SPRINGFIELD ARMORY

RESEARCH AND DEVELOPMENT

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TECHNICAL REPORT

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REPORT TITLE DEVELOPMENT OF SIGHTS FOR U. S. RIFLE CAL. .30 M1. MANUFACTURING DEVELOPMENT PROGRAM NO. 45.

SPRINGFIELD, MASSACHUSETTS

ITEM .30 R M1 DATE 13 Jan. 1948 SA-TR 11-1600

Springfield Armory

RESEARCH AND DEVELOPMENT DIVISION

SPRINGFIELD ARMORY

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RESEARCH AND DEVELOPMENT DIVISION

SPRINGFIELD ARMORY

DATE: 13 Jan. 1948

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REPORT TITLE: Development of Air Gage for U. S. Rifle Cal..30 M1. Manufacturing Development Program No. 45.

AUTHORITY: O.O. 474.2/13 3A474.2/2026
Production Order 3-5098
J.O. 3E48-6860

PRIORITY: 3A

OBJECT: To develop, design and test an air gage for checking the effective gas seal in U. S. Rifles Cal..30 M1.

SUMMARY: An air gaging device was developed and fabricated that would measure the effective gas seal in U. S. Rifles, Cal..30, M1. Extensive tests of this apparatus were conducted using weapons pending overhaul from which an acceptance criterion for rifles was established.

This device will select all weapons for acceptance in which the clearance between the gas cylinder and piston is representative of clearances ranging up to a maximum allowable drawing clearance.

CONCLUSIONS: It is concluded that air gaging is a practical means of obtaining measurements of gas seal values. It also provides a method of reasonably estimating functional life in so far as the gas system is concerned. It does not assure function because other factors such as friction and worn or broken components are not taken into consideration by air gaging.

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SPRINGFIELD ARMORY

SUBJECT: Air Gage for U. S. Rifle, Cal..30, M1

REFERENCES: OO474.2/13 SA474.2/2026
Manufacturing Development Program No. 45
Production Order 3-5098
J.O. 3848-6860

INTRODUCTION: 1. Considerable difficulty was experienced by the 38th Infantry Division with short recoil malfunctions in the U. S. Rifle, Cal..30, M1. This, through exhaustive test, was found to be due to excessive wear between the operating rod and gas cylinder which allowed the escape of available gas pressure to the extent where the initial impetus given the operating parts was insufficient to carry out the entire cycle of semi-automatic fire. The problem of selecting deficient weapons was presented to Col. Haskell, Ordnance Officer, Headquarters XI Corps. Col. Haskell's approach was based on the principle that, at a given pressure, the flow of air through an orifice is in direct proportion to the size of the orifice, and that the rate of flow may be indirectly measured by means of pressure gages on either side of the orifice. Then by establishing the pressure balance or rate of flow through a new gas system assembly as compared to an unserviceable one, it would be possible to set limits of serviceability and determine expected life of operation. With this in mind the Office of Chief of Ordnance presented the problem to Springfield Armory as a development project.

2. A portable air gage model was fabricated and tested at the Armory and a tentative draft of Notes on Materiel was prepared. This gage was subjected to test at Raritan Arsenal, based upon which a list of refinements to be incorporated in the gage was suggested by the Office of Chief of Ordnance. The development of an improved air gage model is contained in this report.

MATERIAL AND EQUIPMENT: See Appendix I

DESTRUCTION OF USAGE: See Appendix II

PROCEDURE:

1. Fifty field service weapons pending overhaul were thoroughly cleaned to eliminate lubrication or other matter which might influence function.

2. Each weapon was checked for differential existing between readings obtained with the operating rod in the forward and rearward positions, and 32 weapons with differentials ranging from 4-3/4 to 13-3/4 pounds were selected for determination of function efficiency.

3. Weapons were then fired in a dry condition from the pendulum and in the jack rest, eight rounds each, using A.P. ammunition.

4. Weapons were then lubricated and tested as before. In addition 8 rounds of M2 ball ammunition was used in each weapon fired in the pendulum.

5. Upon completion of this test, all components which effect power seal were gaged.

6. A second test was run with six other field service weapons ranging from 4 to 15 pounds differential, selected for determining the probable border line condition of differential. Pistons of .5220, .5230, .5240 and .5250 diameter were assembled in weapons for air gaging and function firing. Weapons were lubricated and functioned from the shoulder using M1 ball ammunition.

7. In each of these tests weapon number 2835841 was used as a reference.

8. In all gage readings with the bolt forward (high pressure reading), the poppet valve opening was sealed with the Poppet Valve Sealing Clamp so as to eliminate any influencing of results by gas leakage.

RESULTS AND DISCUSSIONS:

1. For a comparative analysis of the weapons referred to in the following discussion refer to Table I and Table II.

2. Weapon #2835841 representing a rifle of maximum clearance between piston and cylinder was air gaged with the following results. With the bolt forward the back pressure reading was 12 pounds, and with the bolt rearward the back pressure reading was 6 pounds, giving a differential of 6 pounds. In other words a differential of 6 pounds indicates a condition equal to a maximum clearance condition between the gas cylinder and piston. A differential of 7 pounds allows a factor of safety of 1 pound.

3. The 56 field service weapons pending overhaul were selected as a possible representation of the 38th Infantry weapon status. Thirty four percent of the lubricated weapons fired from the jack rest with A.P. Ammunition short recoiled. The differential of the faulty weapons ranged from 6-1/2 to 10-1/2 pounds. Since these values are above the air gage differential of the reference weapon #2835841 it is reasonable to assume that failure was not necessarily dependent entirely on inferior power seal. This reasoning is substantiated by the fact that two other weapons with differentials of 4-3/4 and 5 pounds functioned properly.

4. Eighty-four percent of the unlubricated weapons short recoiled in the jack rest. This was an increase of fifty percent failure over jack rest lubricated weapons, indicating that a good percentage of short recoil malfunctions can be caused by friction.

5. Ninety-seven percent of the lubricated weapons fired in the pendulum with A.P. ammunition short recoiled. This was an increase of sixty-three percent failure over jack rest lubricated weapons, indicating need of support as a safeguard against short recoil malfunctions.

6. The number of short recoils produced with M2 Ball Ammunition in lubricated weapons fired in the pendulum was twenty-seven percent less than the number of short recoils produced by using A.P. Ammunition. The A.P. Ammunition used in this test had a lower port pressure than the M2 Ball Ammunition (reference - Partial Memorandum Report No. SA-MR-11-1002) resulting in a condition which tended to produce more short recoils, due to less pressure being induced on the piston. This condition could tend to produce short recoils particularly in marginal powered weapons. Further pressure testing of ammunition is anticipated in order to determine if this condition is characteristic of A.P. and Ball Ammunition, or of the particular lots of ammunition used in this test.

7. Weapons not lubricated and fired from the pendulum with A.P. Ammunition short recoiled every round fired. Successful operation under these conditions indicates that the weapon is overpowered and malfunctions may result that are similar in aspect to short recoils. That is to say, in an overpowered weapon the recoil and rebound are so rapid that the bolt fails to pick up a round and chamber it. The same result exists from a short recoil where the bolt does not recoil sufficiently to pick up the succeeding round. In both cases the bolt is closed on an empty chamber.

8. A comparison of manual gaging with port pressure reading (reading on back pressure gage with bolt rearward) ranging from 4 to 6-1/4 pounds, shows the possibility of checking port hole size with the air gage. Readings of 5 to 6 pounds show that the port hole opening was acceptable to the manual gage. Therefore port pressure readings of less than 5 pounds or greater than 7 pounds should be investigated by manual gaging of the port hole. The 7 pound figure is used because in some cases the gas cylinder assembly with the piston back will influence the low pressure reading. This condition can be eliminated by removing the gas cylinder lock screw.

