IHF:AC

Letter Circular LC 14
(Communication B510)
Gage Section
Bureau of Standards
Washington, D. C.
Revised Nov. 21, 1919
14 Sheets

CONSTRUCTION AND OPERATION OF PROJECTION APPARATUS FOR MEASURING SCREW THREAD GAGES AND PROFILES.

DRAWING REFERENCE.

The general assembly of the apparatus is shown on drawing D1044 and an assembly of the gage-holding device is shown on drawing D1041. The details of the entire assembly are given on B.S. drawings D1027, D1038, D1039, D1040, D1043, D1048 and D1049.

CONSTRUCTION NOTES.

Most of the construction in the apparatus is straight machine work, and therefore needs no explanation. Certain points, however, need to be emphasized. Marked sliding fits between straight surfaces should be scraped flat and into line. Sliding fits between cylindrical surfaces should be lapped to size. This is to insure smooth action at all points. The axes of the centers used to hold the plug gages must be in line so that the tips of the ground points will touch wherever brought together. All center lines must be maintained exactly and at right angles, except where otherwise indicated. The center line through the lens B, about which the lantern turns, must be accurately maintained in order that the parallel rays from the lens A may always fill the lens B.

DETAILED ORDER LIST.

The following parts of the machine may be bought in the open market:

Lamp House	Bausch & Lomb Universal Balopticon.
Arc Lamps	D.C. automatic feed for above.
Lens A	44 mm aperture, 218 mm focal length telescope objective.
Lens B	32 mm aperture, 152 mm focal length telescope objective.
Lens C	B. & L. Tessar, Series II B, 4" x 5" photo objective.
Prism	2 1/2" x 2 1/2" x 2 1/2" glass prism.

Rack & Pinion — Rack to be 75 mm long and 10 mm wide; pinion to be 14.5 mm O.D. and spaced from rear of rack as per sketch on drawing D1040. Other racks and pinions may be used and under such circumstances suitable alterations in the dimensions given on the drawings must be made.

MICROMETER HEADS.

Any standard make may be used. Drawings call for B. & S. head 294. Any change in head will cause changes in parts D1027-20 and D1027-22.

NOTE ON SELECTION OF LENSES.

The selection of the projection lens is very important. It must be free from distortion over the portion of the projected shadow employed in making measurements. It is desirable also to select a short focus lens in order that a reasonably large magnification may be secured with a minimum distance between the lens and the screen. A lens which satisfies these conditions very well has been secured at the Bureau of Standards by combining a 32 mm aperture, 152 mm focus telescope objective, (lens B), with a Tessar Series II B, 4" x 5" photographic objective (lens C). These are mounted in a brass tube so that their separation can be adjusted to a point where the distortion effects are a minimum. The details of the mounting for lenses "B" and "C" are shown on drawing D1039. When properly adjusted these lenses "B" and "C" have a combined focal length of approximately 100 mm, and a magnification of 50 is obtained with a screen of 5.6 meters from the projecting lens combination.

Another lens which has been used at the Bureau of Standards in place of both lenses "B" and "C" is a Tessar Series I C, 75 mm focus photographic objective. This lens will give a magnification of about 70 with the same screen distance as with the combination of lenses previously mentioned.

MEASUREMENT OF SCREW THREADS.

In principle, the use of the projection apparatus is as follows: The screw is placed in a beam of parallel light and an enlarged image of its shadow is obtained on a distant screen by means of a projecting lens. The screen is optically parallel with the axis of the screw and perpendicular to the axis of projection. The parallel

beam of light must pass through the thread of the screw at the helix angle so that the shadow cast will be that of a section made in an axial plane of the screw.

Referring to drawing D1044, which shows an assembly of the projection apparatus, the operation is as follows: The screw to be examined is supported on the stand "E", and occupies the position as indicated by the dotted circle. A thread plug gage is supported between the centers. If a sulphur cast of a ring gage is under inspection, it is supported between the centers placed butt to butt.

After the screw is fixed in its support, the lamp is turned about the axis of its support until it is in a proper position to permit parallel rays of light from the lens "A" to pass through the helix angle of the thread. The correct position of the lantern is indicated when a symmetrical fringe pattern is formed about the projected shadow of the gage, the gage being slightly out of focus in the direction of the lens. The position of the screw is then changed until the image on the screen is in a sharp focus and the angle of thread is determined from the shadow by means of a suitable protractor, template or other device. The thread is also examined for imperfections in lapping, and in case it is desired, an exposure is made with bromide paper to record such details. In the apparatus shown, the projection is reflected by the prism upward to an optically flat mirror which is supported about ten feet above. The projection is then reflected by the mirror, vertically downward, to the top of a table which forms the screen. The use of the prism and mirror may be dispensed with and the projection made directly on a vertical screen of sufficient distance from the lens.

MEASUREMENT OF PROFILE GAGES.

Profile gages may be clamped between the plates D1027-7 and D1027-10 by tightening up on the knobs D1027-9. Distance from one point to another on the gage may be determined as follows: Indicate the position on the screen of the image of some point of the gage. Set up the micrometer on the anvil fastened to the slide and take a reading, calling it R1. Then move the gage until the image of the point to which the measurement is being made occupies the same position as that formerly occupied by the image of the first point. Then, without moving the micrometer clamp, take another reading using distance blocks or rods, if necessary, on the anvil. Call this reading R2. Then R2 - R1 will be the distance traversed by the gage and therefore the distance between the two given points.

In case the two points do not lie in the same straight line, parallel to the direction of motion, a measurement thus made represents, of course, only the dimension parallel to the line of motion.

REFLECTING PRISM AND MIRROR.

The use of the prism and a mirror (not shown) enables a single operator to conveniently adjust the screw and lantern, and at the same time be able to observe the image at close fange. If the prism is used, a 2 1/2" aperture right prism will be found of sufficient size, and a mirror having a diameter of about 8" will be amply large. The prism should have its three faces accurately flat to within one wave length of light, which corresponds to about .00001 of an inch. The mirror must also be flat to the same degree of accuracy and silvered on the front, otherwise the projected shadow will be distorted.

GAGE HOLDER.

A screw gage support, the assembly of which is shown in drawing D1041, will be found convenient, as it has a motion for focusing the screw, one for raising and lowering the screw, and also one for shifting the screw parallel to its axis, in order that different threads may be examined.

Further details in regard to the design, construction, and use of this machine will be made available to any manufacturer who cares to visit or communicate with the Bureau of Standards.

BUREAU OF STANDARDS.

D 1027

28	SET SCREW	1	STL.	
27	FOCUSING SCR.	1	STL.	HEAD A1065-4
26	SLOWMOTION SCR.	1	STL.	HEAD A1065-2
25	SLEEVE	1	BRS.	
24	FOCUSING SCR.	1	STL.	HEAD A1065-4
23	ANVIL	1	STL.	
22	VERT. MICRO. HOLDER	1	STL.	
21	MICROMETER	2		B&S #294
20	HOR. MICRO. HOLDER	1	STL.	
19	FIL. HD. MACH. SCR	4	M.S.	#10-24 x 1/2" LONG
18	SLEEVE	1	BRS.	
17	SLOWMOTION SCR.	1	STL.	HEAD A1065-2
16	FIL. HD. MACH. SCR.	4	M.S.	#8-32 x 1" LONG
15	SLOW MOTION BLOCK	1	STL.	
14	FLAT HD. MACH. SCR	6	M.S.	#14-20 x 5/8" LONG
13	WAYS	1	STL.	
12	FIL. HD. MACH. SCR	2	M.S.	#12-24 x 1 3/8" LONG
11	ANVIL & CLAMP	1	STL.	
10	PROFILE CLAMP	1	STL.	
9	STD. KNOB	1	BRS.	A1065-5
8	STUD	2	STL.	
7	SLIDE	1	STL	
6	CLAMP SCREW	4	STL.	HEAD A1065-1
5	GIB	2	STL.	
4	SPRING CENTER	1	T.S.	E1007-3
3	PLAIN CENTER	1	T.S.	E1007-2
2	CLAMP SCREW	2	STL	
1	STANDARDS	2	BRS.	PATT. D1027-1
#	NAME	REQD	MATL	

REVISED GAGE-HOLDER DETAILS.
OPTICAL PROJECTION APPARATUS.

