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U. S. NAVAL PROVING GROUND
DAHLGREN, VIRGINIA

REPORT NO. 1208

20MM AIRCRAFT GUNS, AN-M3 AND AN-M24
EXPERIMENTAL AND DEVELOPMENTAL TESTS

12th Partial Report

- - - - - - - - - - - - - - - - - - - -

20MM AMMUNITION ASSIST FEEDER
DEVELOPED BY HARVEY MACHINE CO.

FINAL Report

Task Assignment NPG-Re&a-108-20-52

Copy No. _____

Classification RESTRICTED SECURITY INFORMATION

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[redacted] NPG REPORT NO. 1208

20mm Ammunition Assist Feeder
Developed by Harvey Machine Company

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PART A

SYNOPSIS

1. This report covers the evaluation of a Harvey Assist Feeder in conjunction with 20mm aircraft gun Mk 16 as suggested by reference (b). The salient features that were to be designed into the mechanism are outlined as follows:

a. Supplies ammunition to gun feeder at essentially zero belt load regardless of belt pull between ammunition box and booster. This increases the reliability and possibly the average rate of fire.

b. Reduces "belt whip" by providing 1 1/2 rounds which can be withdrawn from the reservoir without any movement of the belt at the beginning of a burst. This reservoir action also cushions the stopping of the belt.

c. Prevents starving of gun during single shot or short burst operation (a condition which occurs in ammunition systems using ordinary booster).

d. Prevents overfeeding of gun through quick release action of single plate type magnetic clutch and "cushion" effect of reservoir.

e. Greatly reduces maximum current drain during starting under load, through unique idling system.

2. On basis of the results it is concluded that:

a. The Harvey Assist Feeder did not perform the task that it is designed to do, at least, not in conjunction with the 20mm aircraft gun Mk 16. Insufficient tests were conducted to definitely establish its performance in conjunction with the 20mm aircraft gun AN-M3.

b. No definite conclusions can be drawn concerning the location of defects in the design of booster since a completely satisfactory operation was never obtained. The tests were terminated after the anti-roll back ratchet wheel had failed.

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20mm Ammunition Assist Feeder
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PART B

INTRODUCTION

1. AUTHORITY:

Reference (a) established Task Assignment NPG-Re8a-20-52 for experimental investigations and developmental tests of the 20mm aircraft guns AN-M3 and M24. This was amended by reference (b) to include the evaluation of the 20mm Harvey Assist feed mechanism.

2. REFERENCES:

a. BUORD Rest ltr NP9 Re8a-JOwsmts of 20 Sept 1951
b. BUORD Rest ltr NP9 Re8a-CFWsmts of 8 Feb 1952

3. OBJECT OF TEST:

The object of this evaluation was to determine the suitability of the Harvey Assist Feeder for use with 20mm aircraft guns AN-M3 and Mk 16 and their associated feed mechanisms.

4. PERIOD OF TEST:

a.	Date of Project Letter	8 February 1952
b.	Date Necessary Material Received	29 January 1952
c.	Date Test Commenced	29 January 1952
d.	Date Test Completed	11 March 1952

20mm Ammunition Assist Feeder
Developed by Harvey Machine Company

PART C

DETAILS OF TEST

5. DESCRIPTION OF ITEM UNDER TEST:

The Harvey Assist Feeder or Booster, shown in Figures 2 and 3, is designed to assist the feeding of the ammunition to the gun on the demand of the gun feed mechanism. This feeding action is accomplished by a 24 volt D.C. motor geared to a sprocket wheel through planetary reduction gears. The booster incorporates a single plate-type magnetic clutch and an ammunition reservoir having one and one half rounds capacity. A quick release action in the magnetic clutch is designed to prevent overfeeding of the gun feed mechanism. The electric motor in the booster idles at half speed when the gun arming switch is closed and the ammunition reservoir is filled with ammunition. This reduces the electric current required at the beginning of a burst and permits quicker acceleration of the sprocket wheel. When the gun feed mechanism pulls on the ammunition belt the magnetic clutch switch is actuated and the clutch is engaged. The sprocket then assists in feeding ammunition to the gun as long as the clutch is engaged. The sprocket wheel free wheels at 135 rpm and has nine sprockets. When the firing switch is released, the booster continues to feed until the ammunition belt depresses the clutch switch which in turn disengages the sprocket wheel from the motor. The motor resumes half speed operation until either the gun is fired again or the arming switch is turned off. To remove the ammunition belt from the booster in a direction opposite to feed, it is necessary to release the anti-roll back device in the motor. This is done by rotating the depressed slotted pin located in one end of the motor.

6. DESCRIPTION OF TEST EQUIPMENT:

a. The following test equipment was used for the evaluation of the booster:

(1) Batteries and a generator as a source for direct current electricity.

(2) 20mm aircraft guns Mk 16 and AN-M3.

(3) 20mm feed mechanisms Mk 8 Mod 0 and AN-M2.

(4) Rigid box type gun mounts.

(5) Two pieces of ammunition chuting each 3 feet long and a wooden ammunition box.

(6) High speed movie camera, 35mm.

(7) 20mm ammunition links M8E1 made by L. A. Young and Company.

(8) Heiland Recording Oscillograph.

(9) 20mm Ammunition, M90 series - 3745 rounds.

b. A photograph of the test setup is shown in Figure (1).

7. PROCEDURE:

A standard 20mm aircraft gun Mk 16 was used in the major portion of the evaluation. Various length bursts, both continuous and interrupted, up to 270 rounds were fired at ambient temperatures. The booster, energized by 27 volts D.C. from either batteries or generated power, was located approximately midway between the ammunition box and the gun feed mechanism. About three feet of ammunition chuting was attached to each end of the booster. The chuting was fixed rigidly on a wooden platform. For portions of the tests the voltage to the booster was changed to as high as 31 volts since it was suspected that the motor speed during feeding was not high enough to keep the gun feed mechanism supplied with ammunition. Also, the action of belt motion in the booster was studied by high speed motion pictures. The action of the clutch switch as well as the current and voltage supplied to booster motor were recorded by a Heiland Recording Oscillograph.

