application. The external magnet is encased in brass, using "O" ring seals. The magnet is soldered to a ring shaped cavity and the cover is put in place, after which the lips of the case are burnished to retain the sealing ring. The chamber is evacuated and filled with oil. The magnet in the main pressure case has its inside diameter ground so a brass disc can be soldered in. The disc is then machined and balancing is done in assembly. The gap between magnets is about one inch. This large gap allows a thick pressure case in addition to wide tolerances in construction.

Swivels

These are made with bronze or Everdur races using Monel balls. The races are in contact with the balls only while tension is on the chain or line attached to the shackles. Electrical insulation is provided on each swivel so that steel equipment can be attached to the instrument without corrosion occurring.

Tail Fin

A flat sheet of Everdur with bracing angles form the tail fins and allows alignment with the current within a few seconds at current values of 1/10 knot.

Pressure Case

The case is made of sections of brass tubing and valve bronze castings. The material used is the common 85-5-5-5 alloy using copper, zinc, tin and lead. Everdur was used for one model but the castings were porous when sand cast. Silver solder is used to join the parts.

This case has been tested to a static head of 500 feet of water.

Film Record

Figure seven illustrates a section of 16 mm film record which has been photographically developed and placed in a film viewer. It will be noticed that for weak currents the "sawtooth" pattern of recording is not apparent. The direction of the current is the compass reading, and the current is inversely proportional to the distance between the pictures. For a particular instrument and viewer a small scale could be placed directly on the ground glass to compute velocity.

Field Disassembly

Figure eight illustrates the disassembly required for removing the camera and light tight case for darkroom development of the film. Eight screws are provided to attach the locking rings in place. When these are removed the rings can be pulled off. An added safety device is provided in the form of a pipe plug in the nose of the instrument. In the event a case leak occurs when the instrument has been submerged for a long time at great depths, air pressure can build up within the case. The "O" ring seal could act as a piston and the plug is provided to release the pressure if it exists.

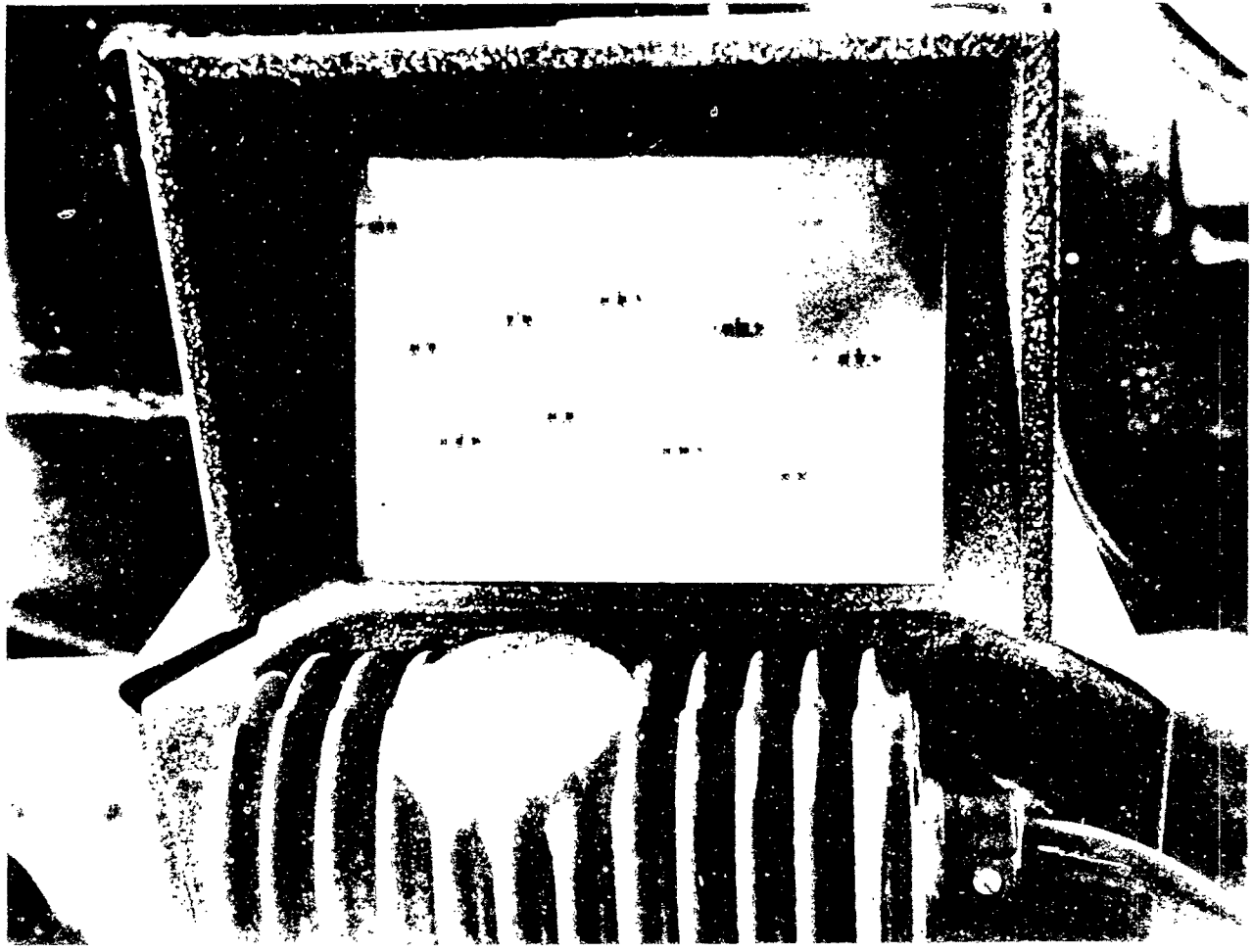


FIGURE 7

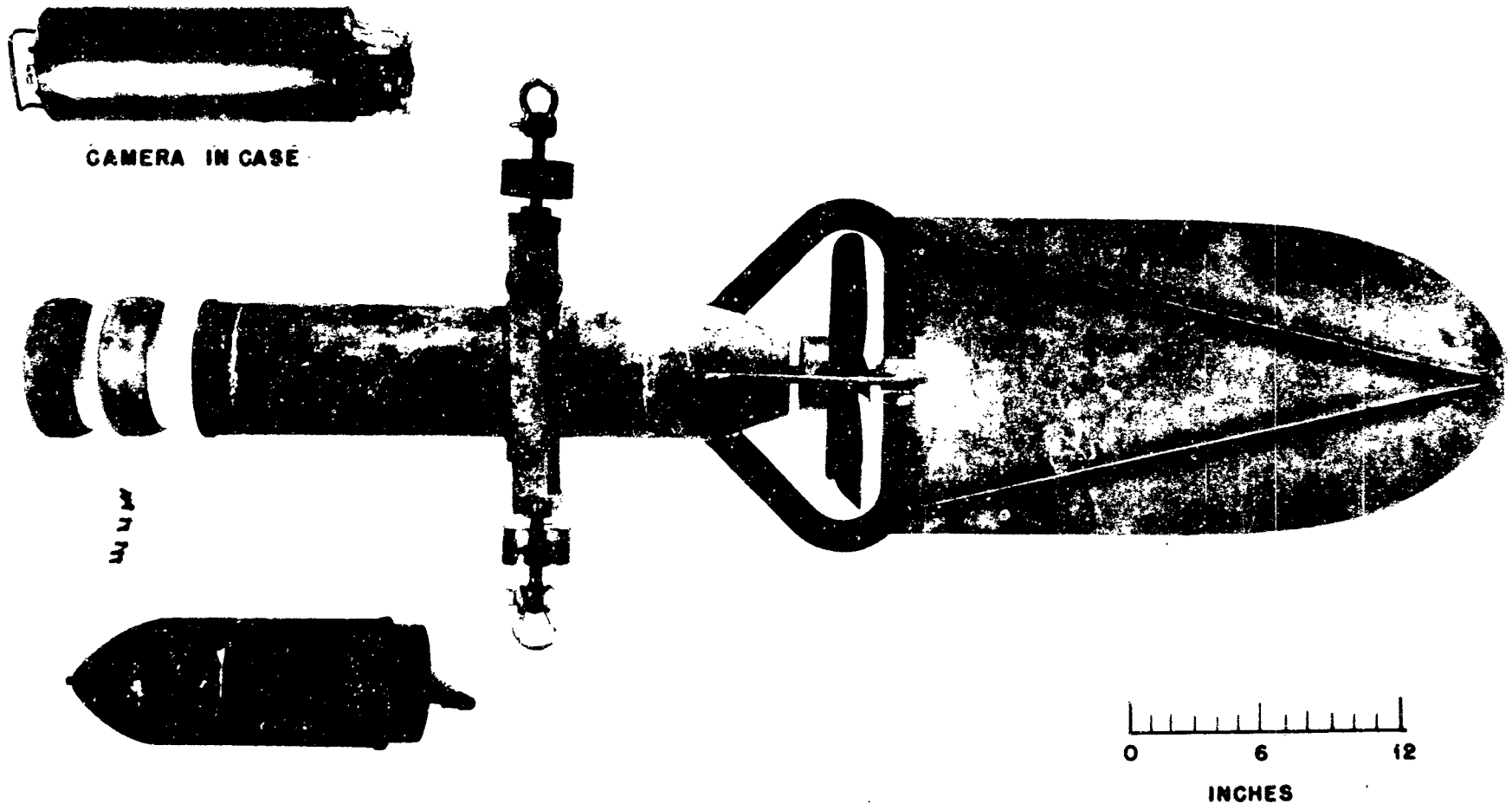
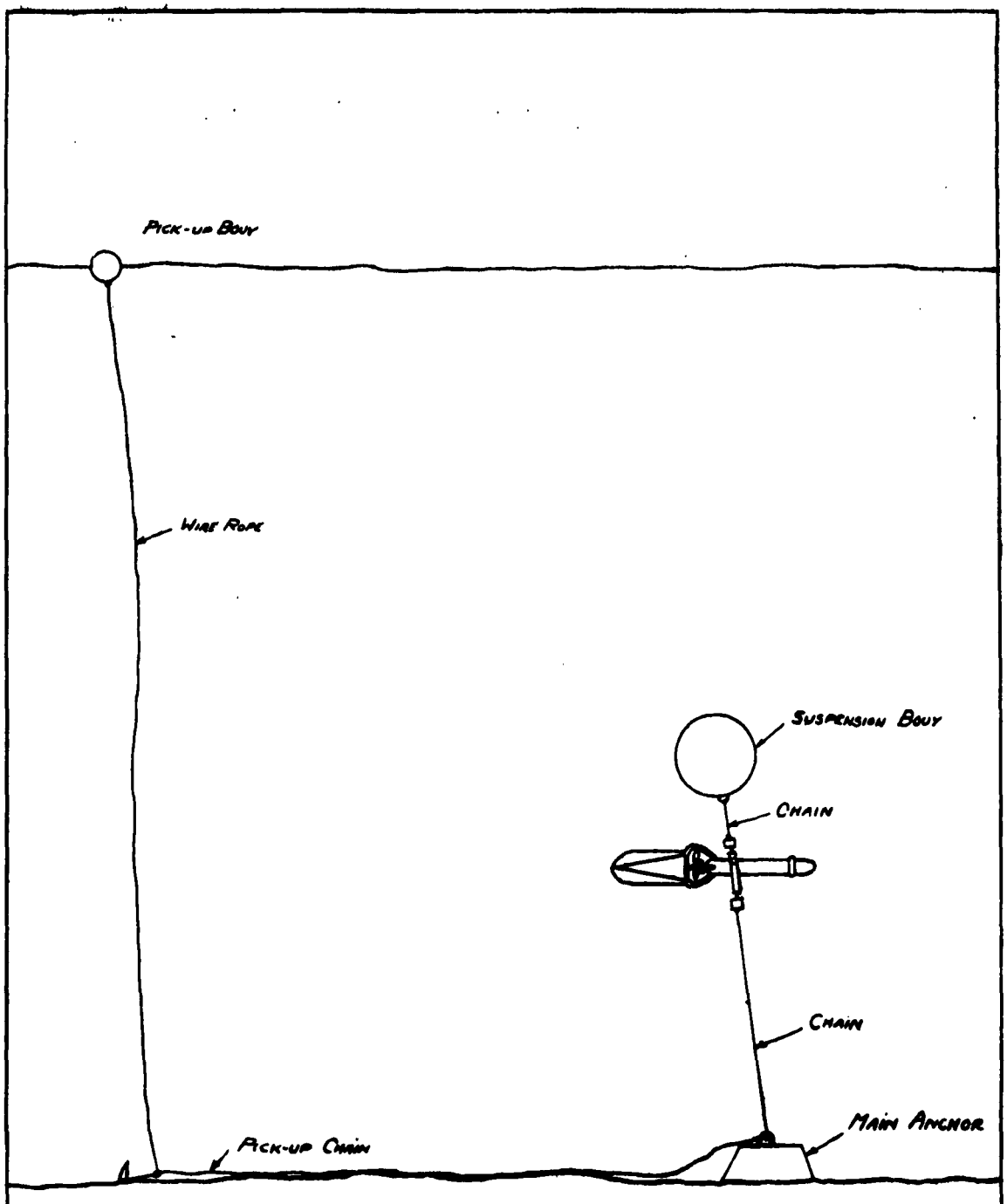


FIGURE 8



PROPOSED MOORING SYSTEM
FOR
CURRENT RECORDER

DEPTH OF WATER - APPROX. 25 Ft
MAIN ANCHOR 200 LB. IN WATER

FIGURE 9

Three Allen head set screws hold the forward end of the camera in place. The other end fits in a ring which is soldered to the inside of the brass tubing of the pressure case. Banana type plugs connect the electrical circuit of the compass and the counter unit. No electrical connection is made to the circuit of the camera but the camera carries a single conductor for its length with connections at each end. During removal of the camera one plug is removed from the camera after the mechanical shutter is closed on the camera case. The plug from the camera to the counter forms another anchor point for the camera.

Method of Mooring

Figure nine illustrates a proposed mooring system for the current recorder. It is, essentially, the mooring system used to obtain the record of figure seven. The suspension buoy is 21 inches in diameter and is sufficient to hold the instrument with a taut suspension chain. A larger buoy may have to be used where corrosion will be encountered and heavier gauge metal is used. The present buoy weighs 30 pounds and displaces 175 pounds of water. With the present design it is necessary to have the buoy in the same flow as the instrument so the simple gimbal has its sides vertical. If the buoy and the instrument are greatly separated a compound gimbal would be necessary.

Temperature Recorder

The clock movement of the current recorder is used in the temperature recorder. The purpose of this movement is to transport a 2" by 3" smoked glass slide by means of a lead screw. With reference to figures ten and eleven, a small pinion driven by the hour wheel engages a compound gear which in turn drives the lead screw gear. A nut on the lead screw has a projection extending through the base plates and pushes the glass slide. The slide is guided and retained by a milled straight edge. The slide is also retained on the opposite side by a series of buttons which are spring loaded. A complicated slide is thus eliminated. Temperature variations are transmitted thermally through the brass case end to a thermal element consisting of a liquid filled capillary and Bourdon tube. A stylus connected to the Bourdon tube makes a temperature vs. time trace on the smoked slide for 500 days. The usual range of sea temperatures will result in a one inch deflection--however, the mechanical operation at low temperature has not been investigated. The outer case is constructed of brass tubing with a double "O" ring seal at the cap. A steel mooring U bolt is electrically insulated from the case by a Micarta fitting.

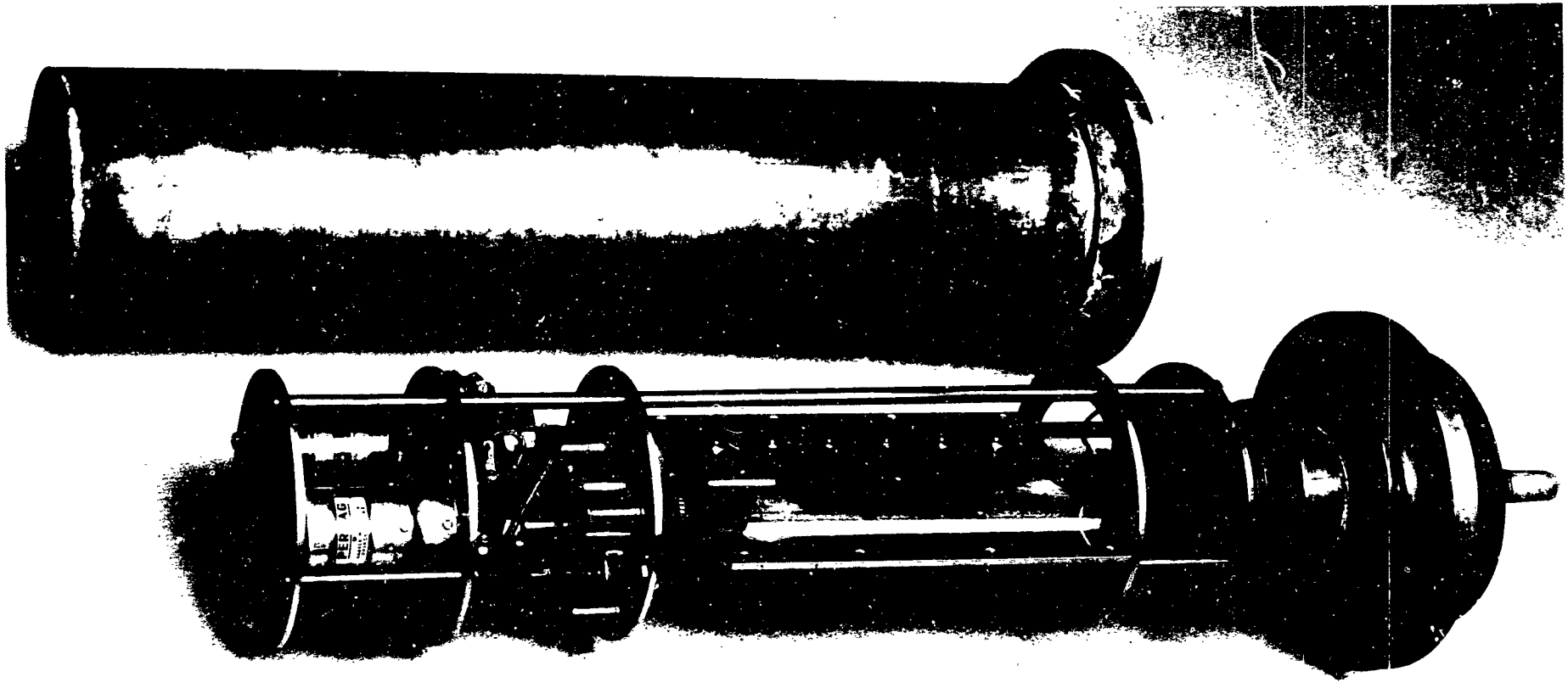


FIG. 10

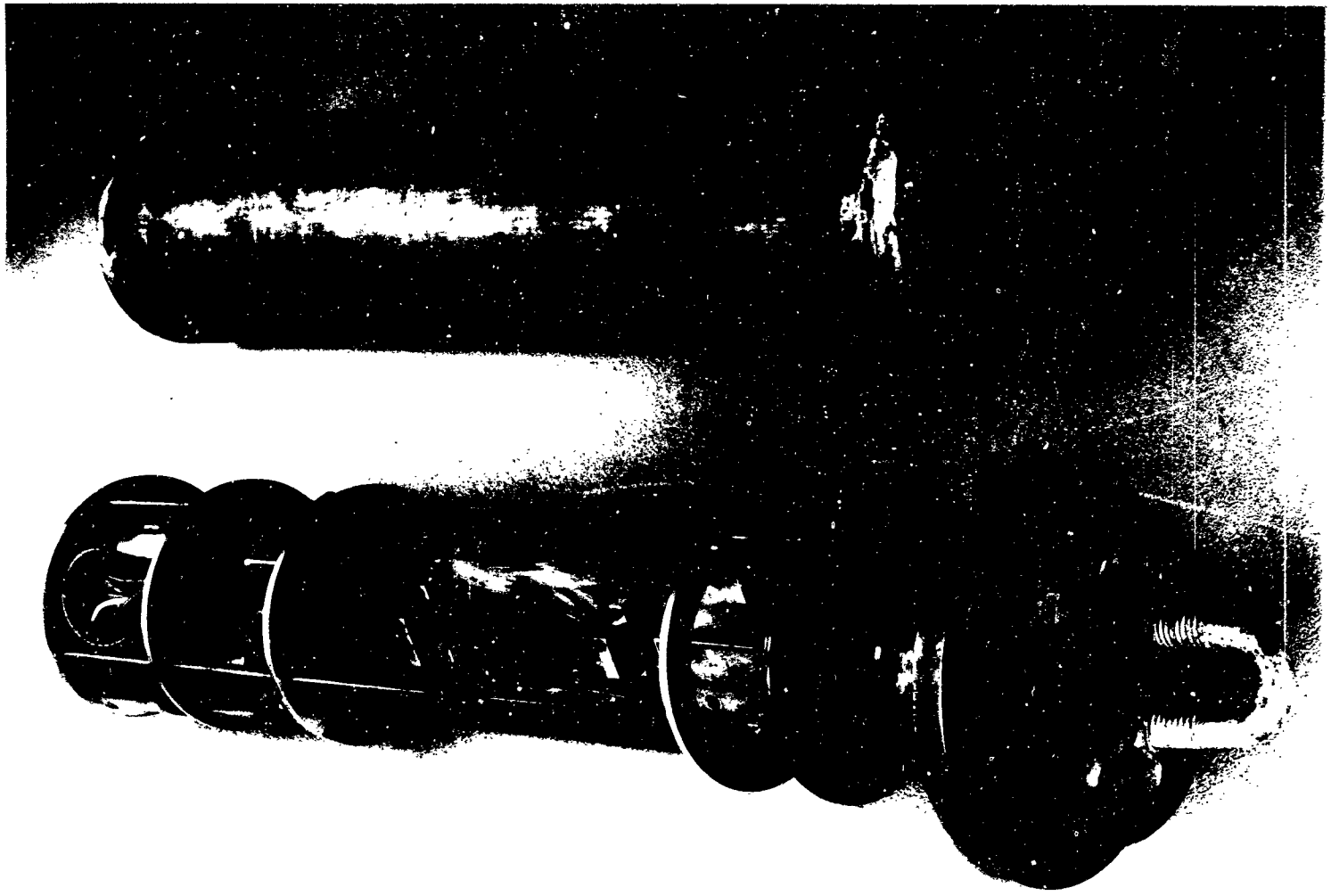


FIG. 11

Summary

A current recorder to be used over a long period must necessarily be made to withstand the corrosion for this time. For this reason all exposed parts of this instrument are at least 1/16 inch thick. Heavier instrument weight and high propeller inertia result. The propeller owes its extreme sensitivity to the use of ball bearings instead of conventional pivots which have been found to wear over short periods and result in change of calibration.[1] At some depths seaweed will catch in the propeller. However, no actual stoppage has occurred. A redesign in favor of a propeller similar to that used on the Roberts[2] radio current meter would be an advantage.

The present instrument hasthe upper limit of approximately 2 knots without superimposing compass images. The propeller may be changed to read higher velocities with a sacrifice of data points for weaker currents. It appears that choice of calibration or instrument should be made for a particular location.

We have found it necessary to select micro switches for the clock winding circuit by means of mechanically moving the switch lever and mechanically counting this movement versus an electrical counter operated by the micro switch.

The motor used for the recorder must be disassembled and the commutator and brushes polished to make positive contact previous to installation. Some tests are being made with a silicone compound on these variable contacts. Motors stored for a length of time must be disassembled and the parts repolished.

A clockwork wound by a pulse with the actuating arm forming the electrical contact is being considered.

The film record is intended to be read on a projector with a ground glass screen. The present image is black on a light background, and it may be an improvement to use reversible film or white image on a black background. This usually results in the film being processed outside the local facilities

It has not been feasible to tow the complete instrument for over-all calibration. Tests on the propeller assembly show a nearly linear curve from 1/20 to 1 knot.

[1] Les Mesures Directes des Courants Marins; M. V. Romansky, Annales Hydrographiques, 1949

[2] Hydrographic Manual U.S. Coast and Geodetic Survey, 1942, Section 477, page 416.
Roberts Radio Current Meter Mod. II Operating Manual, Capt. E. B. Roberts, U.S. Coast and Geodetic Survey, revised 1950.

PARTS LIST

I. CASE AND MOUNTINGS

1. nose piece, 85-5-5-5 bronze
2. forward section body tube
3. male junction ring, 85-5-5-5 bronze
4. female junction ring, 85-5-5-5 bronze
5. main body tube
6. tail piece and inboard bearing, 85-5-5-5 bronze
7. propeller guard and outer bearing support
8. outer bearing support
9. outer bearing
10. bearing lock nut
11. clamping band
12. mooring hanger axle
13. axle bearing cone
14. axle lock nut
15. hanger barrel
16. hanger clamp
17. hanger side member
18. hanger end member
19. mooring swivel body
20. swivel end plate and outer ball race
21. swiver inner ball race
22. mooring swivel nut
23. mooring swivel shank
24. swivel insulating block
25. mooring swivel U bolt
26. insulating block bolt
27. propeller hub
28. propeller blade
29. propeller magnet case
30. magnet case end ring

II. REVOLUTION COUNTER

1. mounting flange
2. base plate and bracket
3. bearing pillar
4. bearing pillar
5. counter shaft
6. main drive shaft
7. shaft collar for counter shaft
8. shaft collar for main drive shaft
9. counter shaft spur gear
10. cam drive worm gear
11. worm gear support
12. worm gear shaft
13. switch cam
14. switch support
15. switch mounting plate
16. switch shaft
17. escapement sector
18. escapement spring

19. spring clamp
20. escapement gear
21. escapement fly wheel
22. spindle for fly wheel
23. spindle for escapement gear
24. magnet mounting flange
25. driven counter magnet
26. Birnbach giant plug
27. insulating collar
28. insulating washer
29. wire leader

III CAMERA AND COMPASS PARTS

1. camera base plate
2. film spool spindle
3. spindle bearing
4. lock nut for spindle bearing
5. spindle drive pulley
6. drive belt guide support
7. belt guide bar
8. belt drive pulley
9. traction ring for belt drive pulley
10. film guide spool
11. spindle for film guide spool
12. film guide post
13. film drive spool
14. bearing for film drive spool
15. lock ring
16. traction ring for film drive spool
17. drive spool shaft
18. drive spool thrust spring
19. spring thrust collar
20. film drive worm gear
21. film gate
22. film backing plate
23. pressure roller
24. roller shaft
25. pressure roller yoke
26. yoke pivot
27. pressure springs
28. spring bearing post
29. shaft collar
30. film and lens drive shaft
31. shaft bearing pillar
32. lens lifting cam
33. lens adjusting ring
34. lens carrier guide
35. lens carrier bed
36. lens carrier
37. carrier return spring clip
38. carrier return spring
39. carrier lifting finger
40. film supply and take-up spool
41. camera end plate

42. clock mounting plate
43. film guide
44. film spool spacer
45. insulating washers
46. motor and battery plate
47. #400 Birnbach banana plug
48. jack plate support
49. jack mounting plate
50. #399 Birnbach jack
51. insulating washers for #399 Birnbach jack
52. lock nut for #399 Birnbach jack
53. chassis spacer
54. chassis spacer
55. chassis spacer
56. chassis spacer
57. camera bed rail
58. battery clamp
59. camera bed rail
60. winding switch cam
61. spring shaft hub
62. motor and spring shaft ends
63. motor and spring shaft coupling
64. clock winding motor
65. spring barrel hub and gear
66. spring barrel cylinder
67. spring retainer
68. clock main spring
69. main shaft drive gear and switch cam
70. camera case tube
71. camera case mounting lug
72. camera case end plate
73. camera case handle
74. case aperture shutter
75. shutter spring
76. insulating collar
77. camera case aperture shield
78. comb. plug and jack camera case connector
79. insulating washer
80. Bendix aircraft compass
81. compass light bank base
82. compass light shield
83. compass light reflector
84. 6 lamp light bank socket
85. compass mounting ring
86. compass light bank connector
87. 6 volt instrument bulb
88. battery clamp for nose piece
89. battery mounting lug
90. lens adjusting wrench
91. lens barrel
92. lens spacer and aperture
93. lens aperture
94. lens retaining ring
95. lens retaining spring
96. camera lens
97. camera drive circuit
98. compass lighting circuit

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Washington, D. C.