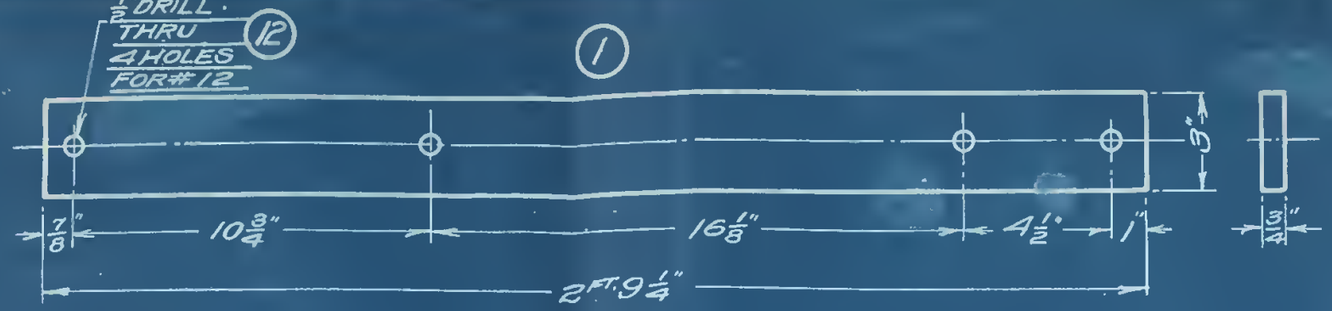
DEPARTMENT OF COMMERCE
BUREAU OF STANDARDS
WASHINGTON, D.C.

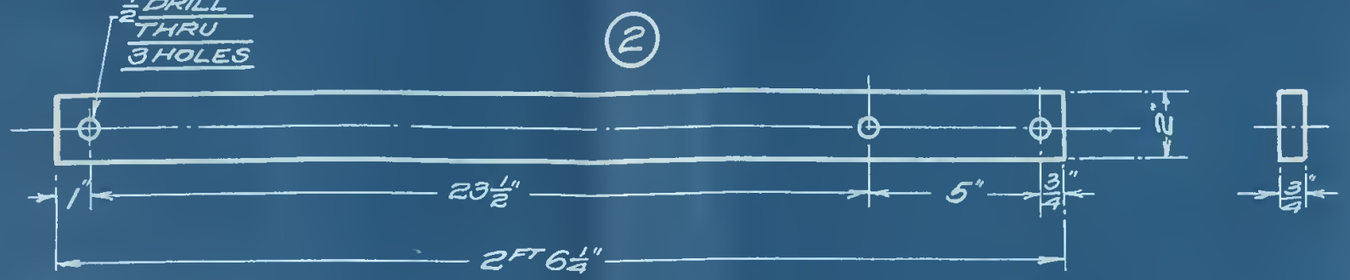
DRN. W.E.G. 11-16-18 | TRACED W.E.G. 11-16-18
CHECK | APPRVD. 12/18/18

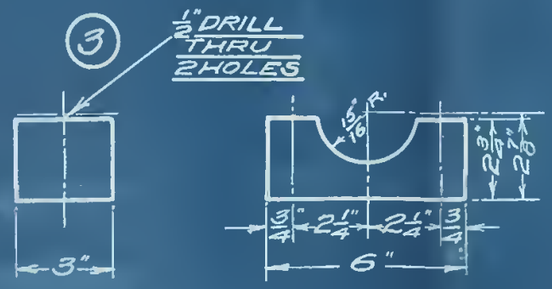
D 1027.

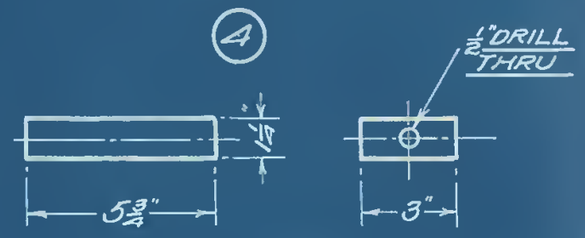
G.D. 341.
G.D. 173

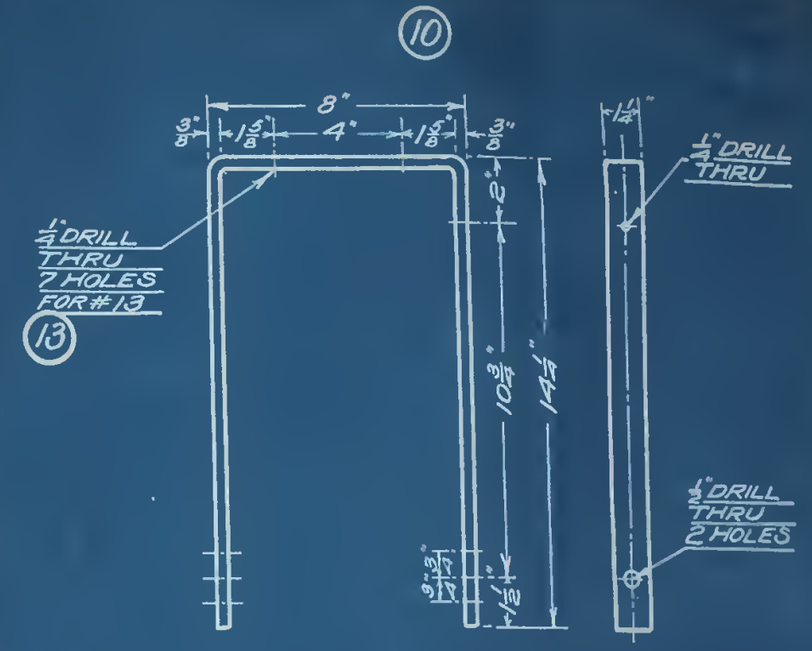
D1038

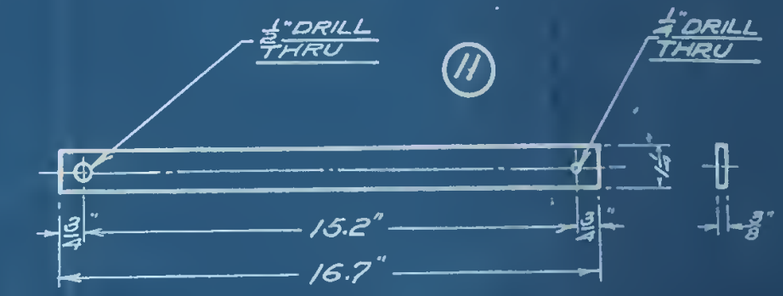












#	NAME	REQD	MATL.	REMARKS
13	BOLT	6	M.S.	1/4" DIA x 1" LONG
12	BOLT	6	M.S.	1/2" DIA. x 9" LONG
11	BRACE	2	W.I.	
10	SUPPORT	2	W.I.	FORGING STOCK TO BE
9	SET SCREW	1	M.S.	1/4" x 1" LONG - TO FIT IN 8
8	COLLAR	1	C.R.S.	FITS D1042 #6
7	BEARING	2	C.R.S.	FITS D1042 #6
6	CLAMP BLOCK	2	Wood	FITS BETWEEN #2
5	SPACING BLOCK	1	Wood	FITS BETWEEN #2
4	SPACING BLOCK	1	Wood	FITS BETWEEN #1
3	CLAMP BLOCK	2	Wood	FIT TOGETHER AS ONE
2	DIAG. BRACE	2	Wood	
1	HORIZ. SUPPORTS	2	Wood	

LAMP HOUSE BRACKET DETAILS
OPTICAL PROJECTION APPARATUS.

DEPARTMENT OF COMMERCE
BUREAU OF STANDARDS
WASHINGTON, D.C.