9. A break-down of gas seal was initiated to determine the probable border line condition of weapon differential. That is the value at which

the power seal is unsatisfactory for normal usage of the weapon. The test materiel consisted of seven weapons with power seal values of from 4 to 15 pounds differential, low port pressure ammunition and four pistons of .5220, .5230, .5240 and .5250 diameter. Weapons were lubricated and fired from the shoulder to simulate normal usage. Test results showed that by selective assembly of the four pistons, in the test weapons, differential from 1 to 2-1/2 pounds caused short recoils, but from 3 pounds up no short recoils occurred. This indicates that the majority of weapons under 3 pounds differential fired with average shoulder support will short recoil.

10. Study of the data indicates that the prime factor in determining back pressure values is clearance between the piston and cylinder, providing the poppet valve seals properly, as air escapement from the relationship between the barrel bearing and cylinder is negligible.

CONCLUSIONS: 1. Air gaging of the Cal..30 M1 rifle's gas system is a practical means of obtaining measurements of gas seal value. It does not imply that gas seal components are within drawing dimensions or that weapons will function properly. The criterion of this inspection only warrants a power seal equal or better than maximum allowable drawing clearance. It does not assure function, as other factors such as friction and worn or broken components are not involved in air gaging. But in comparison to manual gaging of gas seal components, air gaging offers a means of readily obtaining gas seal values and an opportunity of reasonably estimating functional life in so far as the gas system is concerned.

2. In the event that a marginal weapon is introduced for test, that is a weapon with a power seal that is on the border line of allowing short recoil malfunctions, it will be rejected as unserviceable, due to a factor of safety allowed in the differential reading above that for a weapon of maximum allowable clearance between the gas cylinder and piston.

SUBMITTED: L. SPALDING
Ord. Eng.

REVIEWED: [illegible]
Ord. Eng.

APPROVED: E. V. HOLLIS
Head Ord. Eng.

APPENDIX I

LIST OF MATERIAL

1 - Clamp, Weapon Mounting Bracket (Plate 1)
1 - Spring, Air Gage Thrust (Plate 2)
1 - Washer, Air Gage Thrust Spring (Plate 3)
1 - Guide, Air Gage Thrust (Plate 4)
2 - Bracket, Air Gage Support (Plate 5 and 6)
1 - Seal Muzzle (Plate 7)
1 - Gage, Needle Valve Adjusting (Plate 8)
1 - Clamp, Poppet Valve Sealing (Photo 63293A)
1 - Bracket, Weapon Mounting (Photo 63303A)
1 - Seal, Chamber (Photo 63293A)
1 - Container, Air Gage (Photo 63285A)
1 - Plate, Base (Photo 63303A)
2 - Norgren Regulating and Reducing Valves, Type 2A3, with back mounted gages 0 to 160 pounds.
1 - Norgren Filter, 3/8 I.P.T.
1 - Ashcroft Duragage 0 to 60 pounds
1 - Schreder Neoprene Air Hose, No. 9617
1 - Crane Brass Steam Cock, No. 268
1 - Crane Square Head Wrench, No. 1-S
2 - Brass Elbows, 3/8 inch I.P.T.
2 - Brass Tees, 1/4 inch I.P.T.
2 - Brass Nipples, 2 inch, 3/8 inch I.P.T.
2 - Brass Close Nipples, 3/8 inch I.P.T.
5 - Brass Close Nipples, 1/4 inch I.P.T.
1 - Brass Reducer, 3/8 inch to 1/4 inch I.P.T.
1 - Lunkenheimer Bronze Needle Valve, No. 906-SS

WEAPONS AND EQUIPMENT:

1 - U. S. Rifle Cal..30 M1 No. 2835841 with a gas cylinder of maximum internal diameter and a piston of minimum outside diameter.
1 - Recoil Jack Rest.
56 - U. S. Rifles Cal..30 M1 pending overhaul.
1 - Pendulum and trigger actuating device for free recoil.

AMMUNITION:

Cal..30 M1 Ball Lot FA 2139
Cal..30 M2 Ball Lot FA 3732
Cal..30 M2 A.P. Lot TW 18968

APPENDIX II

OPERATION OF GAGE

1. Unfold carrying case to expose air gage (Photo 63313A)
2. Fully open pet cock on bottom of filter (turn counter-clockwise)
3. Back off adjusting screw on top of both reducing valves (turn counter-clockwise) until screw turns freely.
4. Close needle valve lightly against its seat (turn clockwise)
5. Turn three way valve handle down (gage check position)
6. Connect air hose to air supply. Allow temporary escapement of air through filter to purge air system of impurities
7. Close pet cock on filter
8. Turn adjusting screw on first reducing valve clockwise until a 60 pound pressure reading on its gage is obtained
9. Turn adjusting screw on second reducing valve clockwise until a 40 pound pressure reading on its gage is obtained
10. Slowly open needle valve adjustment counter-clockwise until a 20 pound pressure reading is obtained on the back pressure gage.
11. Raise three way valve handle to operating position. Air gage is now ready for inspection of the weapon gas system.
12. Unfold Weapon Mounting Bracket and lock against Air Gage Support Bracket with Weapon Mounting Bracket Clamp.
13. Insert muzzle end of weapon into Muzzle Seal and press butt end into Weapon Mounting Bracket.
14. Open bolt to rear locking position, insert Chamber Seal, and hold with thumb pressure sufficiently to effect a chamber air seal for obtaining low pressure reading on back pressure gage. (Photo 63325A)
15. Lower three way valve handle to check position. This eliminates tendency for Chamber Seal to be expelled
16. Release bolt against Chamber Seal
17. Raise three way valve handle to operating position, and hold operating rod forward with slight thumb pressure. (Photo 63333A) Place forefinger of left hand over the gas cylinder lock screw poppet valve opening, or use Poppet Valve Sealing Clamp to eliminate possible leakage through the poppet valve. Now obtain high pressure reading on back pressure gage.
18. Release forefinger or Poppet Valve Sealing Clamp. Any drop in pressure reading denotes poppet valve leakage. If a difference of 4 or more pounds is noted, replace Gas Cylinder Lock Screw Assembly.
19. The high pressure reading less the low pressure reading shows the weapon differential. A differential of seven pounds or greater is considered acceptable.

RECOMMENDATIONS:

1. Thoroughly clean weapon before air gaging.

2. After air gaging, function fire weapons which meet the air gage criterion with A.P. ammunition, from a free hold hip position so as to reject any weapon which malfunctions for reasons other than gas system failure.

3. Twenty pound adjustment on the back pressure gage should be occasionally checked during usage of gage and reset if necessary.

4. All weapons with a differential reading of less than seven pounds should be rejected pending replacement of gas system components.

5. In the event that the air gage reading with the bolt rearward is greater than 7 pounds, remove the gas cylinder lock screw. If the air gage reading remains above the 7 pound limit, the weapons should be rejected pending investigation of the gas port opening.

