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 AFATL-TR-75-30

**FUNCTION TESTING OF SMITH AND WESSON
MODEL 15 REVOLVERS MODIFIED TO FIRE
THE 9mm LUGER CARTRIDGE**

**GUNS AND ROCKETS BRANCH
GUNS, ROCKETS AND EXPLOSIVES DIVISION**

FEBRUARY 1975



FINAL REPORT: SEPTEMBER 1974 - DECEMBER 1974

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) The objective of this program was to modify a Model 15 revolver to fire 9mm ammunition and to test the functioning of both .38 Special and 9mm ammunition in the modified revolver. The Air Force modification consisted of machining an annular cut on the rear face of the revolver cylinder and ejector starwheel and reaming each of the six cylinder chambers to accept the 9mm cartridge. In addition, steel half-moon clips were provided to hold and headspace the 9mm cartridges in the modified cylinder. The Smith and Wesson modification consisted of .38 Special and		

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20. ABSTRACT (Concluded)

9mm ammunition changeable revolver cylinders. Both modifications performed satisfactorily.

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PREFACE

This technical report is based on an analysis of tests performed at Eglin Air Force Base, Florida from 4 September 1974 to 19 December 1974 under Project 2560, Task No. 03, Work Unit No. 001. Captain John D. Edgar (DLDG) managed the program for the Armament Laboratory.

This technical report has been reviewed and is approved for publication.

FOR THE COMMANDER

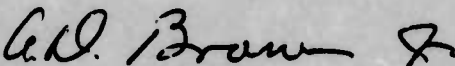

ALFRED D. BROWN, JR., Colonel, USAF
Chief, Guns, Rockets & Explosives Division

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SECTION I

INTRODUCTION

The standard personal defense weapon used by Air Force personnel is the Smith and Wesson Model 15 Combat Masterpiece revolver chambered for the .38 Special cartridge. This revolver is used by security police and base defense forces as well as by aircrew members aboard combat aircraft. The United States is the only country which uses the .38 Special cartridge in a military weapon. The .38 Special M41 ball cartridge is a low pressure (16,000 psi chamber pressure), low velocity (758 ft/sec) round using a 132-grain full metal jacketed bullet. As a result, it has less available bullet energy than other military pistol calibers which are heavier (.45 ACP) or faster (9mm Luger).

A program to evaluate the feasibility of firing 9mm Luger (also known as 9mm Parabellum) ammunition in modified Smith and Wesson Model 15 .38 Special revolvers was established because of the following facts. First, in recent years the M41 ball ammunition has experienced a high frequency of bullet-in-bore incidents. As a result, many lots of this ammunition have been placed on the restricted or suspended list and Air Force inventories are almost entirely expended. Secondly, the Air Force has been evaluating the possibility of adopting a 9mm automatic pistol to replace the .38 revolver as the primary personal defense weapon and/or as a weapon for the aircrew survival vest. At present, the Air Force has a large inventory (over two million rounds) of 9mm ammunition on hand. If a 9mm automatic pistol were adopted, a question would arise as to what to do with the Air Force's inventory of over 100,000 Model 15 .38 Special revolvers. As a possible solution to this problem, Major Stephen J. Bilsbury of the Air Force Armament Laboratory suggested a modification to the Model 15 revolver which would allow it to fire both .38 Special and 9mm ammunition interchangeably.

This report summarizes the results of testing to evaluate the feasibility of the suggested modification.