1 Chesapeake Bay Institute
Johns Hopkins University
1315 St. Paul Street
Baltimore 2, Md.

1 Director
Lamont Geological Observatory
Palisades, New York

1 Marine Laboratory
University of Miami
Coral Gables, Florida
Attn: Dr. F. G. Walton Smith

1 Commanding Officer
U.S. Navy Underwater Sound Laboratory
New London, Conn.

1 Beach Erosion Board
5201 Little Falls Road N.W.
Washington 16, D. C.

1 U.S. Waterways Experiment Station
Vicksburg, Mississippi

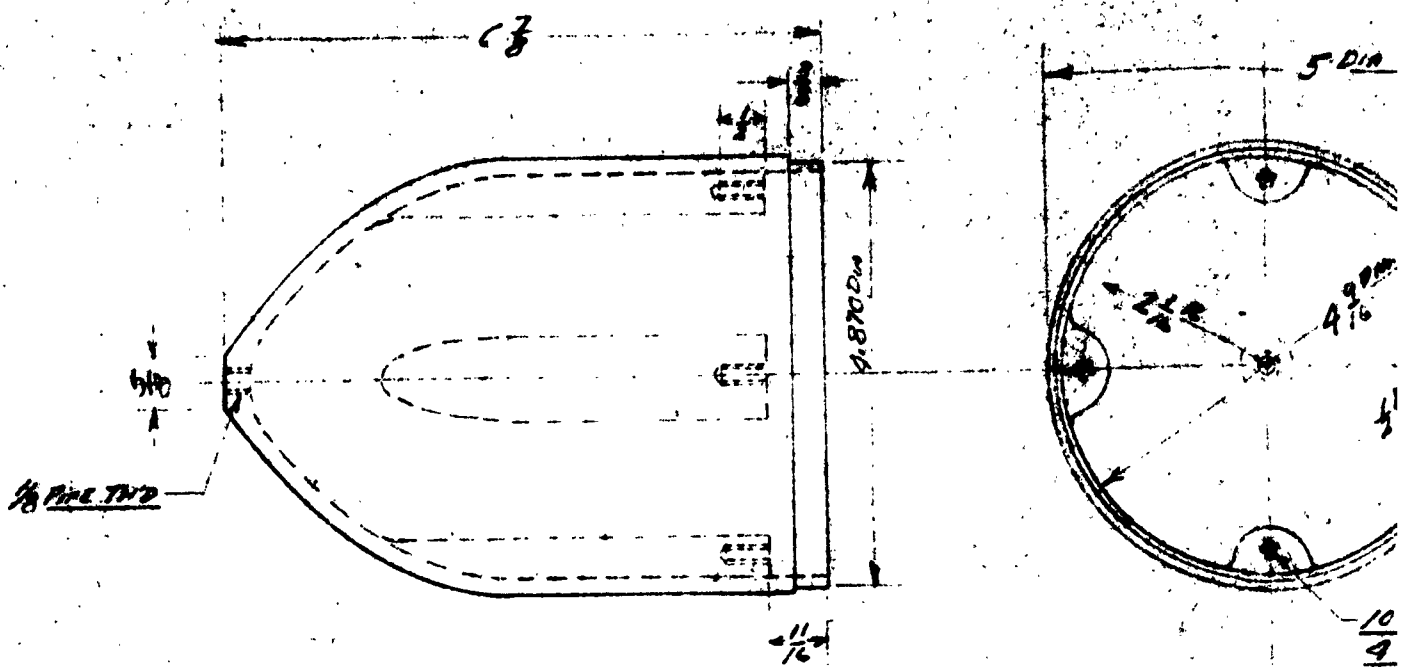
1 Hydrodynamics Laboratory
National Research Council
Ottawa, Canada

1 Dr. G.E.R. Deacon
Admiralty Research Laboratory
Teddington, England

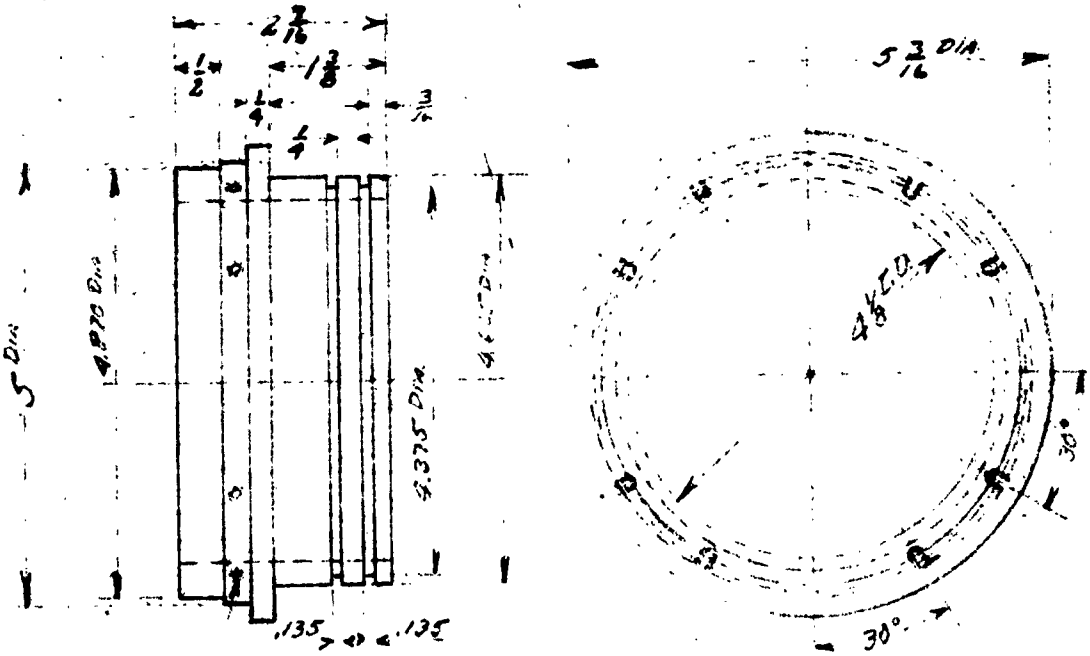
1 Mr. Joseph H. Kahl
G.M. Manufacturing Co.
50 W. Third St.
New York 12, N. Y.

1 Mr. K. T. Adams, Acting Director
U. S. Coast and Geodetic Survey
Washington 25, D. C.

1 Oceanographic Laboratories
University of Washington
Seattle 5, Washington

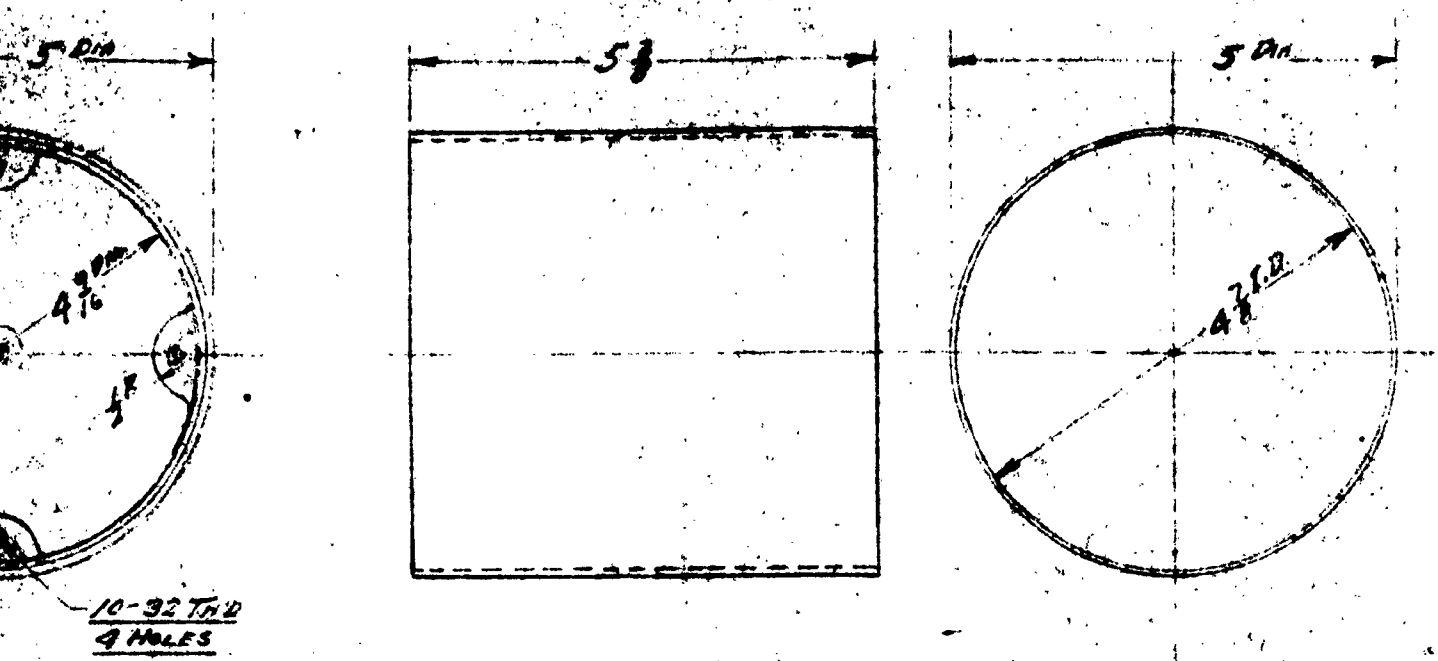


(1) NOSE PIECE - BRONZE CASTING - 1 REQ'D



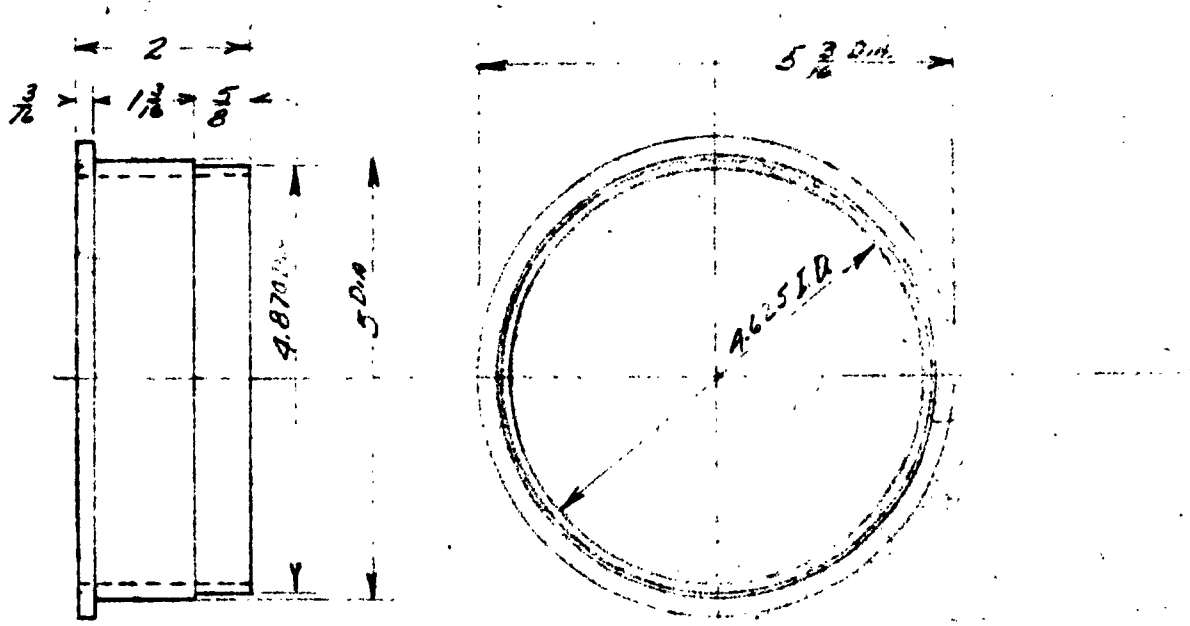
10-32 THD - 8 HOLES - 3/16 DEEP
SILVER SOLDER TO (2)

(3) MALE JUNCTION RING - 1 REQ'D - BRONZE CASTING



TUBE SILVER SOLDERED TO NOSE PIECE

(2) FORWARD SECTION BODY TUBE - 1 REQ'D - BRASS

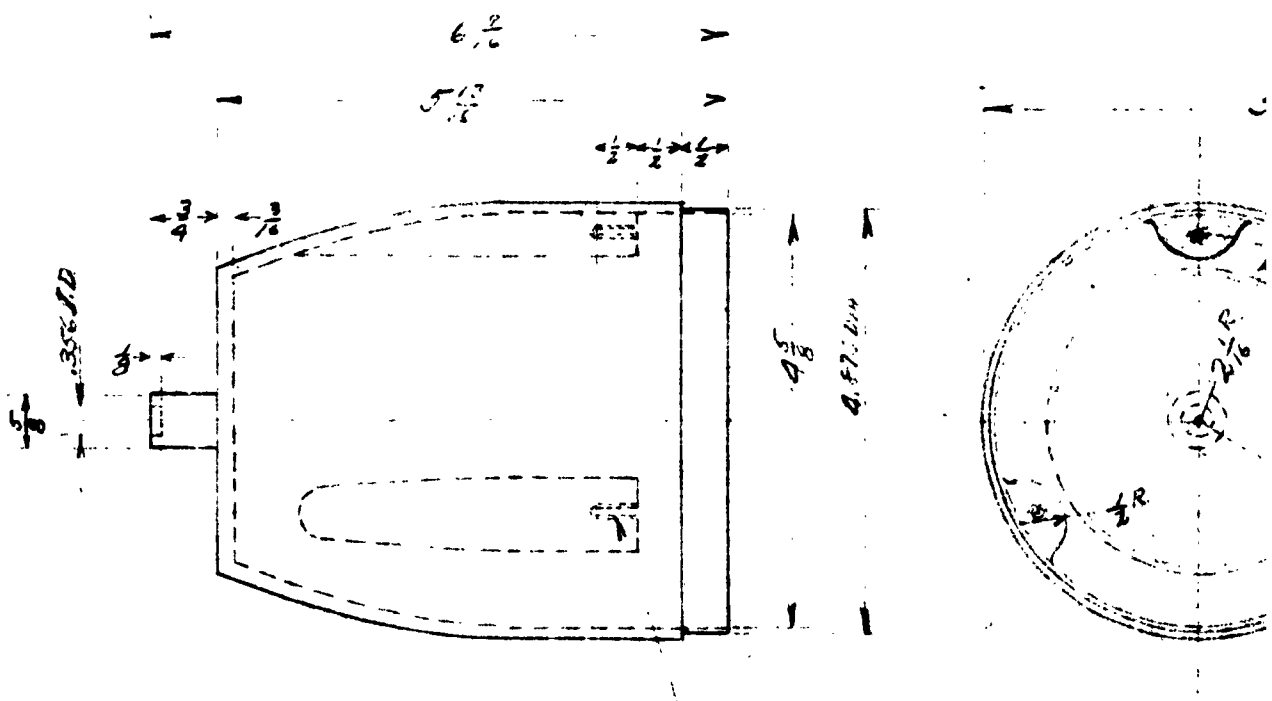


SILVER SOLDER TO (3)

(4) FEMALE JUNCTION RING - 1 REQ'D - BRONZE CASTING

2

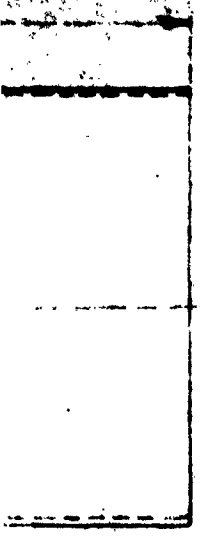
(5) MAIN BODY TUBE - 1 REQ'

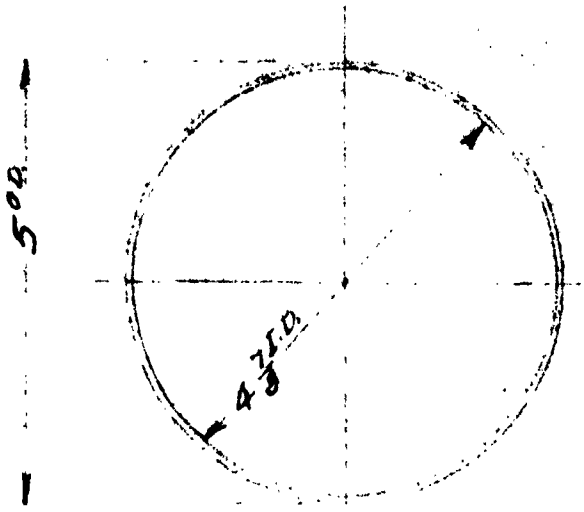


— 10-32 TH'D - 3 HOLES

SILVER SOLDER TO (5)

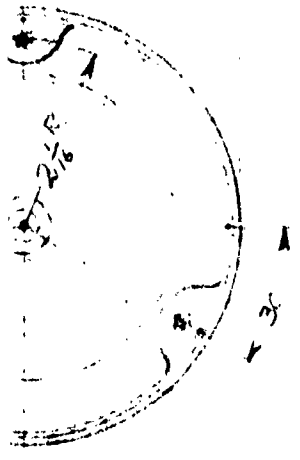
(6) TAIL PIECE & INBOARD BEARING - 1 REQ'D - BRONZE





REQ'D - BRASS

5 DIA



IZE CHANGING

4

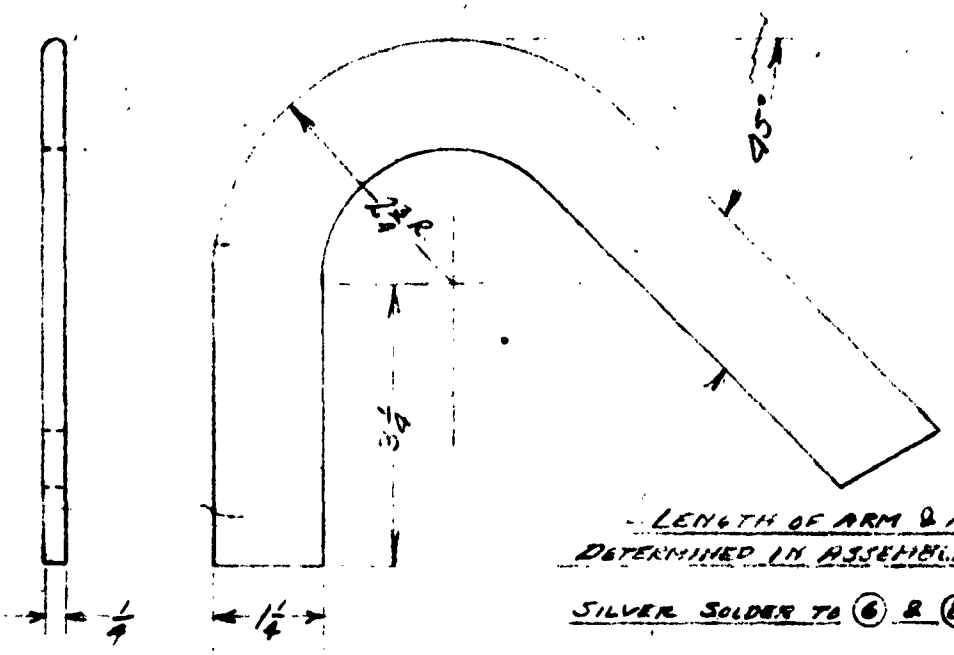
400 DAY CURRENT RECORDER

CASE DETAILS

1/2 SCALE

DESIGN - A. H. KLEBBA DWG - L. A. THOMPSON

WOODS HOLE OCEANOGRAPHIC INSTITUTION 11-20-59

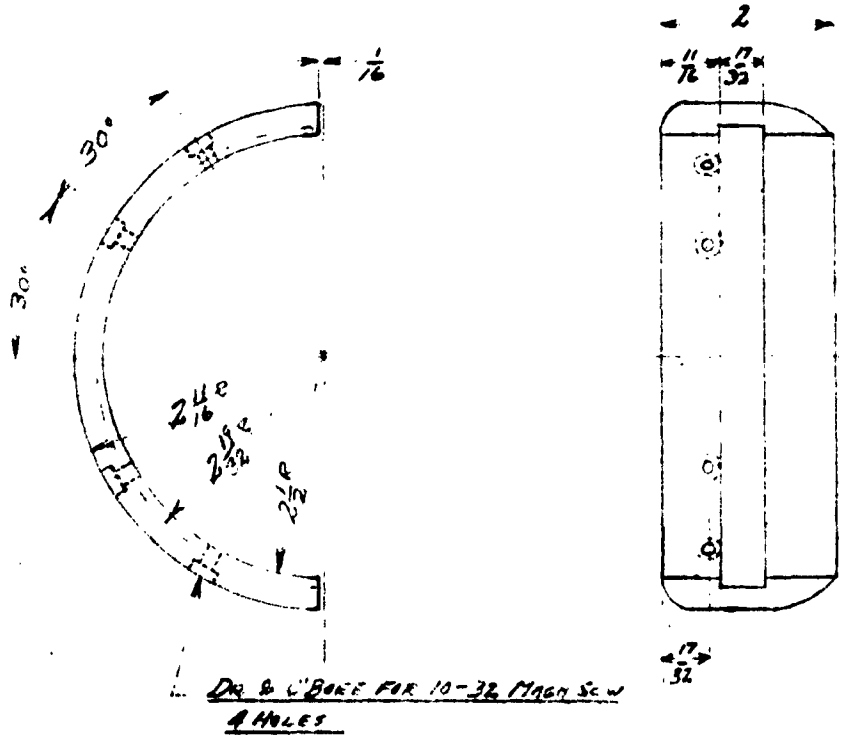


LENGTH OF ARM & ANGLE OF END DETERMINED IN ASSEMBLY OF TAIL SECTION

SILVER SOLDER TO (6) & (8)

(7) PROPELLER GUARD & OUTLET BEARING SUPPORT - 1 REQ'D - BRONZE CASTING

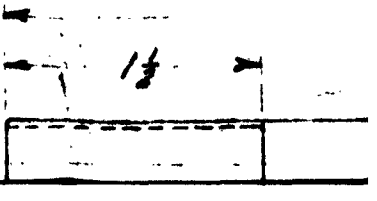
1/2 SCALE

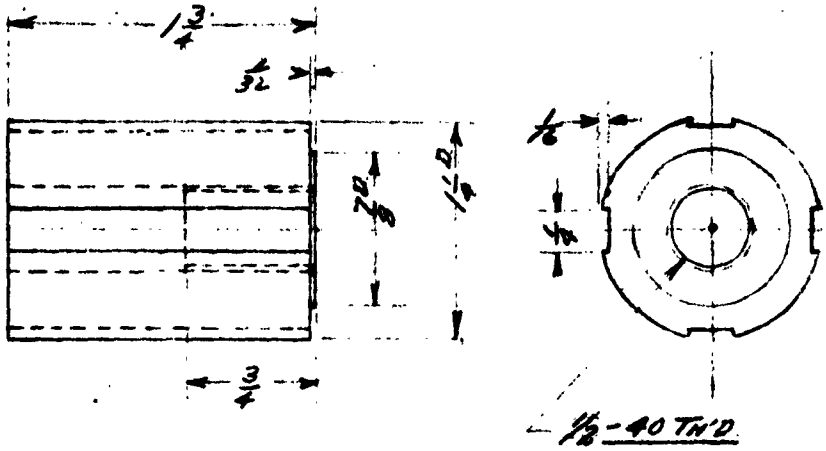


DR & C'BORE FOR 10-32 MACH SCW 4 HOLES

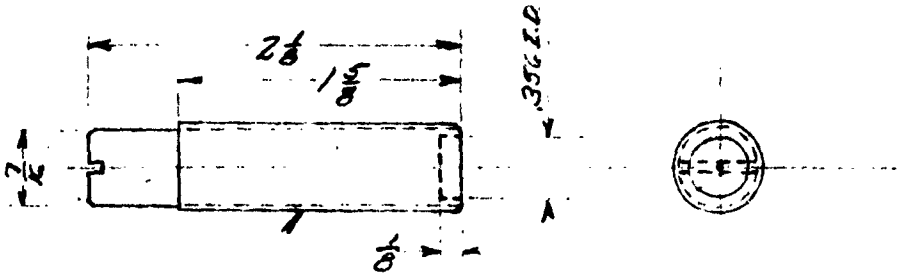
(H) CLAMPING BAND - 2 REQ'D - BRONZE CASTING

1/2 SCALE

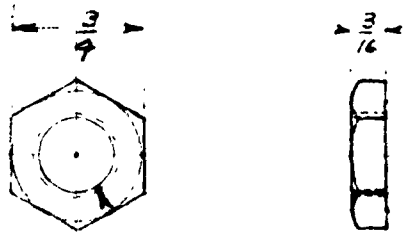




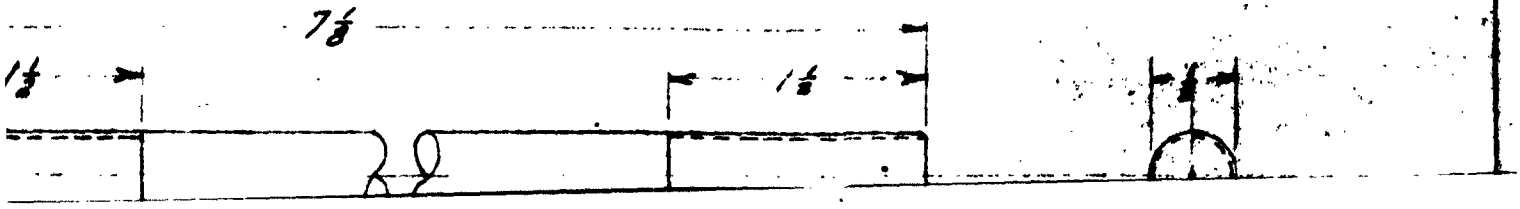
(8) OUTER BEARING SUPPORT - 1 REQ'D - EVERDUR