TABLE I

[illegible] OF GAS PRESSURE, EFFICIENCY

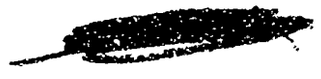
RIFLE NO.		GAS PRESSURE READING IN POUNDS: BOLT FORWARD	BOLT REARWARD	DIFFERENTIAL	STANDARD-DRY A.P. AMMO. SHORT RECOILS	STANDARD-LUBRICATED A.P. AMMO. SHORT RECOILS	STANDARD-LUBRICATED M2 BALL AMMO. SHORT RECOILS	JACK RUST-DRY A.P. AMMO.	JACK RUST-LUBRICATED A.P. AMMO. SHORT RECOILS	GAS PORT OPENING .0790+.0015: GO GAGE	NO GO GAGE		PISTON DIA. .5260 - .005
1	2835841	12	6	6	8	4		OK	OK	OK	OK		.5255
2	723523	10½	5½	5-3/4	8	8	3	OK	OK	OK	OK		.5248
3	3181675	11½	6½	5	8	8	8	8	OK	OK	OK		.5247
4	2024053	11½	5	5½	8	Cartridge seizes in chamber				OK	OK		.5251
5	1704397	12	5½	6½	8	8	8	8	2	OK	OK		.5249
6	2772468	12½	5	6½	8	8	7	8	OK	OK	OK		.5246
7	3069727	13	6	7	8	8	8	8	3	OK	OK		.5248
8	243083	12½	5½	7	8	8	8	8	4	OK	OK		.5249
9	2142552	11½	4	7½	8	8	2	6	OK		GO		.5245
10	20551	13-3/4	6½	7½	8	8	8	8	5	NO			.5253
11	2362391	12	5½	7½	8	7	OK	7	OK	OK	OK		.5242
12	1256131	13½	5½	7-3/4	8	8	8	8	4	OK	OK		.5251
13	1308721	13½	5-3/4	7-3/4	8	8	8	8	OK	OK	OK		.5253
14	3409196	14½	6½	8	8	8	3	6	OK	OK	OK		.5253
15	919272	14	6	8	8	8	8	8	8	OK	OK		.5245
16	2151549	14½	6	8½	8	8	8	8	OK	OK	OK		.5253
17	2725588	14	5½	8½	8	8	2	8	OK	OK	OK		.5246
18	724692	14½	5½	8-3/4	8	8	8	8	1	OK	OK		.5258
19	2964597	15½	6½	9	8	8	7	8	OK	NO			.5249
20	1258362	15-3/4	6½	9½	8	8	8	8	2	NO			.5252
21	3109935	15½	6	9½	8	7	7	OK	OK	OK	OK		.5252
22	2745831	15	5-3/4	9½	8	8	8	8	1	OK	OK		.5254
23	2991209	16	6½	9-3/4	8	8	6	8	OK	NO			.5255
24	1493965	16	6	10	8	8	5	8	1	OK	OK		.5258
25	3123484	16½	6	10½	8	8	5	8	OK	OK	OK		.5257
26	1846723	16	5½	10½	8	8	7	7	OK	OK	OK		.5254
27	3375368	15	5½	10½	6	6	2	7	1	OK	OK		.5256
28	1611098	16½	5	11½	8	8	8	8	OK	OK	OK		.5256
29	2038564	15½	5½	12	8	8	2	8	OK	NO			.5254
30	2647198	18½	5½	12-3/4	8	8	3	6	OK	OK	OK		.5257
31	78367	18	5	13	8	OK	OK	OK	OK	OK	OK		.5259
32	2443544	19½	6	13½	8	8	2	OK	OK	OK	OK		.5256
33	3007889	19	5½	13-3/4	8	2	1	4	OK	OK	OK		.5256

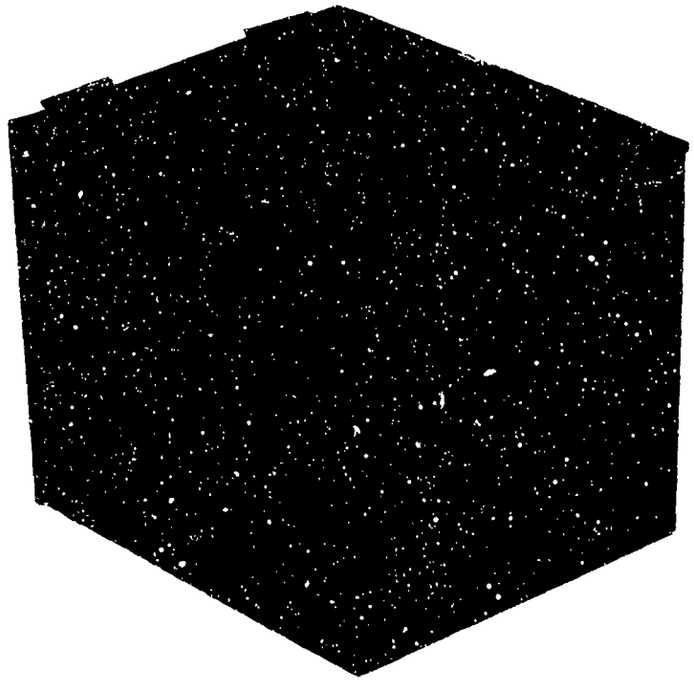
TABLE II

BREAK DOWN OF GAS SEAL TO DETERMINE PROBABLE BORDER LINE CONDITION OF REAR DIFFERENTIAL

WEAPON AS RECEIVED FIRING (SYSTEM) CAL..30 M1 BALL AMMO.				
	GAGE PRESSURE READING - LBS.			
RIFLE NUMBER	BOLT FORWARD	BOLT REARWARD	DIFF.	SHORT RECOILS
2835841	12	6	6	None
1309732	11	7	4	None
623715	13	6	7	None
2761165	15	6	9	None
2983507	17½	7	10½	None
2786207	20	5	15	None
2755145	20	6	14	None
PISTON DIA. .525				
1309732	10	6½	3½	None
PISTON DIA. .524				
1309732	8-3/4	6-1/4	2½	7
623715	9	6	3	None
PISTON DIA. .523				
1309732	8	6	2	8
2761165	9	6	3	None
2835841	9	6	3	None
PISTON DIA. .522				
2835841	8	6	2	3
1309732	7½	6½	1	8
623715	7	5½	1½	8
2761165	8	6	2	5
2983507	9	6	3	None
2786207	8½	5	2½	None
2755145	8	5	3	None

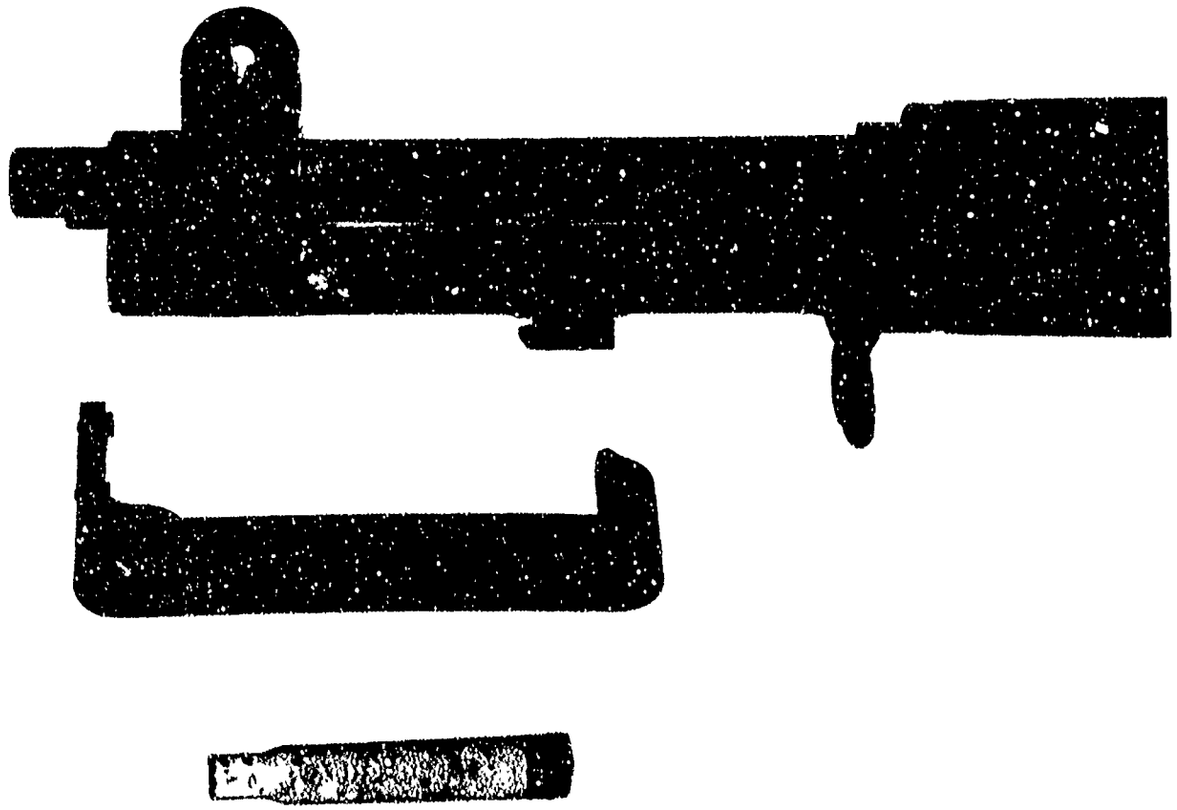
NOTE: All weapons fired from the shoulder.