SECTION II

PROGRAM OBJECTIVE AND REVOLVER MODIFICATION DESCRIPTIONS

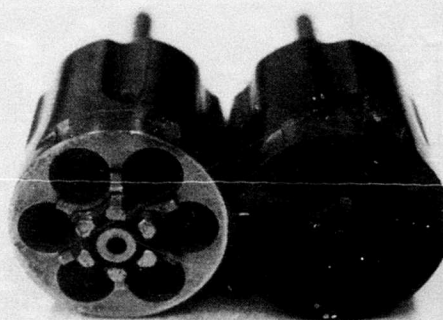
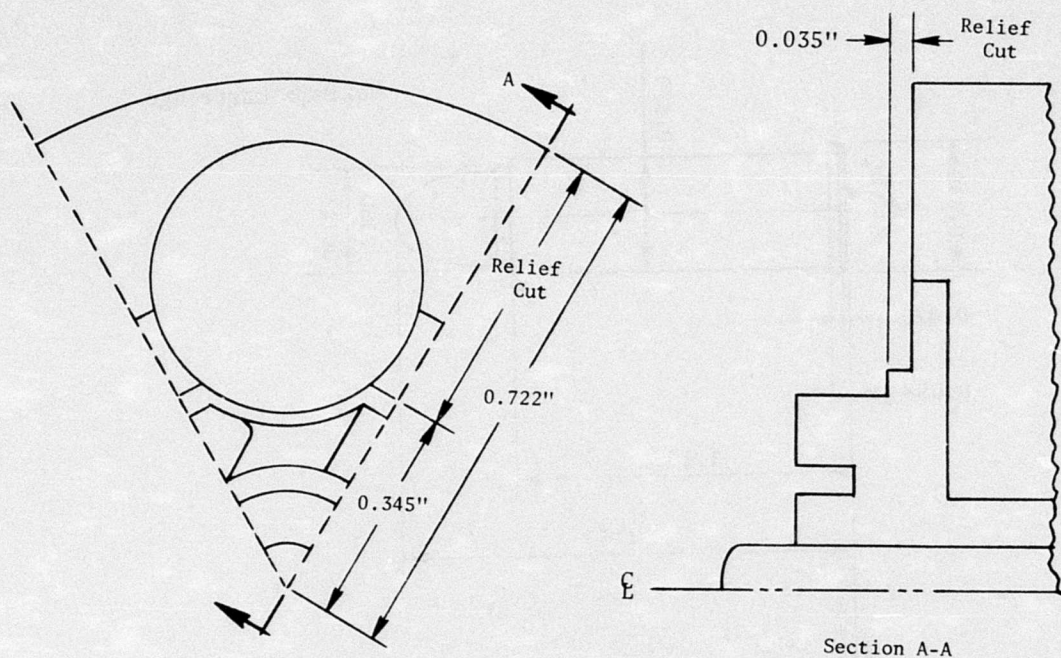
The objective of the program discussed in this report was to modify a Model 15 revolver to fire 9mm ammunition and to test the functioning of both .38 Special and 9mm ammunition in the modified revolver. Midway through the program, Smith and Wesson provided a Model 15 revolver modified by an alternate method which was also capable of firing .38 Special and 9mm ammunition using changeable revolver cylinders.

Air Force Revolver Modification

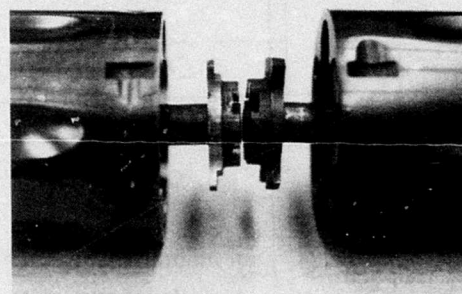
This modification consisted of machining an annular cut on the rear face of the revolver cylinder and ejector starwheel (Figure 1) and reaming each of the six cylinder chambers to accept the 9mm cartridge. These changes were based on the cartridge and chamber drawings (Figures 2 and 3). In addition, steel half-moon clips (Figure 4) were provided to hold and headspace the 9mm cartridges in the modified cylinder.

Basically, the .38 Special cartridge case is a straight walled cylinder, 0.379 inch diameter by 1.155 inches long, which headspaces on a protruding rim which is 0.058 inch thick. On the other hand, the 9mm Luger cartridge case is a tapered cylinder, 0.394 inch in diameter at the base by 0.754 inch long, with a non-protruding rim which is 0.050 inch thick. The 9mm case normally headspaces on the forward lip of the case. Therefore, by reaming the aft section of a .38 Special chamber as shown in Figure 5, the chamber can be made to accept both .38 Special and 9mm cartridges. However, there is no lip in the chamber which the 9mm case mouth can headspace against. Therefore, a steel half-moon clip which snaps into the extractor grooves of three cartridges was used as a device to headspace the cartridges. To securely hold the 9mm cartridges the half-moon clip must be about 0.035 inch thick, the minimum width of the 9mm cartridge extractor groove. This method of achieving proper headspace was used previously on the Army Model 1917 .45 ACP revolver (Figure 6). The outer diameter of the 9mm half-moon clips must be sized to clear the cylinder retaining nib (on the lower left rear of the revolver frame) (Figure 7) during cartridge ejection.

Use of the half-moon clips requires an additional modification to the cylinder. Since there is insufficient clearance between the rear face of the cylinder and the revolver frame, an annular clearance cut must be machined on the rear of the cylinder. The depth of the cut must equal the thickness of the half-moon clip less 0.008 inch (the difference in the cartridge case rim thicknesses). This places the primers of both cartridges the same distance forward of the revolver firing pin. The inner diameter of the annular cut is designed to leave full metal thickness on the inner arcs of the ejector starwheel teeth. When .38 Special cartridges are inserted into the modified cylinder their rims headspace on these inner arcs.



Rear View



Side View

NOTE: The Air Force modified cylinder is on the left with an unmodified cylinder on the right for comparison. In both photos the ejector starwheels are extended slightly to the rear as they would be during ejection.