(9) OUTER BEARING - 1 REQ'D - EVERDUR

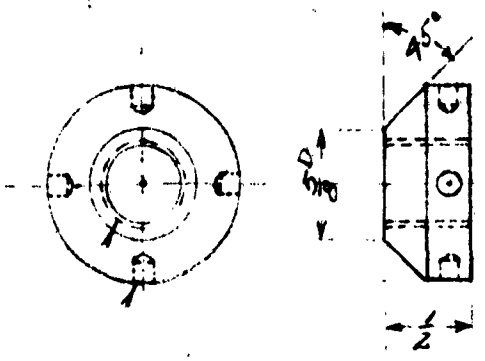


(10) BEARING LOCK NUT - 1 REQ'D - EVERDUR



(11) CLAMPING BAND - 2 REQ'D - BRONZE CASTING

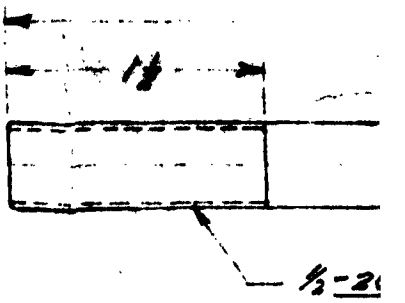
½ SCALE



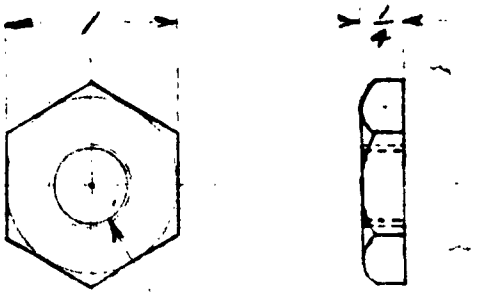
– ⅛ DR – ⅛ DEEP – 4 HOLES

– ½-20 TH'D

(12) MOORING HAN

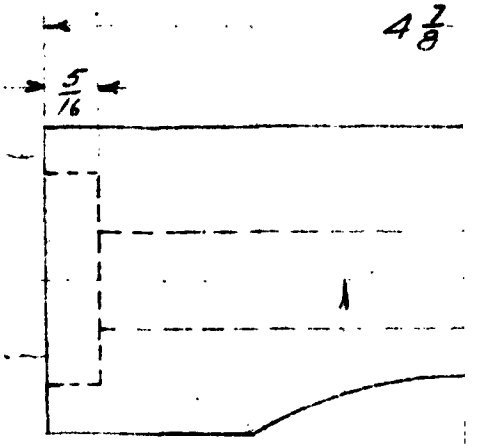


(13) AXLE BEARING CONE - 2 REQ'D - EVERDUR

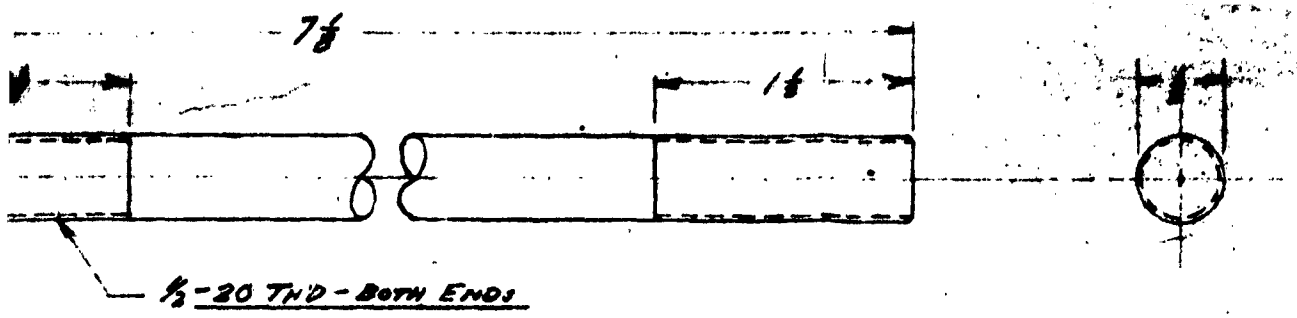


– ½-20 TH'D

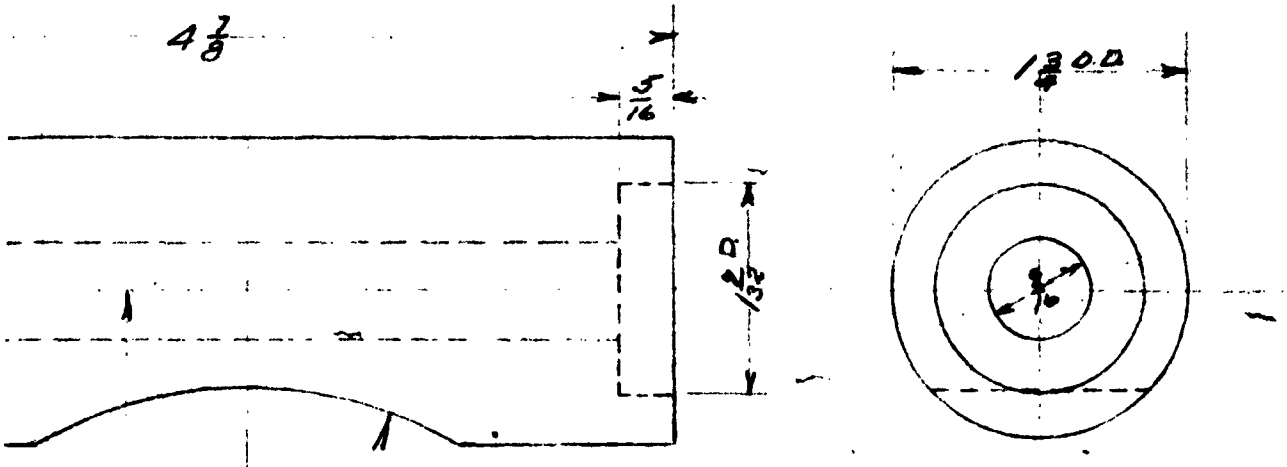
(14) AXLE LOCK NUT - 4 REQ'D - EVERDUR



(15) HANGER BAR



MOORING HANGER AXLE - 1 REQ'D - EVERDUR



HANGER BARREL - 1 REQ'D - BRONZE CASTING

4

400 DAY CURRENT RECORDER

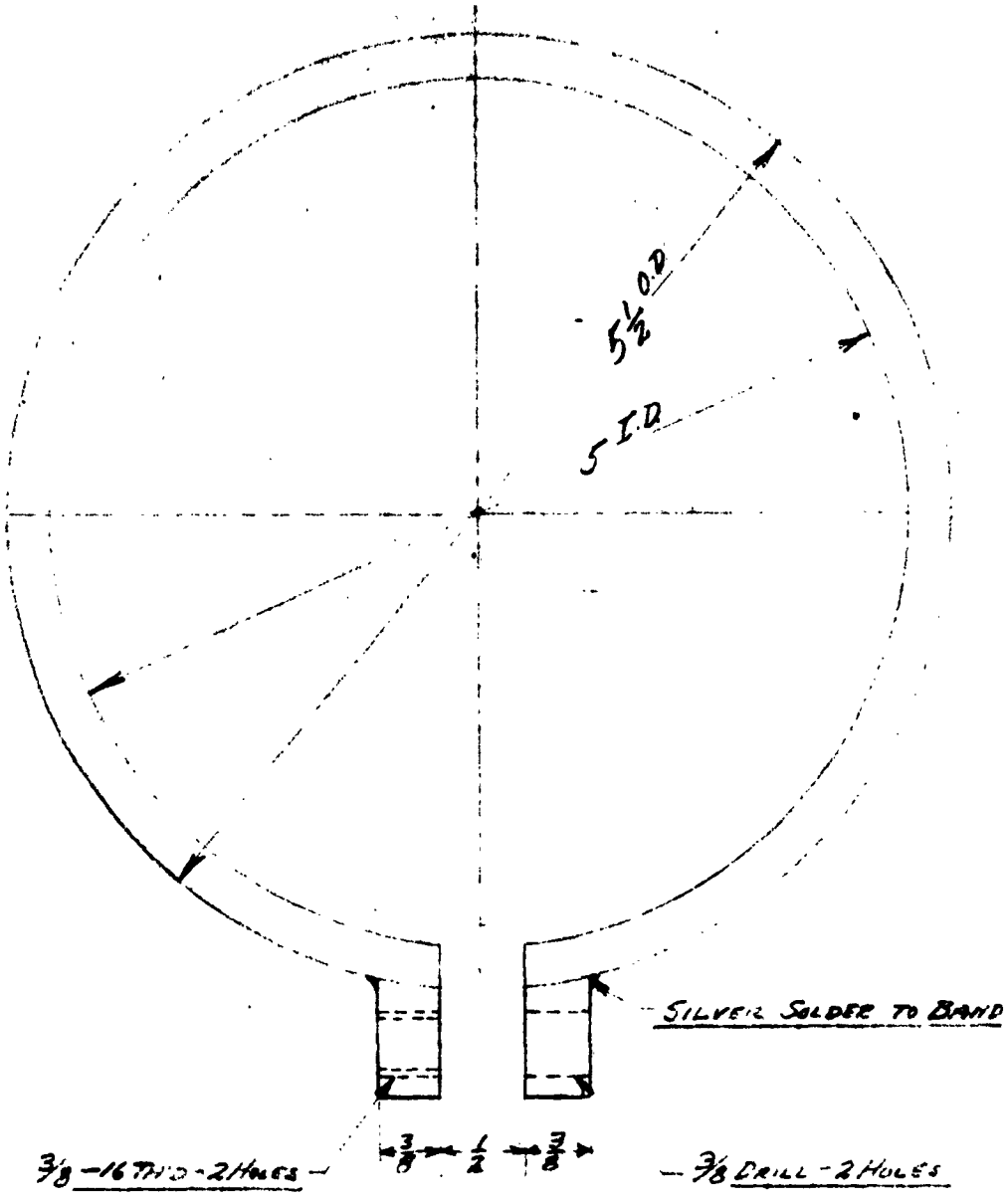
CASE DETAILS

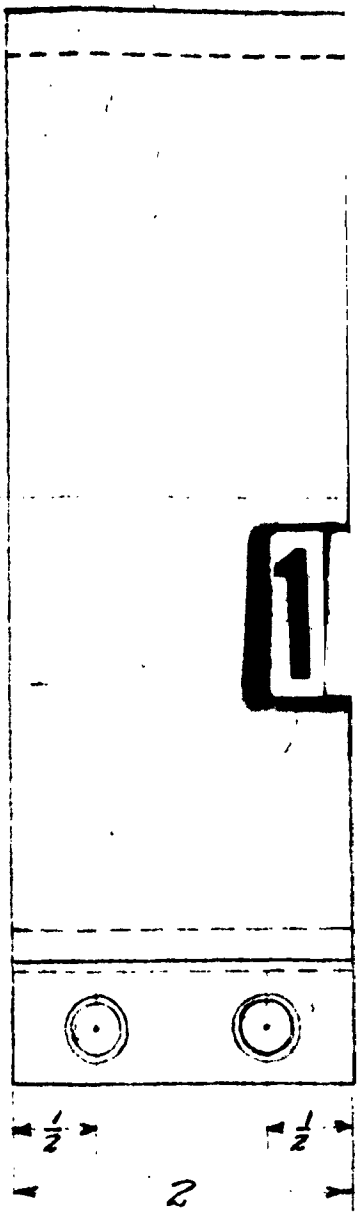
SCALE 1"=1" EXCEPT AS INDICATED

DESIGN - A.A. KLEBBA

DWG - L.A. THAYER

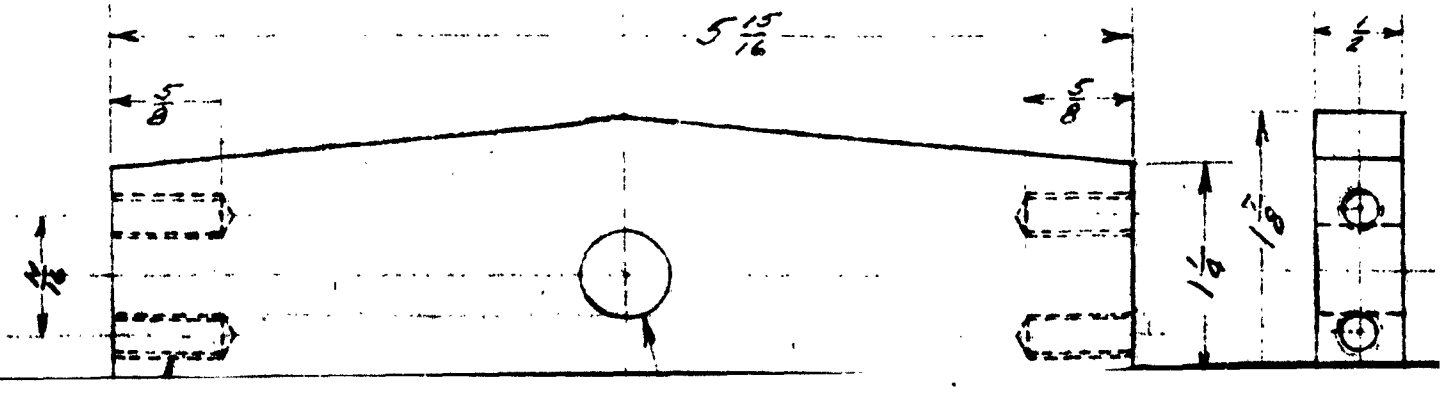
WOODS HOLE OCEANOGRAPHIC INSTITUTION 11-20-50

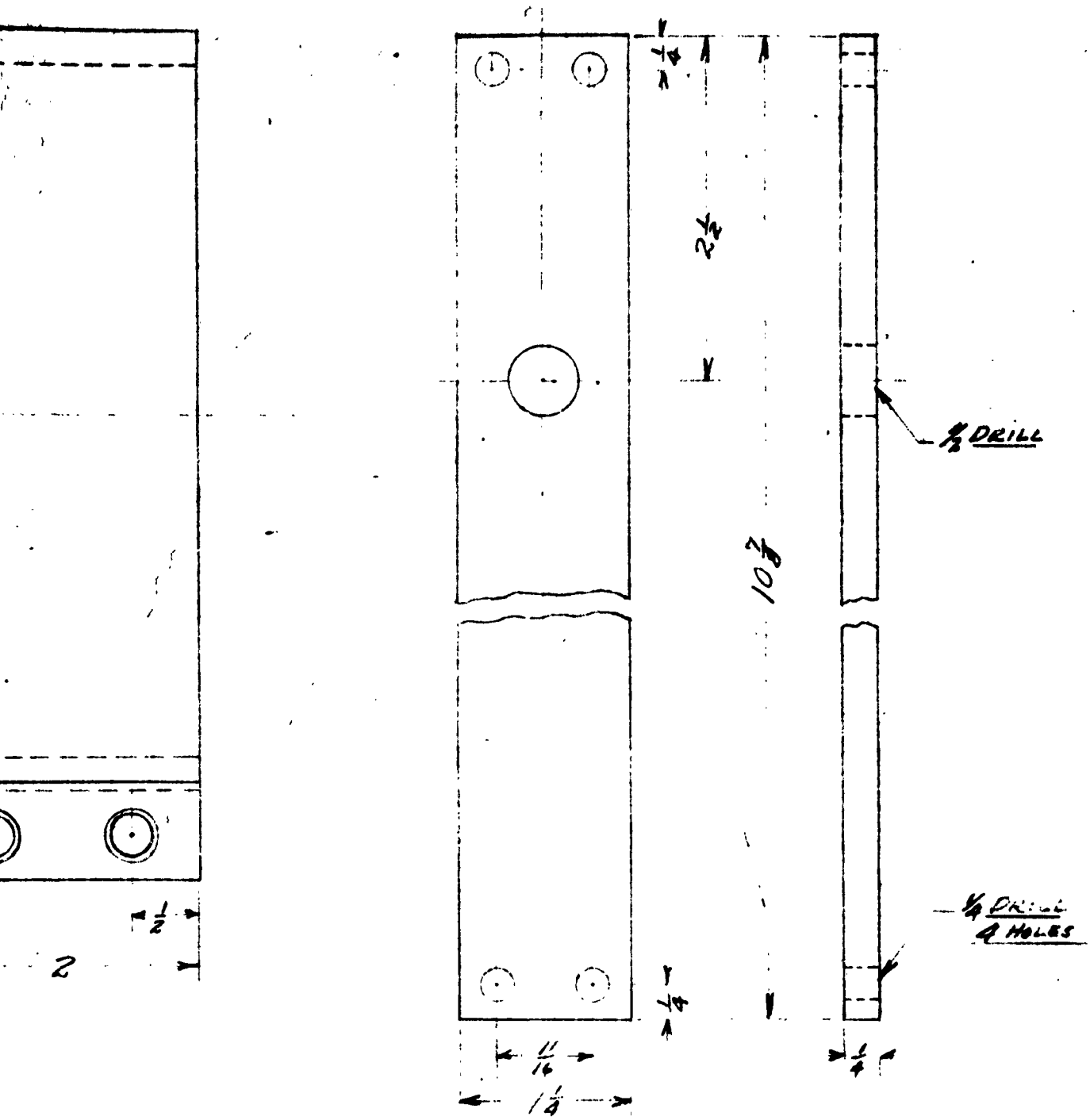




SILVER SOLDER TO (15

(16) HANGER CLAMP - 1 REQ'D. - BRASS.

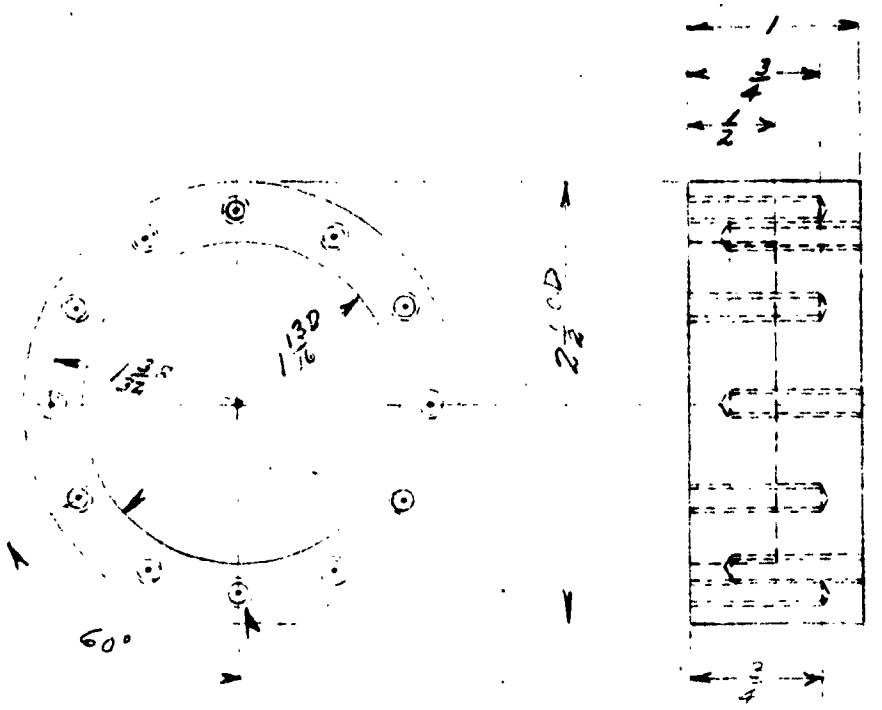




(17) HANGER SIDE MEMBER - 2 REQ'D - BRASS

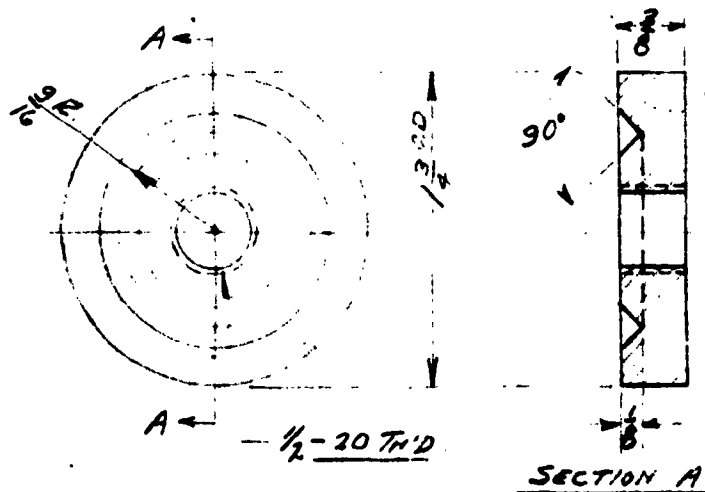
— 1/4-20 TH'D — 4 HOLES — 1/2 DRILL

(18) HANGER END MEMBER - 2 REQ'D - BRASS

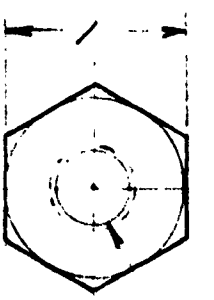


— 10-32 TH'D - 6 HOLES EACH SIDE - STAGGERED 30°

(19) MOORING SWIVEL BODY - 1 REQ'D - EVERDUR



(20) SWIVEL E

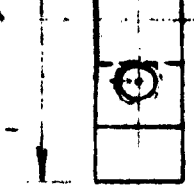


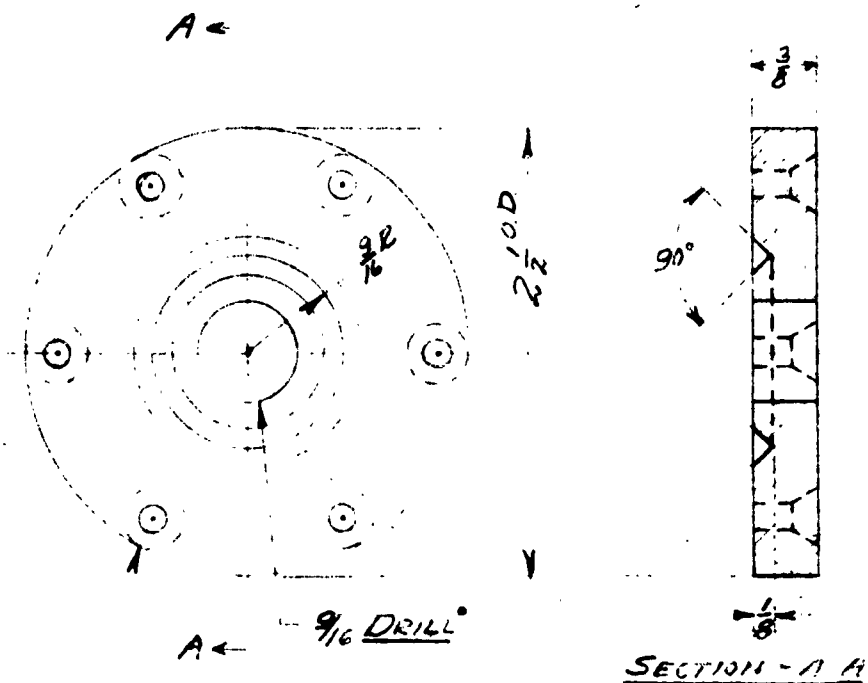
— 1/2-20

(21) SWIVEL INNER BALL RACE - 1 REQ'D - EVERDUR

(22) MOORING SWIVEL

EVERDU

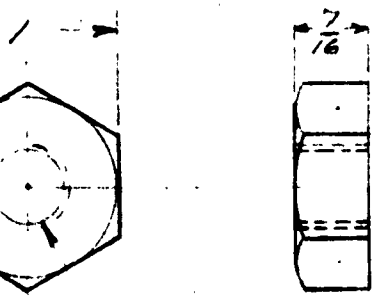




— DR & C'SINK FOR 10-32 FLAT H.C. - 6 HOLES

4

(20) SWIVEL END PLATE & OUTER BALL RACE - 1 REQ'D - EVERDUR



— 1/2 - 20 TH'D

ING SWIVEL NUT - 2 REQ'D

EVERDUR

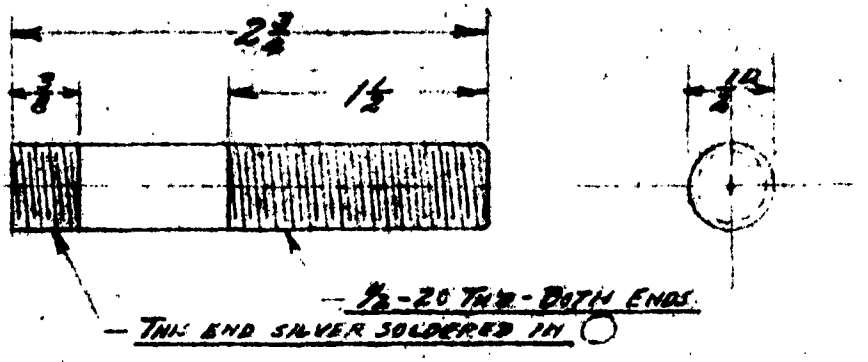
400 DAY CURRENT RECORDER

HANGER & SWIVEL DETAILS

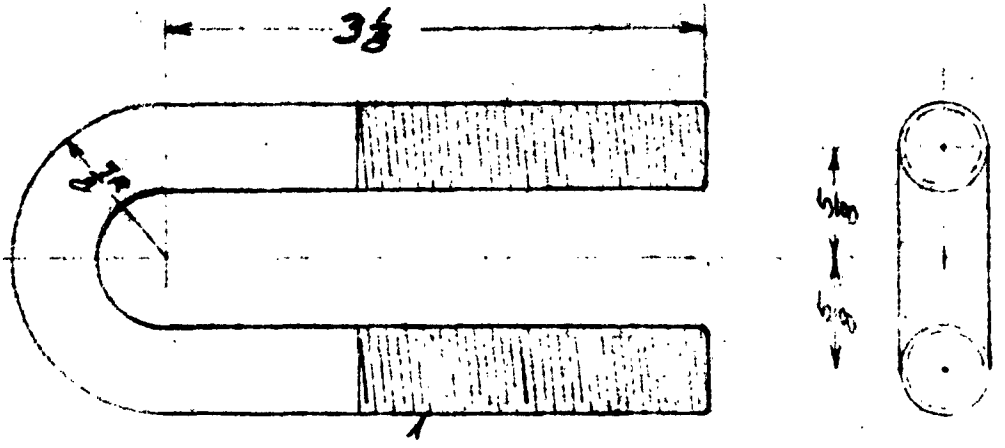
SCALE — 1" = 1"

DESIGN - A. A KLEBBA D'W'G - L. A. THAYER

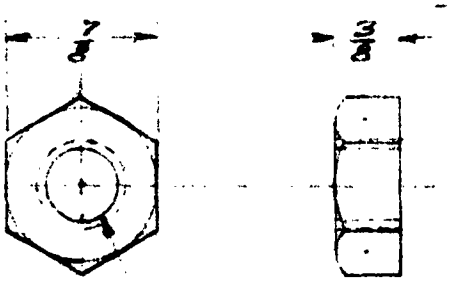
WOODS HOLE OCEANOGRAPHIC INSTITUTION 12-5-50



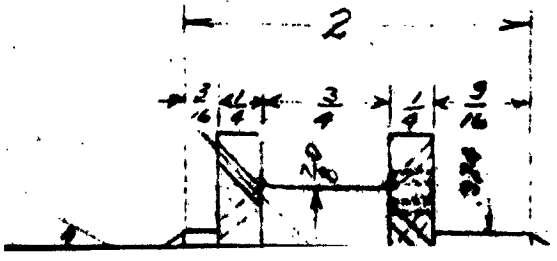
(23) MOORING SWIVEL SHANK - 1 REQ'D - EVERDUR

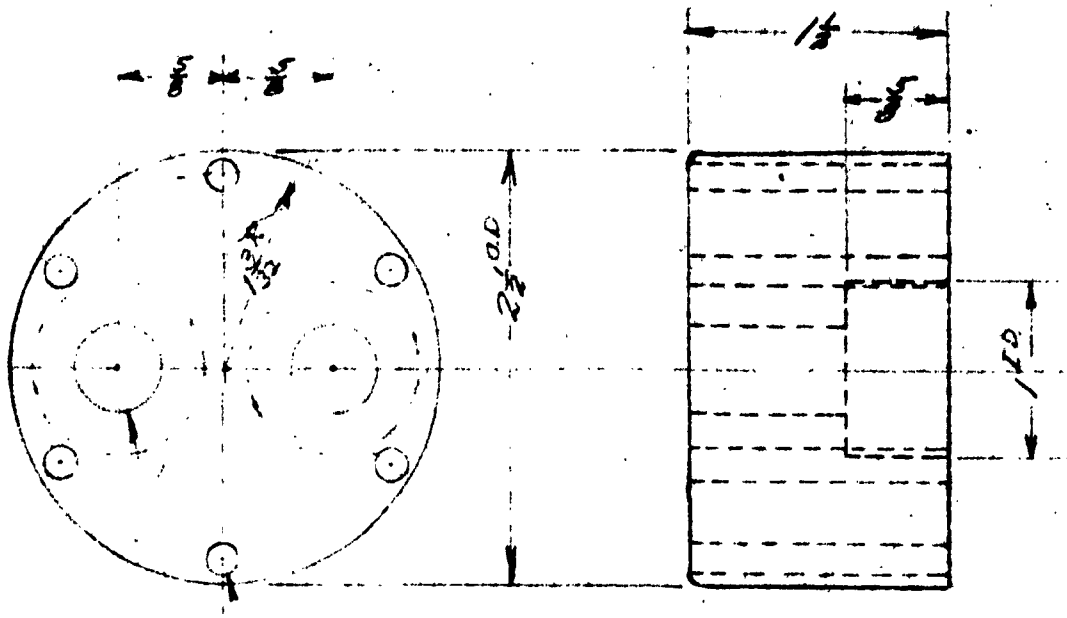


(25) MOORING SWIVEL U BOLT - 1 REQ'D - GALVANIZED IRON



(25A) U BOLT NUT - 4 REQ'D - GAL. IRON

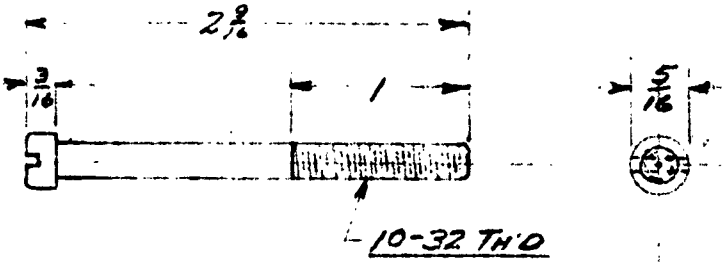




— #9 DRILL – 6 HOLES

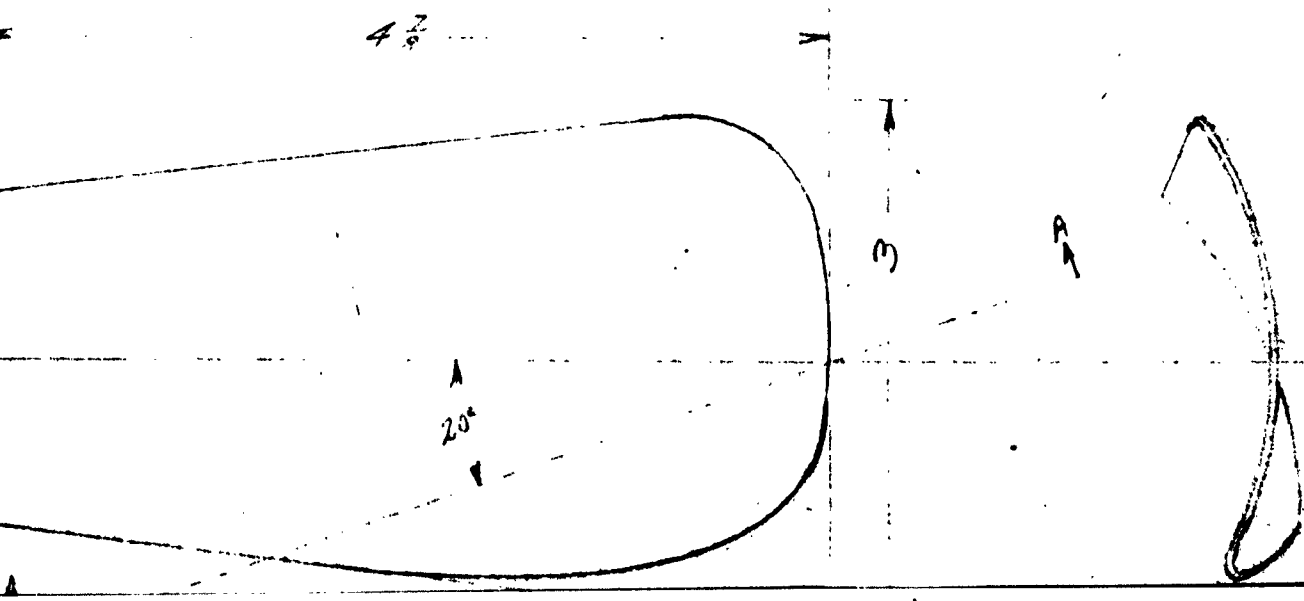
— 1/2 DRILL – 2 HOLES

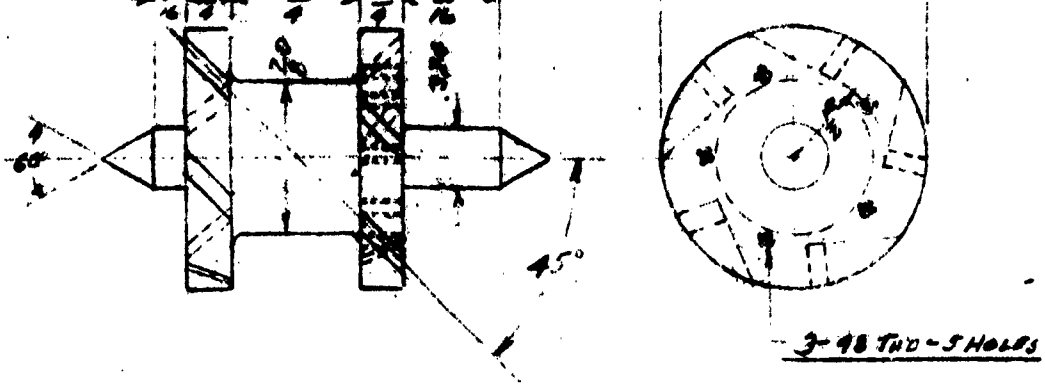
(24) SWIVEL INSULATING BLOCK – 1 REQ'D – FORMICA