8. RESULTS AND DISCUSSION:

Complete detailed results are included as Appendix (A). The results show that the booster does not supply ammunition at the rate required by a 20mm aircraft gun Mk 16 as is evidenced by failures to feed, link deformations on the outboard side of the gun feed mechanism belt retaining pawls, and belt separations between the gun feed mechanism and the booster. Only 19 of 64 attempts, exclusive of belt pull tests and stoppages from other causes, were successfully fired out. The tests were terminated because of the failure of the anti-roll back ratchet wheel in the booster before it was established whether this inability to maintain adequate ammunition supply was caused by the faster firing rate of 20mm aircraft gun Mk 16 (about 790 rpm as compared to 740 rpm using an AN-M3 gun) or by the more severe nature on belt motion of intermittent reciprocating feeding action of the Mk 8 feed mechanism as compared to more uniform flow of ammunition in the rotary action of the AN-M2 feed mechanism. Each of the three firing attempts made with a 20mm aircraft gun AN-M3 was a successful firecut. Even though the failures to feed cannot all be blamed on the booster, about one third of the failures to feed were accompanied by stretched links. This would indicate that a sizeable ratio of the failures to feed were directly chargeable to the booster. The motion pictures showed that there was considerable tension applied intermittently to the ammunition belt as it passes through the booster. A sequence of events taken from the motion pictures is included as Figure 6. The oscillograms showed that the clutch switch is open about 3/7 of the gun firing cycle, but that the clutch rarely disengages. It is seen from Figure 5 that the clutch pull-in is very rapid, about the order of 1 millisecond, but that the drop out is in excess of 50 milliseconds. The disturbances noted by both the voltage and current element in the motor circuit is apparently caused by surge of current drawn by the magnetic clutch slipping because of lubricants or other foreign materials on the faces of the plates. This was obviated by thoroughly cleaning them twice during the tests. While somewhat improved operation was obtained after the second cleaning, the belt separation and failures to feed were not entirely eliminated. The results appear anomalous, however, in that one form of gun feed malfunction which had been prevalent in previous firings of Mk 8 feed mechanisms using the same links was not noted in these tests. The double loops of the belt link deformed toward each other sufficiently permitting the link to ride off the stripper. The link would tend to follow the round into the feed throat causing a gun stoppage. These links had a Rockwell C-38 hardness which is within the limits specified by

BUORD Dwg. 7238242. It was later found that links having Rockwell C-46 would function satisfactorily in the 20mm feed mechanism Mk 8. The motor load current and voltage was an average about 11 amperes and 23 volts D.C. The transient current at the beginning of a burst is approximately as high as 65 amperes under normal starting conditions without any extraneous load applied to the belt. The transient period is about 85 milliseconds under the same conditions.

PART D

CONCLUSIONS

9. On basis of the results it is concluded that:

a. The Harvey Assist Feeder did not perform the task that it is designed to do, at least, not in conjunction with the 20mm aircraft gun Mk 16. Insufficient tests were conducted to definitely establish its performance in conjunction with the 20mm aircraft gun AN-M3.

b. No definite conclusions can be drawn concerning the location of defects in the design of booster since completely satisfactory operation was never obtained. The tests were terminated after the anti-roll back ratchet wheel had failed.

20mm Ammunition Assist Feeder
Developed by Harvey Machine Company

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[redacted] UNCLASSIFIED NPG REPORT NO. 1208

U. S. NAVAL PROVING GROUND
DAHLGREN, VIRGINIA

Twelfth Partial Report

on

20mm Aircraft Guns, AN-M3 and AN-M24

Experimental and Developmental Tests

- -

Final Report

on

20mm Ammunition Assist Feeder

Developed by Harvey Machine Company

Classification cancelled in accordance with [illegible] 1953

J. Biel 8/4/54 [illegible] Center [illegible] Agency

Project No.: NPG-Re8a-108-20-52 Date: DEC 3-1953
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20mm Ammunition Assist Feeder Developed by Harvey Machine Company — HPG REPORT NO. 1208

TABULATED FIRING Data

20mm Aircraft Gun, Mk 16 Serial Number 6190

Date	Rounds in Belt	Rounds Fired	Total Rounds on Gun	Cyclic Rate (RPM)	Total Rounds on Feeder	Feeder Air Pressure (PSI)	Harvey Ammunition Booster Total Rounds	Idling Voltage V.D.C.	Idling Current AMPS	Surge Voltage V.D.C.	Surge Current AMPS	Operating Voltage V.D.C.	Operating Current AMPS	Average Time Clutch Micro-Switch Closed (Millisec)	Average Time Clutch Micro-Switch Open (Millisec)	Remarks
2-1-52	ADJUST. ION BOOSTER LOCATED IN FEED CHUTE BETWEEN AMMUNITION BOX AND FEEDER. MK. 8 FEEDER EX-11 (194 ROUNDS) L.H. 80 ROUNDS OF AMMUNITION BETWEEN BOOSTER AND GUN FEEDER. BOOSTER FIRE WHILE AT 135 RPM.															
2-1-52	250	28	5439	768	180	600	28	-	-	-	-	-	-	-	-	
2-1-52	221	187	5608	787	367	600	188	-	-	-	-	-	-	-	-	Rounds stubbed high on feeder end plate.
2-1-52	52	52	5658	-	399	600	245	-	-	-	-	-	-	-	-	Same as last burst.
2-1-52	250	38	5696	765	437	600	283	-	-	-	-	-	-	-	-	Fired out satisfactorily.
2-1-52	212	18	5731	757	452	600	258	-	-	-	-	-	-	-	-	Failure to feed. Round not down in time to be shouldered by belt.
2-1-52	197	19	5750	761	471	600	317	-	-	-	-	-	-	-	-	Failure to feed. Single loop of link stretched very badly.
2-2-52	GUN 8190 (5730 ROUNDS) REPLACED WITH GUN 22562 (1549 ROUNDS). MK. 8-0 FEEDER EX-11 (471 ROUNDS) REPLACED WITH EX-10 (2315 ROUNDS) WHICH HAS CHANGED FROM R.H. TO L.H.															
2-2-52	200	2	1548	-	2317	600	319	-	-	-	-	-	-	-	-	Combed round in feeder.
2-2-52	198	0	1851	719	2328	600	326	-	-	-	-	-	-	-	-	Same as last burst.
2-2-52	192	10	1561	730	2333	600	336	-	-	-	-	-	-	-	-	Round failed to get down in time. Single loop of link from last round fired stretched very badly.
2-2-52	182	18	1576	-	2348	600	350	-	-	-	-	-	-	-	-	Same as last burst.
2-2-52	38	20	1596	725	2368	600	350	-	-	-	-	-	-	-	-	Ammunition booster not used for this burst only. Belt rode under round.
2-2-52	107	107	1703	771	2475	600	457	-	-	-	-	-	-	-	-	Fired out satisfactorily.
2-2-52	250	52	1755	764	2527	600	509	-	-	-	-	-	-	-	-	Belt separation. Single loop of link on last round fired deformed very badly.
2-2-52	210	198	1953	770	2725	600	707	-	-	-	-	-	-	-	-	Round failed to get down in time.
2-2-52	250	35	1988	770	2760	600	742	-	-	-	-	-	-	-	-	Failure to feed. Round not down in time to be shouldered by belt.
2-2-52	215	149	2137	770	2909	600	891	-	-	-	-	-	-	-	-	Same as last burst.
2-5-52	MK. 8 FEEDER EX-10 CLEANED AND RELUBRICATED. FEEDER FLOOR FROM EX-8 USED WITH FEEDER ROTOR EX-10.															