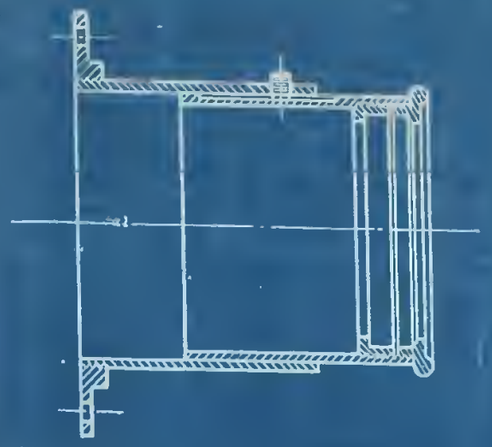
DRAWN	CHECKED
JGW 7/20/18	WBA 7/20/18
TRACED	APPROVED
JGW 7/20/18	[illegible] 7/25/18

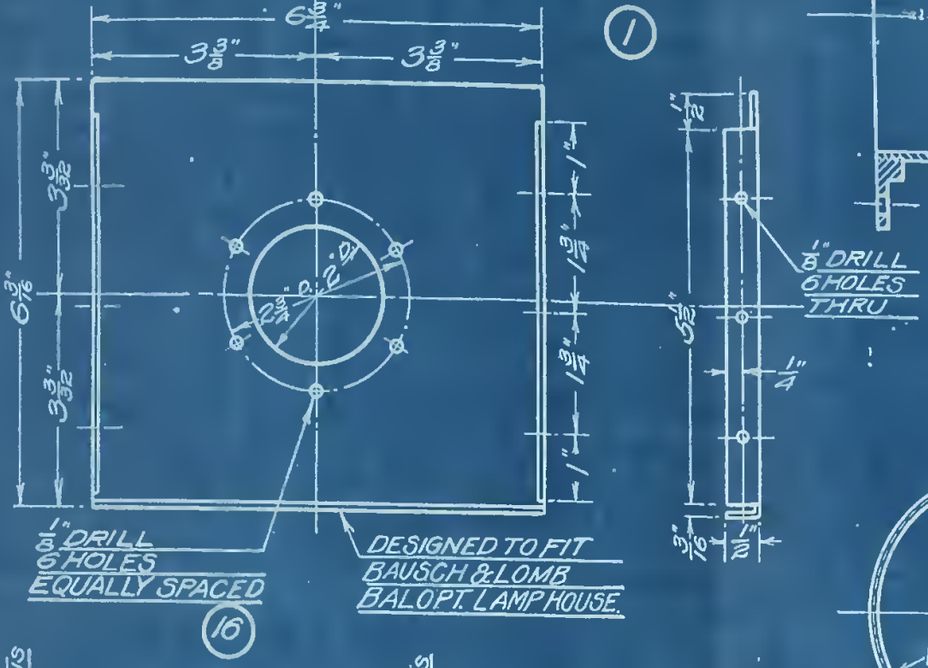
D1038

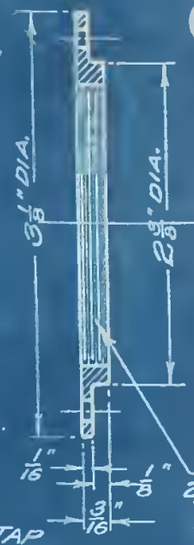
G.D. 341

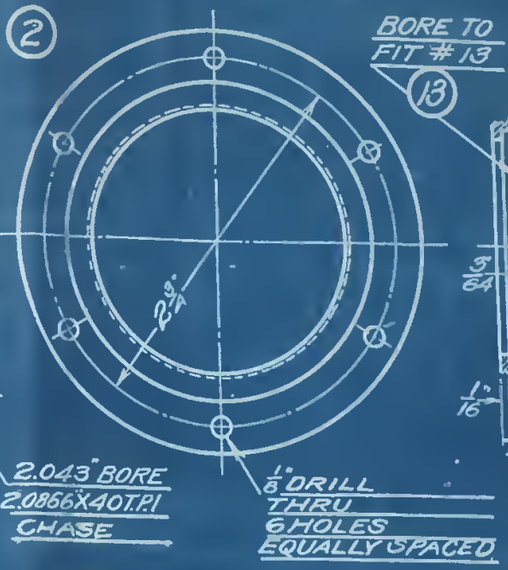
D1039

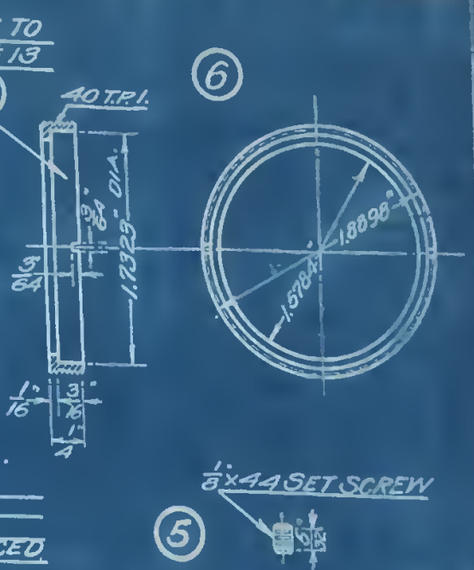
#18 BLACK SHEET IRON .05" THICK

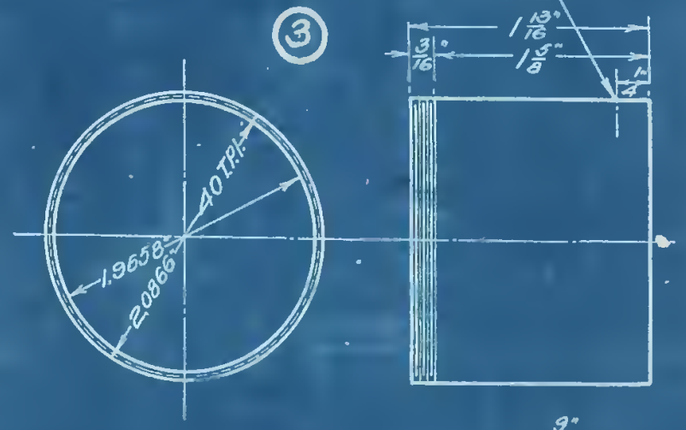


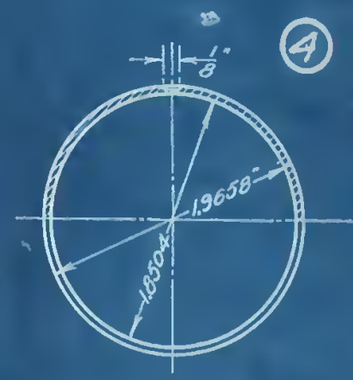


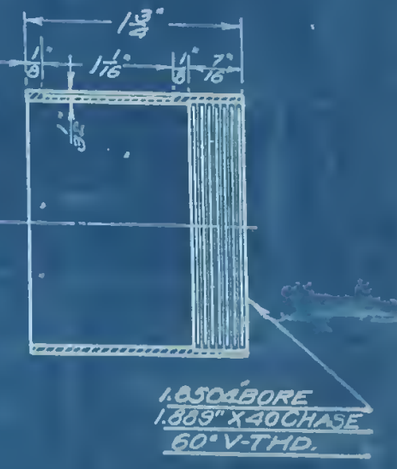


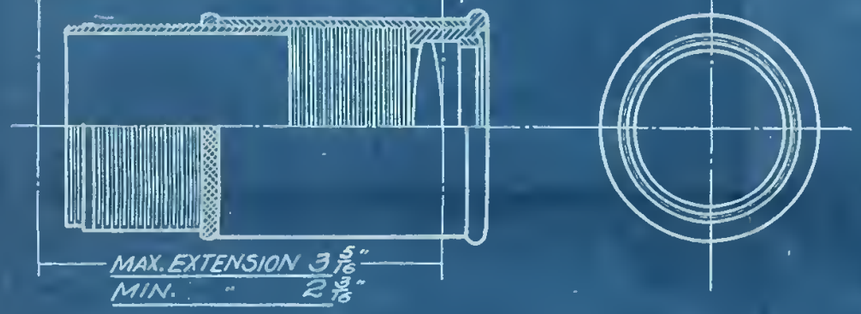


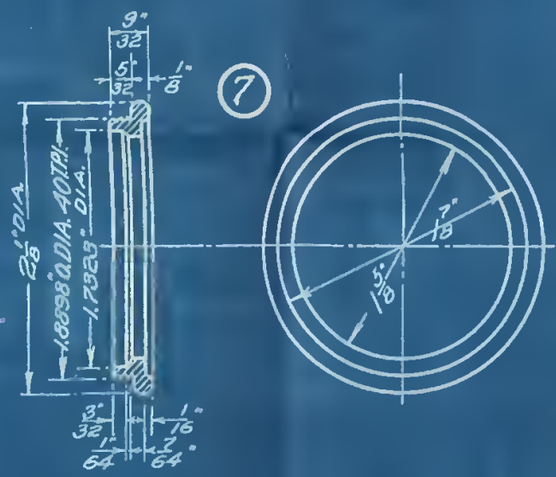


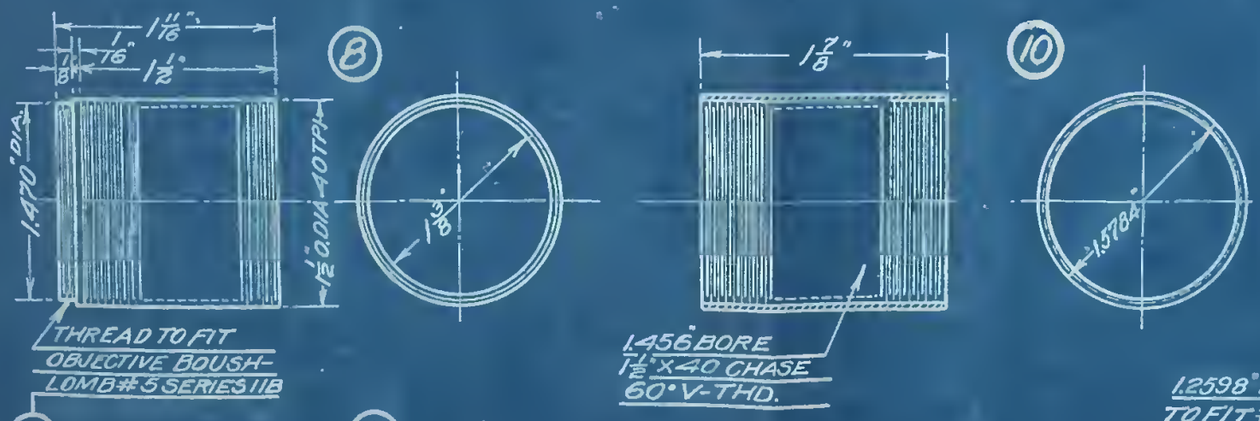


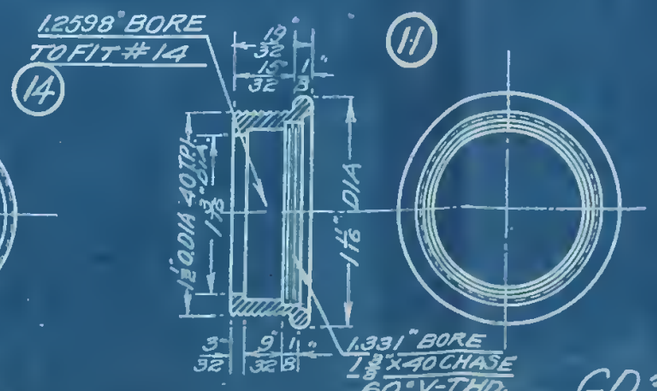












#	NAME	REQD	MATL	REMARKS
16	RD. HD. MACH. SCR. & NUT	6	M.S.	#4-48 x 1/4 LONG.
15	B & L TESSAR	1	GLS	#5 SERIES IIB.
14	B & L TEL OBJ	1	GLS	32mm. DIA. 152mm. F.L.
13	B & L TEL. OBJ.	1	GLS	44mm. DIA. 218mm. F.L.
12	RETAINING RING	1	BRS	
11	LENS FRAME	1	BRS.	
10	EXTENSION SECTION	1	BRS	
9	LOCKING RING	1	BRS	
8	FIELD LENS HOLDER	1	BRS	
7	RETAINING RING	1	BRS	
6	LENS FRAME	1	BRS	
5	SET SCREW	1	M.S.	
4	SLIDING SECTION	1	BRS	
3	BODY COL. LENS HOLD'R	1	BRS	
2	FLANGE	1	BRS	
1	FRONT PLATE	1	STL.	#18 - .05" THICK

PROJECTION LANTERN DETAILS
OPTICAL PROJECTION APPARATUS.

DEPARTMENT OF COMMERCE
BUREAU OF STANDARDS
WASHINGTON, D.C.

DRAWN J.E.W. 1-6-41 | CHECKED W.E.A. 1-7-41
TRACED J.E.W. 1-7-41 | APPROVED [illegible]

D1039

G.D.341.

D1040

(5)
A1065-4
1/16" DRILL THRU
(10)
7mm. REAM THRU
15/16"
5/16"

1/16" DRILL THRU