(26) INSULATING BLOCK BOLT – 6 REQ'D – EVERDUR

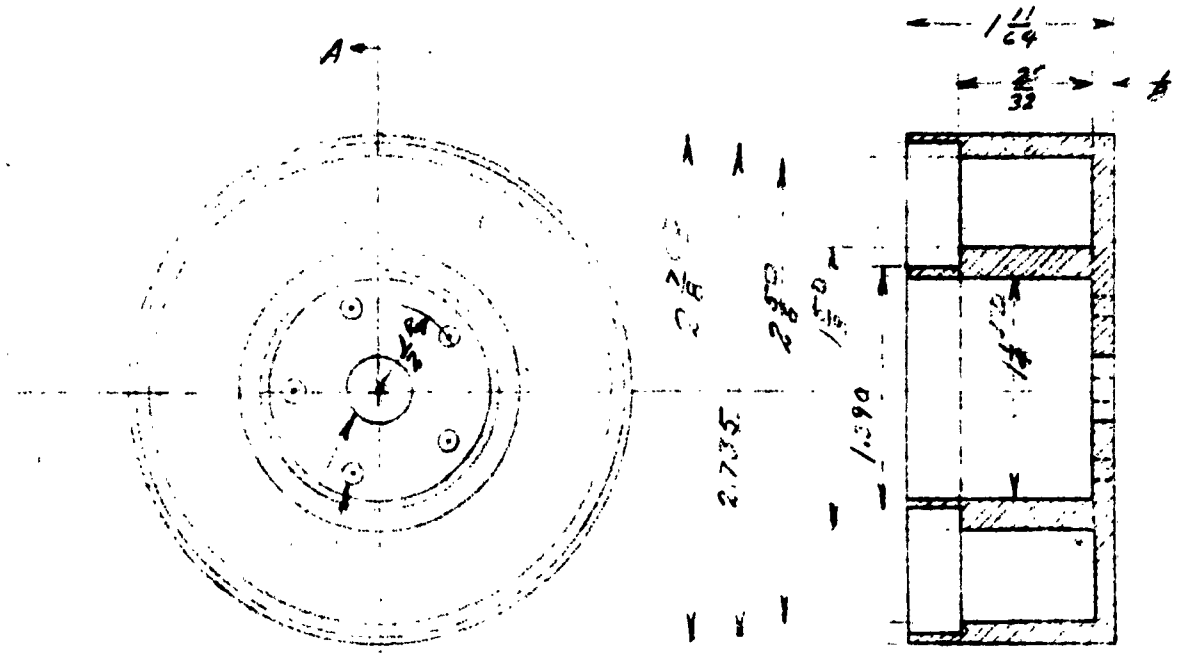
2





BLADE SLOTS MILLED 3/16" DEEP

(27) PROPELLER HUB - 1 REQD - EVERDUR

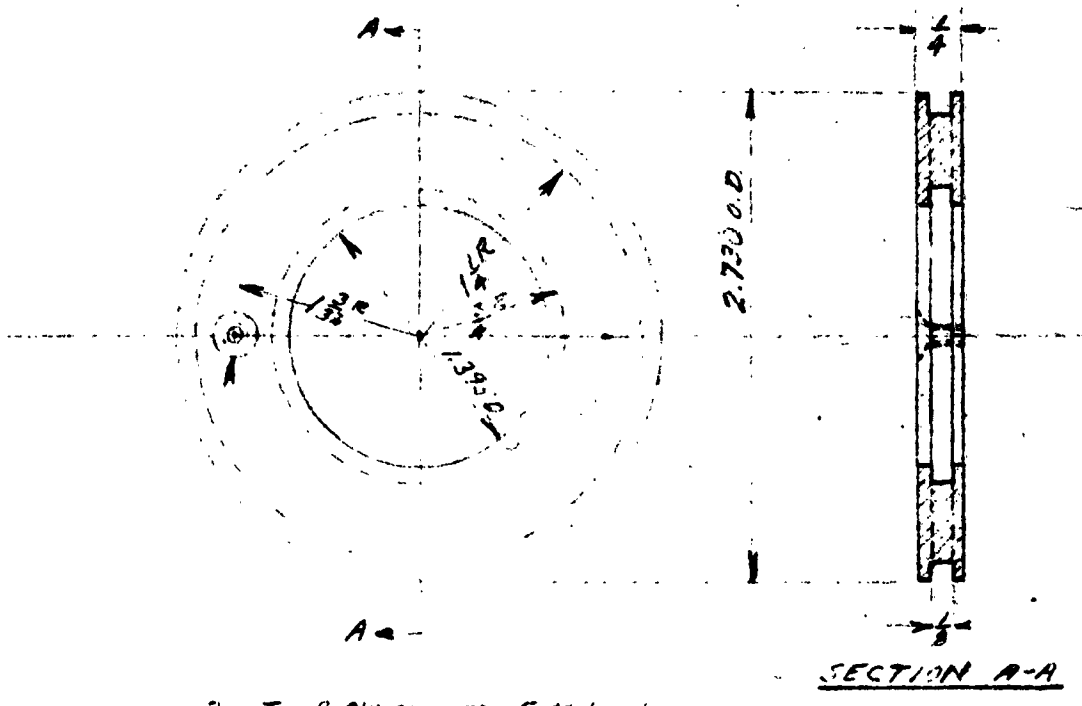


(29) PROPELLER MAGNET CASE - 1 REQD - BRASS

(28) PROPELLER

A-A AXIS OF CURVATURE – 2½" RADIUS

PROPELLER BLADE – 5 REQ'D – 1/16" THICK EVERDUR



2H TOP & CYRSINK FOR 5-40 F.H.M.S.

(30) MAGNET CASE END RING – 1 REQ'D – BRASS

4

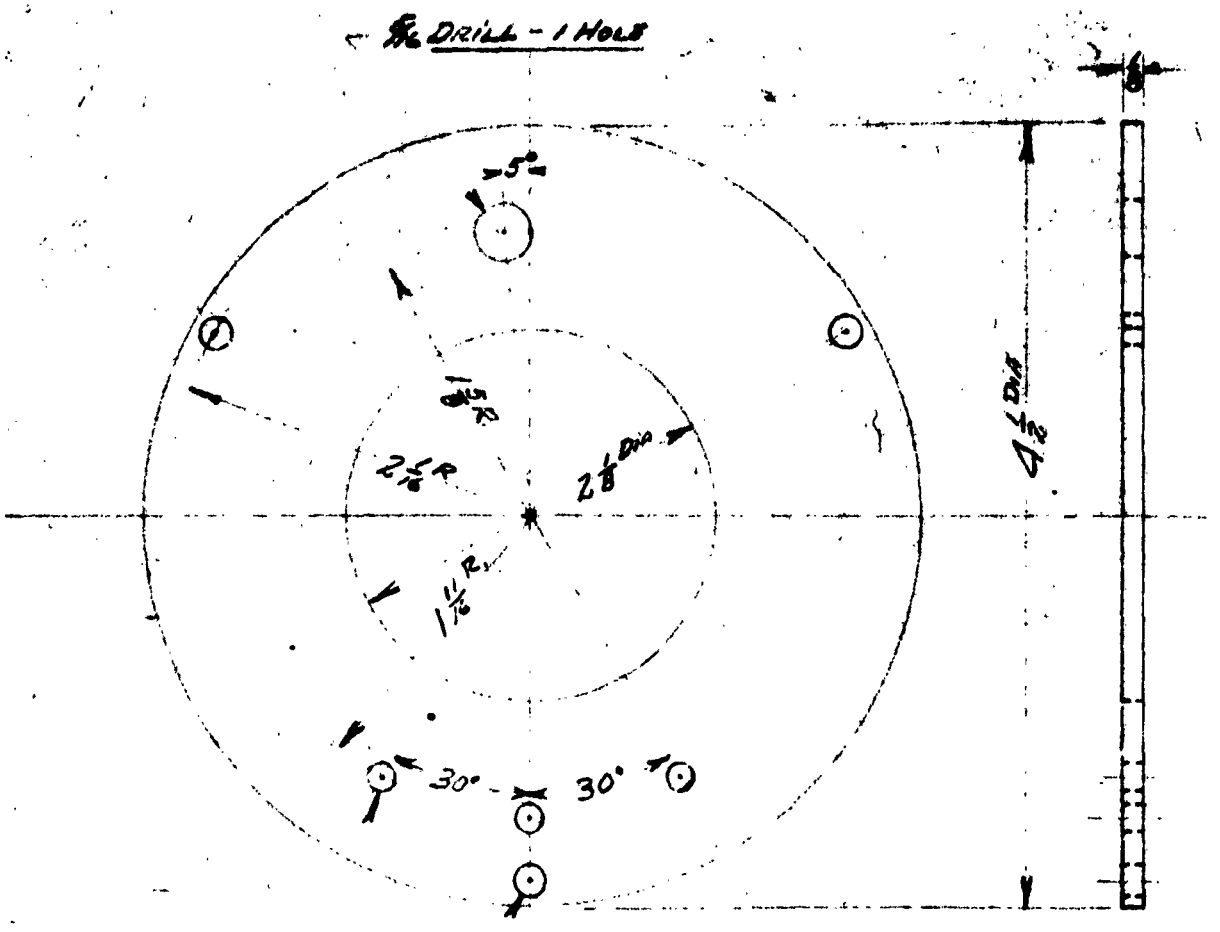
400 DAY CURRENT RECORDER

SWIVEL & PROPELLOR DETAILS

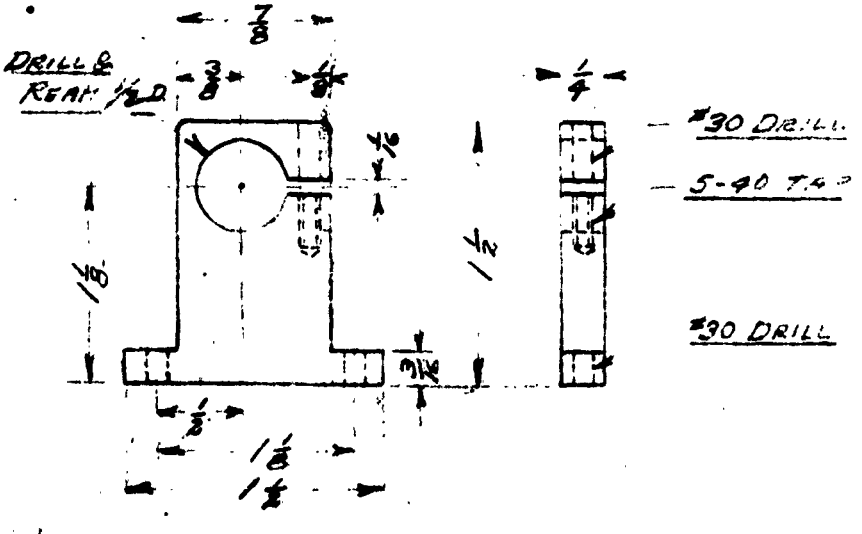
SCALE – 1" = 1"

DESIGN – A. A. KLEBBA DWG – L. A. THAYER

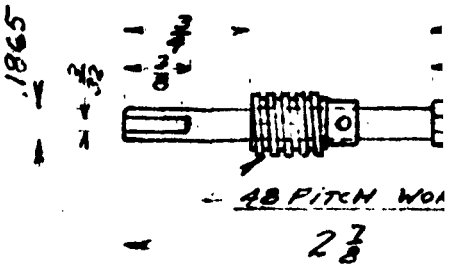
WOODS HOLE OCEANOGRAPHIC INSTITUTION 12-8-50



(1) MOUNTING FLANGE - 1 R REQ'D - ALUMINUM

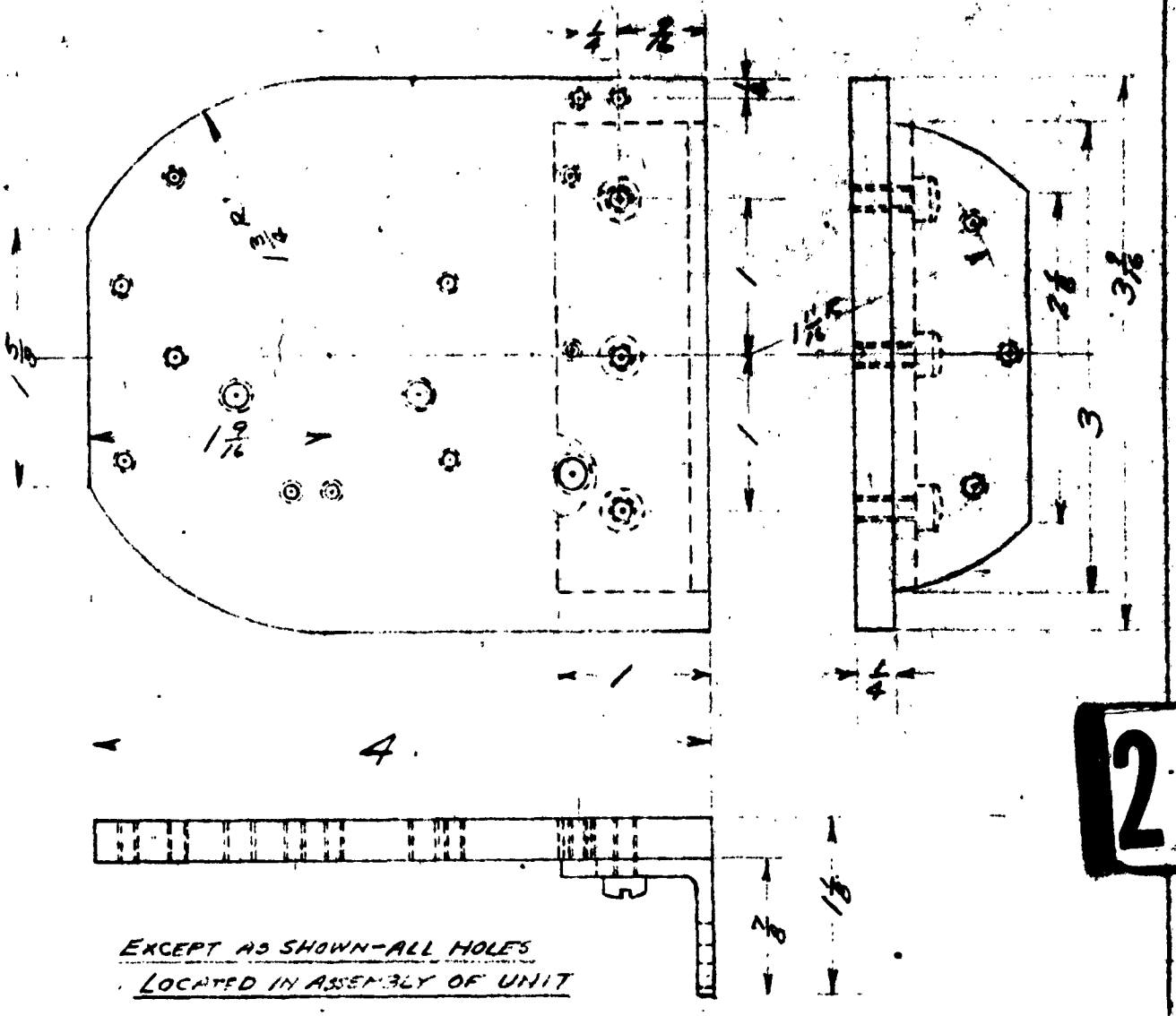


(3) BEARING PILLAR - 2 R REQ'D - BRASS



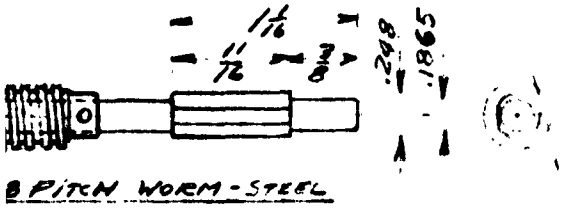
(5) COUNTER SHAFT -

- 6 TOOTH STEEL

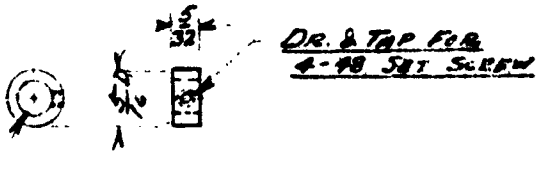


2

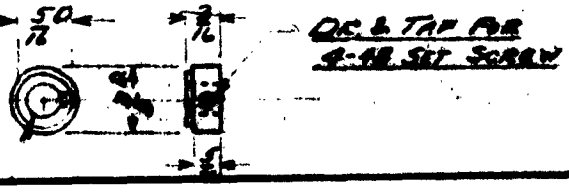
(2) BASE PLATE & BRACKET - 1 PC. EACH REQ'D - ALUMINUM



SHAFT - 1 PC. REQ'D - BRASS

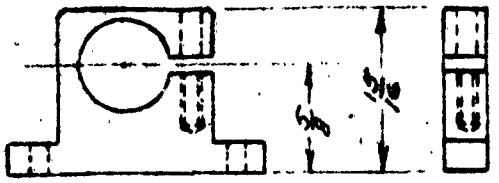


(7) SHAFT COLLAR FOR (3) - 1 REQ'D - BRASS



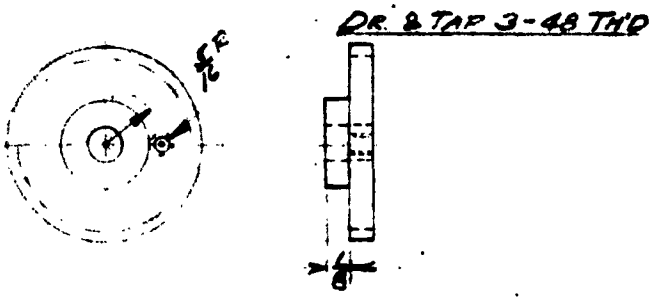
TH STEEL PINION 8-32 TH'D

(3) BEARING PILLAR - 2 PC REQ'D - BRASS



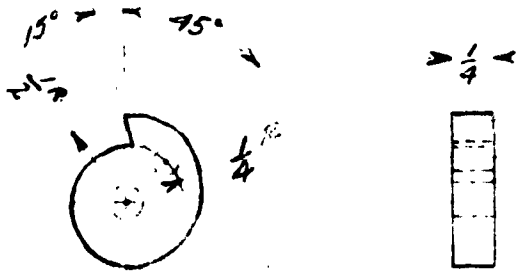
ALL DIMENSIONS SAME AS (3) EXCEPT AS SHOWN

(4) BEARING PILLAR - 2 PC. REQ'D - BRASS



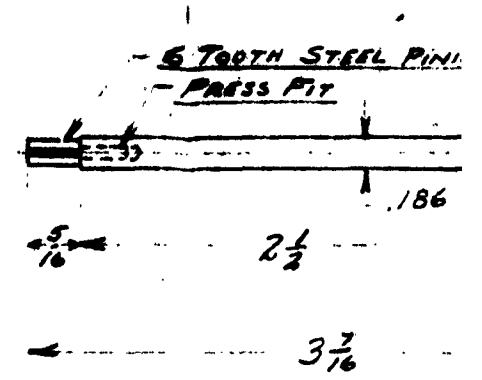
STD G1021 BOSTON WORM GEAR MODIFIED AS SHOWN

(10) CAM DRIVE WORM GEAR - 1 REQ'D - BRASS

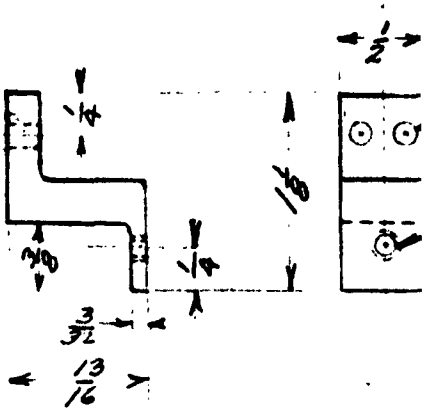


LINEAR CAM 1/4 RISE PER REVOLUTION

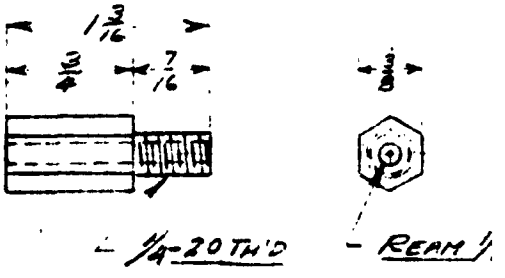
(13) SWITCH CAM - 1 REQ'D - BRASS



(6) MAIN DRIVE SHAFT - 1 P

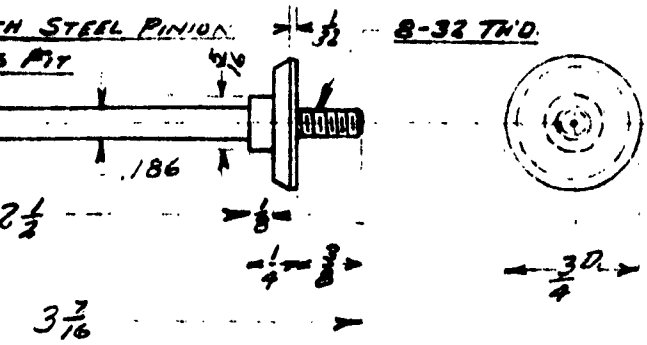


(11) WORM GEAR SUPPORT -

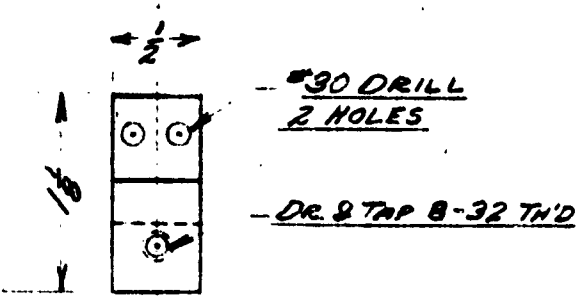


(14) SWITCH SUPPORT & BEAR

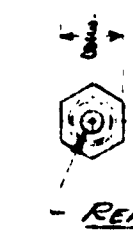
3



SHAFT - 1 PC. REQ'D - BRASS

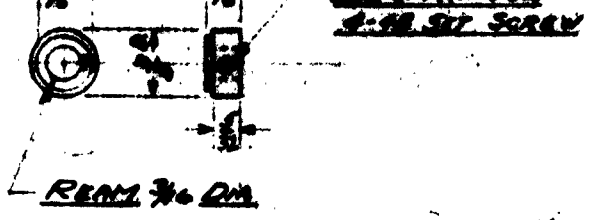


SUPPORT - 1 PC - BRASS

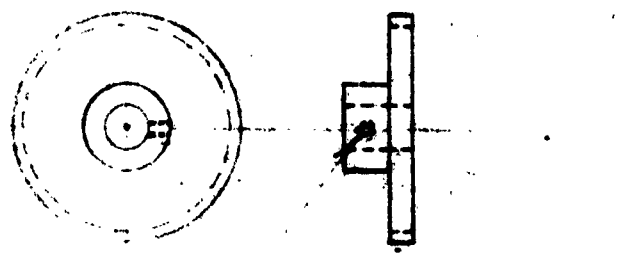


- REAM 1/8 DIA

& BEARING - 1 REQ'D - BRASS

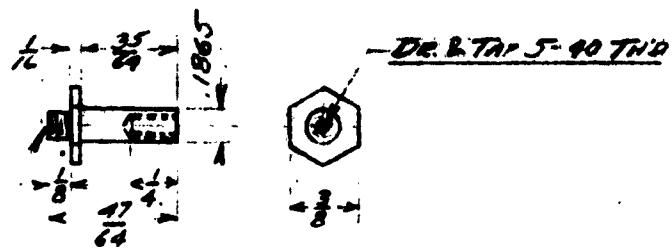


⑧ SHAFT COLLAR FOR ⑥ - 2 REQ'D - BRASS



STD G 141 BOSTON GEAR

⑨ SHAFT ⑤ SPUR GEAR - 1 REQ'D - BRASS



- 8-32 TH'D

⑫ WORM GEAR SHAFT - 1 REQ'D - ST'NLS STEEL

4

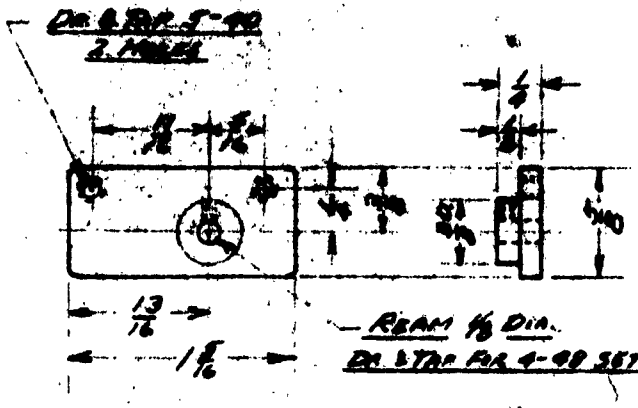
400 DAY CURRENT RECORDER

REVOLUTION COUNTER DETAILS

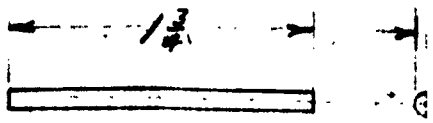
SCALE - 1" = 1"

DESIGN - A. A. KLEBBA DW'G - L. A. THAYER

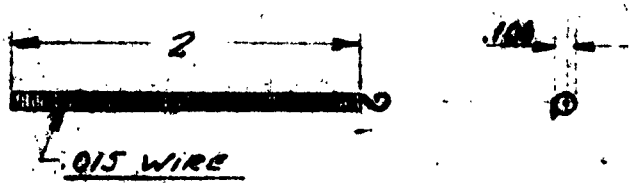
WOODS HOLE OCEANOGRAPHIC INSTITUTION 11-1-50