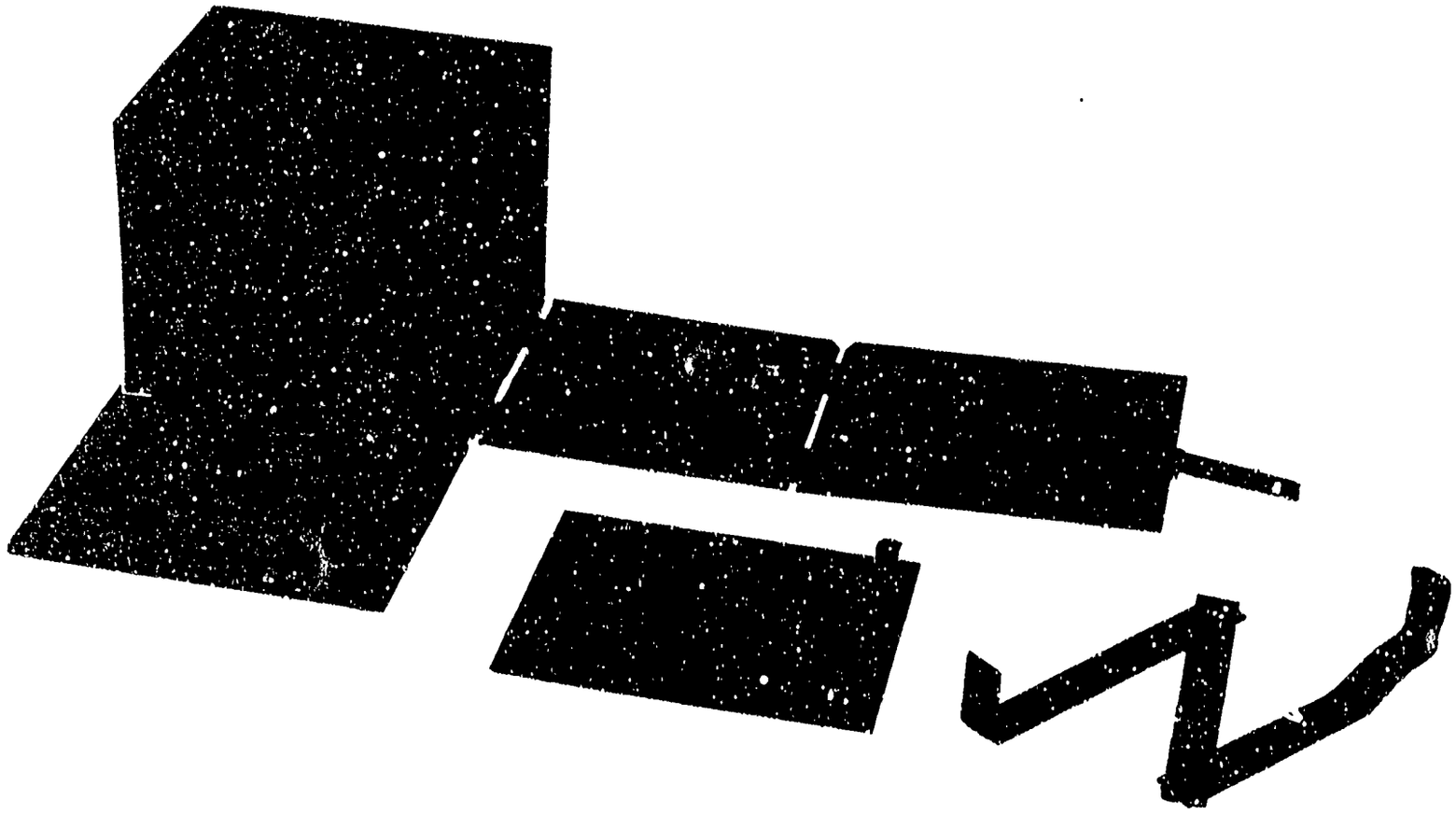
6328-SA SPRINGFIELD ARMORY - ORDNANCE DEPT. 13 Jan 1948

CONTAINER for Caliber .30 M1 Rifle Air Gage



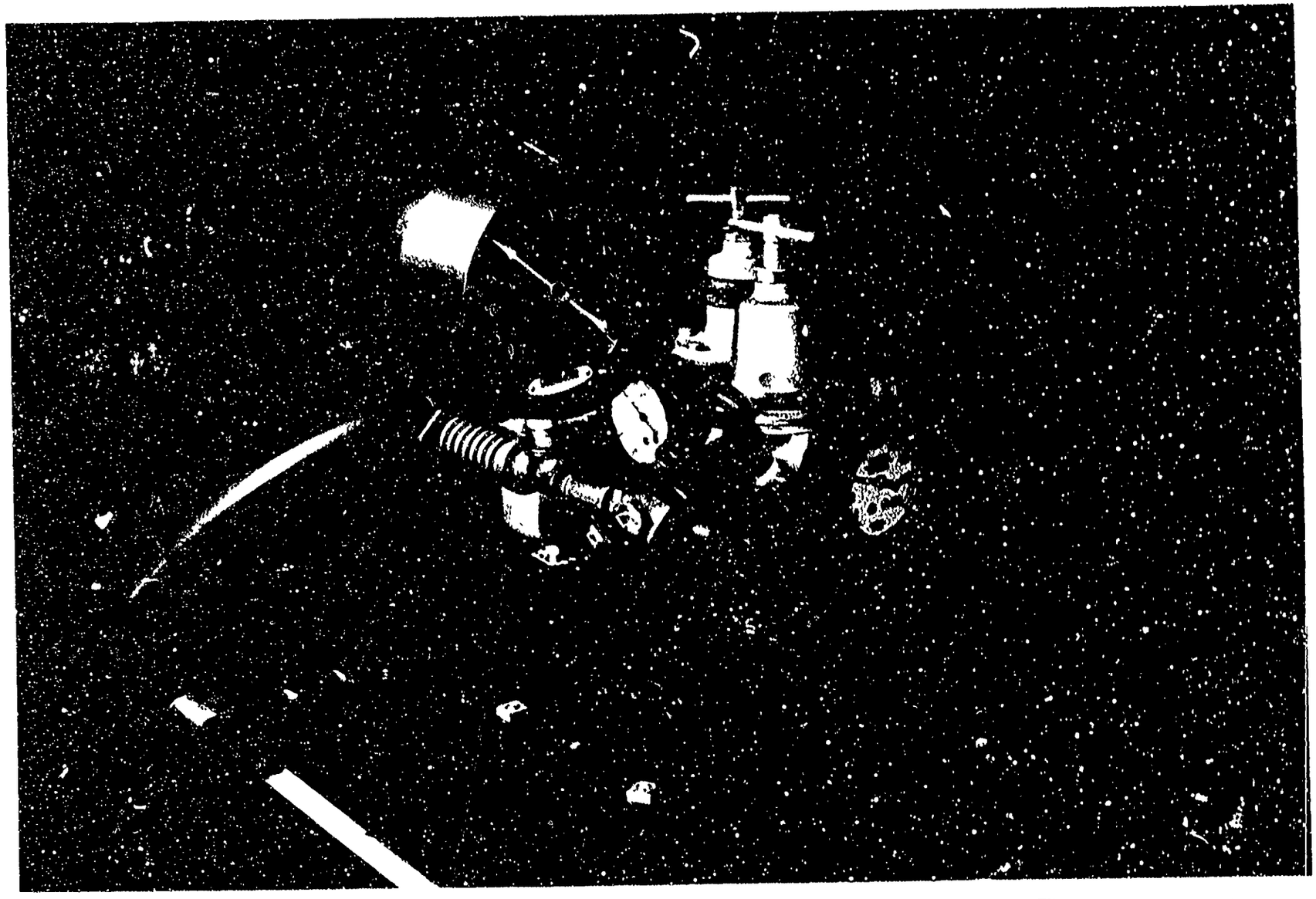
6320-SA SPRINGFIELD ARMORY - ORDNANCE DE[illegible] 3 Jan 1948

Showing Poppet Valve Sealing Clamp to prevent possible gas leakage through Poppet Valve and Chamber Seal to seal off gas leakage through barrel.