10mm.
1/16" DRILL THRU
(10)
(6)
5/8"
2 3/8"
1 1/4"
7/32"
3 5/8"
7mm. DIA.
PINION 14.5mm. DIA.

(7)
9/32"
9/16"
1/8"

9/32" DRILL THRU
5/8" DIA.
1 1/4"
(8)

5/16 X 18 TAP U.S. STD THD. THRU
11/32" DRILL
1/2" DEEP
FOR #9
RUNNING FIT WITH #3
3/16"
10mm.
1 1/8"
3/4"
6 1/2°
1 1/4"
3/16"
7mm. REAM THRU
5/8" BORE
1.07 DEEP

#8-32 TAP
AM. SCR. CO. STD.
2 HOLES
FOR D1027-23

(2)
2 1/4" DIA.
1 3/8"
1.000"
1/8" RAD.
1/2"
1/2"
1/16"
5/8"
5/8" RAD.
5 1/4"

#10-24 TAP
AM. SCR. CO. STD.
3/4" DEEP
FOR D1027 #28
1" RAD.
3/16"
5/16"
1 1/4"
5/16"
3/4"
7 1/4"
8 3/4"
1/4" DRILL THRU

(3)
1/4" DRILL THRU
.32mm.
10mm.
6"
7"
1"
1 1/4" DIA.

#6-40 TAP
A.S.M.E. STD.
THRU
3 HOLES
(11)
1/2"
1/8"
1"
4"
1"
6"

5/8"
10"
5/8"
3/8" RAD.
2 3/4"
8 1/2"
2 3/4"
1"

(9)
2"
1/4" R
1/2" DIA
1"
1/8"
5/16"
5" 16 X 18 SCREW U.S. STD. THD.

PITCH LINE
3.2mm.
14.5mm.
20.41mm.
1.000"

(4)
120° C-SINK TO FORM SEAT FOR POINT OF #11. 3 HOLES.
5/16"
60°
1/8"
1"
2"
2"
1"
6"

(1)
9/8" X 40 TAP U.S. STD THD. THRU FOR D1027 #24
4 3/8"
4 1/2"
5/8"
3/4"
60°
7/8"
1/2"
3/16"
1"
1 1/4"
1 1/4"
5"
5"
5/8"
4 1/2"
1 3/8"
1/8"
5 1/2"

#	NAME	REQD.	MATL.	REMARKS.
11	HDLESS SET SCR	3	M.S.	#6-40 x 3/16" LONG.
10	PIN	2	STL	1/16" x 9/16 LONG.
9	CLAMP SCREW	1	STL.	
8	SLEEVE	1	STL.	
7	WASHER	1	STL.	
6	PINION	1	STL.	
5	KNOB	1	BRS.	A 1065-4
4	GIB	1	STL.	
3	POST	1	STL.	
2	POST CARRIAGE	1	C.I.	PATT. NO. D-1005-2
1	BED PLATE	1	C.I.	PATT. NO. D-1006-1

POST AND CARRIAGE DETAILS--GAGE HOLDER.
OPTICAL PROJECTION APPARATUS.