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APPENDIX A

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TABULATED FIRING DATA (Continued)

20mm Aircraft Gun, Mk 12 Serial Number [illegible]

Date	Rounds in Belt	Rounds Fired	Total Rounds on Gun	Cyclic Rate (RPM)	Total Rounds on Feeder	Feeder Air Pressure (PSI)	Harvey Ammunition Booster Total Rounds	Idling Voltage V.D.C.	Idling Current AMPS	Surge Voltage V.D.C.	Peak Surge Current AMPS	Operating Voltage V.D.C.	Operating Current AMPS	Average Time Clutch Micro-Switch Closed (Millisec)	Average Time Clutch Micro-Switch Open (Millisec)	Remarks
2-6-52	250	92	2229	773	3001	600	983	-	-	-	-	-	-	-	-	Shuttle valve stuck in incorrect position allowing air to escape from gun feeder.
2-5-52	150	61	2290	773	3062	600	1044	-	-	-	-	-	-	-	-	Same as last burst.
2-5-52	132	26	2316	755	3088	600	1070	-	-	-	-	-	-	-	-	Same as last burst.
2-5-52	106	22	2338	772	3110	600	1092	-	-	-	-	-	-	-	-	Same as last burst. Feeder motor reclaimed and lubricated with "S-61" (Lighter in consistency than stop cock grease). Feeder cover spring replaced.
2-5-52	270	270	2608	773	3380	600	1362	-	-	-	-	-	-	-	-	Fired out satisfactorily.
2-13-52	32	32	2640	-	3412	580	1394	-	-	-	-	-	-	-	-	Fired out satisfactorily.
2-13-52	33	33	2673	-	3445	580	1427	-	6	-	44	-	10	40	31	Fired out satisfactorily.
2-13-52	215	15	2688	-	3460	580	1442	-	6	-	47	-	13	45	32	Front end plate on feeder floor sheared off. No indication of stub on each round. Feeder XE-7 ([illegible] rounds) installed.
2-13-52	203	83	2771	-	327	540	1525	-	5	-	43	-	10	42	29	Ammunition jammed in chute at entrance to ammunition booster (from ammunition box) causing belt separation at feeder.
2-13-52	120	34	2805	-	361	560	1559	-	6	-	45	-	10	41	30	Failure to feed. Round failed to get down in time to be chambered by bolt.
2-13-52	86	10	2815	-	371	580	1569	-	5	-	42	-	11	42	32	Same as last burst.
2-13-52	76	9	2824	-	380	580	1578	-	-	-	-	-	-	-	-	Removed [illegible] ([illegible] rounds) and [illegible] vent plug and installed rough cylinder wall finish [illegible] vent plug [illegible]. Voltage element installed in oscillograph. Power supplied from batteries. Voltage input 27 v D.C.
2-14-52	100	5	2829	-	385	580	1583	-	-	-	-	-	-	-	-	Belt held up due to electrical failure.
2-15-52	130	9	2838	750	394	500	1592	-	-	-	-	-	-	-	-	Belt separation at feeder belt holding pawls. Single loop of link on last round fired stretched very badly.
2-15-52	129	11	2849	709	405	500	1603	-	5	-	35	-	9	40	30	Link jam in ejection chute.
2-15-52	118	35	2884	704	440	600	1638	-	6	-	45	-	10	38	30	Intentional gun stoppage for oscillographic record.
2-15-52	88	31	2915	701	471	600	1669	7	6	15	41	23	10	38	30	Same as above.
2-15-52	167	24	2939	701	495	600	1693	6	6	15	60	24	11	38	26	Same as above.
2-15-52	200	24	2963	702	519	600	1717	6	5	16	60	23	12	40	30	Same as above.
2-15-52	180	29	2992	-	548	600	1746	10	5	15	60	22	10	38	30	Stubbed round.
2-15-52	221	5	2997	-	553	600	1751	-	-	-	-	-	-	-	-	Belt separation at feeder belt holding pawls. Single loop of link on last round fired stretched very badly
2-16-52	218	133	3130	793	686	600	1884	5	8	15	60	23	10	37	29	Intentional gun stoppage for oscillographic record.

TABULATED FIRING Data (Continued)

20mm Aircraft Gun, Mk 15 Serial Number 22268

Date	Rounds in Belt	Rounds Fired	Total Rounds on Gun	Cyclic Rate (PSI)	Total Rounds on Feeder	Feeder Air Pressure (PSI)	Harvey Ammunition Booster Total Rounds	Firing Voltage V.D.C.	Firing Current AMPS	Surge Voltage V.D.C.	Peak Surge Current AMPS	Operating Voltage V.D.C.	Operating Current AMPS	Average Time Clutch Micro-Switch Closed (Milliseconds)	Average Time Clutch Micro-Switch Open (Milliseconds)	Remarks
2-18-52	256	18	5148	-	708	600	1900	-	5	19	49	22	11	89	80	Belt separation at feeder belt holding pawls. Single loop of link on last round fired stretched very badly.
2-18-52	240	4	5160	-	706	600	1906	-	-	-	-	-	-	-	-	Voltage on booster raised to 29 v D.C. Gun stoppage same as above.
2-18-52	236	7	5167	-	715	600	1921	-	-	-	-	-	-	-	-	Same as above.
2-18-52	229	15	5172	-	728	600	1926	-	-	-	-	-	-	-	-	Station generator power. Same as above.
2-18-52	29	29	5201	-	707	600	1926	-	-	-	-	-	-	-	-	Booster taken out of circuit. Fired out satisfactorily.
2-18-52	185	16	5217	798	773	600	1962	-	-	-	-	-	-	-	-	31 v D.C. input to ammunition booster. Round failed to get down in time to be taken home by belt.
2-18-52	159	6	5223	-	779	600	1968	-	-	-	-	-	-	-	-	Same as above.
2-18-52	152	9	5232	-	788	600	1967	-	-	-	-	-	-	-	-	MS link in belt - both ears sheared causing gun stoppage - breechblock block crushed behind ears (5232 rounds) replaced with standard MS lock. The Harvey Booster was disassembled and clutch plates cleaned. On disassembly of feeder EX-7 for routine cleaning the following components broken; fiber buffer washers, shuttle cracked and shuttle stop plate badly battered. Feeder EX-14 substituted.
2-25-52	200	4	5236	-	186	600	1981	-	-	-	-	-	-	-	-	27 v D.C. from batteries applied to booster. Single loop of link on last round fired stretched very badly.
2-25-52	196	15	5251	791	179	600	1976	-	-	-	-	-	-	-	-	29 v D.C. applied to booster from batteries - same stoppage as above.
2-25-52	181	5	5256	-	188	600	1979	-	-	-	-	-	-	-	-	31 v D.C. applied to booster from batteries. Split base on empty chamber. Round on top of belt.
2-25-52	176	5	5267	-	192	600	1988	-	-	-	-	-	-	-	-	Same as above.
2-25-52	17	16	5271	788	196	600	1988	-	-	-	-	-	-	-	-	Harvey booster not used this burst. Belt home empty. Round on top of belt.
2-25-52	30	30	5301	788	220	600	1988	-	-	-	-	-	-	-	-	Booster not used this burst.
2-25-52	108	105	5406	788	322	600	2088	-	-	-	-	-	-	-	-	Voltage reduced to 29 v D.C. Gun replaced several times. Fired 5ab satisfactorily.
2-25-52	120	6	5420	-	328	600	2089	-	-	-	-	-	-	-	-	Single loop of link stretched very badly.
2-25-52	146	8K	5460	800	324	600	2167	-	-	-	-	-	-	-	-	Belt rode under round.