6330-SA SPRINGFIELD ARMORY - ORDNANCE DEPT 25 Jun 1948

Showing Air Gage Container unfolded, Base Plate and Weapon Mounting Bracket.



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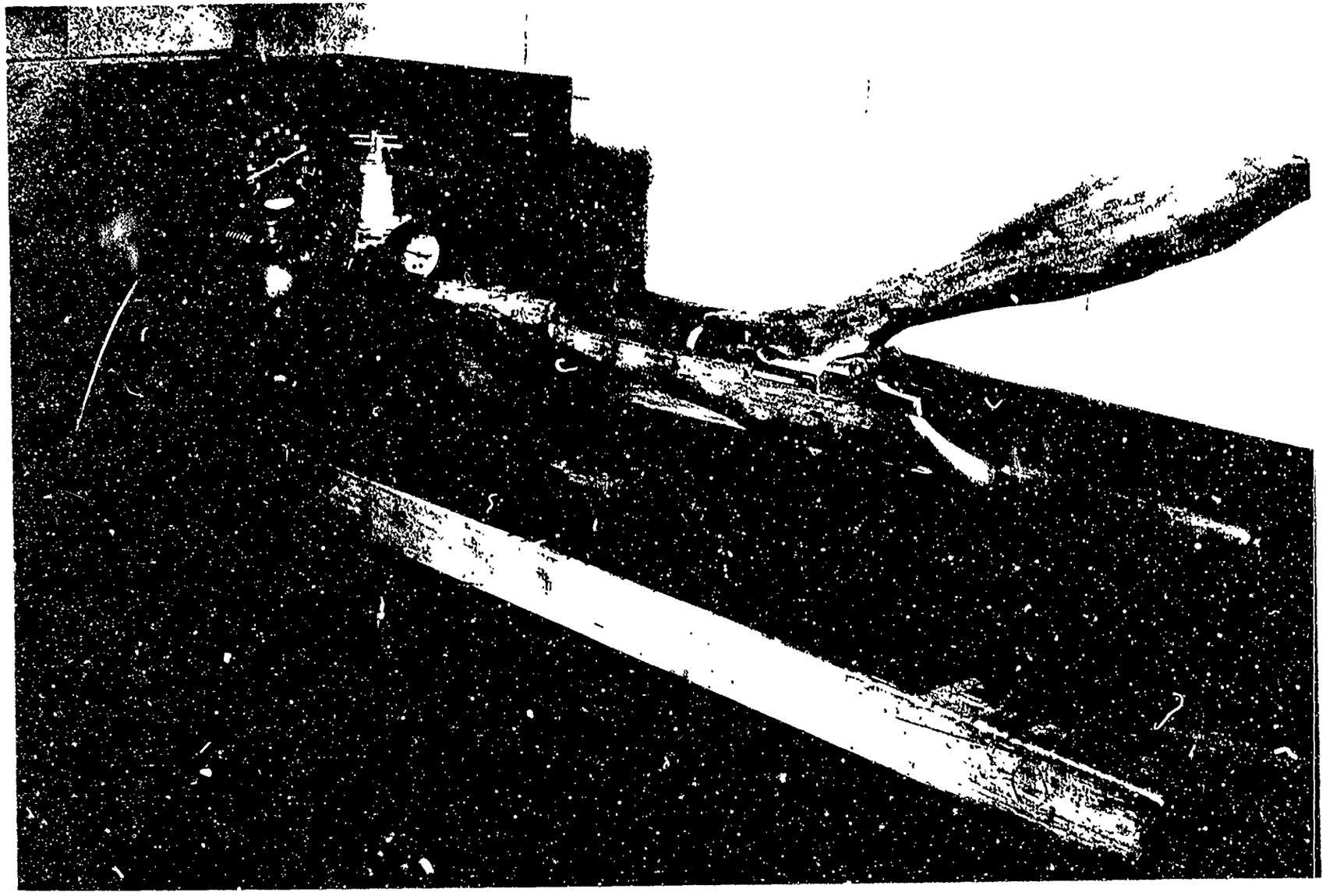

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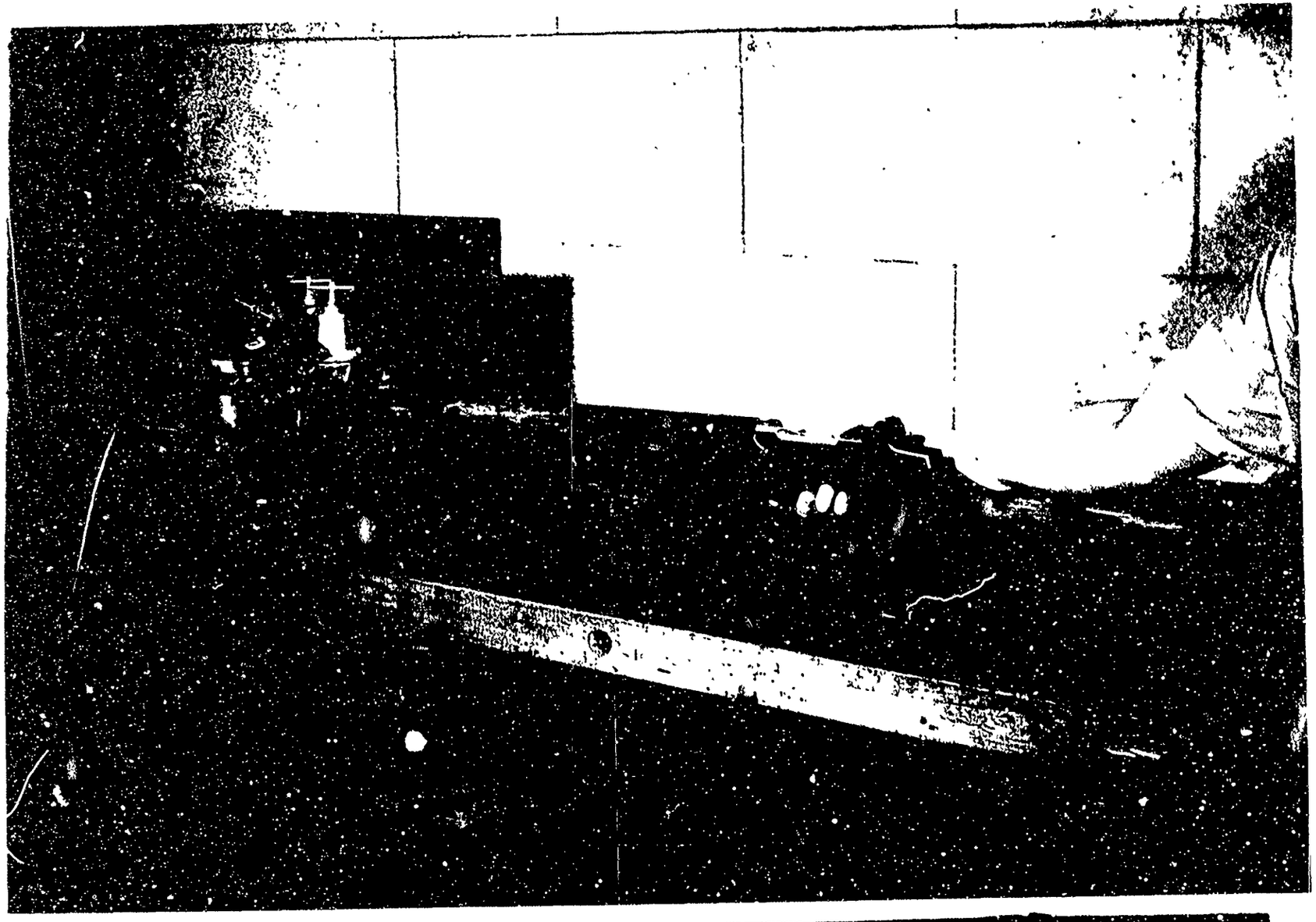