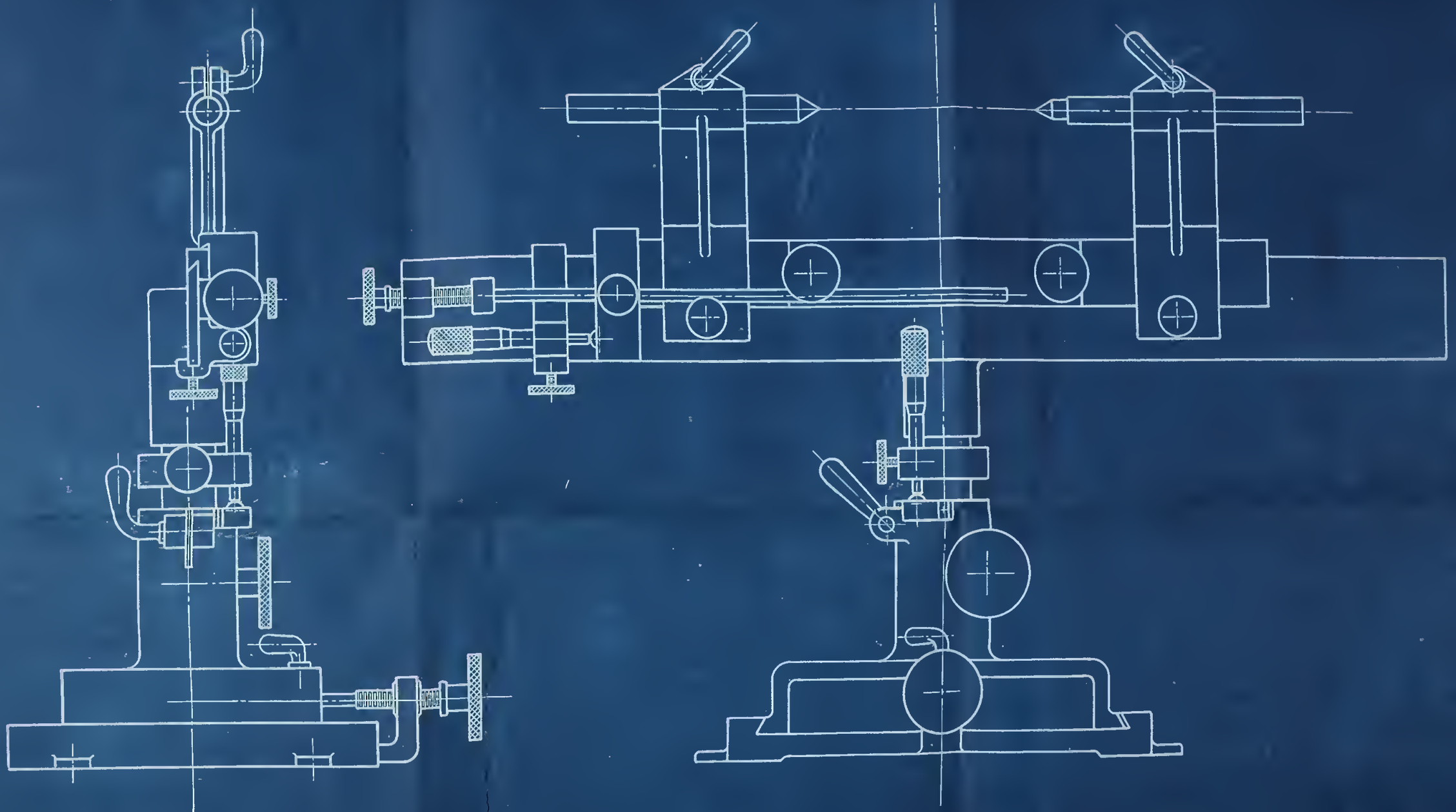
DEPARTMENT OF COMMERCE
BUREAU OF STANDARDS
WASHINGTON, D.C.

DRAWN L.E.W. 7/9/18
CHECKED W.G.A. 7/9/18
TRACED L.E.W. 7/9/18
APPROVED. A.T.M. 7/11/18

D1040

GD341.

D1041



REVISED GAGE-HOLDER ASSEMBLY
OPTICAL PROJECTION APPARATUS

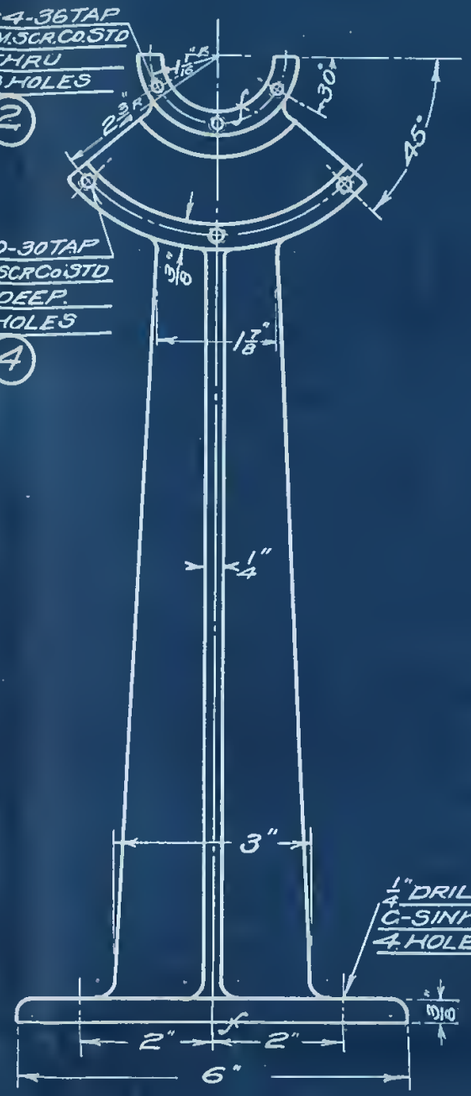
DEPARTMENT OF COMMERCE
BUREAU OF STANDARDS
WASHINGTON, D.C.

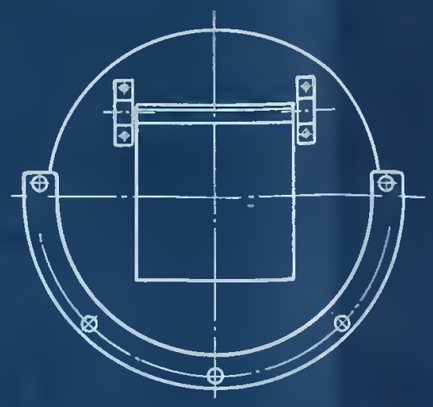
DRAWN	CHECKED
J.E.L.O. 7/24/18	W.A.W. 7/29/18
TRACED	APPROVED
J.E.W. 7/31/18	W.A.W. 7/29/18