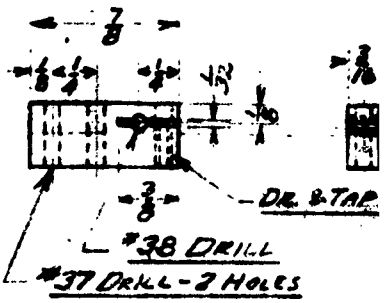
(15) SWITCH MOUNTING PLATE - 1 REQ'D - BRASS



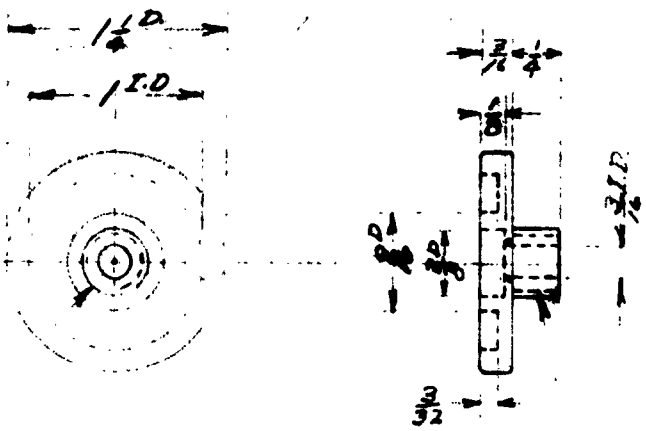
(16) SWITCH SHAFT - 1 REQ'D -



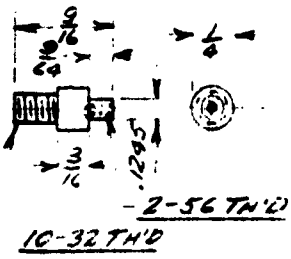
(18) ESCAPEMENT SPRING - 1 REQ'D - PHOS. BRONZE



(19) SPRING CLAMP - 1 REQ



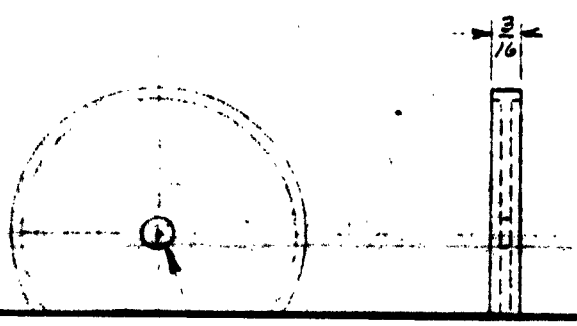
- INNER DIAMETER SPUN IN TO RETAIN SUITABLE BALL BEARING

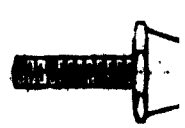


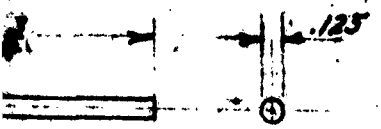
(22) SPINDLE FOR (21) - 1 REQ'

- 16 TOOTH - 48 PITCH PINION SILVER SOLDERED

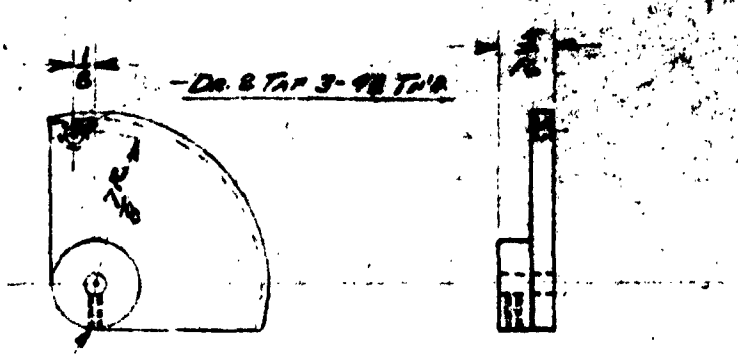
(21) ESCAPEMENT FLY-WHEEL - 1 REQ'D - BRASS





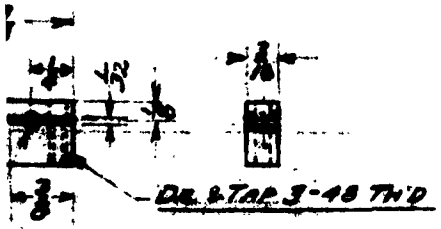


SHAFT - 1 REQ'D - STNLS STEEL



SECTOR OF 48 PITCH 96 TOOTH GEAR - HUB MODIFIED AS SHOWN

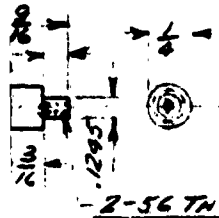
(17) ESCAPEMENT SECTOR - 1 REQ'D - BRASS



#38 DRILL

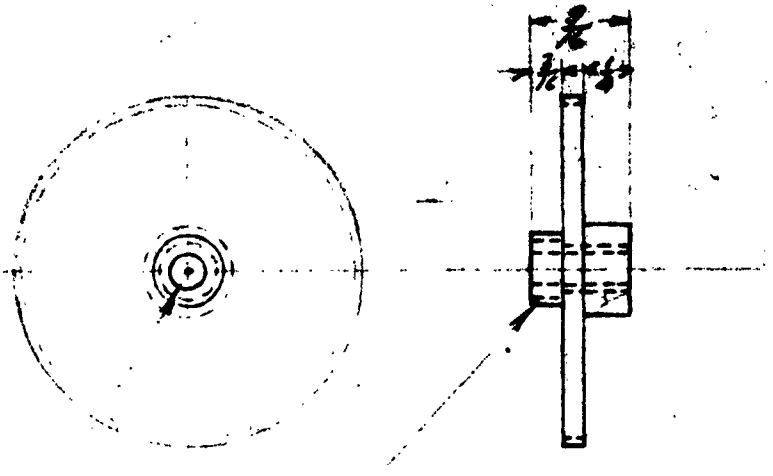
DRILL - 2 HOLES

CLAMP - 1 REQ'D - ALUMINUM

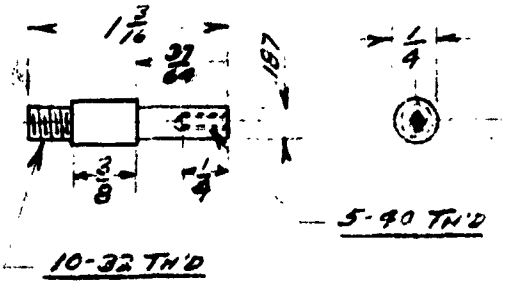


-32 TH'D

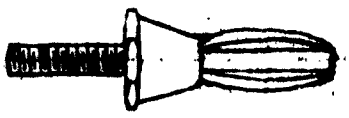
FOR (21) - 1 REQ'D - BRASS



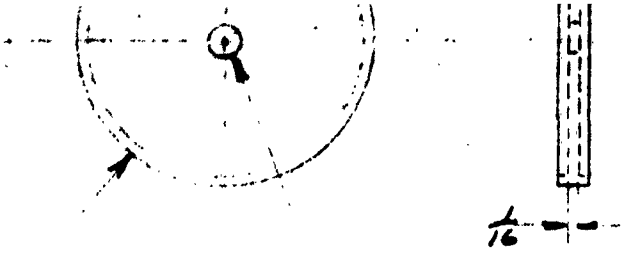
(20) ESCAPEMENT GEAR - 1 REQ'D - BRASS



(23) SPINDLE FOR (20) - 1 REQ'D - BRASS



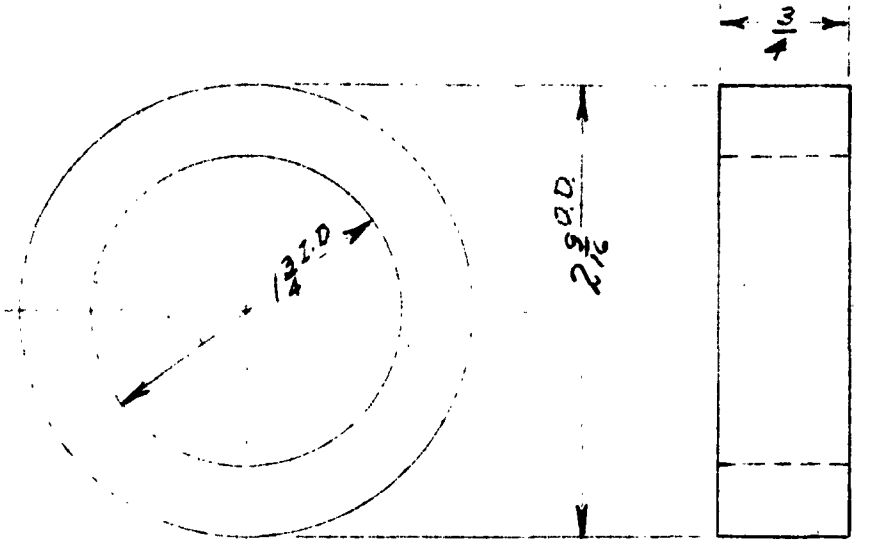
12



#21 DRILL

1/16 RIM - DIAMETER TO SUIT I.D. OF MAGNET FLANGE SOFT SOLDERED IN MAGNET & BALANCED

(24) MAGNET MOUNTING FLANGE - 1 REQ'D - BRASS



ALL DIMEN APPROX.

MAGNET POLARIZED ACROSS DIAMETER

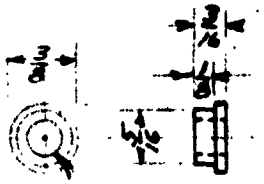
(25) DRIVEN COUNTER MAGNET - 1 REQ'D - ALNICO VI

(26) BIRNBACH

(27) INSULAT

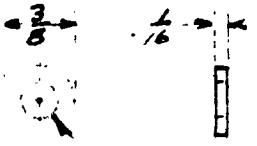
(28) INSULA

'NBACH #396 GIANT PLUG



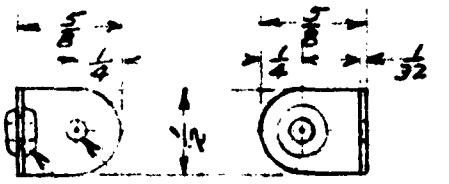
#9 DRILL

INSULATING COLLAR - 1 REQ'D - FORMICA



#9 DRILL

INSULATING WASHER - 1 REQ'D - FORMICA



#30 DRILL

— RUBBER GROMMET

(29) WIRE LEADER - 1 REQ'D - BRASS

4

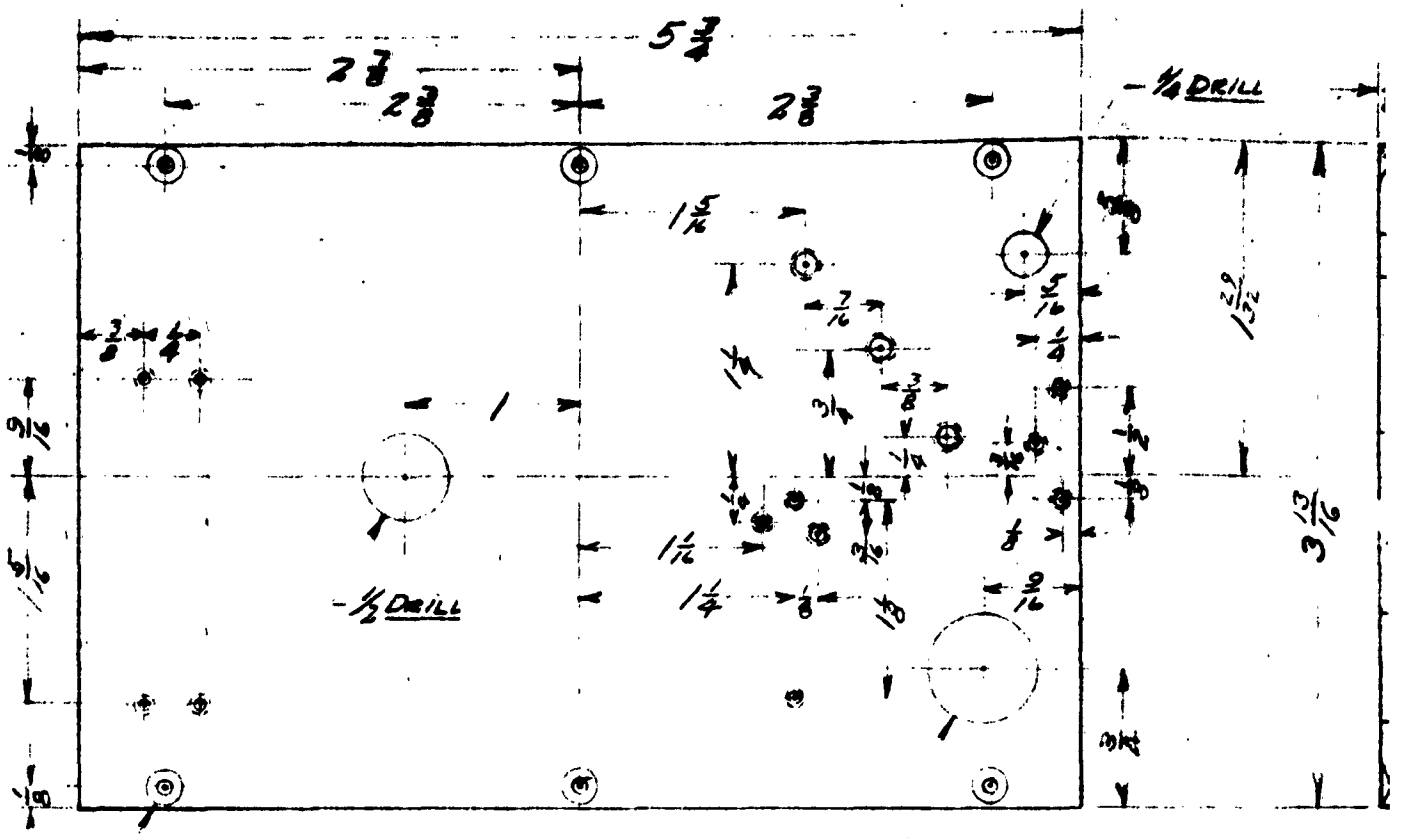
400 DAY CURRENT RECORDER

REVOLUTION COUNTER DETAILS

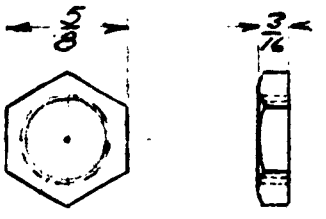
SCALE - 1" = 1"

DESIGN - A.A. KLEBBA DWG - L.A. THAYER

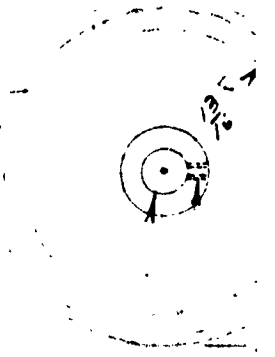
WOODS HOLE OCEANOGRAPHIC INSTITUTION 11-1-50



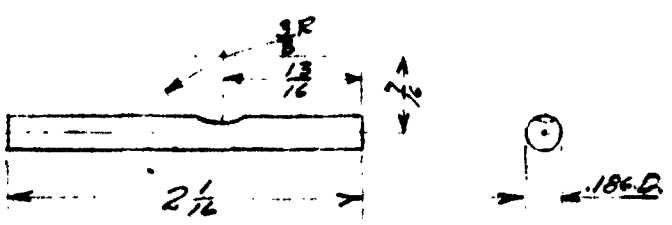
(1) CAMERA BASE PLATE - 1 REQ'D - ALUMINUM



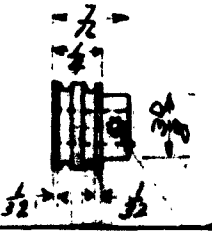
(4) LOCK NUT FOR (3) - 1 REQ'D - BRASS



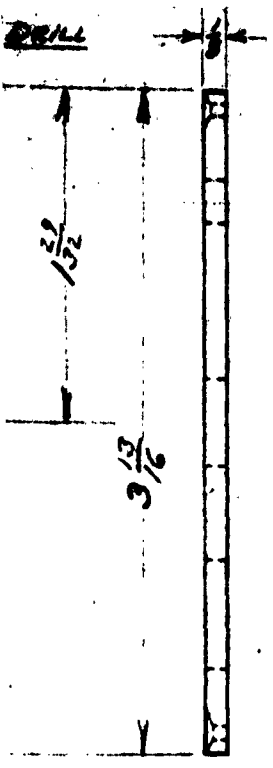
(5) SPINDLE DRIVE

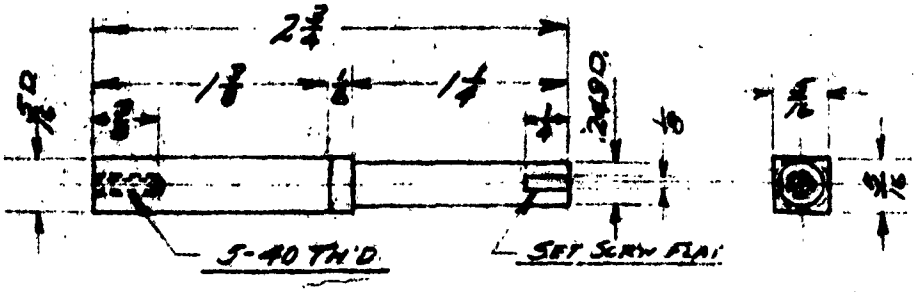


(7) BELT GUIDE BAR - 1 REQ'D - ST'NL'S STEEL

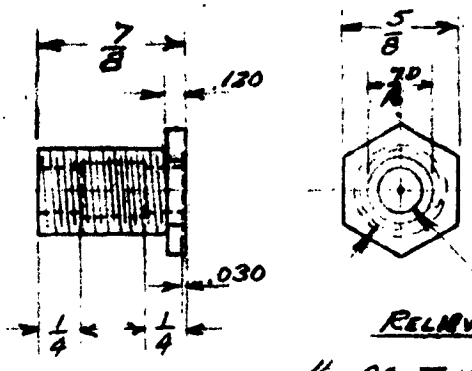


1



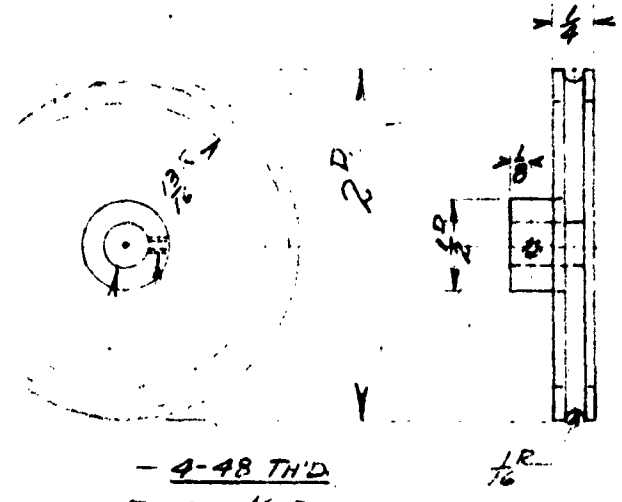


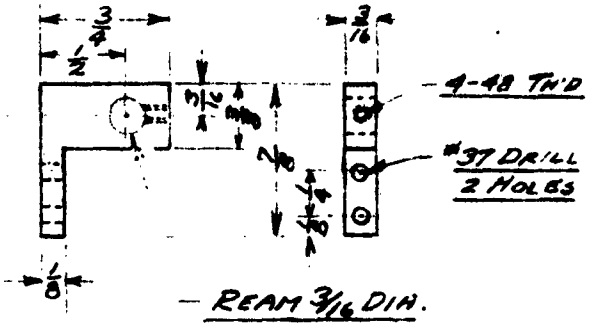
(2) FILM SPOOL SPINDLE - 1 REQ'D - STN'LS STEEL



RELIEVE 3/8" IN CENTER TO 9/32 DIA

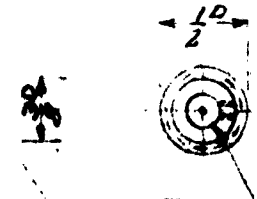
(3) SPINDLE BEARING - 1 REQ'D - BRASS.





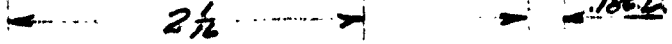
(6) DRIVE BELT GUIDE SUPPORT
2 REQ'D — BRASS

LE DRIVE PULLEY - 1 REQ'D - BRASS



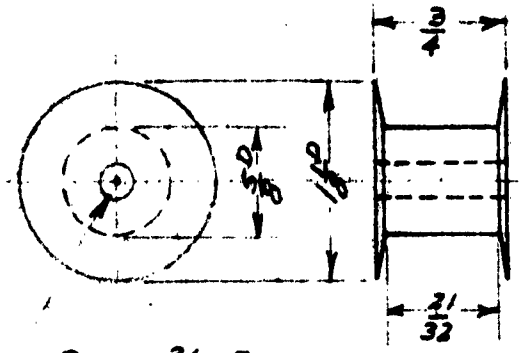
2

(7) BELT GUIDE BAR - 1 REQ'D - STN'L'S STEEL



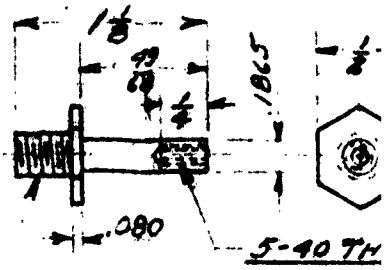
1/32 RADIUS GA

(8) BELT DRIVE PUL



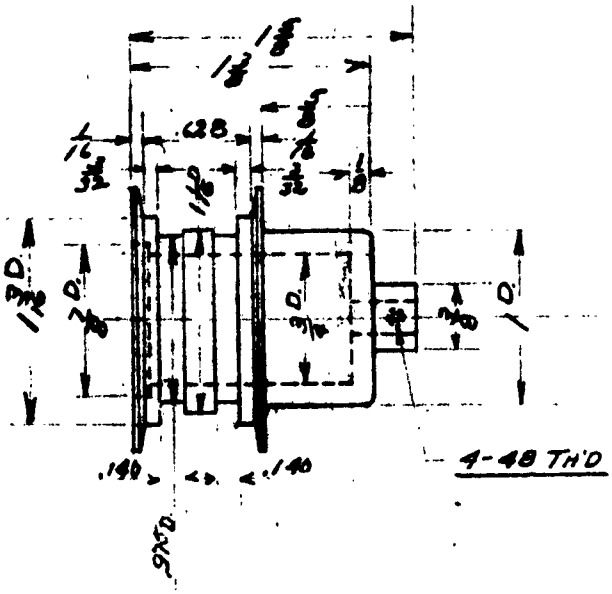
- REAM 3/16 DIA.

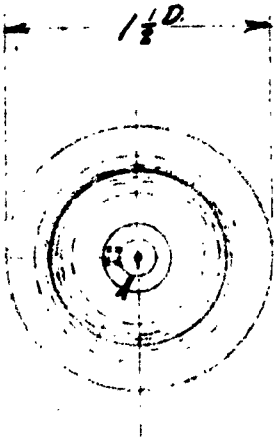
(10) FILM GUIDE SPOOL - 1 REQ'D - BRASS



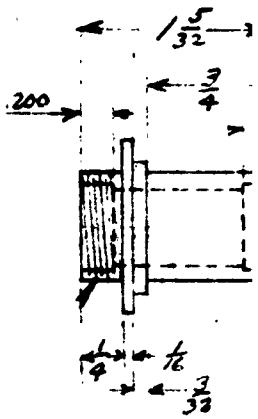
- 1/4-20 TH'D

(11) SPINDLE FOR (10) - 1 RE





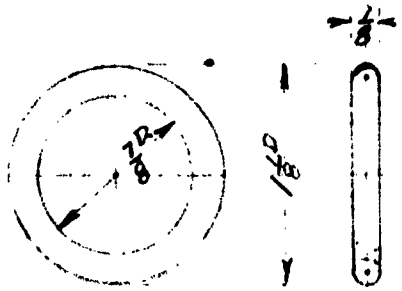
- REAM 3/16 DIA.



5/8 - 40 TH'D

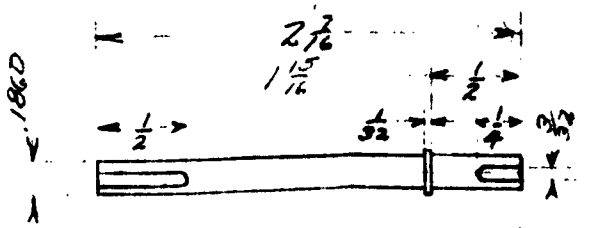
(14) BEARING FOR (1

(13) FILM DRIVE SPOOL - 1 REQ'D - BRASS

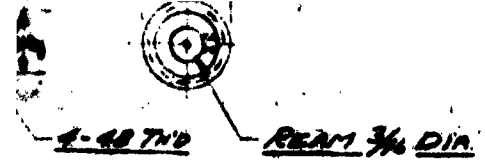


- Nº 17 SERIES 1820 "O" RING - LINEAR INC

(16) TRACTION RING FOR (13) - 2 REQ'D - RUBBER

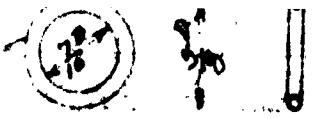


(17) DRIVE SPOOL SHAFT - 1 REQ'D -



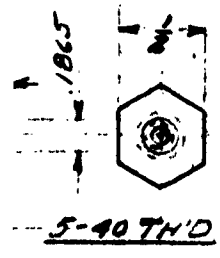
1/32 RADIUS GROOVES

RIVE PULLEY - 1 REQ'D - BRASS

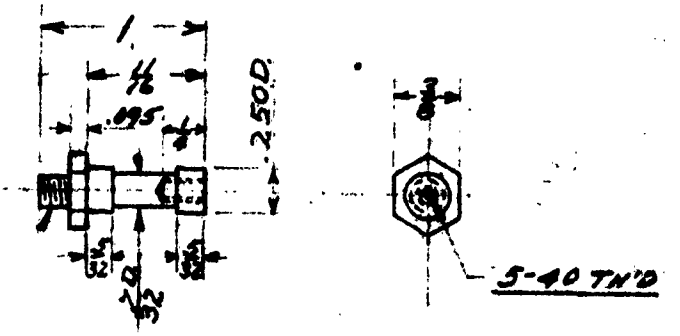


- NO. 9 SERIES 1820 "O" RING - LINEAR INC

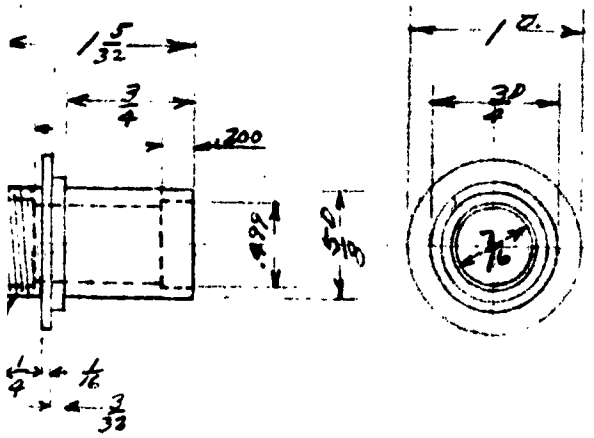
(9) TRACTION RING FOR (8) - 2 REQ'D. - RUBBER



E (10) - 1 REQ'D - ST'NL'S STEEL

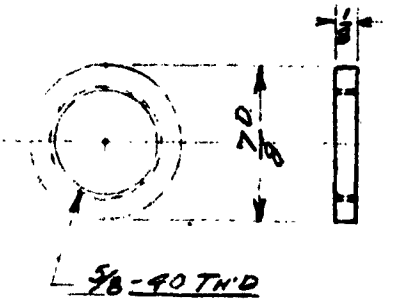


(12) FILM GUIDE POST - 3 REQ'D - ALUMINUM

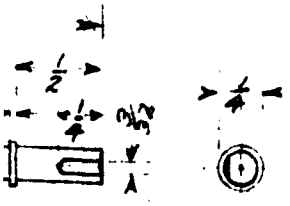


-40 TH'D

NG FOR (13) - 1 REQ'D - BRASS



(15) LOCK RING FOR (14) - 1 REQ'D - BRASS



' REQ'D - ST'NL'S STEEL

400 DAY CURRENT RECORDER

CAMERA DETAILS

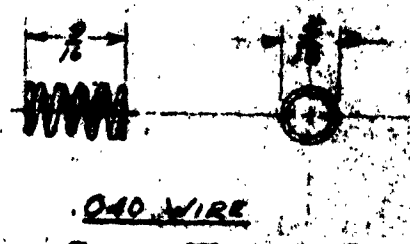
SCALE - 1" = 1"