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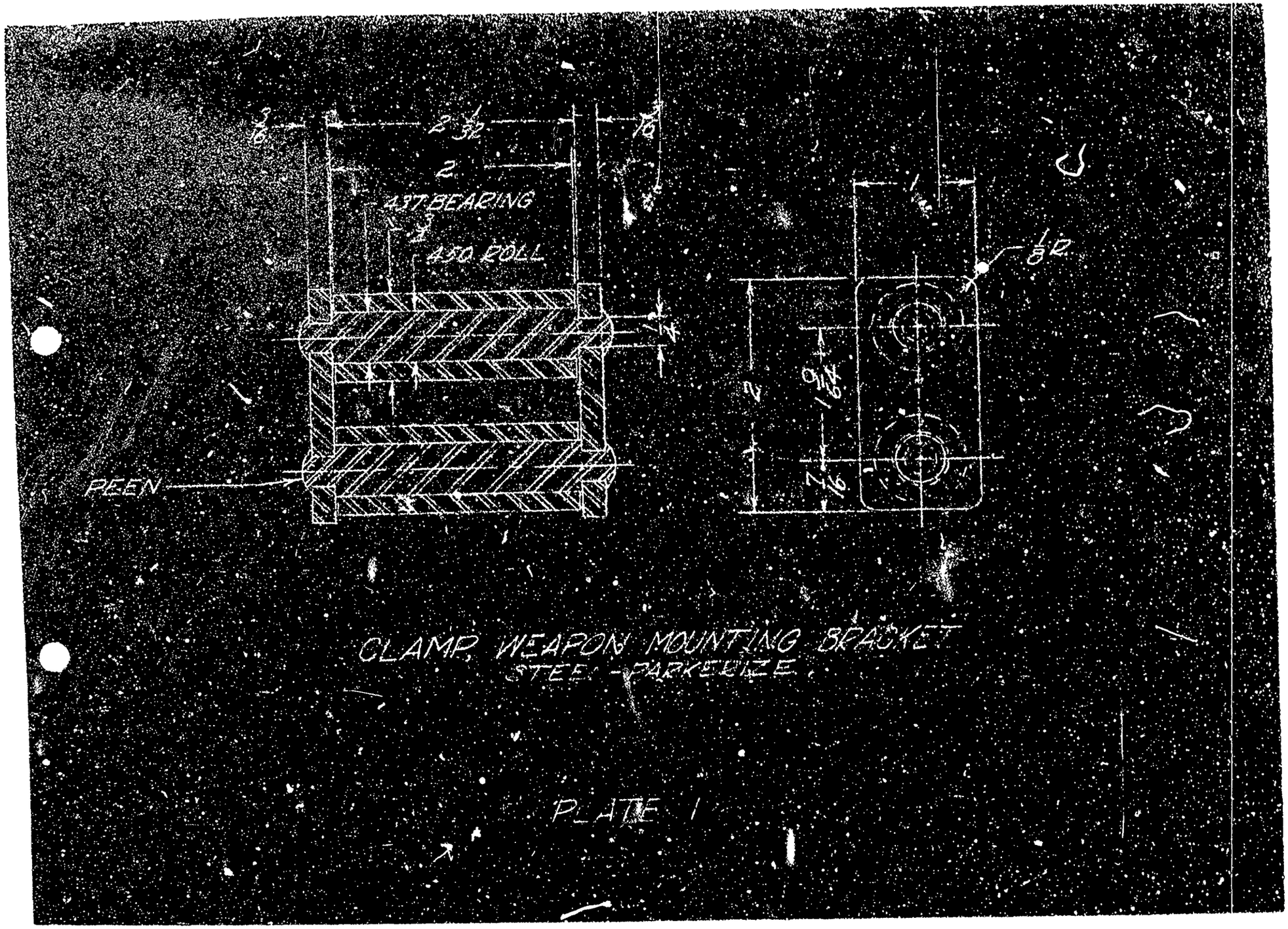
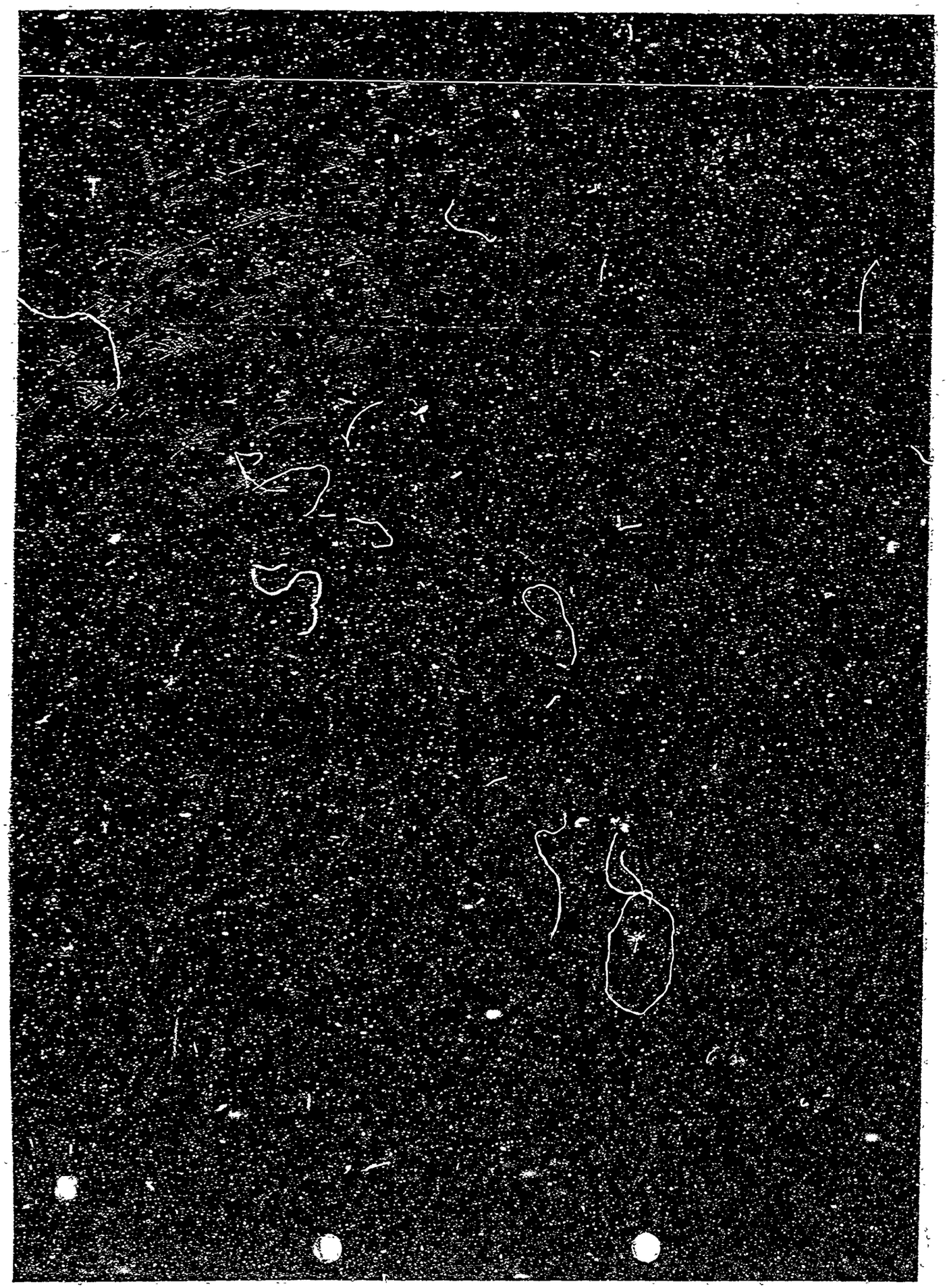
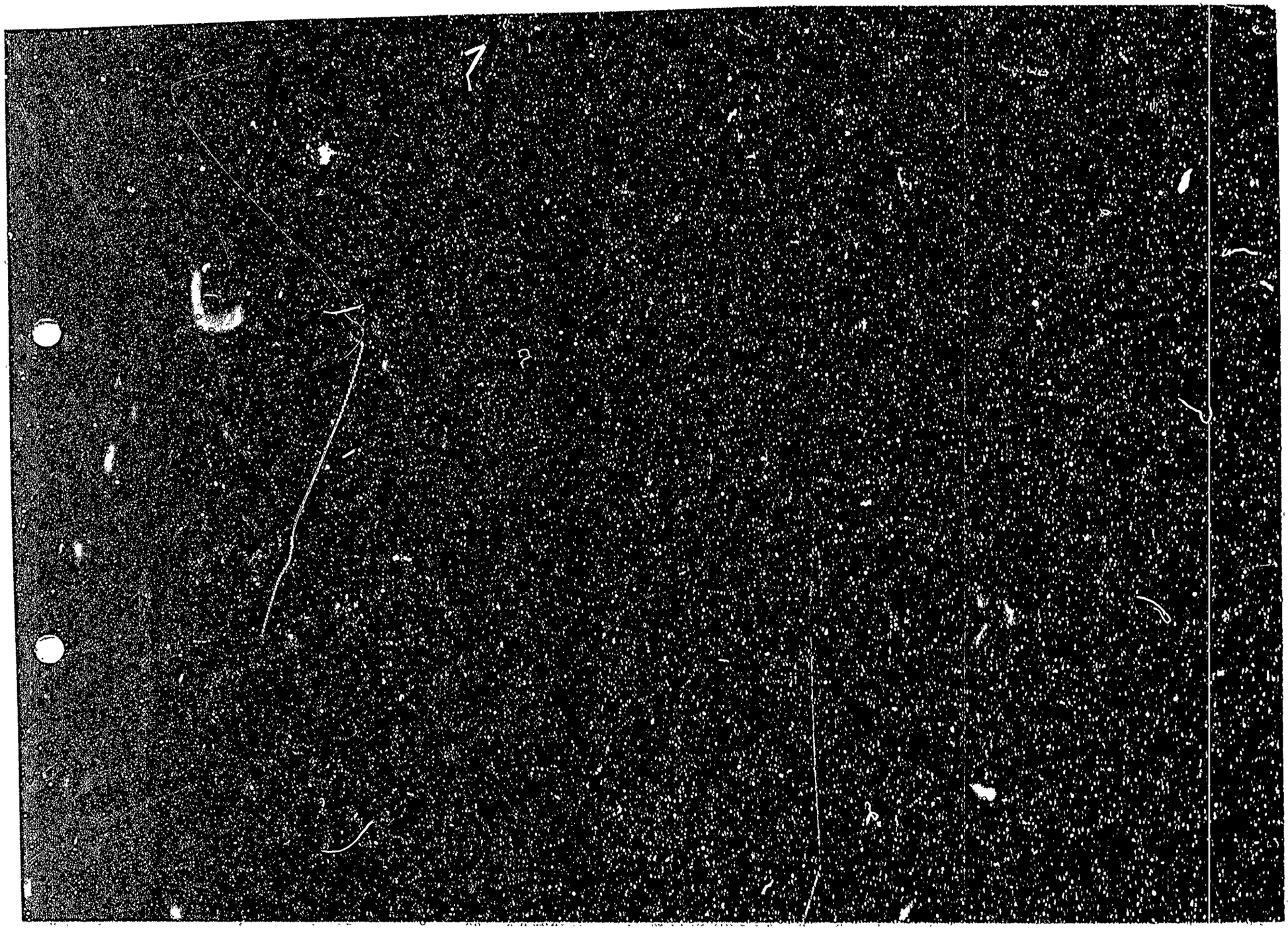
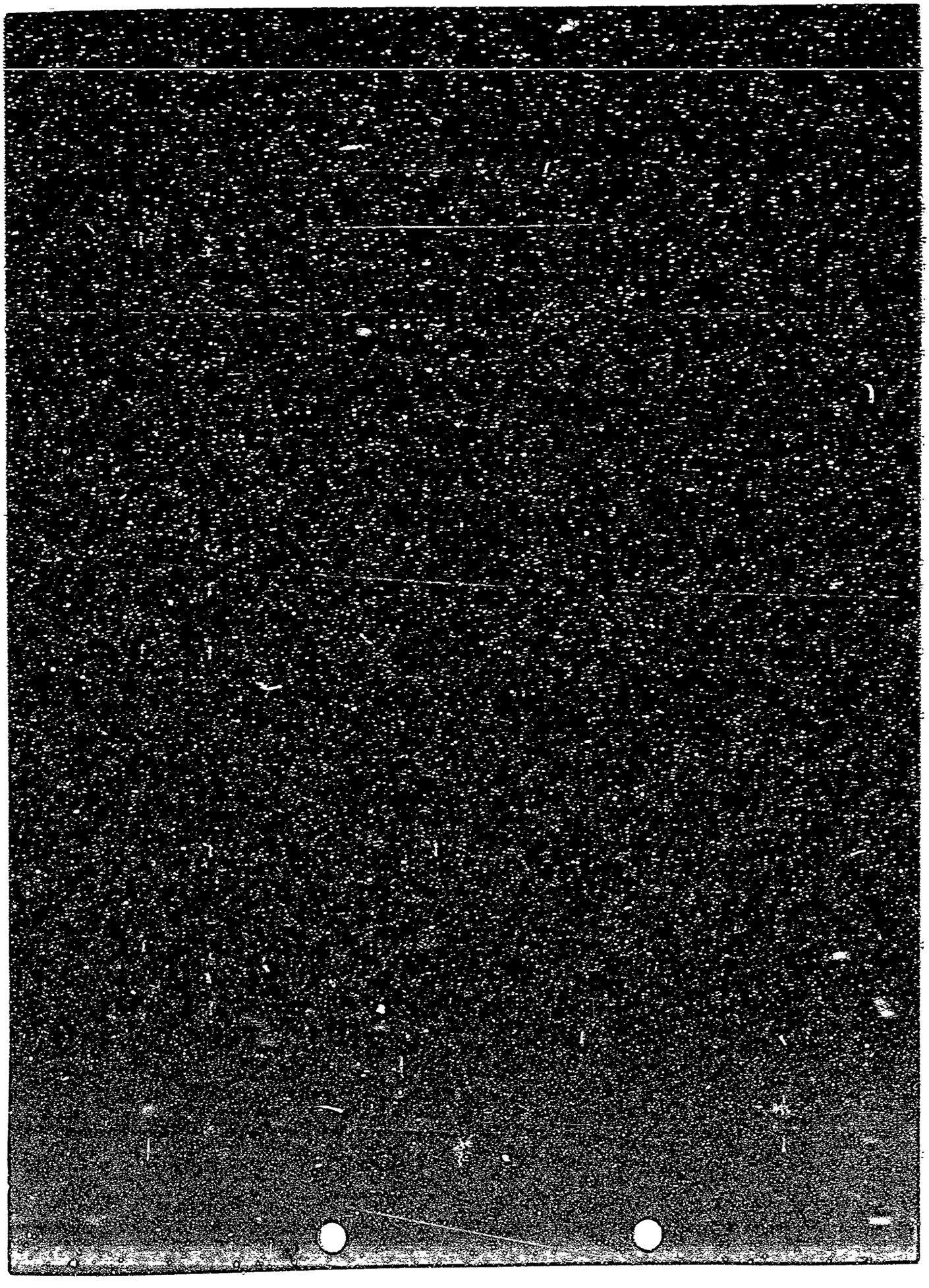