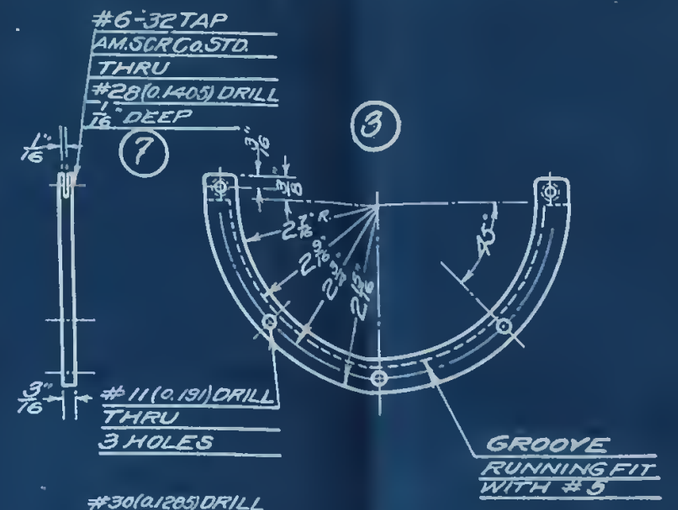
D1041

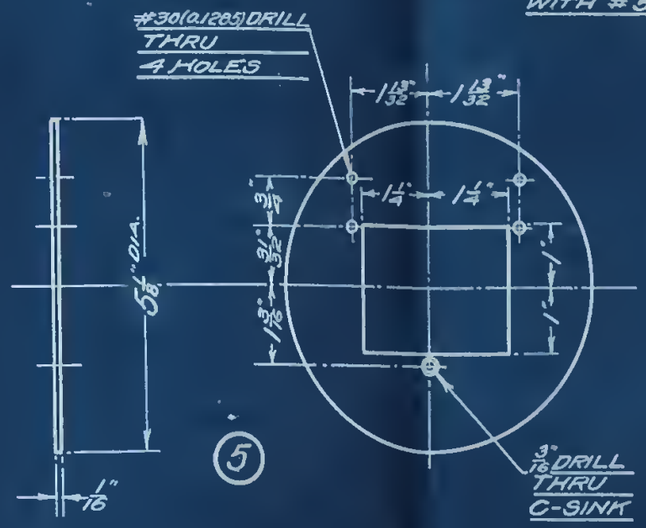
GD 341

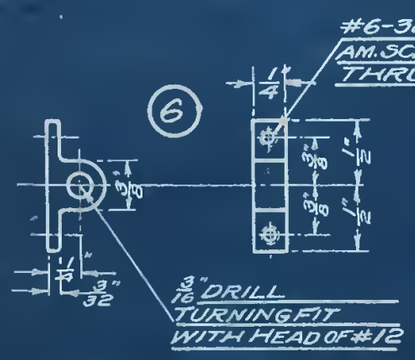
D1042

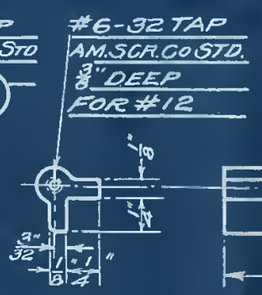


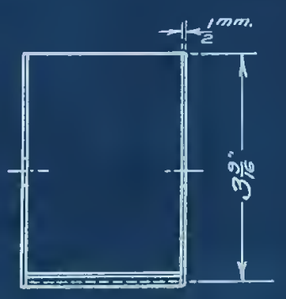


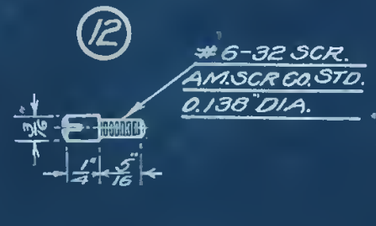












RIVET TO #5
#4-36 TAP
AM. SCR. CO. STD.
THRU
FOR #10

#	NAME	REQD.	MATL.	REMARKS
12	SCREW	2	M.S.	
11	ANGLE BAR	1	BRS	
10	FIL. HD. MACH. SCR	1	M.S	#4-36 x 1/4" LONG
9	BUSHING	1	BRS	
8	PRISM FRAME	1	SHBRS	
7	FIL. HD. MACH. SCR	6	M.S.	#6-32 x 3/8" LONG
6	BEARING	2	BRS	
5	DISC	1	C.R.S	
4	FIL. HD. MACH. SCR	3	M.S	#10-30 x 3/8" LONG
3	DISC HOLDER	1	C.R.S.	
2	FIL. HD. MACH. SCR	3	M.S	#4-36 x 3/4" LONG
1	SUPPORT	1	C.I.	PATT NO D1042-1

LENS AND PRISM SUPPORT AND HOLDER DETAILS
OPTICAL PROJECTION APPARATUS.

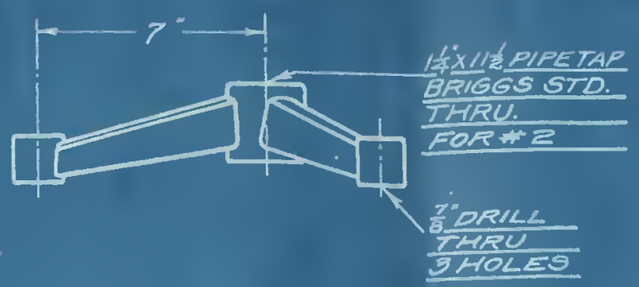
DEPARTMENT OF COMMERCE
BUREAU OF STANDARDS
WASHINGTON, D.C.

DRAWN WEW 7/24/18 | CHECKED WBA 7/24/18
TRACED WCH 7/24/18 | APPROVED [illegible] 7/25/18
D1042

G.D. 341

D1043

(1)



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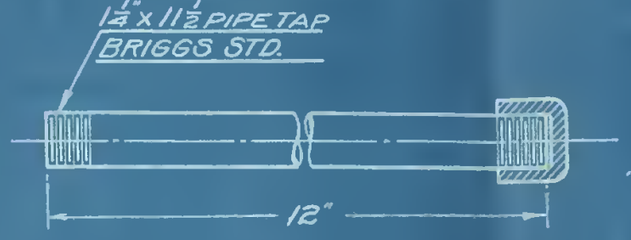

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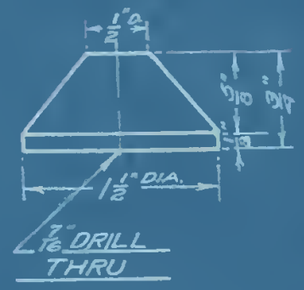
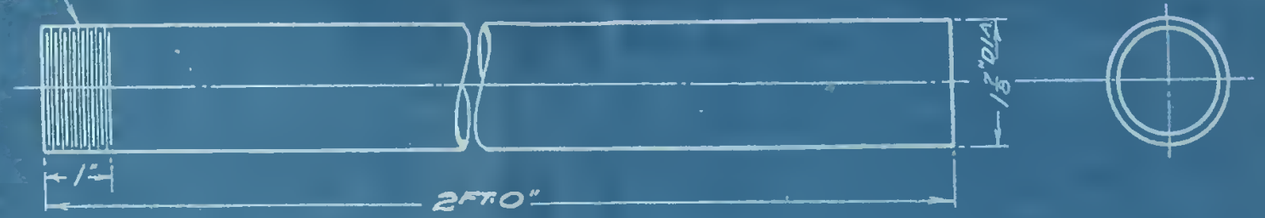
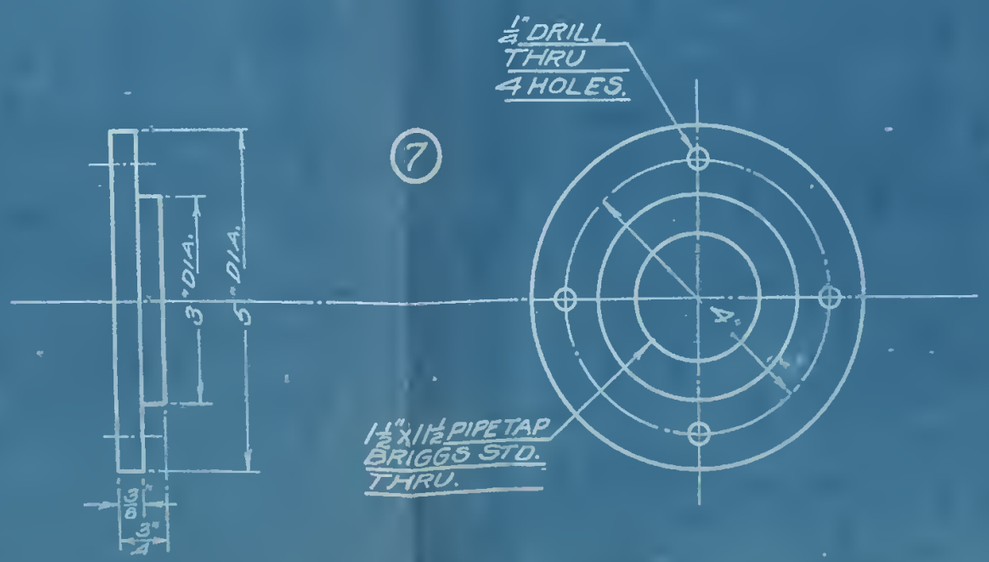