DESIGN - A. A KLEBBA

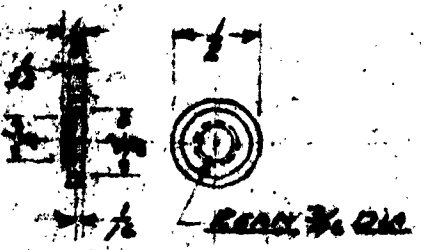
D'WG - L. A. THAYER

WOODS HOLE OCEANOGRAPHIC INSTITUTION 11-7-50

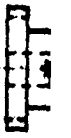
4



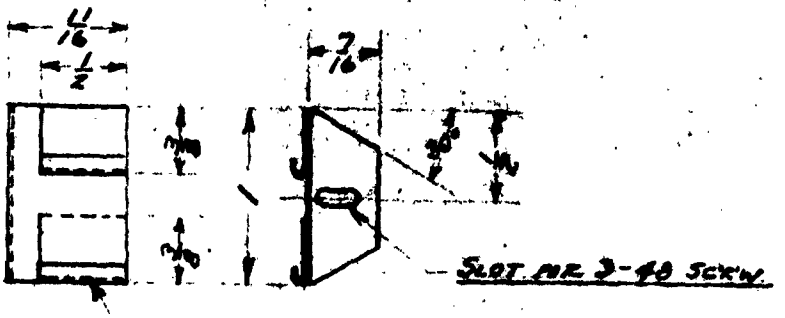
(18) DRIVE SPOOL THRUST SPRING
1 REQ'D - STEEL

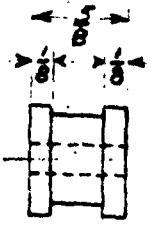


(19) SPRING THRUST COLLAR
1 REQ'D BRASS



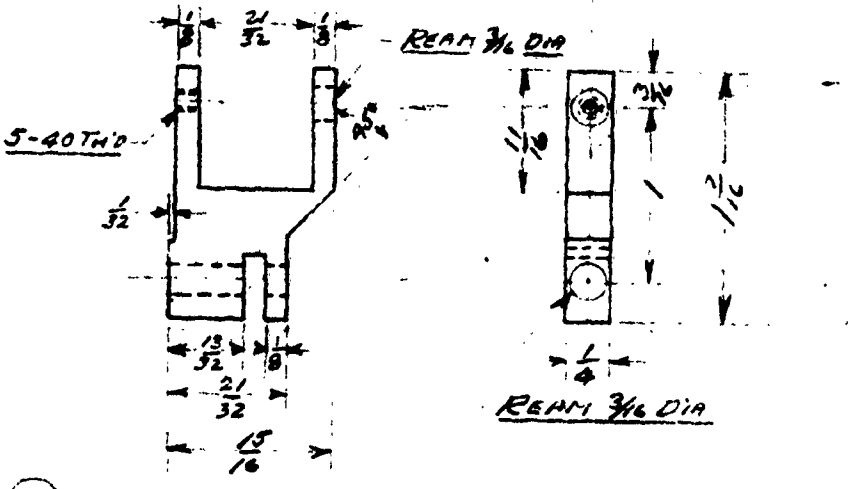
STD
(20) FILM



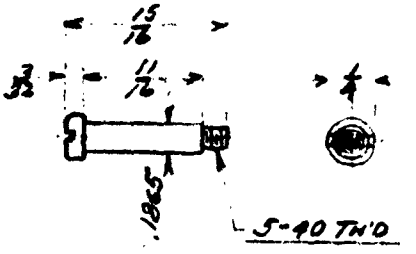


(22) FILM BACKING PLATE - 1 REQ'D - .015 BRASS

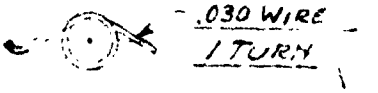
(23) PRESSURE ROL



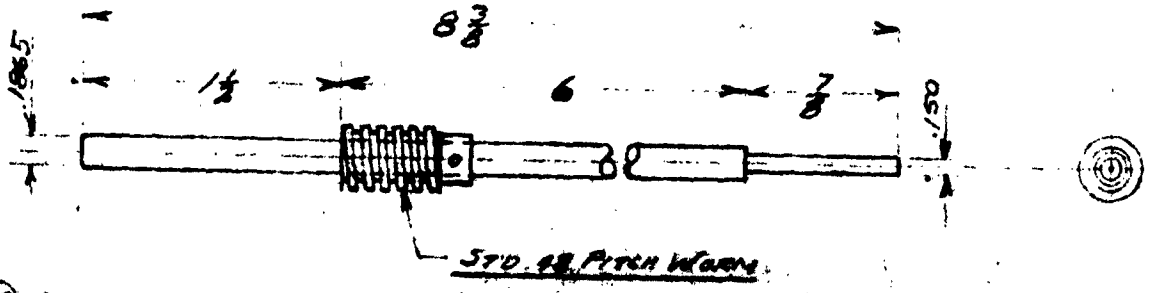
(25) PRESSURE ROLLER YOKE - 1 REQ'D - ALUMINUM



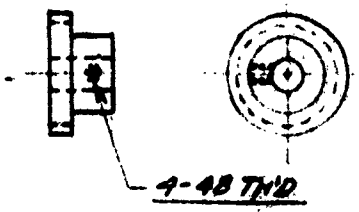
(26) YOKE PIVOT - 1 REQD -



(27) PRESSURE SPRING - 1 REQ'D



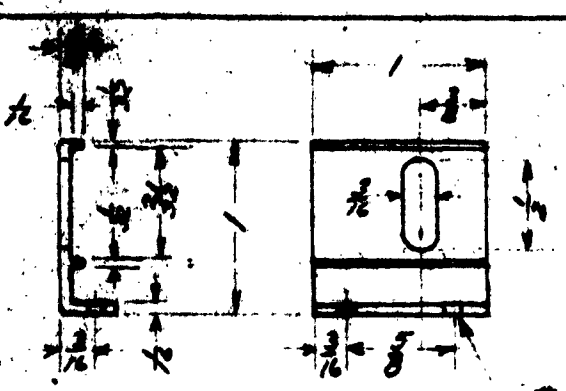
(30) FILM & LENS DRIVE SHAFT - 1 REQ'D - STN'LS STEEL



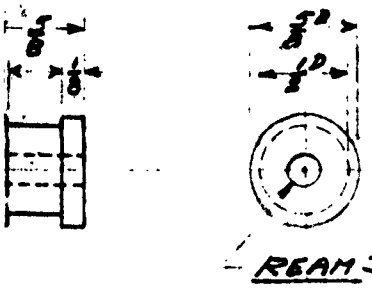
STD ᴹG 1019 BOSTON GEAR

(20) FILM DRIVE WORM GEAR

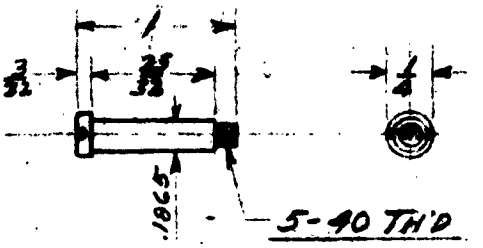
1 REQ'D - BRASS



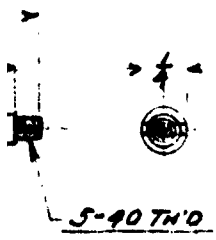
(21) FILM GATE - 1 REQ'D - BRASS



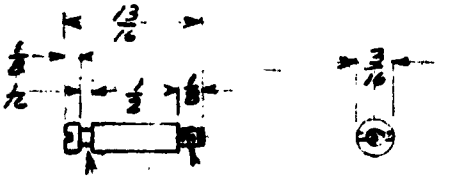
ESSURE ROLLER - 1 REQ'D - BRASS



(24) ROLLER SHAFT - 1 REQ'D - BRASS



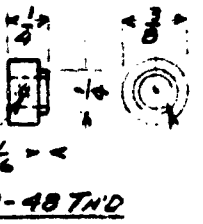
OT - 1 REQD - BRASS



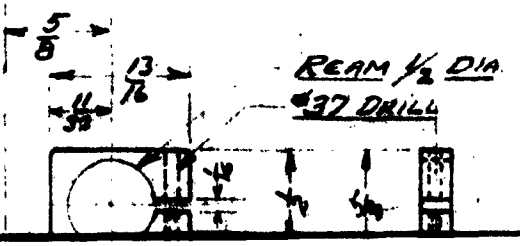
(28) SPRING BEARING POST - 1 REQ'D - BRASS

- .030 WIRE
1 TURN

RING - 1 REQ'D - STEEL



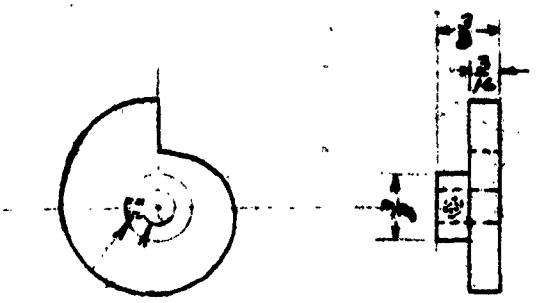
(29) SHAFT COLLAR - 2 REQ'D - BRASS



2

STD. 48 PITCH WORM

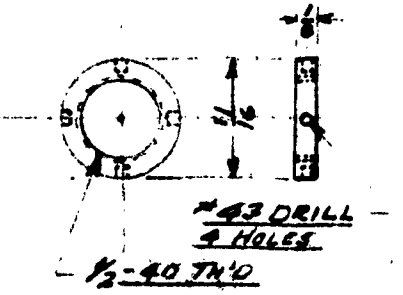
(30) FILM & LENS DRIVE SHAFT - 1 REQ'D - STN'L'S STEEL



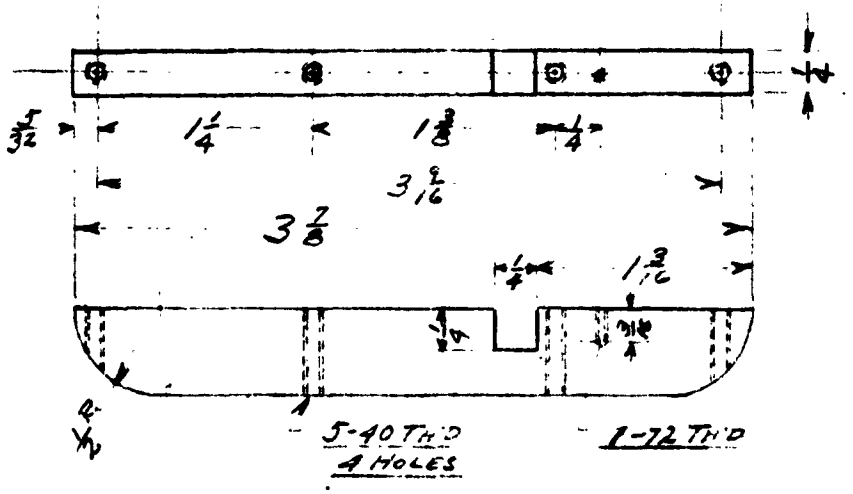
- REAM 3/16 DIA
- 4-48 TH'D

LINEAR CAM 5/16 RISE PER REVOLUTION

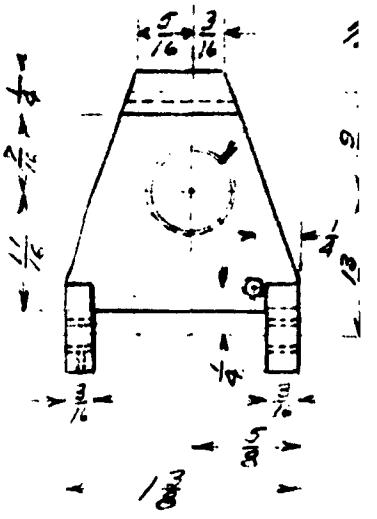
(32) LENS LIFTING CAM - 1 REQ'D - BRASS



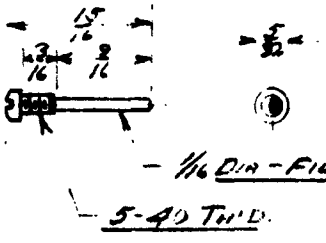
(33) LENS ADJUSTING RING
2 REQ'D - ALUMINUM



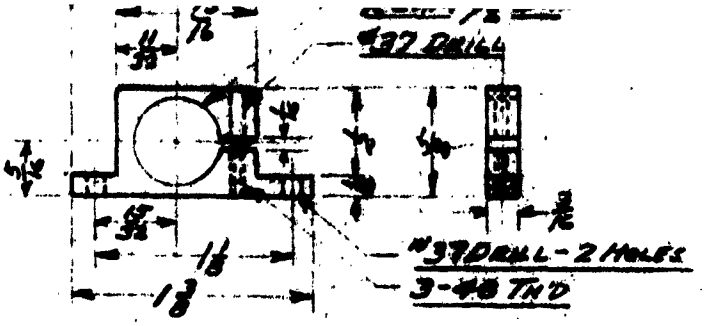
(35) LENS CARRIER BED - 1 REQ'D - BRASS



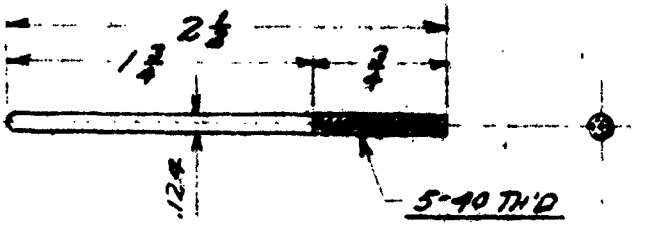
(36) LENS CARRIER - 1 RE



(39) CARRIER LIFTING FINGER - 1 REQ'D - BRASS

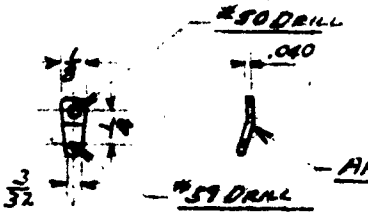


(31) SHAFT BEARING PILLAR - 1 REQ'D - BRASS

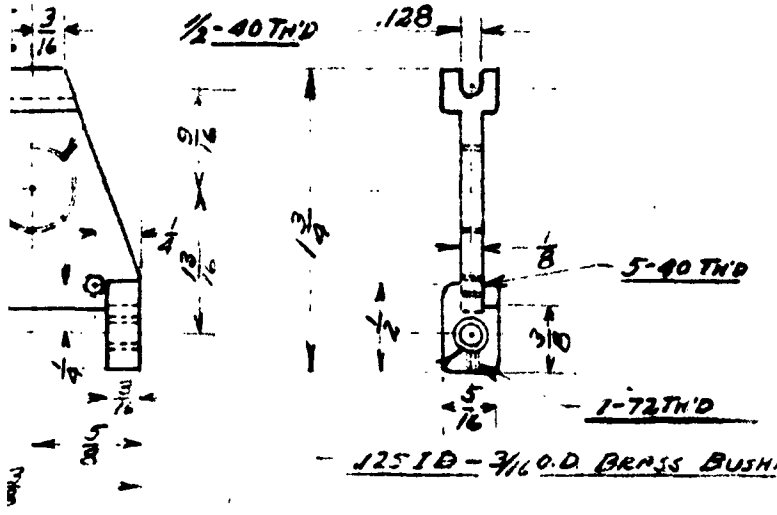


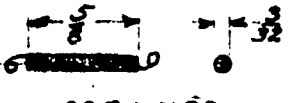
16

(34) LENS CARRIER GUIDE - 2 REQ'D - STAINLESS STEEL



(37) CARRIER RETURN SPRING CLIP
1 REQ'D - BRASS





(38) CARRIER RETURN SPRING
1 REQ'D - STEEL

RIER - 1 REQ'D - ALUMINUM

400 DAY CURRENT RECORDER

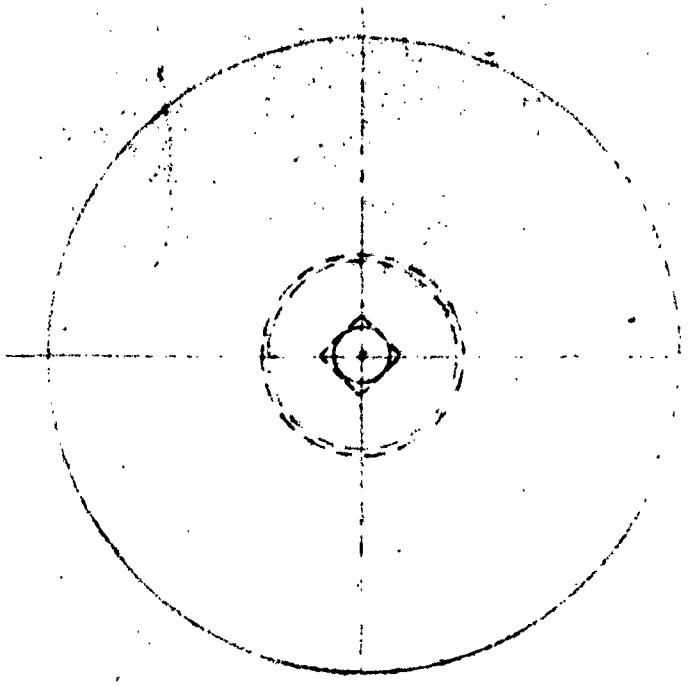
CAMERA DETAILS

SCALE - 1" = 1"

4

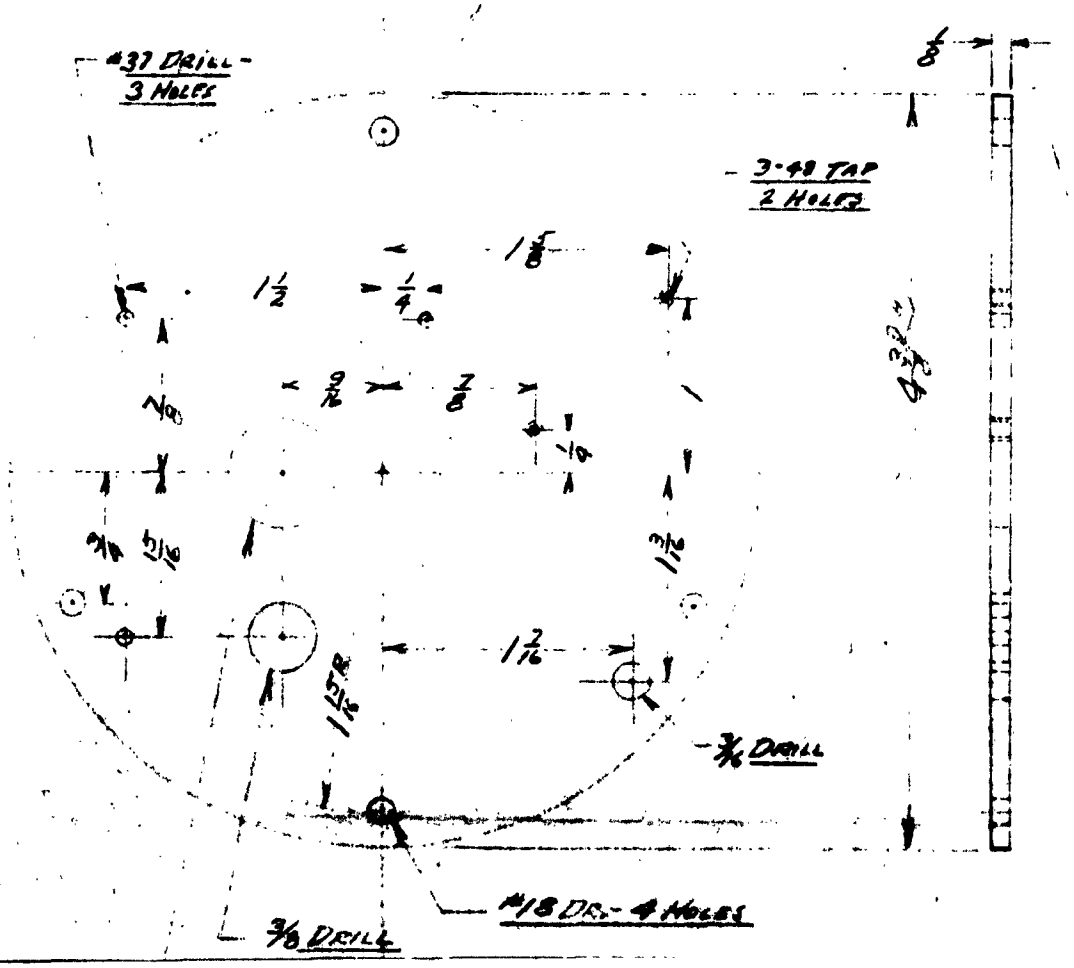
DESIGN - A.A. KLEBBA D'WG - L.A. THAYER

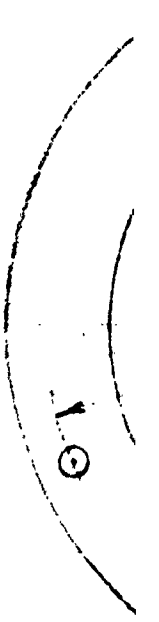
WOODS HOLE OCEANOGRAPHIC INSTITUTION 11-7-50



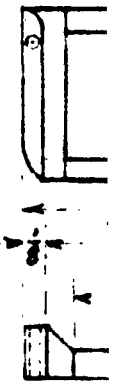
STD 100'-16MM CINE KODAK SPOOL

(40) FILM SUPPLY & TAKE-UP SPOOL - 1 EACH REQ'D - ALUMINUM





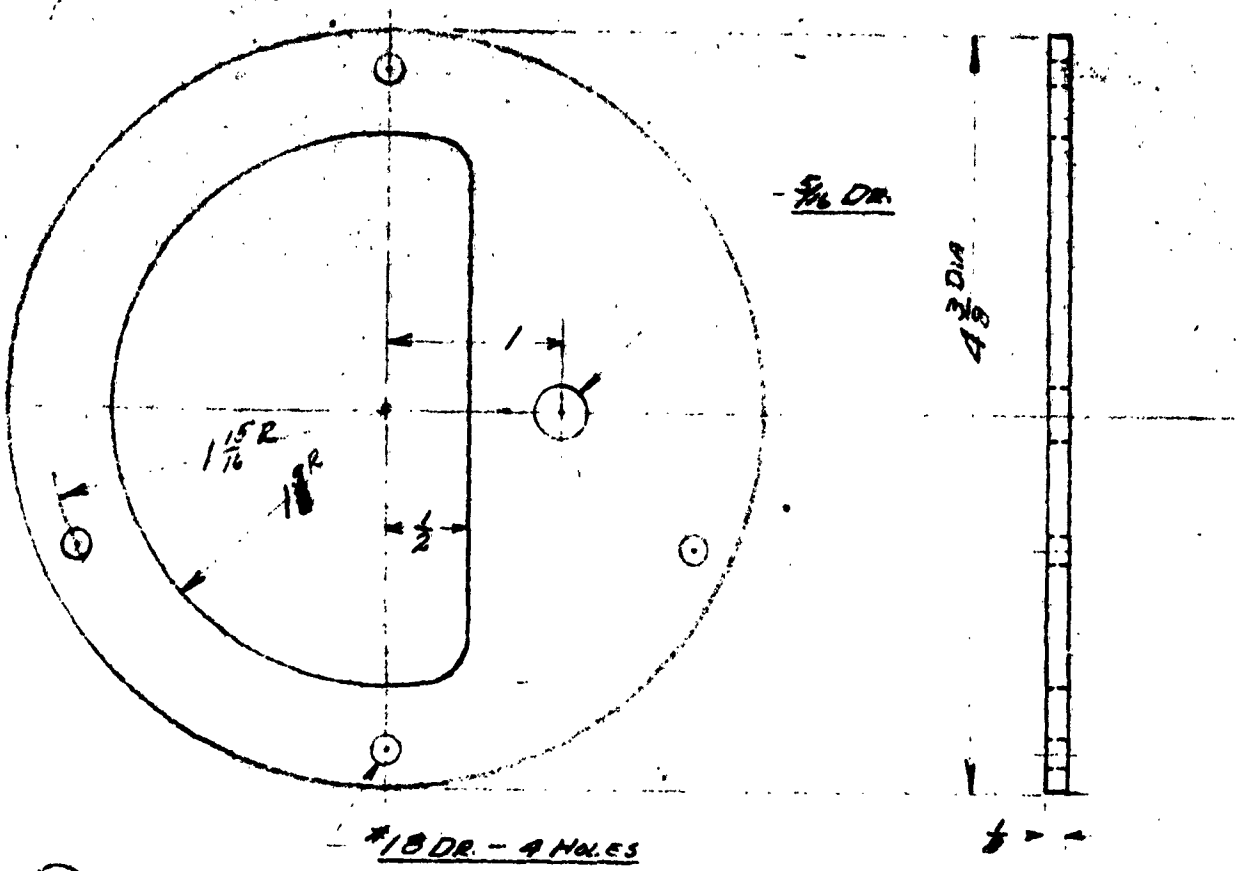
(41) C



ROUN
FILE O
WHE

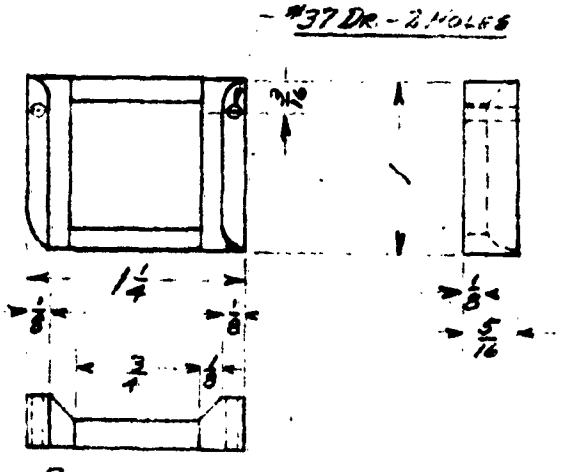
(43) FILM

1



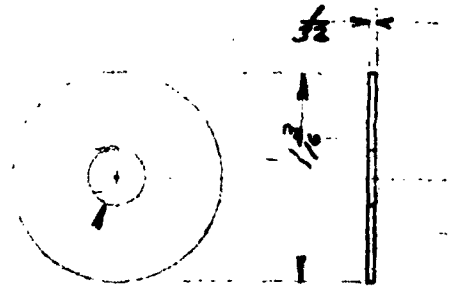
#18 DR. - 4 HOLES

(41) CAMERA END PLATE - 1 REQ'D - ALUMINUM



ROUND ALL INTERNAL CORNERS
FILE OUTER CORNER TO FIT RADIUS OF (42) WHEN ASSEMBLED

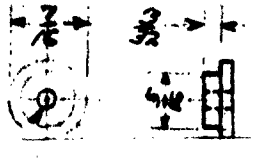
(43) FILM GUIDE - 1 REQ'D - ALUMINUM

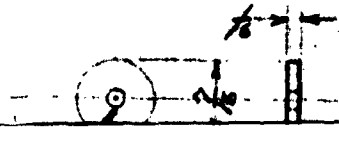


5/16 DRILL

(44) FILM SPOOL SPACER - 1 REQ'D - BRASS

2





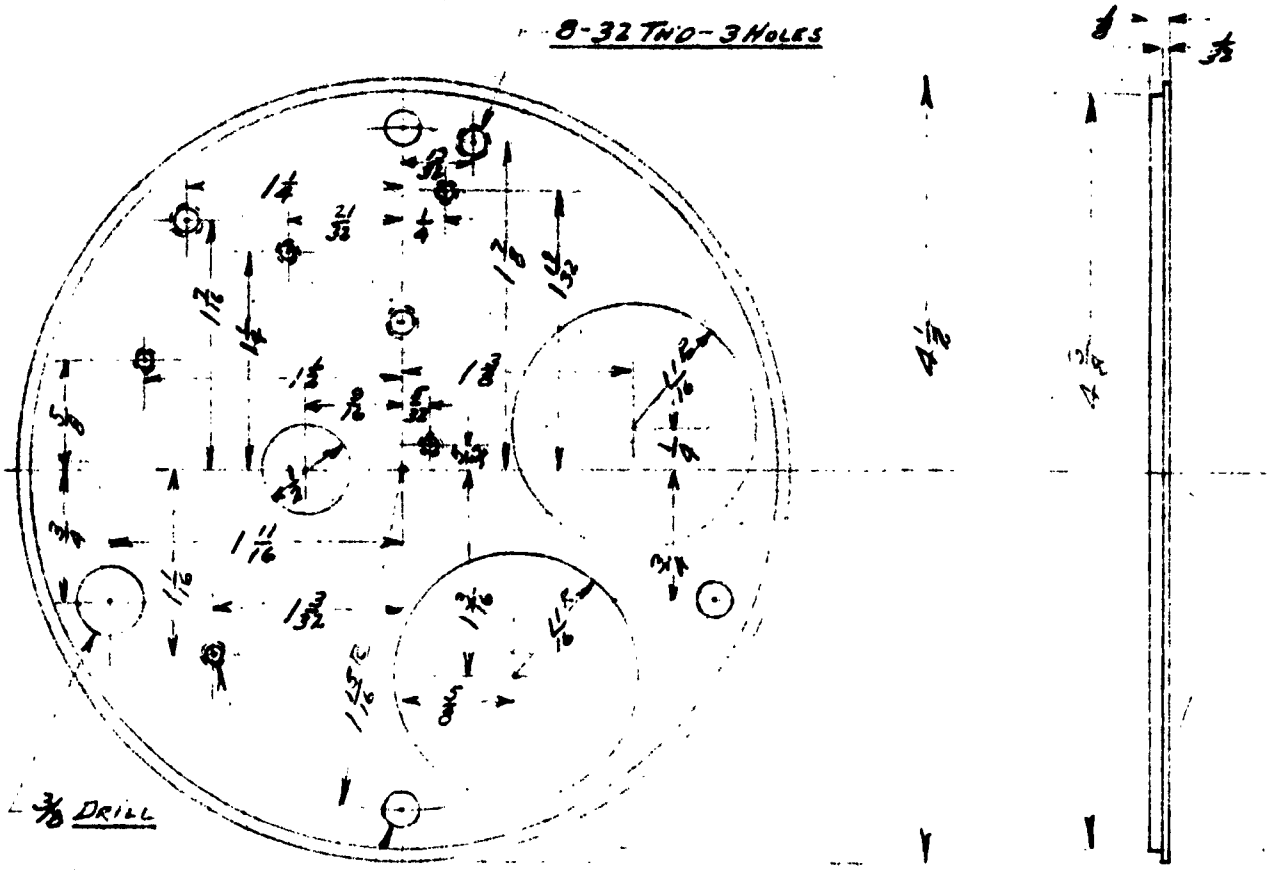
#18 DR. - 4 HOLES

3/8 DRILL

5/8 DRILL

(42) CLOCK MOUNTING PLATE - 1 REQ'D - ALUMINUM

8-32 THD - 3 HOLES

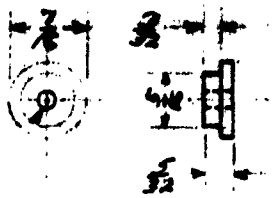


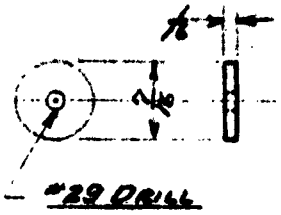
3/8 DRILL

5-40 THD - 5 HOLES

#18 DRILL - 3 HOLES

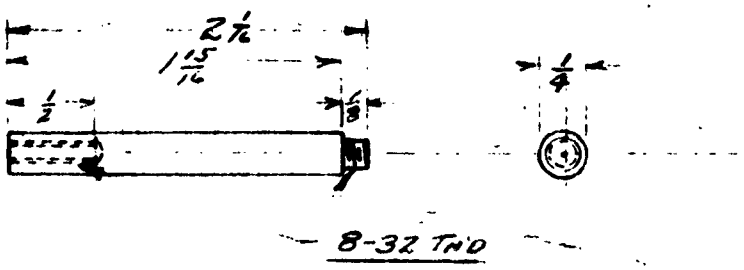
(46) MOTOR & BATTERY PLATE - 1 REQ'D - BRASS