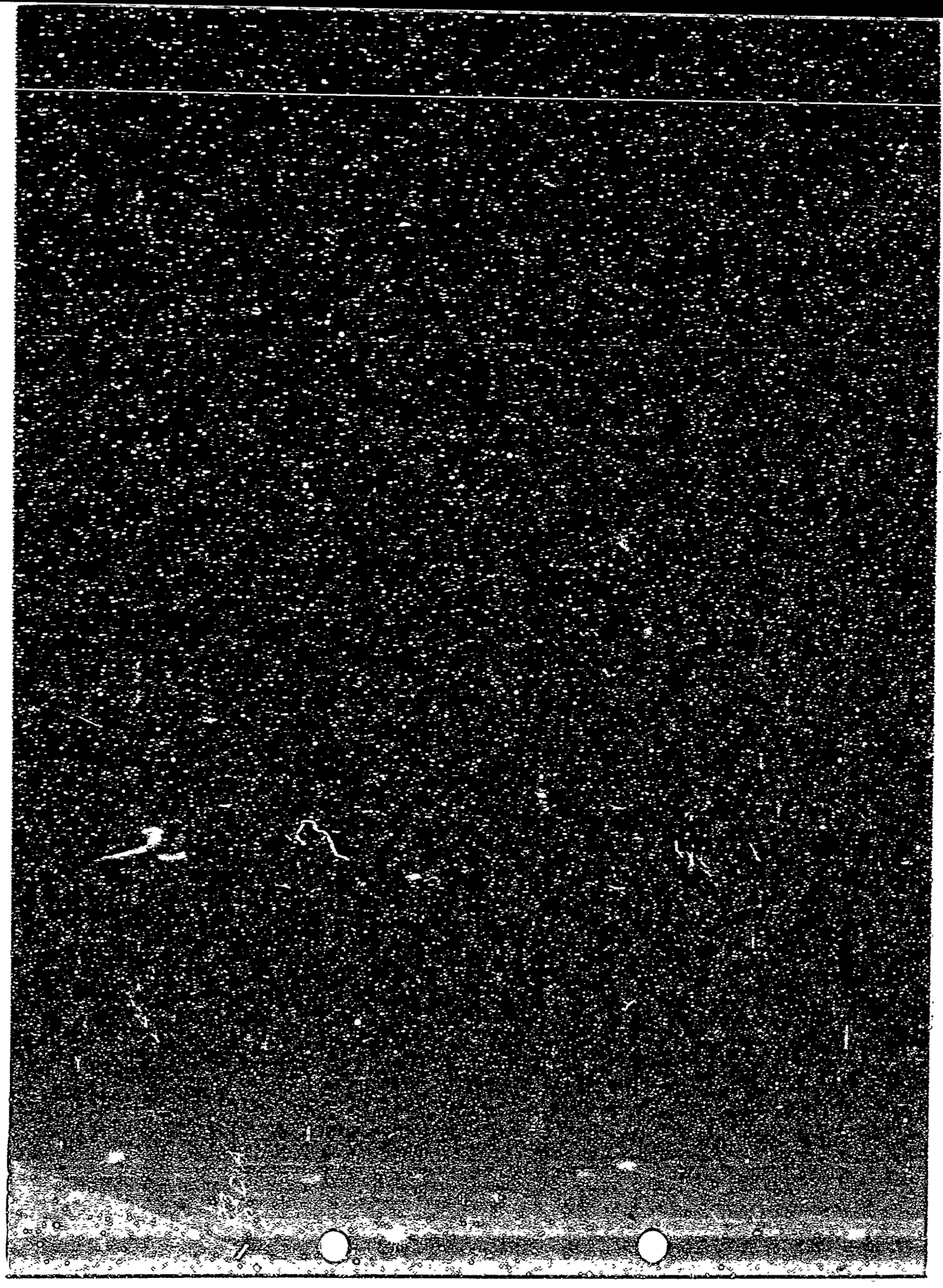
CLAMP, WEAPON MOUNTING BRACKET
STEEL - PARKERIZE.