(4)

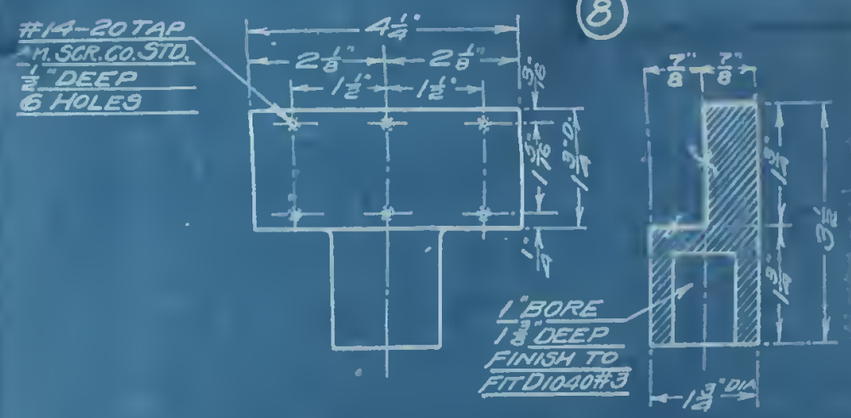
(6)



(7)



(8)



#	NAME	REQD.	MATL.	REMARKS.
8	SUPPORTING MEMBR	1	C.I.	PAT. NO. D-1003-3
7	FLANGE	1	C.I.	
6	SUSPENSION PIPE	1	C.I.	FOR D 1038
5	BOLT & HEX. NUT.	3	W.I.	⅜" x 6½" LONG
4	MIRROR DISC	1	Wood	
3	BEARING	6	C.I.	"F" ALL OVER.
2	SUSPENSION	1	W.I.	
1	SPIDER	1	C.I.	

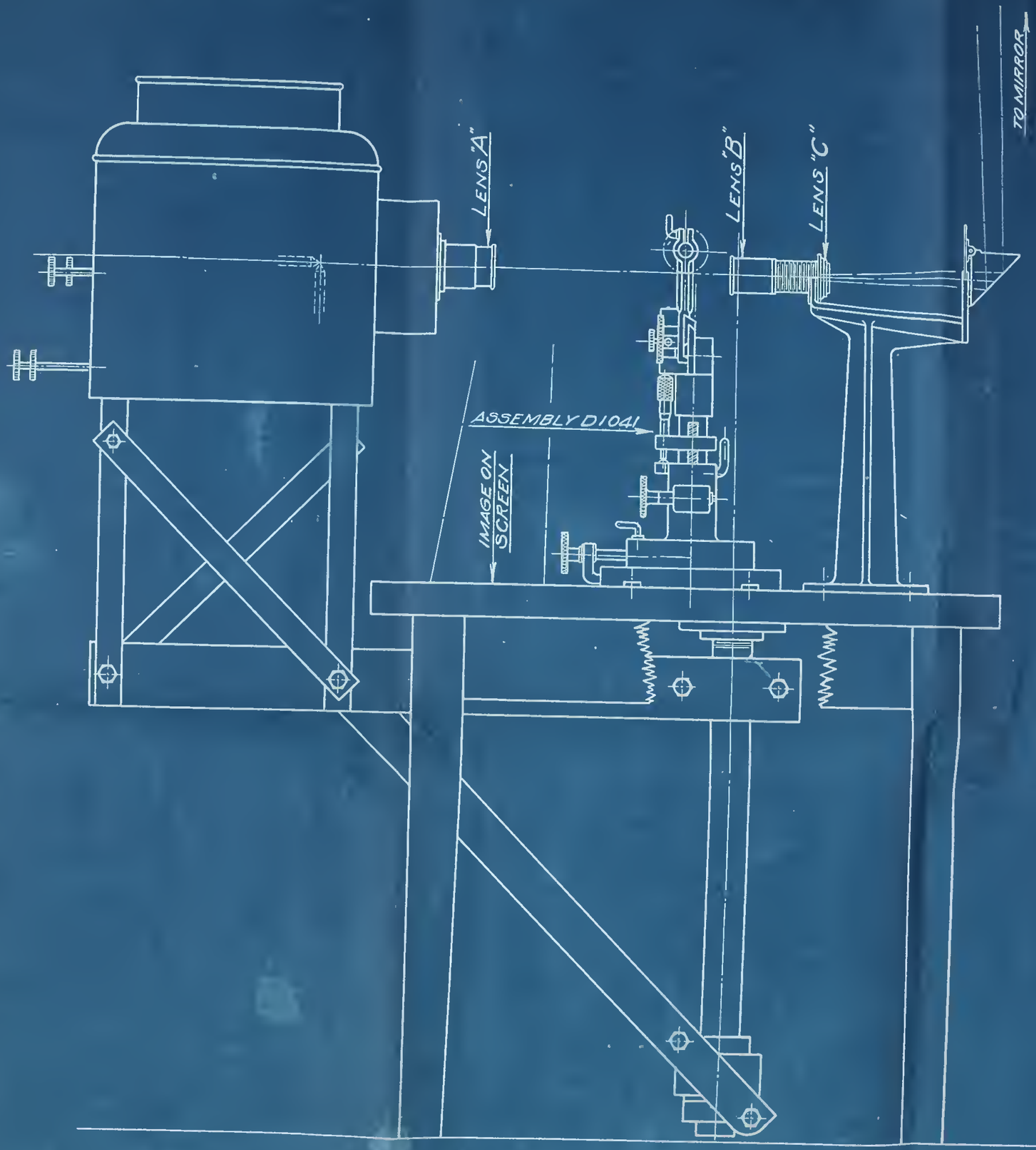
MIRROR SUSPENSION DETAILS
OPTICAL PROJECTION APPARATUS

DEPARTMENT OF COMMERCE
BUREAU OF STANDARDS
WASHINGTON, D.C.