[redacted]

TABULATED FIRING DATA (Continued)

20mm Aircraft Gun, Mk 16 Serial Number 22868

Date	Rounds in Belt	Rounds Fired	Total Rounds on Gun	Cyclic Rate (PSI)	Total Rounds on Booster	Feeder Air Pressure (PSI)	Harvey Ammunition Booster Total Rounds	Idling Voltage V.D.C.	Idling Current AMPS	Surge Voltage V.D.C.	Peak Surge Current AMPS	Operating Voltage V.D.C.	Operating Current AMPS	Average Time Clutch Micro-Switch Closed (Millisec)	Average Time Clutch Micro-Switch Open (Millisec)	Remarks
2-25-52	88	3	5469	-	5[illegible]	600	2180	-	-	-	-	-	-	-	-	Belt rode under round.
2-25-52	85	75	5544	-	67[illegible]	600	2255	-	-	-	-	-	-	-	-	Belt rode under round.
2-25-52	100	25	5637	771	5[illegible]	600	2318	-	-	-	-	-	-	-	-	Belt rode under round.
2-26-52	600 PSI APPLIED TO FEEDER. 27 v D.C. (BATTERIES) APPLIED TO GUN SOLENOID AND HARVEY BOOSTER.															
2-26-52	200	24	5661	788	5[illegible]	600	2338	2	7	8	48	20	10	20	20	
2-26-52	175	166	5827	803	70[illegible]	60[illegible]	2490	-	-	-	-	-	-	-	-	Belt separation on booster side of feeder belt holding pawls. This burst fired with clutch engaged throughout burst. Micro-switch completely out of circuit. Intentional gun stoppage.
2-27-52	600 PSI APPLIED TO THE FEEDER AND 27 v D.C. APPLIED TO BOOSTER. NEW OSCILLOGRAPH, STANDARD RATE ELEMENT AS BEFORE. ELEMENT ACROSS MICRO-SWITCH TO INDICATE OPERATION OF SAME. FIRST THREE TESTS WILL NOT HAVE POWER APPLIED TO BOOSTER SO GUN FEEDER WILL HAVE TO PULL AMMUNITION THROUGH BOOSTER.															
2-27-52	228	5	5830	-	75[illegible]	600	2502	-	-	-	-	-	-	-	-	Single loop of link stretched very badly.
2-27-52	225	3	5833	-	76[illegible]	600	2505	-	-	-	-	-	-	-	-	Belt separation at feeder belt holding pawls.
2-27-52	82	3	5836	-	76[illegible]	600	2508	-	-	-	-	-	-	-	-	Same as above.
	BOOSTER CLUTCH ASSEMBLY ENGAGED ON SUBSEQUENT BURSTS SO THAT MICRO-SWITCH OPERATION DOES NOT CUT CLUTCH IN AND OUT															Same as above.
2-27-52	222	54	5870	808	79[illegible]	600	2542	-	-	-		-	-	-	-	Element installed in booster micro-switch to check for operation. Intentional gun stoppage.
2-27-52	188	40	5910	801	833	600	2582	-	-	18	87	12	24	-	-	Same as above. Intentional gun stoppage.
2-27-52	148	31	5941	796	86[illegible]	600	2615	-	-	-	86	14	21	-	-	Same conditions as above.
	BOOSTER REVERSED TO PERMIT CLUTCH ACTION															
2-27-52	117	5	5946	-	874	600	2618	-	-	-	-	-	-	-	-	
2-27-52	112	27	5973	798	90[illegible]	600	2645	-	-	-	-	-	-	-	-	Belt separation on booster side of feeder belt holding pawls. Gun reliable. Gun stoppage due to belt separation.

Harvey booster clutches torn down - Found to have very small amount of grease on clutch plates. Broken anti-roll back spring. Paper pins (2) which secure booster hold down arms found to be sheared - Are shaped slot end in booster to observe ammunition travel in booster.

TABULATED FIRING DATA (Continued)

20mm Aircraft Gun, Mk 12 Serial Number 27562

Date	Rounds in Belt	Rounds Fired	Total Rounds on Gun	Cyclic Rate (RPM)	Total Rounds on Feeder	Feeder Air Pressure (PSI)	Harvey Ammunition Booster Total Rounds	Idling Voltage V.D.C.	Idling Current AMPS	Surge Voltage V.D.C.	Peak Surge Current AMPS	Operating Voltage V.D.C.	Operating Current AMPS	Average Time Clutch Micro-Switch Closed (Millisec)	Average Time Clutch Micro-Switch Open (Millisec)	Remarks
2-29-52	154	4	3977	-	907	600	2649	-	-	-	-	-	-	-	-	Belt separation at feeder belt holding pawls.
2-29-52	152	59	4036	797	964	600	2708	7	6	17	67	21	13	40	30	Intentional gun stoppage. Gun recharged once.
2-29-52	148	5	4041	-	969	600	2713	-	3	-	86	-	13	41	30	Belt separation at feeder belt holding pawls.
2-29-52	143	5	4046	-	972	600	2718	-	7	-	86	-	13	31	31	Belt separation at feeder belt holding pawls.
2-29-52	140	93	4137	800	1065	600	2809	6	6	18	62	22	13	32	30	Intentional gun stoppage. One continuous burst.
2-29-52	216	5	4142	-	1070	600	2814	3	6	12	64	21	15	39	31	Round failed to get down in time to be taken home by belt.
2-29-52	211	63	4205	798	1133	600	2877	3	5	16	58	22	11	40	30	Intentional gun stoppage. Gun recharged once.
2-29-52	148	131	4336	799	1264	600	3008	4	5	17	55	22	11	33	31	Intentional gun stoppage. One continuous burst.
																Gun Number 27562 (normally a Mk 12 gun) converted to an AN-M3 gun for comparison of Harvey booster operation. No changes made in gun except changes necessary to convert gun to M3.
3-5-52	257	48	4384	730	-	None	3056	-	-	-	-	-	-	-	-	Intentional gun stoppage. Gun recharged several times.
3-5-52	209	63	4447	731	-	None	3139	5	6	14	61	19	15	41	33	Intentional gun stoppage. Gun recharged several times.
3-5-52	122	122	4569	739	-	None	3261	5	9	15	65	21	14	31	42	One continuous burst. Fired out satisfactorily.
GUN NUMBER 27562 RECONVERTED TO A MK 12 MOD																
3-6-52	200	1	4570	-	1265	600	3252	-	-	-	-	-	-	-	-	M3 links used this burst. Rear stripper of feeder broken. Feeder motor EE-14 and flour EE-1 used to continue firing.
3-6-52	199	65	4635	798	1330	600	3327	-	-	-	-	-	-	-	-	M3 links used this burst. Both ears sheared off link allowing round and link to drop down between link strippers. Links used hereafter, unless otherwise noted, are M8E1 T8W C1 links.
3-6-52	200	7	4642	-	1337	600	3334	-	-	-	-	-	-	-	-	Round failed to get down in time to be taken home by belt.
3-6-52	198	188	4830	789	1525	600	3522	-	-	-	-	-	-	-	-	Same as last burst.
3-6-52	200	4	4834	-	1529	600	3526	6	5	17	60	21	18	30	25	Same as last burst.