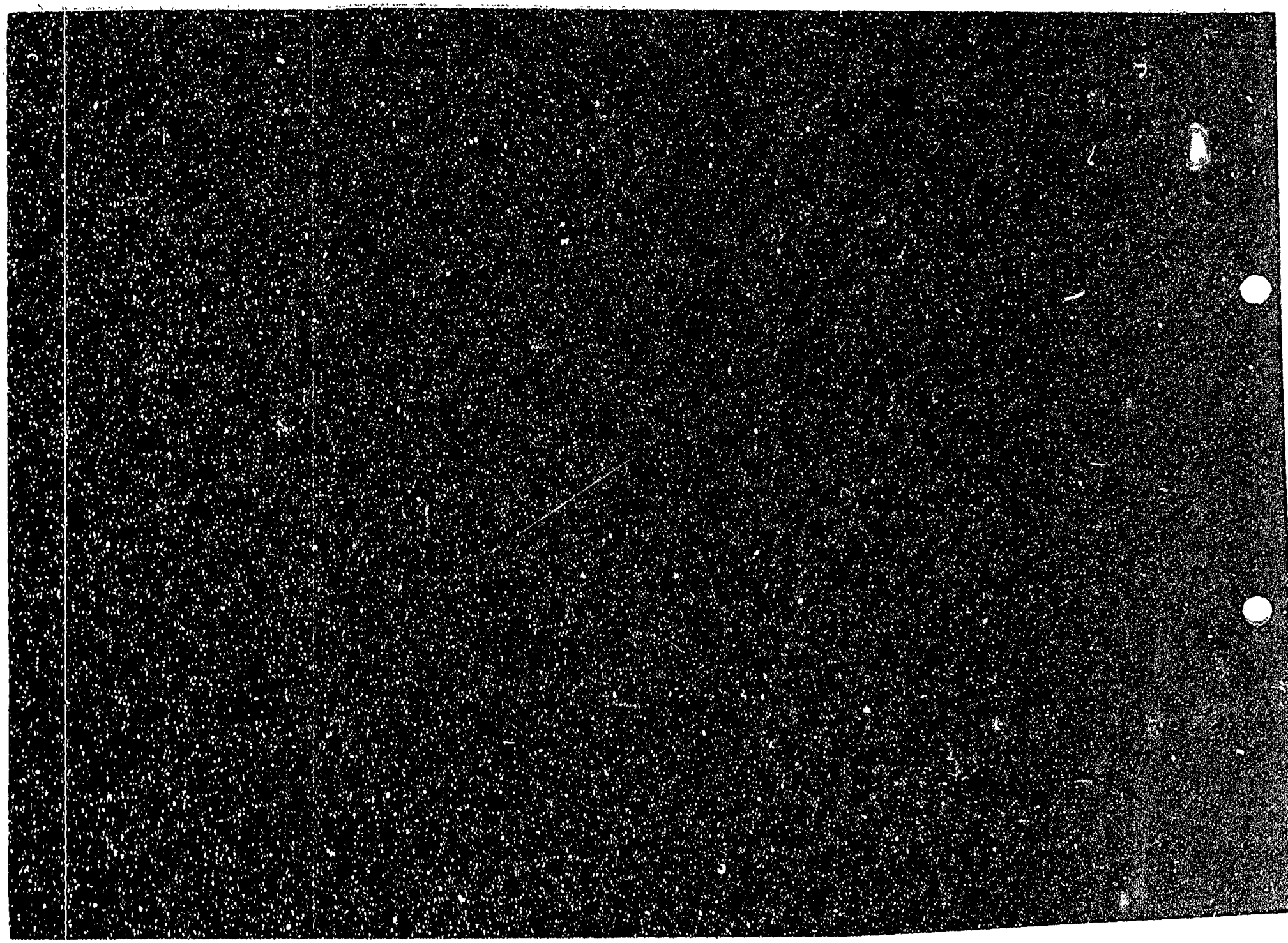
PLATE 1











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