DRAWN | CHECKED
TRACED | APPROVED

D1043

G.D. 341



GENERAL ASSEMBLY
OPTICAL PROJECTION APPARATUS

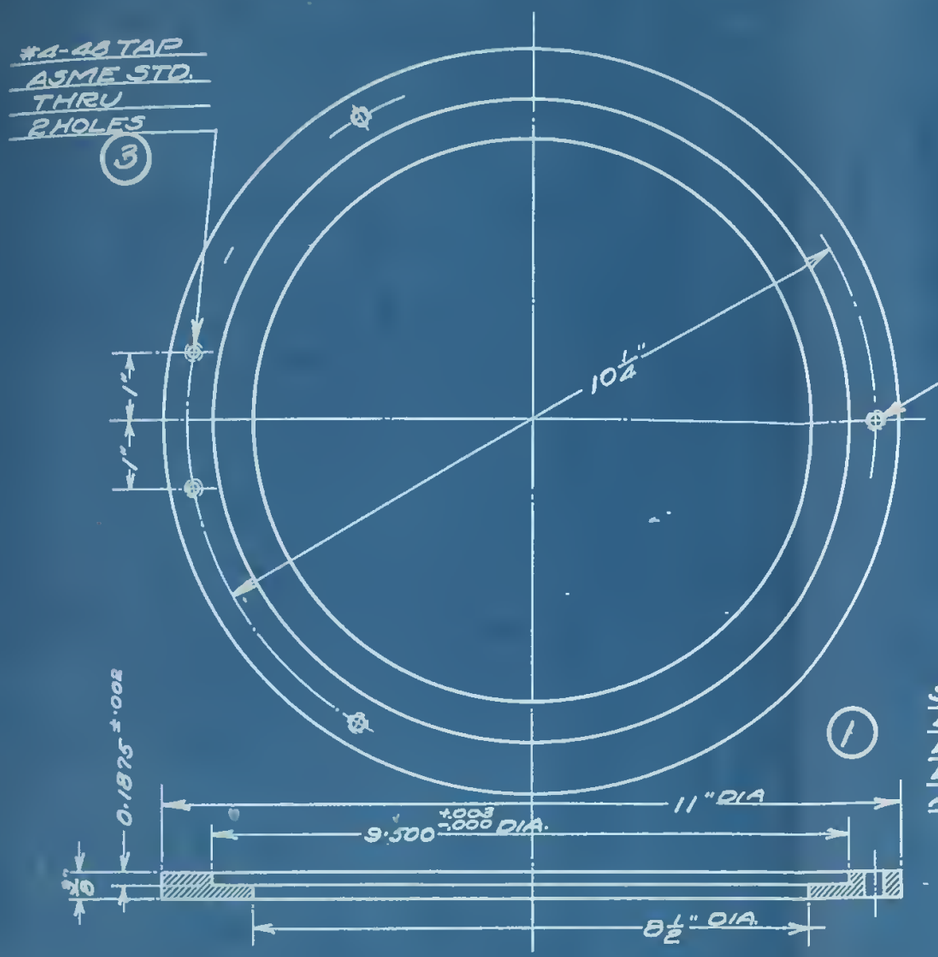
DEPARTMENT OF COMMERCE
BUREAU OF STANDARDS
WASHINGTON, D.C.

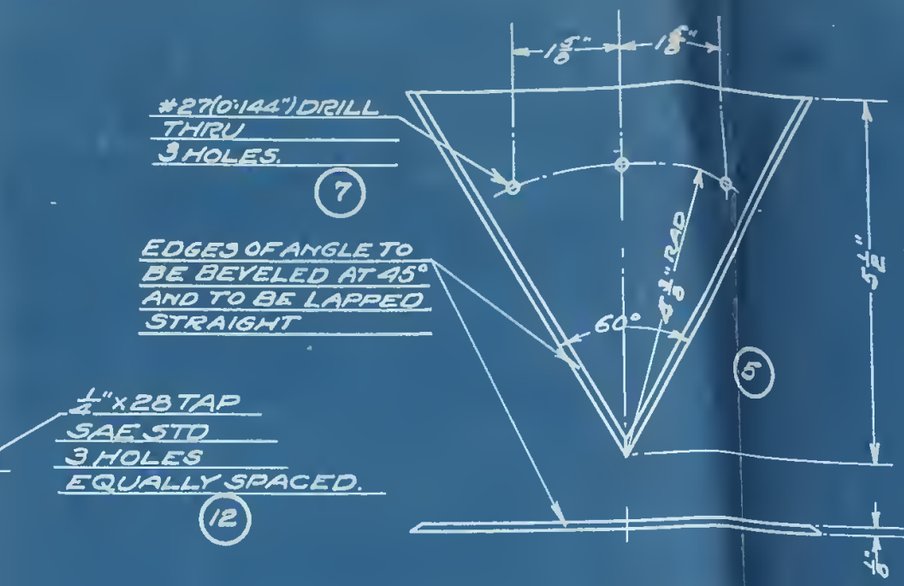
DRAWN	CHECKED
J.E.W. 3/7/18	W.C.A. 3/9/18
TRACED	APPROVED
J.E.W. 3/11/18	[illegible] 3/25/18

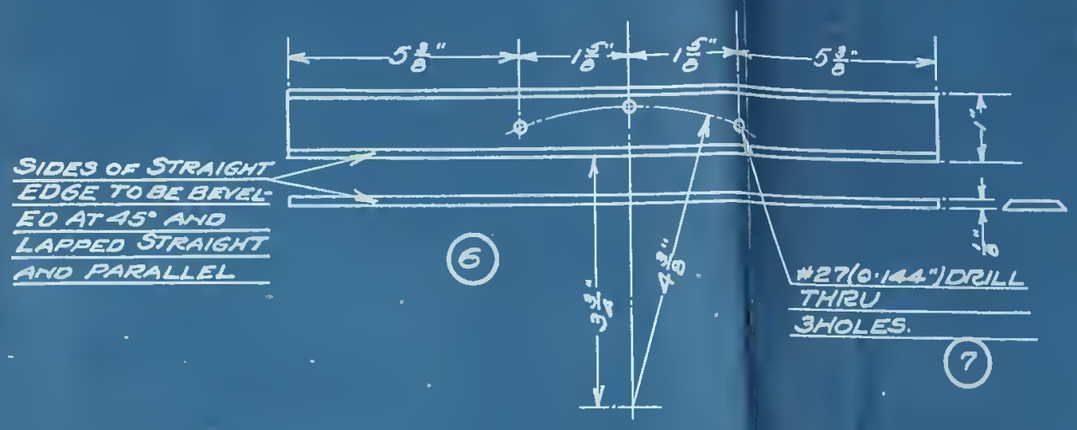
D 1044

GD. 341.

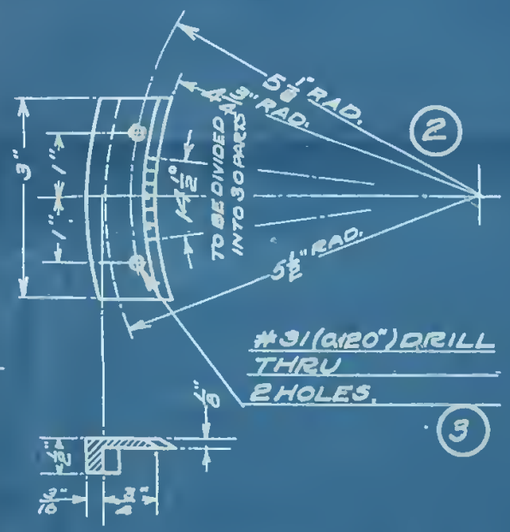
D1048

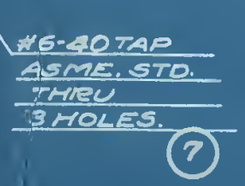






HOLE TO BE CUT WHERE INDICATED TO FIT #11. BEND ON DOTTED LINES.





13	LAMP HOUSE WALL	1	FBR.	
12	LEG	3	STL.	
11	JEWELERS GLASS	1	-	
10	COVER	1	S.I.	
9	MIN. LAMP SOCKET	1	—	
8	LAMP HOUSE WALL	1	FBR.	
7	FILL. HD. MACH. SCR.	3	M.S.	#6-40 x 1/4" LONG
6	STRAIGHT EDGE	1	STL.	
5	60° ANGLE	1	STL.	
4	SCALE	1	BRS.	
3	FILL. HD. MACH. SCR.	2	M.S.	#4-48 x 3/16" LONG
2	VERNIER	1	STL.	
1	BASE RING	1	BRS.	
#	NAME	REQD	MATL.	

PROTRACTOR
OPTICAL PROJECTION APPARATUS.

DEPARTMENT OF COMMERCE
BUREAU OF STANDARDS
WASHINGTON, D.C.

DBN	CHECK
WBA 9/13/18	AGW 9/15/18
TRACED WBA 9/17/18	APVD. AWR 9/15/18

D 1048

GD.341.

D1049

#	NAME	REQD	MATL	REMARKS
	ASSEMBLY OF PROTRACTOR OPTICAL PROJECTION APPARATUS			

DEPARTMENT OF COMMERCE
BUREAU OF STANDARDS
WASHINGTON, D. C.

DRAWN R.G.W. 5-31-18 | CHECK. W.G.A. 7/11/18
TRACED R.G.W. 5-31-18 | APPR'D.

D.1049

G.D.341