(45) INSULATING WASHERS - 1 EACH REQ'D - BAKELITE

(47) #400 BIRNBACH BANANA PLUG - 1 REQ'D



(48) JACK PLATE SUPPORT - 3 REQ'D - BRASS

4

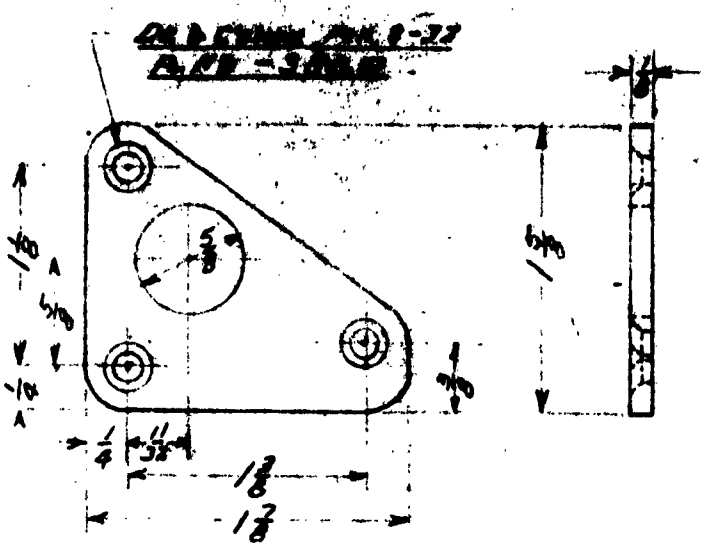
400 DAY CURRENT RECORDER

CAMERA DETAILS

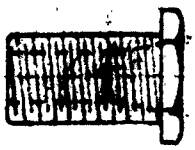
SCALE - 1" = 1"

DESIGN - A.A. KLEBBA D'WG - L.A. THAYER

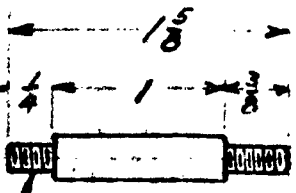
WOODS HOLE OCEANOGRAPHIC INSTITUTION 12-20-50



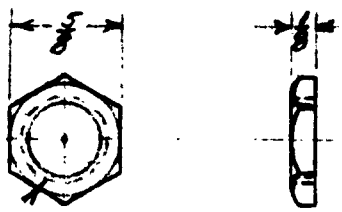
(49) JACK MOUNTING PLATE - 1 REQ'D - BRASS



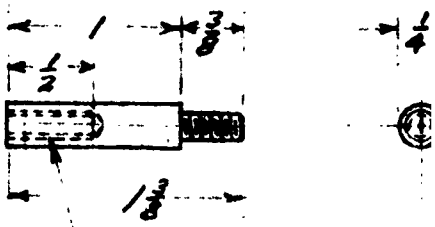
(50) #399 BIRNBACH J



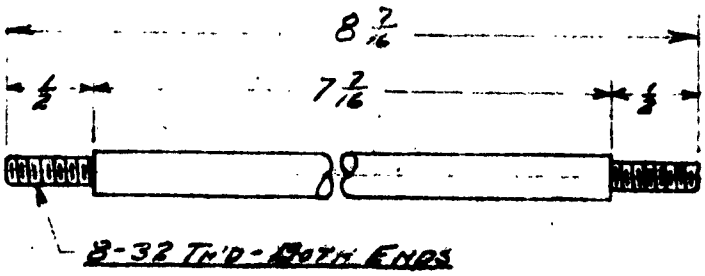
(53) CHASSIS SPACER - 1 RE



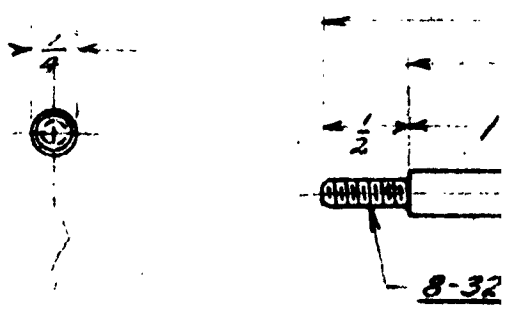
(52) LOCK NUT FOR (50) - 2 REQ'D - BRASS

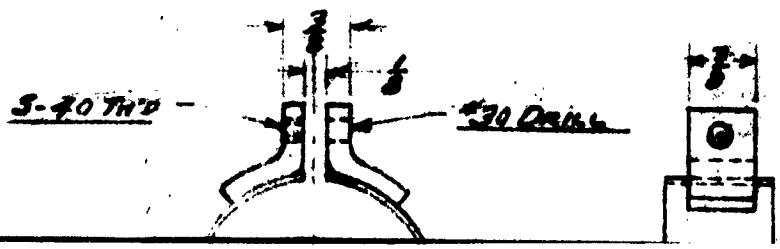


(54) CHASSIS SPACER - 3 RE

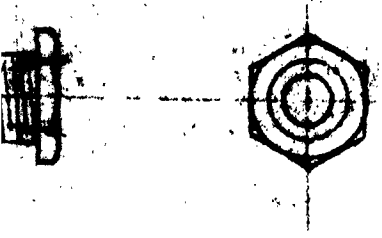


(56) CHASSIS SPACER - 1 REQ'D - BRASS

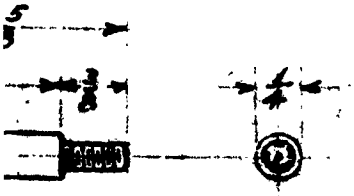




(57)

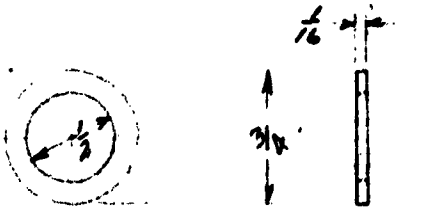


ENBACH JACK - 1 REQ'D.

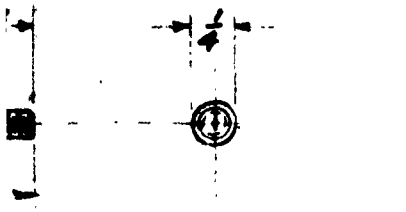


- BOTH ENDS

PACER - 1 REQ'D - BRASS

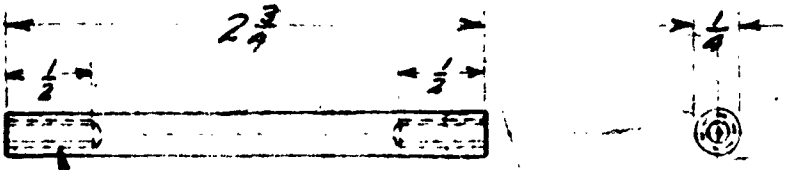


(51) INSULATING WASHERS FOR (50) - 1 EACH REQ'D - FORMICA

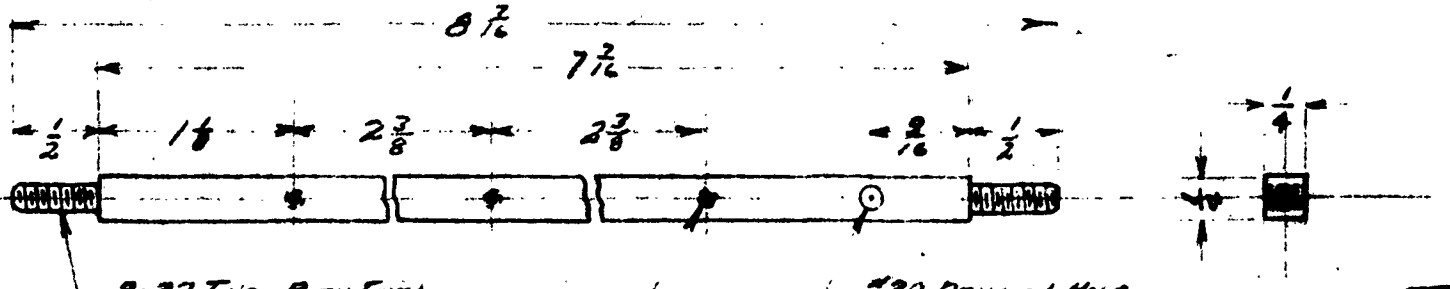


'D - BOTH ENDS

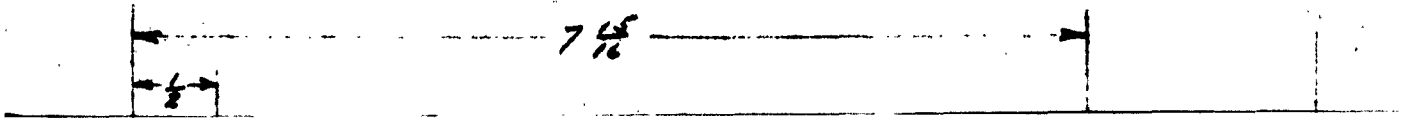
PACER - 3 REQ'D - BRASS



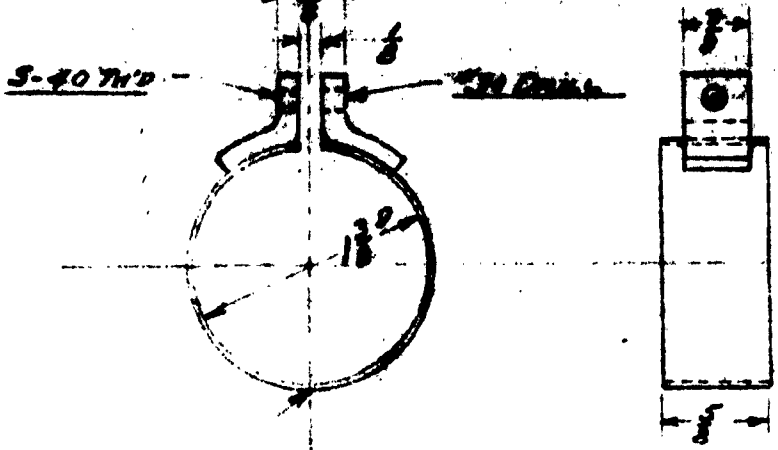
(55) CHASSIS SPACER - 3 REQ'D - BRASS



(57) CAMERA BED RAIL - 1 REQ'D - BRASS

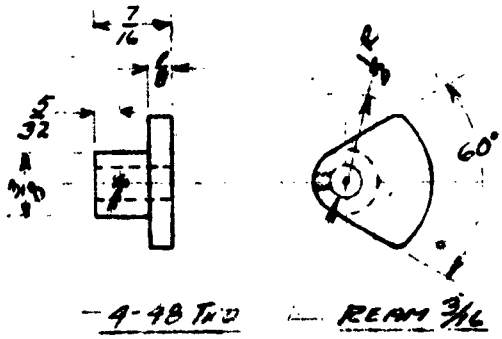


12

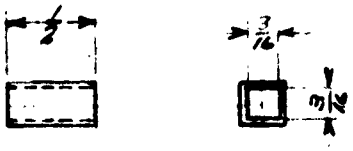


1/32 BAND SILVER SOLDERED AT THIS POINT TO (44)

(58) BATTERY CLAMP - 2 REQ'D - BRASS

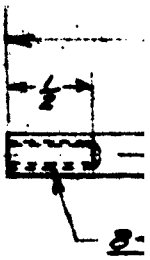


(60) WINDING SWITCH CAM - 1 REQ'D - BRASS

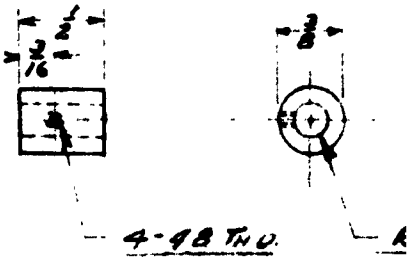


(63) MOTOR & SPRING SHAFT COUPLING — 1 REQ'D - BRASS

(57) CAMER

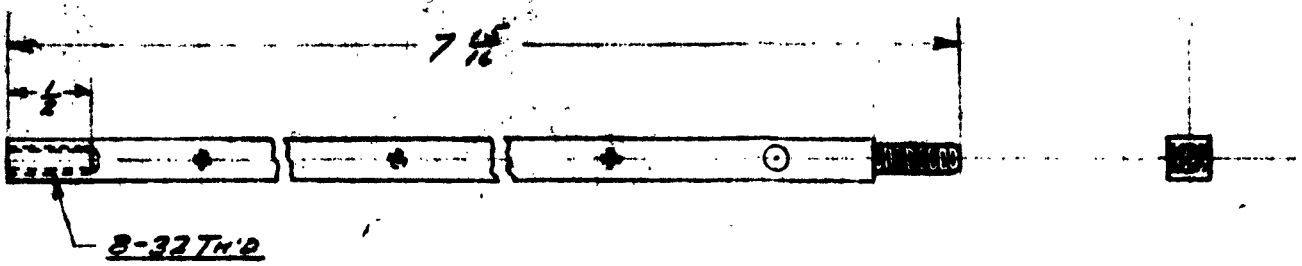


(59) CAME



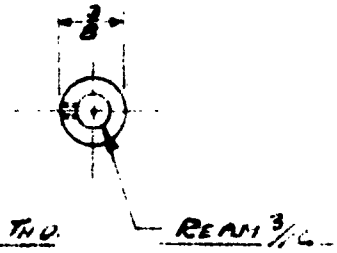
(61) SPRING SHAFT HUB - 1 RE

(57) CAMERA BED RAIL - 1 REQ'D - BRASS



ALL DIMENSIONS SAME AS (57) EXCEPT AS SHOWN

(59) CAMERA BED RAIL - 1 REQ'D - BRASS



HUB - 1 REQ'D - BRASS

SILVER SOLDERED INTO (60) & (21)

(62) MOTOR & SPRING SHAFT ENDS - 2 REQ'D - BRASS

4

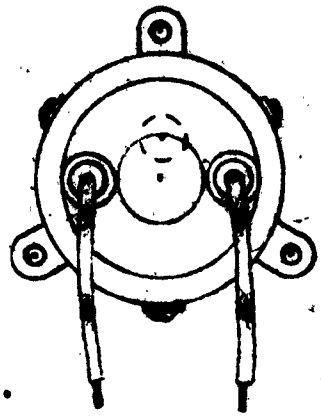
400 DAY CURRENT RECORDER

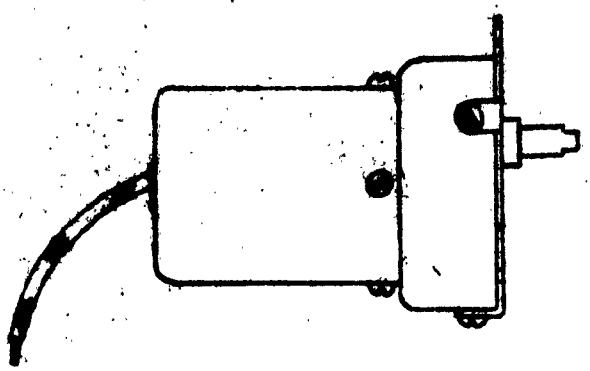
CAMERA DETAILS

SCALE - 1" = 1"

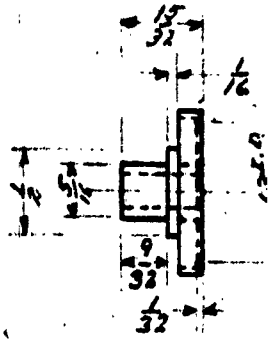
DESIGN - A. A. KLEBBA DWG - L. A. THAYER

WOODS HOLE OCEANOGRAPHIC INSTITUTION 12-28-50





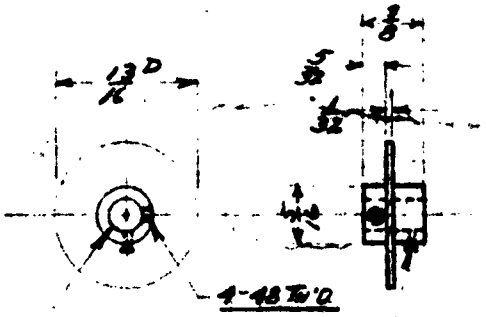
HANSEN PERMAG MOTOR - TYPE "C" - 6 VOLT D.C.
HANSEN MFG CO., INC. PRINCETON, IND.



STD G141 BOSTON

(65) SPRING BARREL

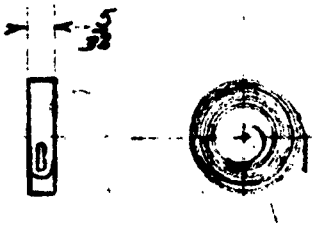
(64) CLOCK WINDING MOTOR - 1 REQ'D



1-48 TH'D

REAM 3/16

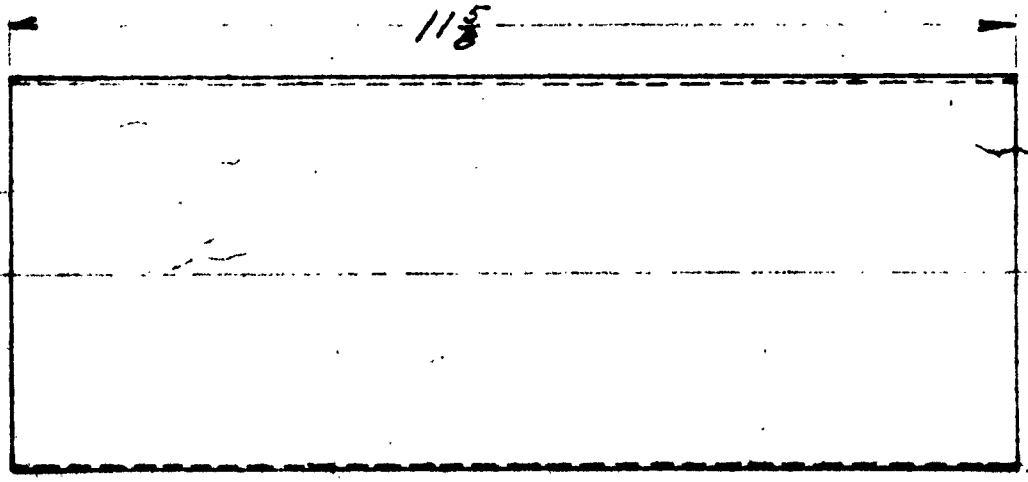
STEEL LUG TO SUIT SPRING END



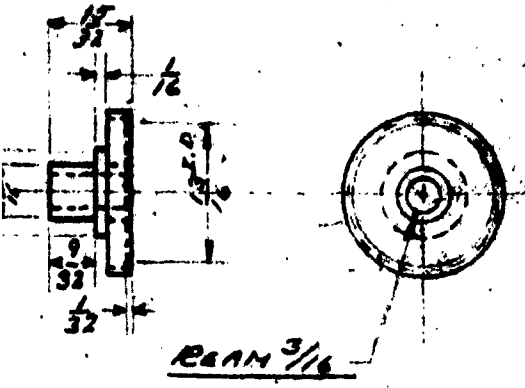
.010 THICK - 18" LONG

(67) SPRING RETAINER - 1 REQ'D - BRASS

(68) CLOCK MAIN SPRING - 1 REQ

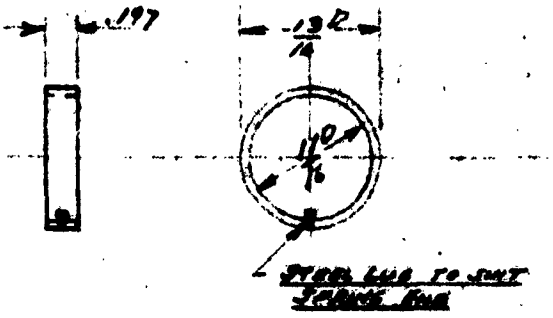


1/2 SCALE



'141 BOSTON GEAR MODIFIED AS SHOWN

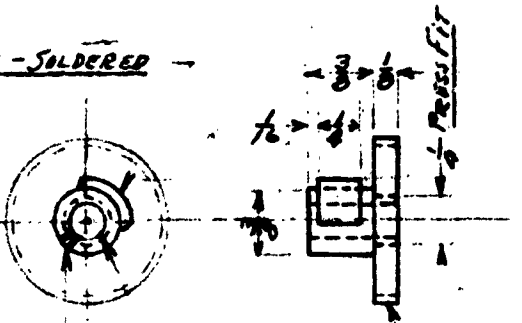
'6 BARREL HUB & GEAR - 1 REQ'D - BRASS



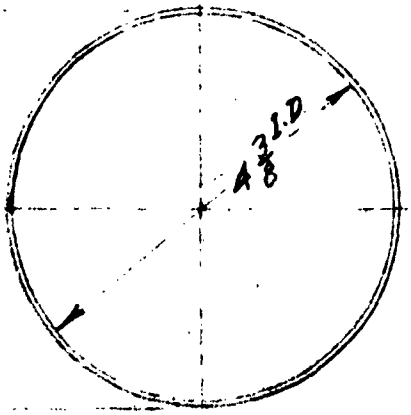
(66) SPRING BARREL CYLINDER - 1 REQ'D - BRASS