TABULATED FIRING DATA (Continued)

20mm Aircraft Gun, Mk 16 Serial Number 22882

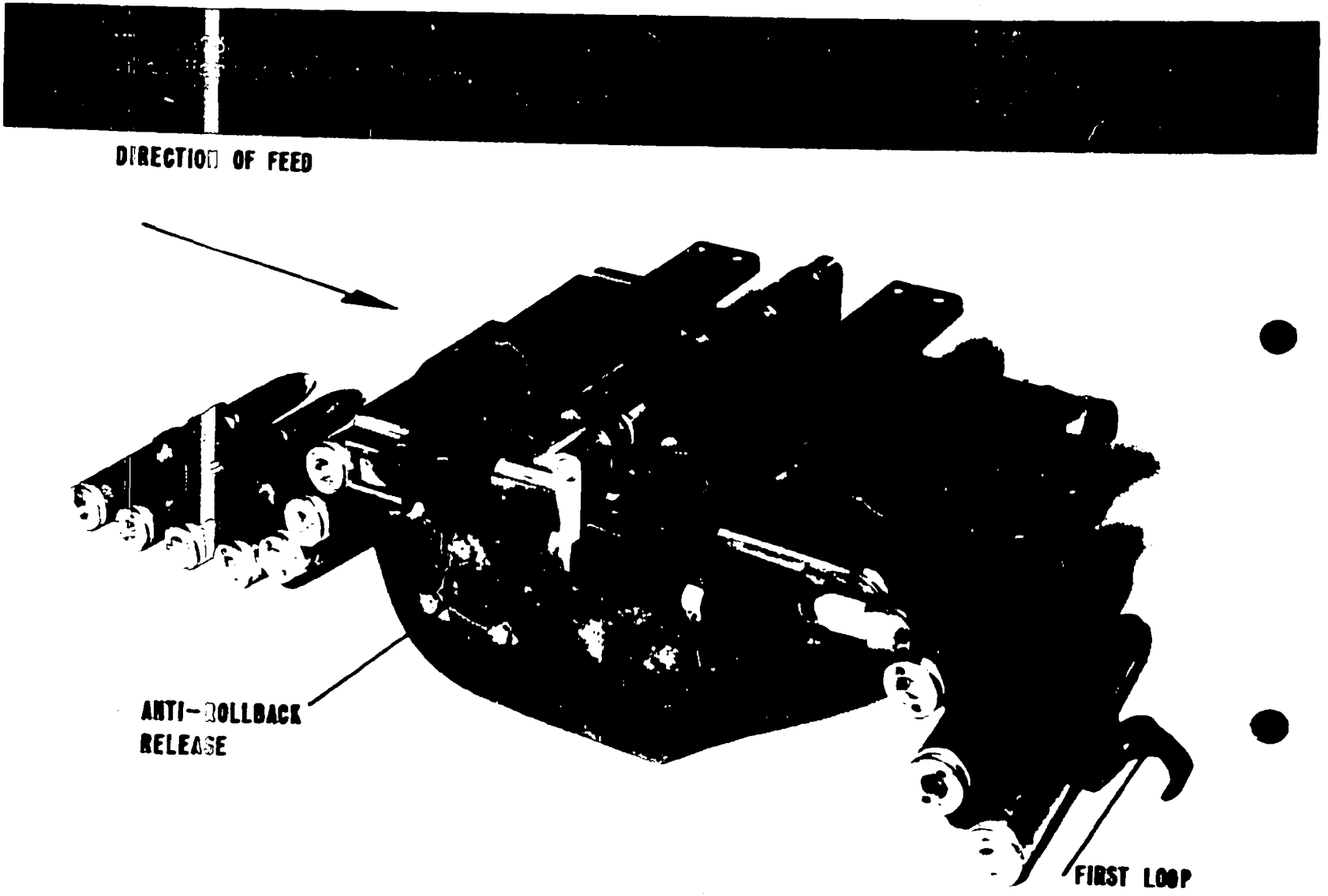
Date	Rounds in Belt	Rounds Fired	Total Rounds on Gun	Cyclic Rate (RPM)	Total Rounds on Feeder	Feeder Air Pressure (PSI)	Harvey Ammunition Booster Total Rounds	Idling Voltage V.D.C.	Idling Current AMPS	Surge Voltage V.D.C.	Peak Surge Current AMPS	Operating Voltage V.D.C.	Operating Current AMPS	Average Time Clutch Micro-Switch Closed (Millisec)	Average Time Clutch Micro-Switch Open (Millisec)	Remarks
3-5-52	198	13	2467	-	1562	600	2539	7	6	17	58	21	11	45	33	Link aimed in belt of MK1 links. Both ears of this link sheared off allowing round and link to drop down between strippers.
3-7-52	153	53	4920	781	1515	600	2592	-	-	-	-	-	-	-	-	Gun stoppage due to dummy round in belt.
3-8-52	64	30	4950	787	1525	600	2622	6	7	17	57	22	14	42	21	In addition to the 64 rounds in the feed tray, a 80 pound belt load was applied to the ammunition belt. Intentional gun stoppage.
3-8-52	64	7	4957	-	1532	600	2629	6	8	17	58	21	21	41	20	Belt went home empty. Single loop of link on last round fired stretched very badly. 80 pound belt load applied to ammunition belt.
3-8-52	57	6	4961	-	1536	600	2633	-	-	-	-	-	-	-	-	80 pound belt load applied to ammunition belt. Failure to eject. Extractor and extractor spring broken. Single loop of link on last round fired stretched very badly.
3-8-52	64	25	4986	781	1551	600	2656	7	6	18	58	21	17	32	21	Intentional gun stoppage. Gun repickled two times. Anti-roll back device in Harvey booster broken. 80 pound belt load applied to ammunition belt.
3-8-52	64	4	4990	-	1555	600	2668	8	8	18	58	21	12	40	20	Belt load increased to 75 pounds. Gun failure due to failure of anti-roll back device mentioned above.
3-11-52	64	6	4996	-	1559	600	2668	9	5	18	48	21	17	-	-	75 pound belt load. Badly stretched single loop of link on last round fired. Belt separation on booster side of feeder belt holding pawls.
3-11-52	60	3	4997	-	1572	600	2669	8	8	18	56	22	19	-	-	Same as last burst.
3-11-52	64	5	5002	-	1577	600	2674	10	6	19	46	23	19	-	-	Same as last burst.
3-11-52	59	3	5008	-	1580	600	2677	-	5	-	50	-	20	-	-	Same as last burst.
3-11-52	64	4	5009	-	1584	600	2681	10	5	19	47	23	19	23	23	Same as last burst.
3-11-52	80	11	5020	784	1595	600	2692	11	8	20	47	22	18	29	29	Feeder shuttle valve stuck in innermost position allowing air to escape. 75 pound belt load.