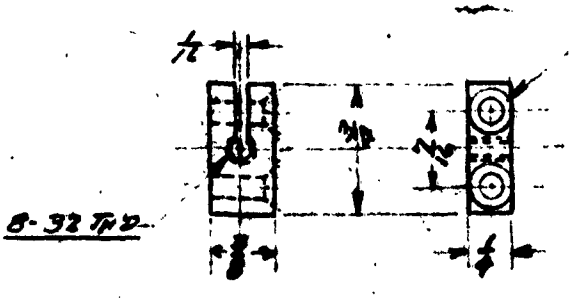
K - 18" LONG

'RING - 1 REQ'D - SP. STEEL



(69) MAIN SHAFT DRIVE GEAR & SWITCH CAM - 1 REQ'D - BRASS

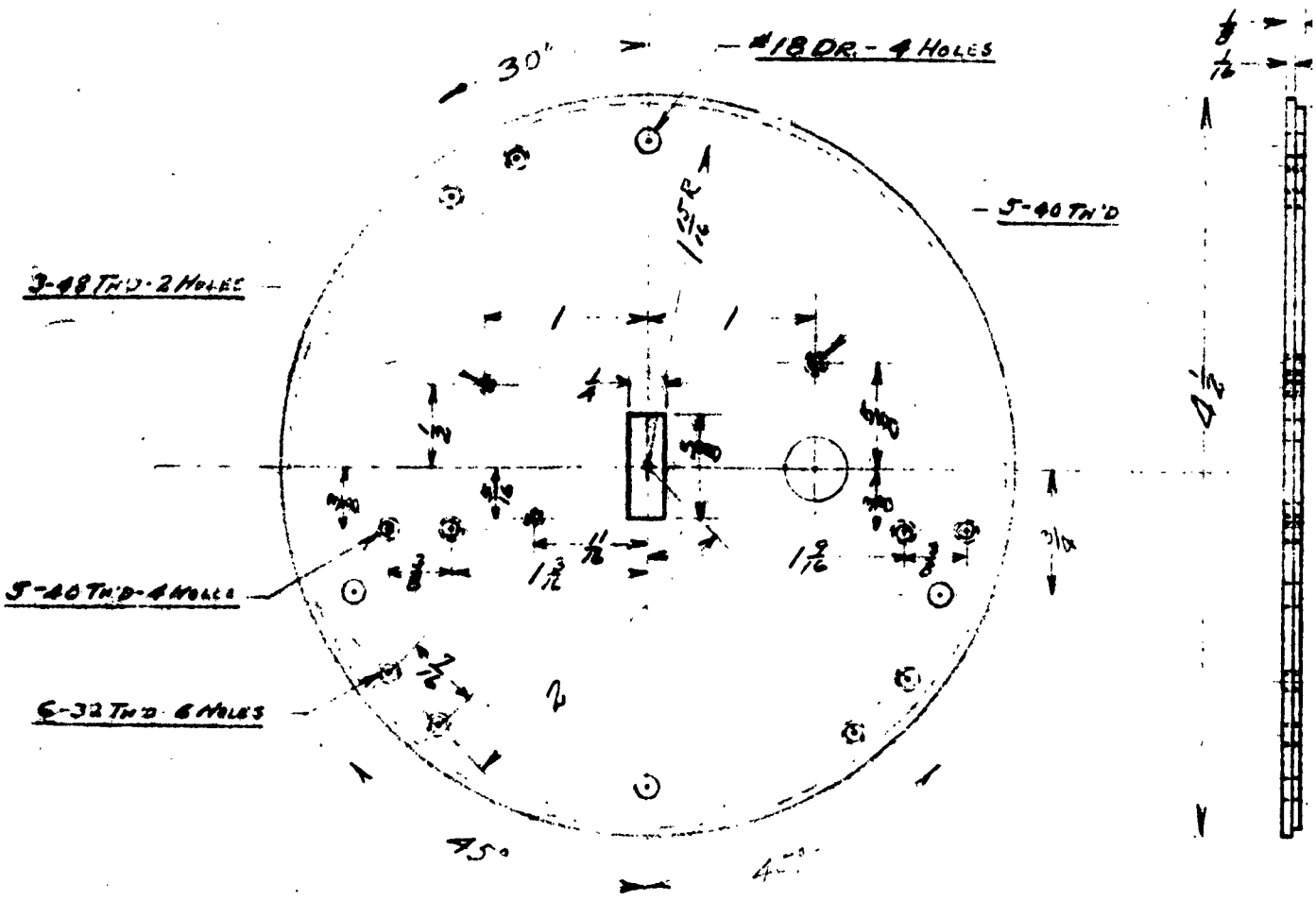




(N) CAMERA CASE MOUNTING LUG - 3 REQ'D - BRASS

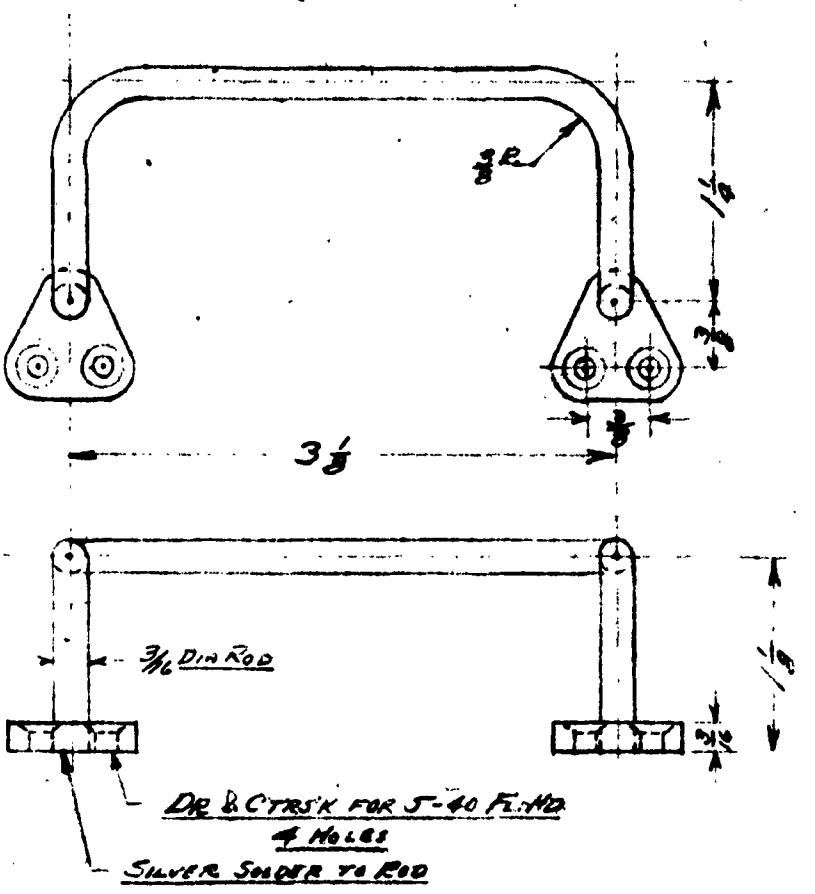
½ SCALE

(70) CAMERA CASE TUBE - 1 REQ'D - BRASS



(72) CAMERA CASE END PLATE - 1 REQ'D - BRASS

(N) CAMERA CASE MOUNTING LUG - 3 REQ'D - BRASS



(73) CAMERA CASE HANDLE - 1 REQ'D - BRASS

4

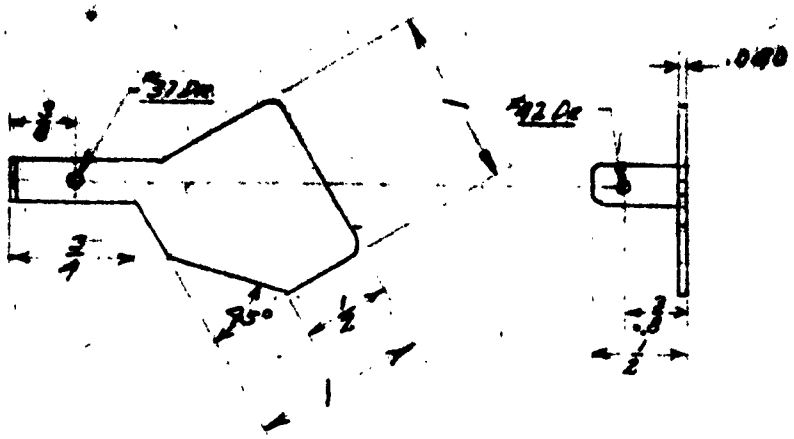
400 DAY CURRENT RECORDER

CAMERA DETAILS

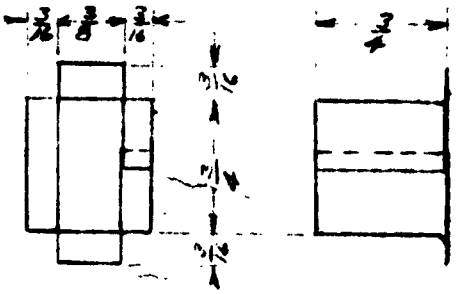
SCALE - 1" = 1"

DESIGN - A.A. KLEBBA DWG - L.M. THAYER

WOODS HOLE OCEANOGRAPHIC INSTITUTION 1-5-51

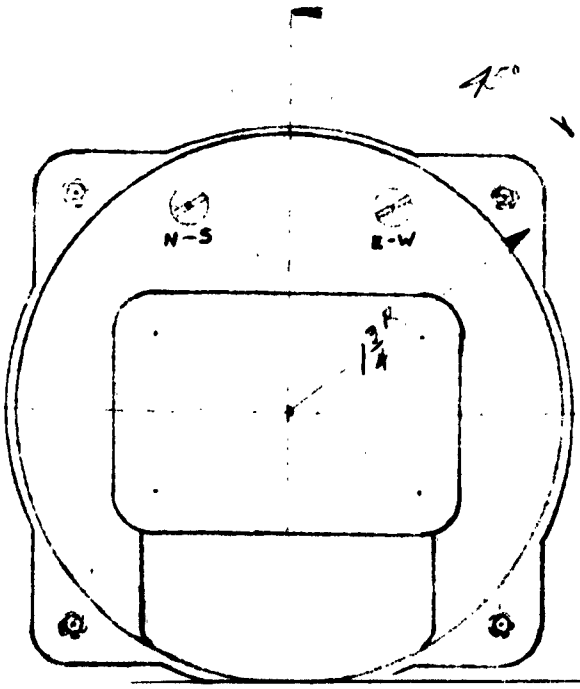


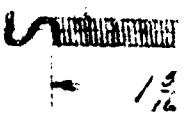
(74) CASE APERTURE SHUTTER - 1 REQ'D - BRASS



FORMED FROM .010 STOCK - SOLDERED TO INSIDE FACE OF CASE END PLATE

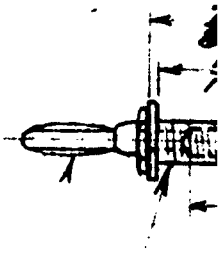
(77) CAMERA CASE APERTURE SHIELD - 1 REQ'D - BRASS





.025 WIRE

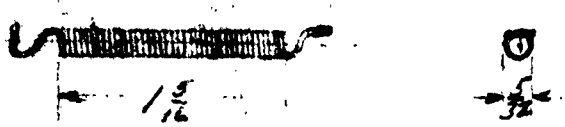
(75) SHUTTER S



#400 BIRM

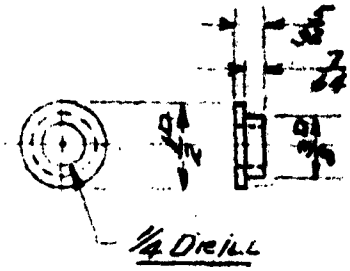
(78) COMB. PLUG &

1

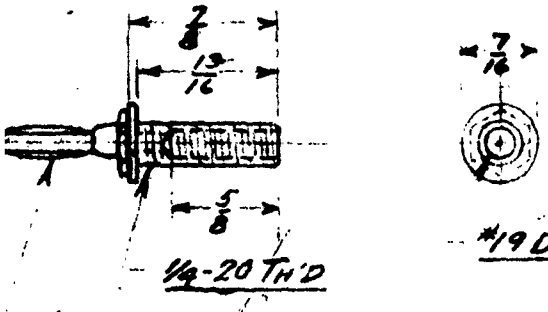


.025 WIRE - 1/8 LOOP EACH END

SHUTTER SPRING - 1 REQ'D - PHOS BRONZE

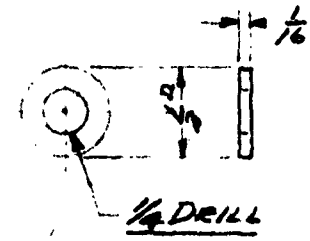


(76) INSULATING COLLAR - 1 REQ'D - BAKELITE



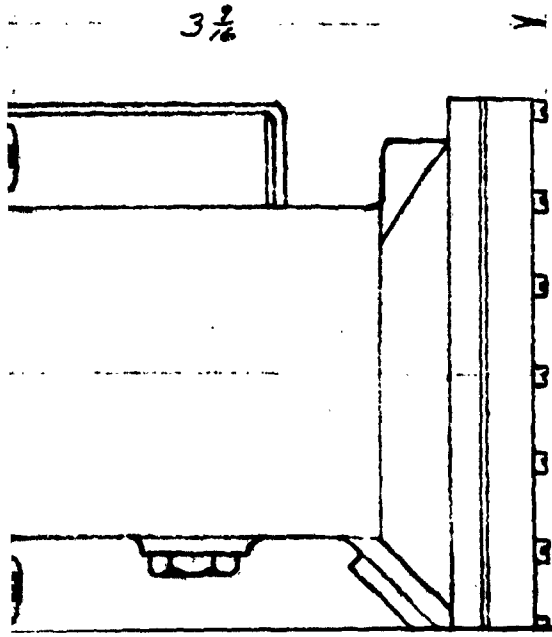
#400 BIRNBACH PLUG SOLDERED INTO JACK

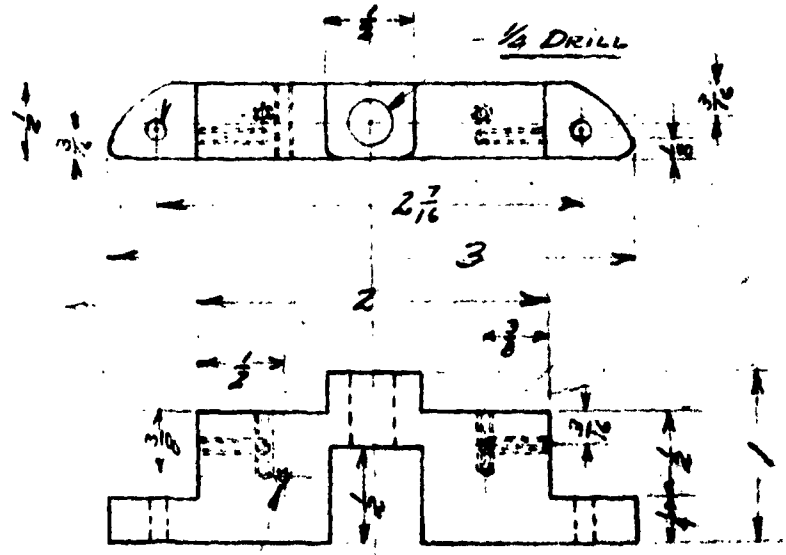
PLUG & JACK CAMERA CASE CONNECTOR
1 REQ'D - BRASS



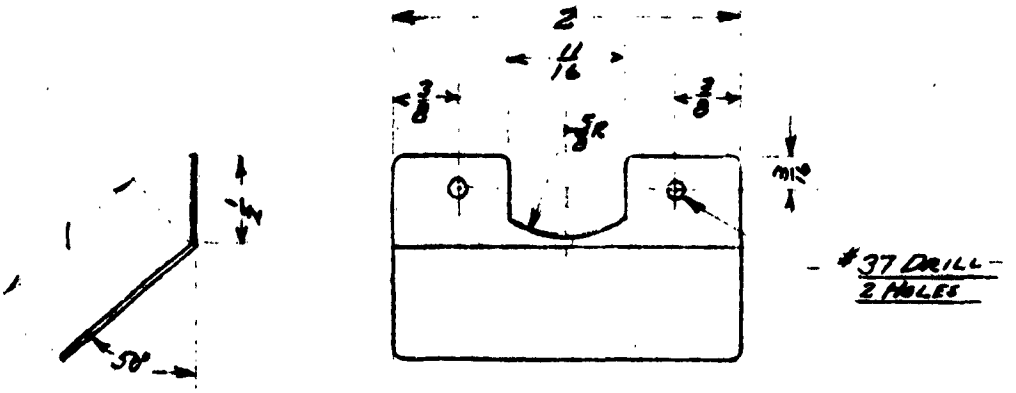
(79) INSULATING WASHER - 1 REQ'D - BAKELITE

2



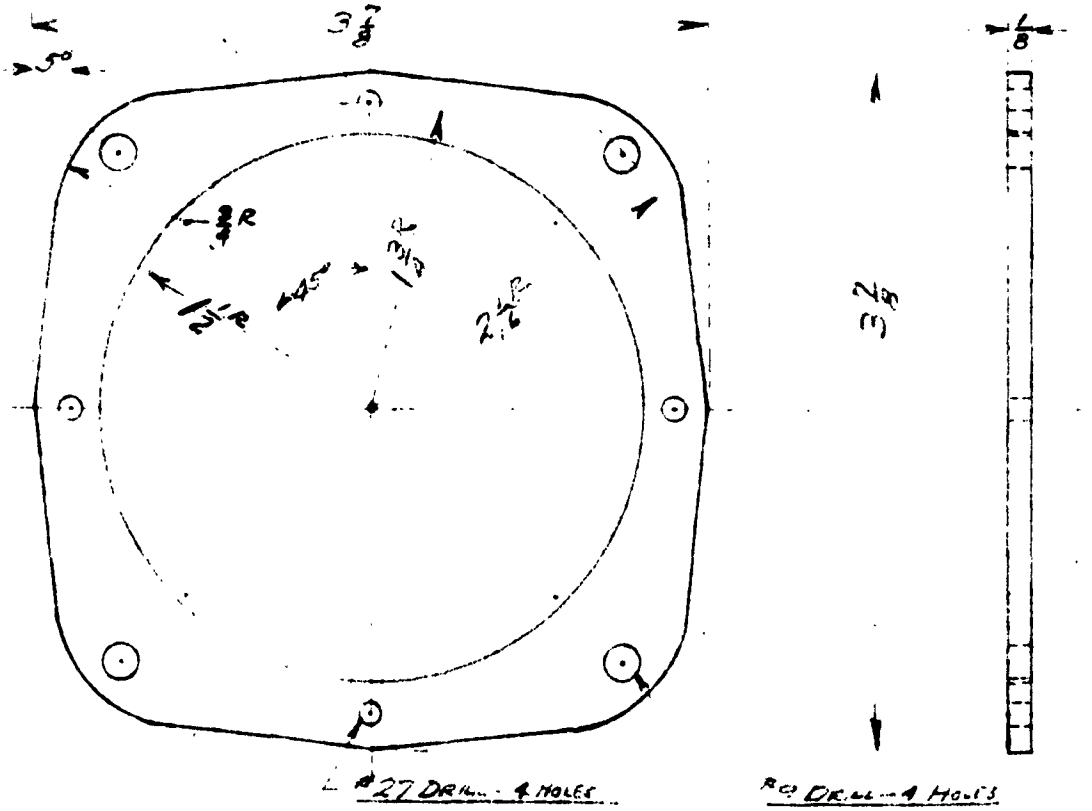


(80) BENDIX AIRCRAFT COMPASS #1818-1-A – 1 REQ'D



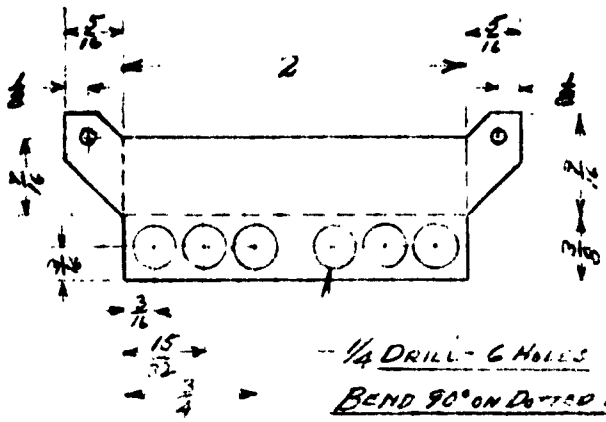
(82) COMPASS LIGHT SHIELD – 1 REQ'D – .020 BRASS

(83) SAME AS ABOVE EXCEPT MATERIAL – .015 WHITE CARDBOARD



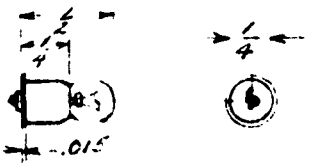
(85) COMPASS MOUNTING RING – 1 REQ'D – ALUMINUM

(85) COMPASS LIGHT BANK BASE — 1 REQ'D — FORMICA



(84) 6-LAMP LIGHT BANK SOCKET — 1 REQ'D — .025 BRASS

(86) COMPASS LIGHT BULB — CONNECTED — 1 REQ'D



(87) 6 VOLT INSTRUMENT BULB — 6 REQ'D

4

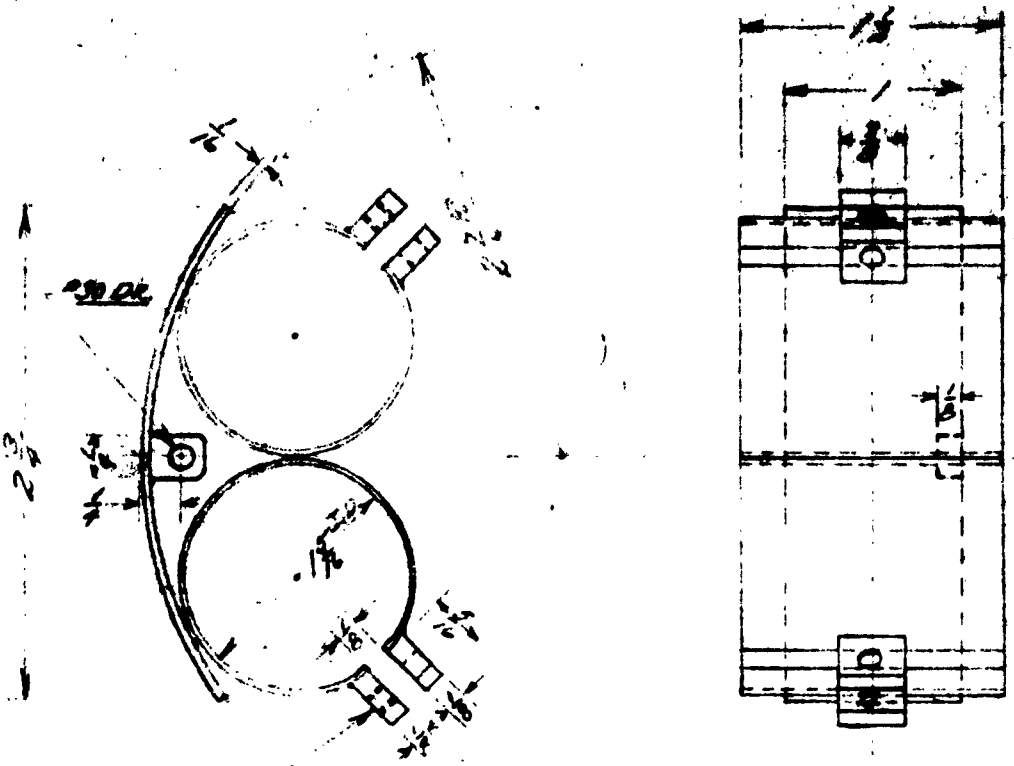
400 DAY CURRENT RECORDER

CAMERA & COMPASS DETAILS

SCALE — 1" = 1"

DESIGN — A.A. KLEBBA D'W'G — L.A. THAYER

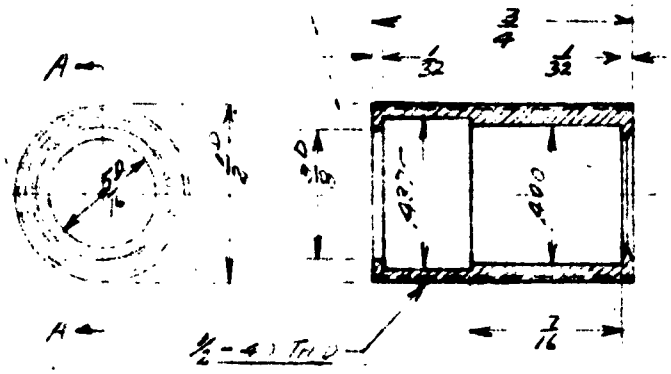
WOODS HOLE OCEANOGRAPHIC INSTITUTION 1-8-51



CLEAR DR. SLOT - TO FIT SOCKET FOR S-40

ALL LUGS & POINTS OF CONTACT SILVER SOLDERED IN ASSEMBLY

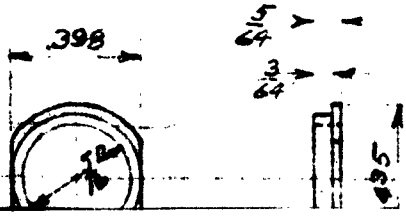
(36) BATTERY CLAMP FOR NOSE PIECE - 1 REQ'D - BRASS

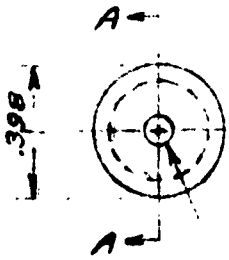


SECTION A-A

SCALE - 1" = ½"

(37) LENS BARREL - 1 REQ'D - BRASS

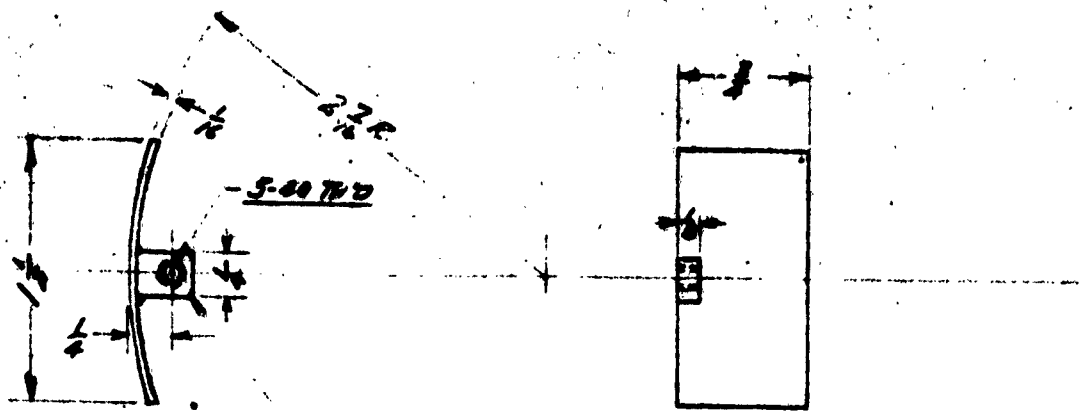




SCALE - 1"

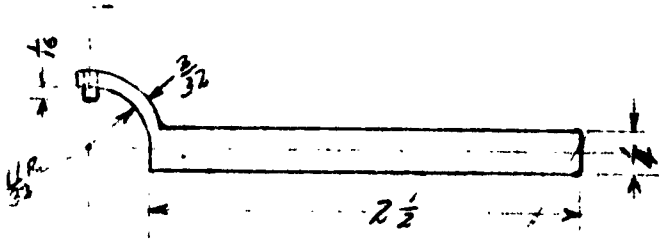
(38) LENS SPACER

1 REQ'D



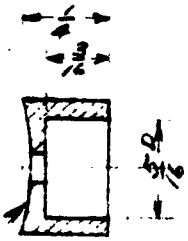
— LUG SILVER SOLDERED TO BAND
BAND SOFT SOLDERED IN PLACE IN NOSE PC.

(89) BATTERY MOUNTING LUG - 1 REQ'D - BRASS



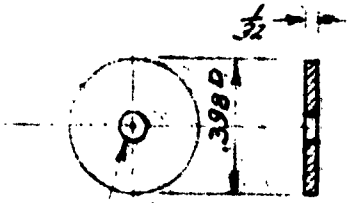
— .087 STEEL PIN - SILVER SOLDERED

(90) LENS ADJUSTING WRENCH - 1 REQ'D - BRASS



— REAMS TO SUIT LENS
— #40 DRILL
SCALE - 1" = 1/2"

SPACER & APERTURE -
1 REQ'D - BRASS

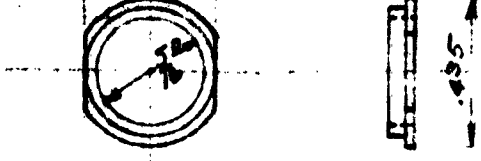


— #40 DRILL
SCALE - 1" = 1/2"

(88) LENS APERTURE - 1 REQD - BRASS

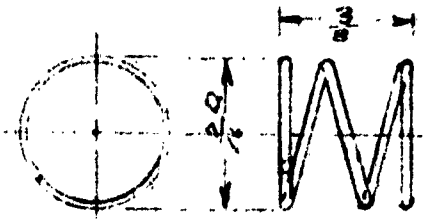
3/8

12



SCALE - 1" = 1/2"

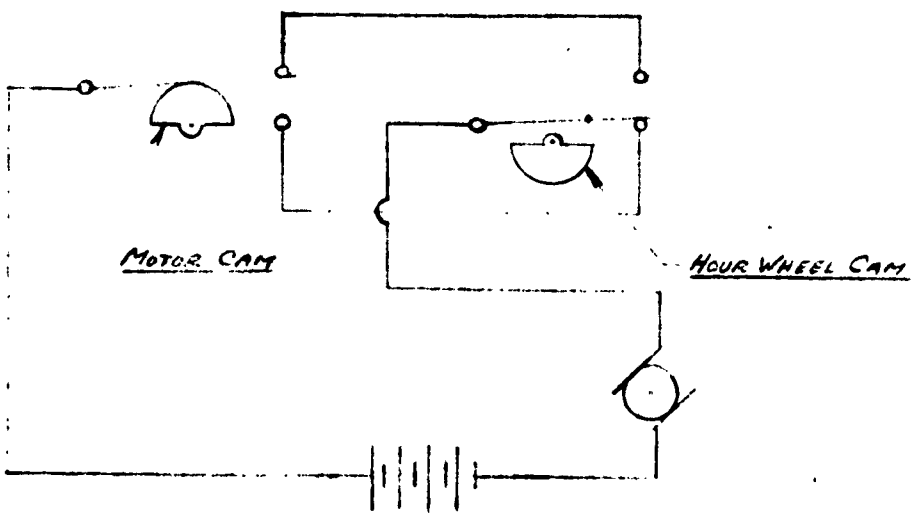
(94) LENS RETAINING RING - 1 REQ'D - BRASS



1/32 WIRE

SCALE - 1" = 1/2"

(95) LENS RETAINING SPRING - 1 REQ'D -



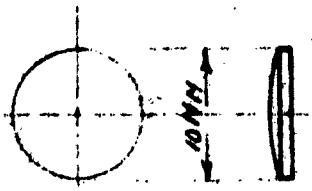
(97) CAMERA DRIVE CIRCUIT

(98)

REQ'D - BRASS

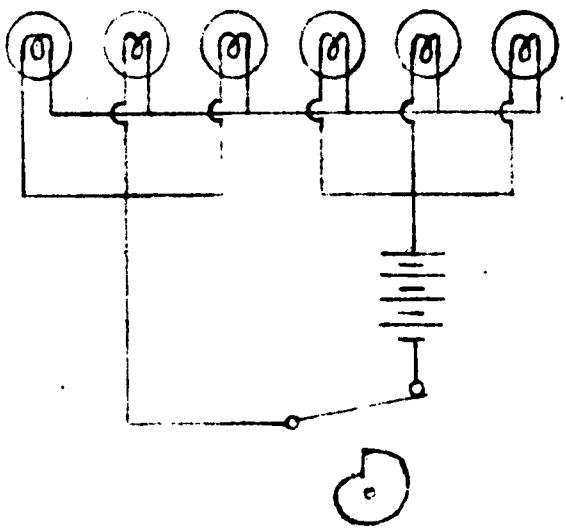
½"

PRING - 1 REQD - PHOS BRONZE



FOCAL LENGTH 22.1MM
SCALE - 1" = ½"

(96) CAMERA LENS - 3 REQ'D



(98) COMPASS LIGHTING CIRCUIT

4

400 DAY CURRENT RECORDER

BATTERY CLAMP & LENS DETAILS

FULL SCALE EXCEPT AS INDICATED

DESIGN - A. A. KLEBBA DWG - L. A. THAYER

WOODS HOLE OCEANOGRAPHIC INSTITUTION 1-18-51