TABULATED FIRING DATA (Continued)

20mm Aircraft Gun, Mk 12 Serial Number 22369

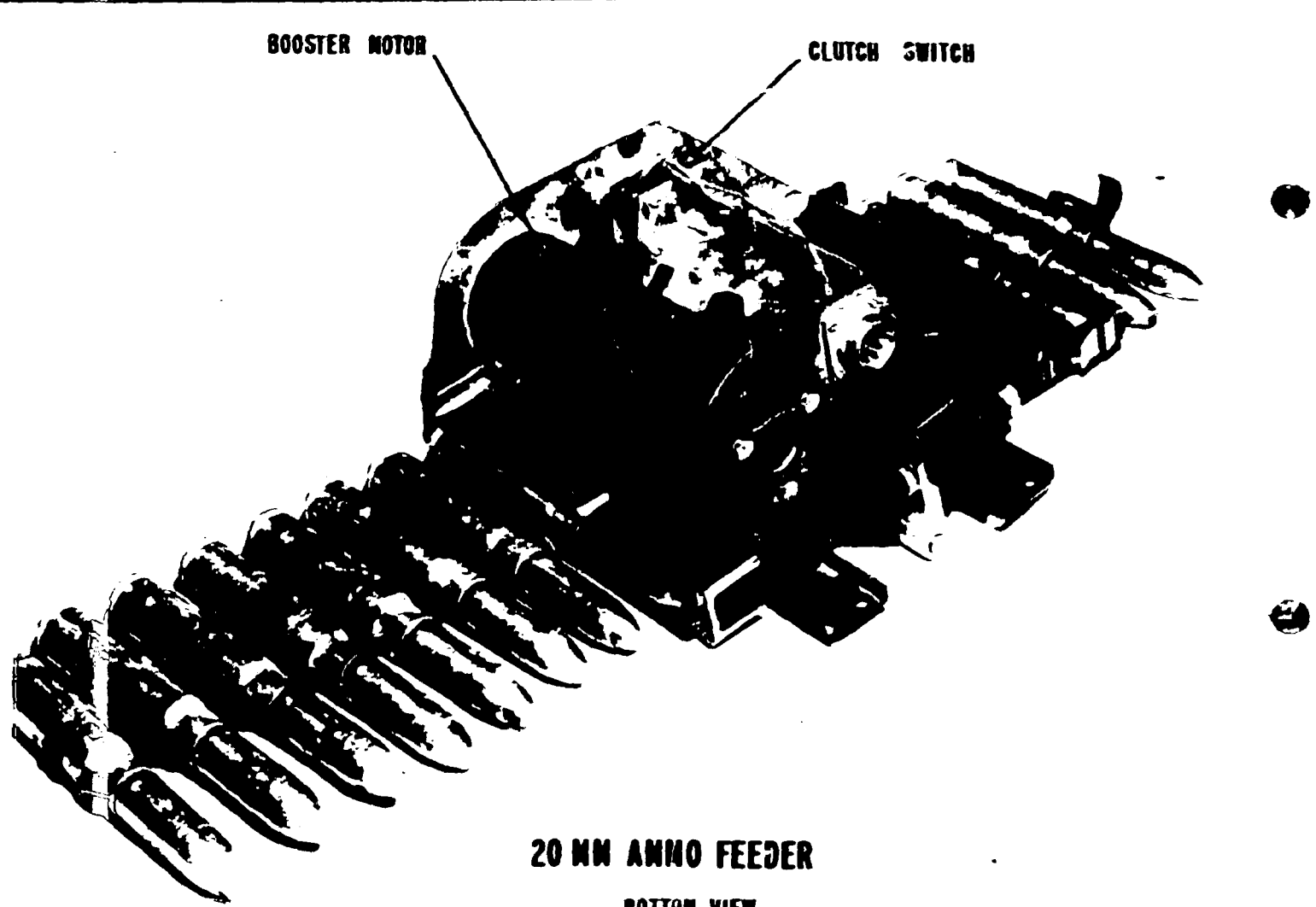
Date	Rounds in Belt	Rounds Fired	Total Rounds on Gun	Cyclic Rate (RPM)	Total Rounds on Feeder	Feeder Air Pressure (PSI)	Harvey Ammunition Booster Total Rounds	Idling Voltage V.D.C.	Idling Current AMPS	Surge Voltage V.D.C.	Peak Surge Current AMPS	Operating Voltage V.D.C.	Operating Current AMPS	Average Time Clutch Micro-Switch Closed (Millisec)	Average Time Clutch Micro-Switch Open (Millisec)	Remarks
3-11-52	64	7	5057	-	1708	600	5690	11	8	20	48	23	15	45	30	75 pound belt load. Belt separation on booster side of feeder belt holding pawls.
3-11-52	64	20	5067	797	1712	600	5719	10	8	18	41	22	11	60	31	Intentional gun stoppage. No belt load applied.
3-11-52	64	4	5061	-	1738	600	5725	-	-	-	-	-	-	-	-	Belt load 60 pounds. Stubbed round high in feeder throat.
3-11-52	60	1	5062	-	1727	600	5754	-	-	-	-	-	-	-	-	Dummy round in ammunition belt.
3-11-52	59	2	5064	-	1729	600	5758	-	-	-	-	-	-	-	-	Belt load 80 pounds. Belt separation on booster side of gun feeder belt holding pawls.
3-11-52	64	4	5066	-	1735	600	5780	-	-	-	-	-	-	-	-	Same as last burst.
3-11-52	60	4	5062	-	1737	600	5784	-	-	-	-	-	-	-	-	Stubbed round high in feeder throat. Belt load 80 pounds.
3-11-52	56	11	5070	-	1748	600	5795	10	8	21	45	23	9	33	30	Intentional gun stoppage. No belt load applied.

NP9 40727
Mk 16 20mm Gun, Mk 8 Mod 0 Gun Feed Mechanism, Harvey Assist Feeder, Ammunition Box and Mitchell Movie Camera.
Figure 1



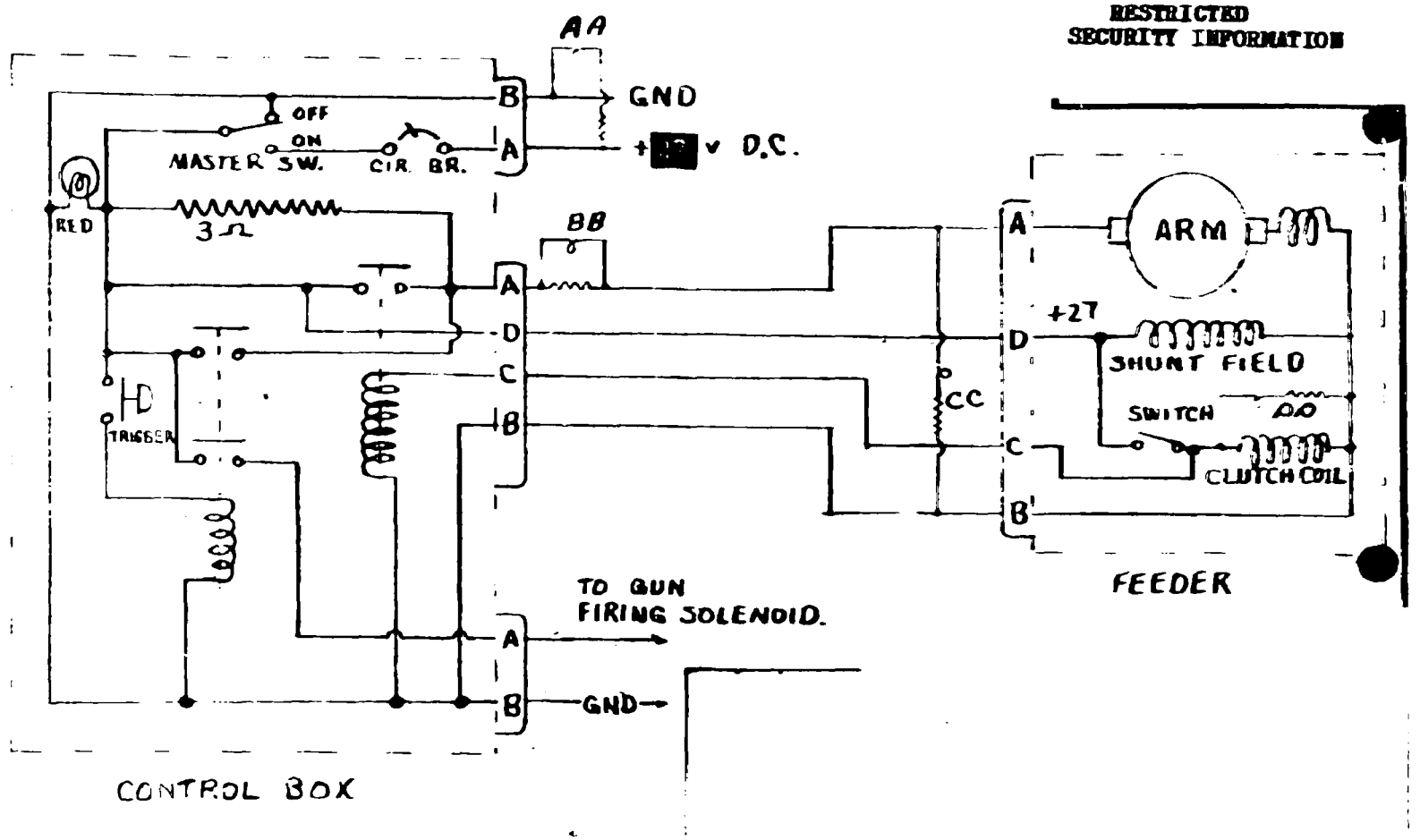
20MM AMMO FEEDER

TOP VIEW



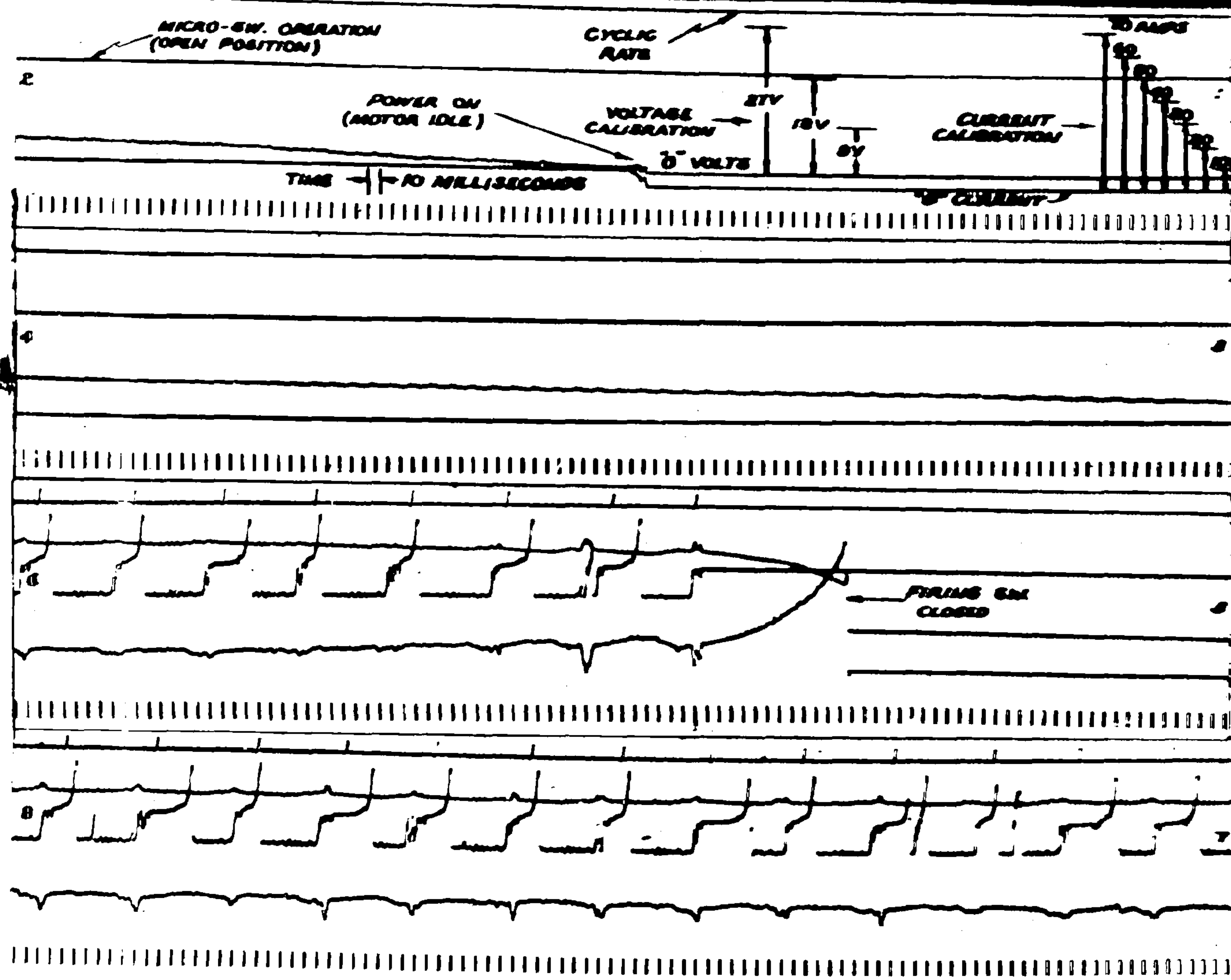
20 MM AMMO FEEDER

BOTTOM VIEW



NPO 42164
Harvey Assist Feeder [illegible]
Feed Mechanism: [illegible]
burst not shown.)

Figure 5



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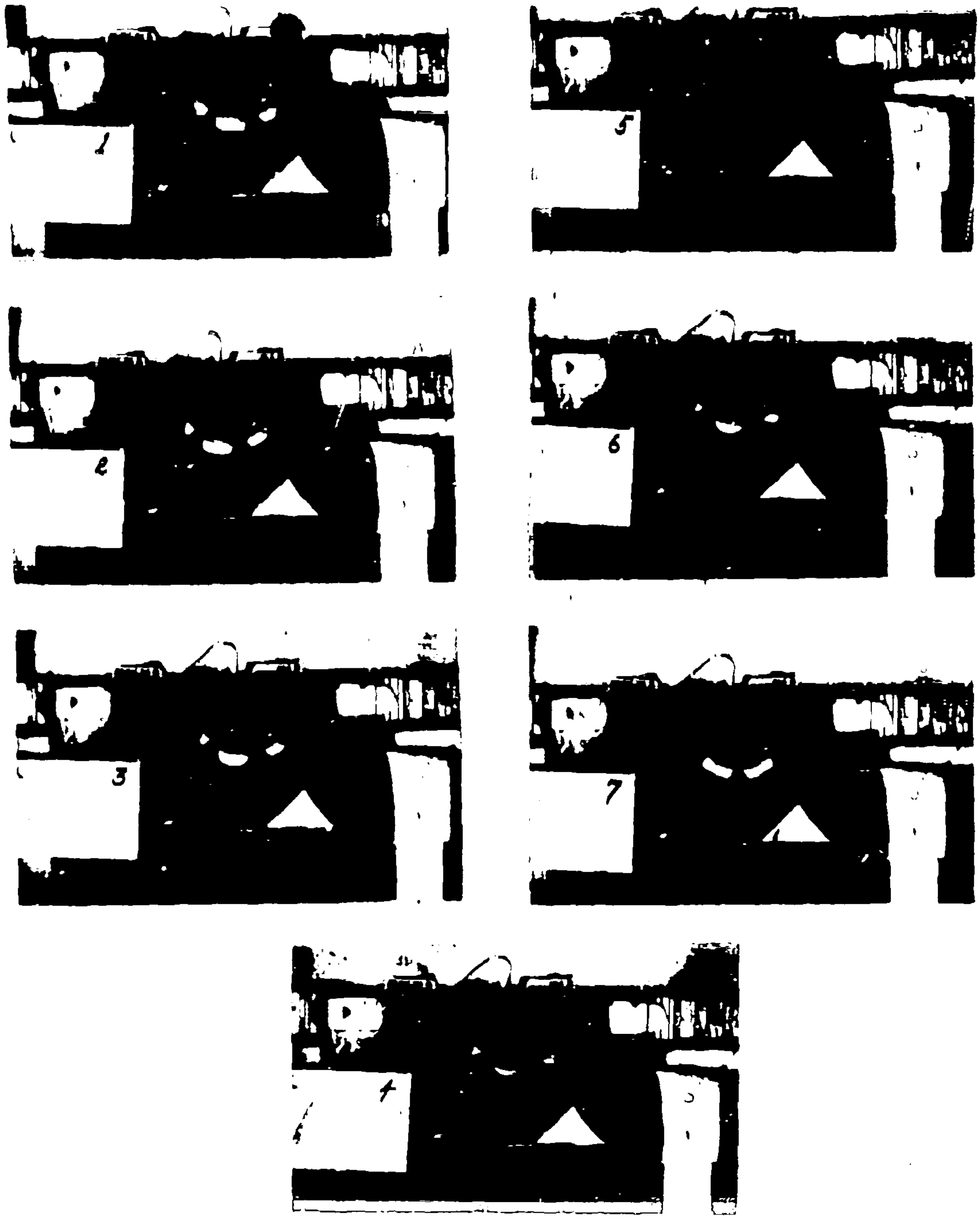


NPG [illegible] [illegible] - SECURITY INFORMATION

[illegible] Film [illegible] Passage Through Harvey Assist [illegible]

Frame 1: [illegible] feeder [illegible] with [illegible] and clutch disengaged.

Frames 2-6: Slow [illegible] Harvey Assist Feeder [illegible] the MK [illegible] Gun Feed [illegible]. In [illegible] frames the [illegible]-switch is [illegible] allowing cu[illegible] feed to energize [illegible] clutch assembly.

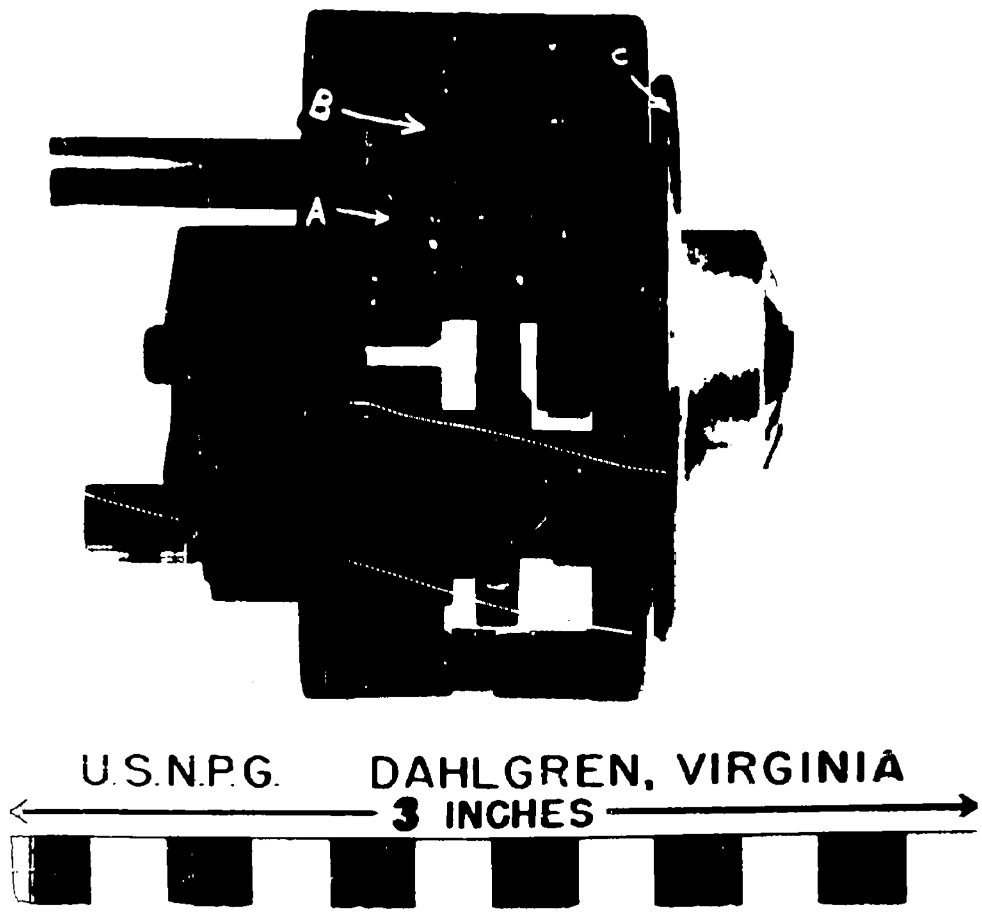
Frame 7: Shows ammunition [illegible] in [illegible] with [illegible]-switch open and clutch disengaged. Direction of ammunition travel is to the right.

Figure [illegible]

APPENDIX B

NP9 48728
Gear reduction [illegible] clutch [illegible] (A) [illegible] burred anti-roll-back rachet wheel, [illegible] (C) Magnetic clutch plate.

Figure 7



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Developed by Harvey Machine Company

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