Figure 1. Cylinder Modifications

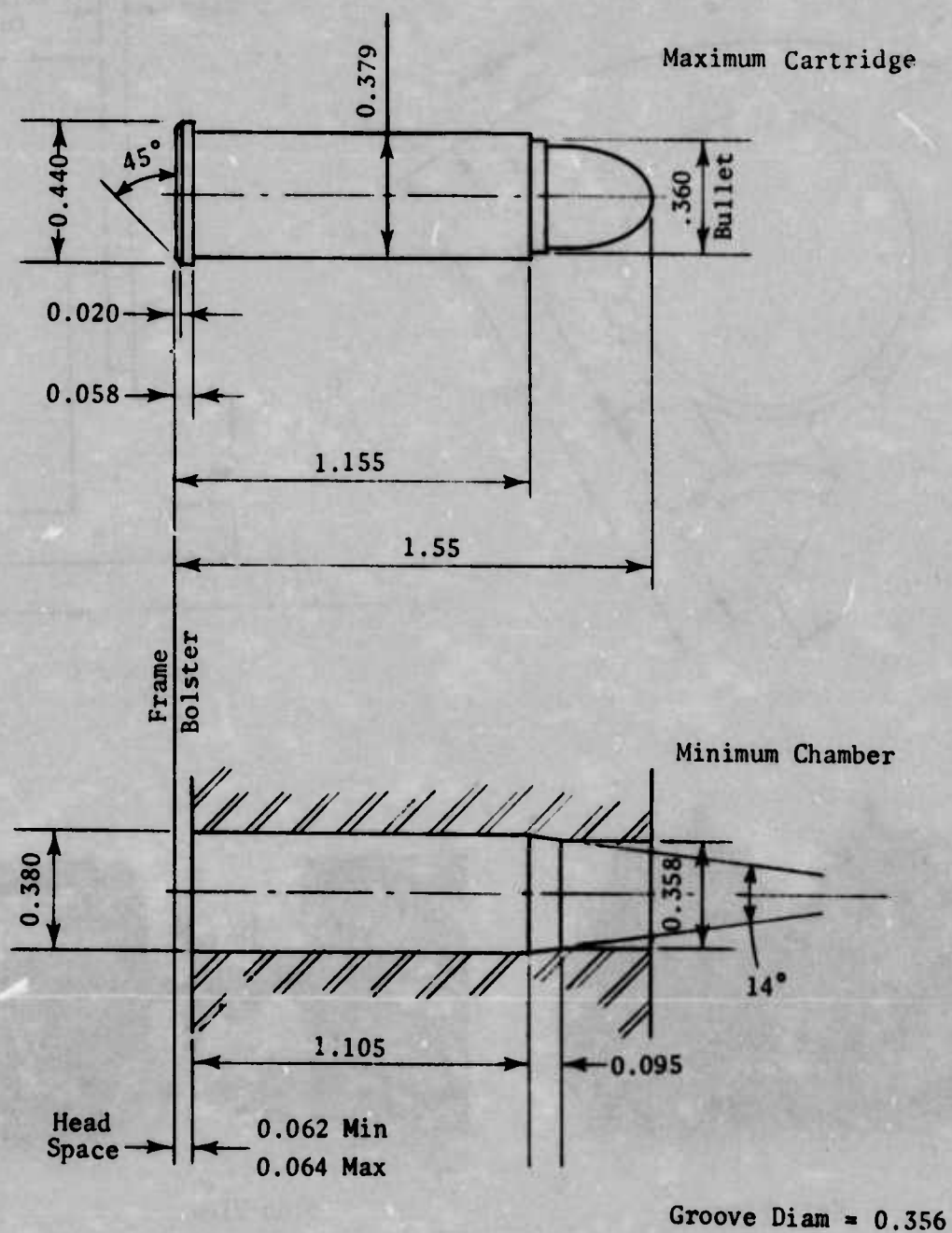


Figure 2. .38 Special Cartridge and Chamber Dimensions

- Revisions
 Ⓐ Radius Reduced from 0.715"



Smith & Wesson
Clip

Air Force
Clip

NOTES:

1. Make from 0.035" thick steel sheet
2. Break all sharp corners
3. Harden to Rockwell C35

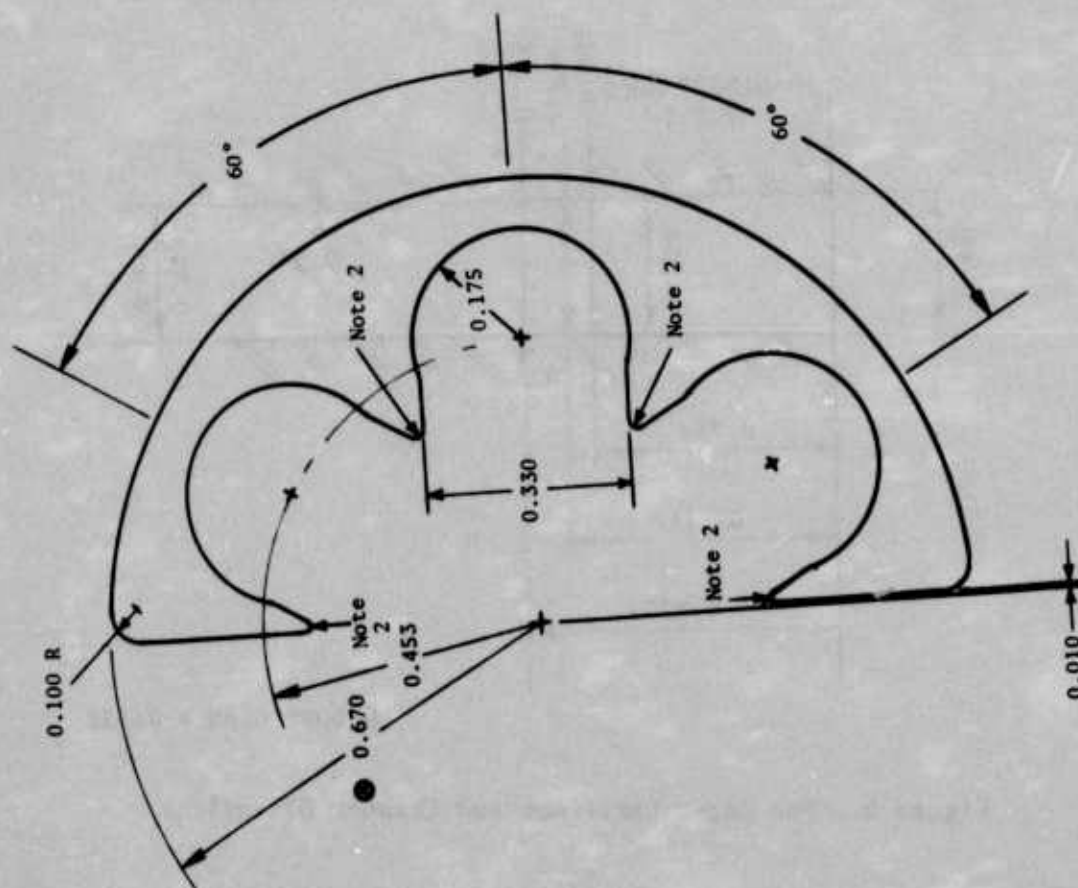


Figure 4. 9mm Half-Moon Clip

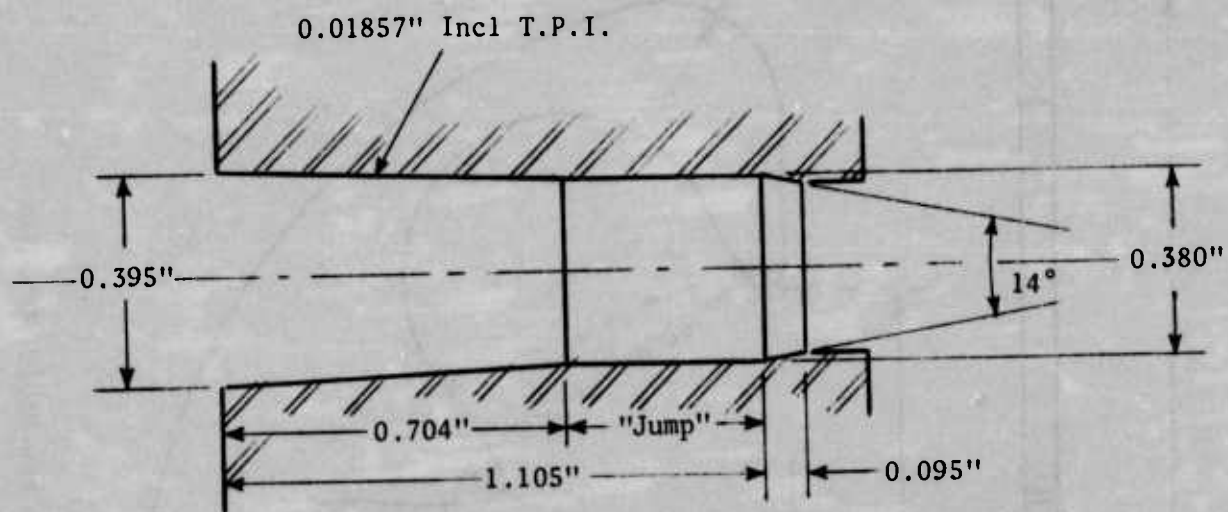


Figure 5. Modified Chamber Dimensions

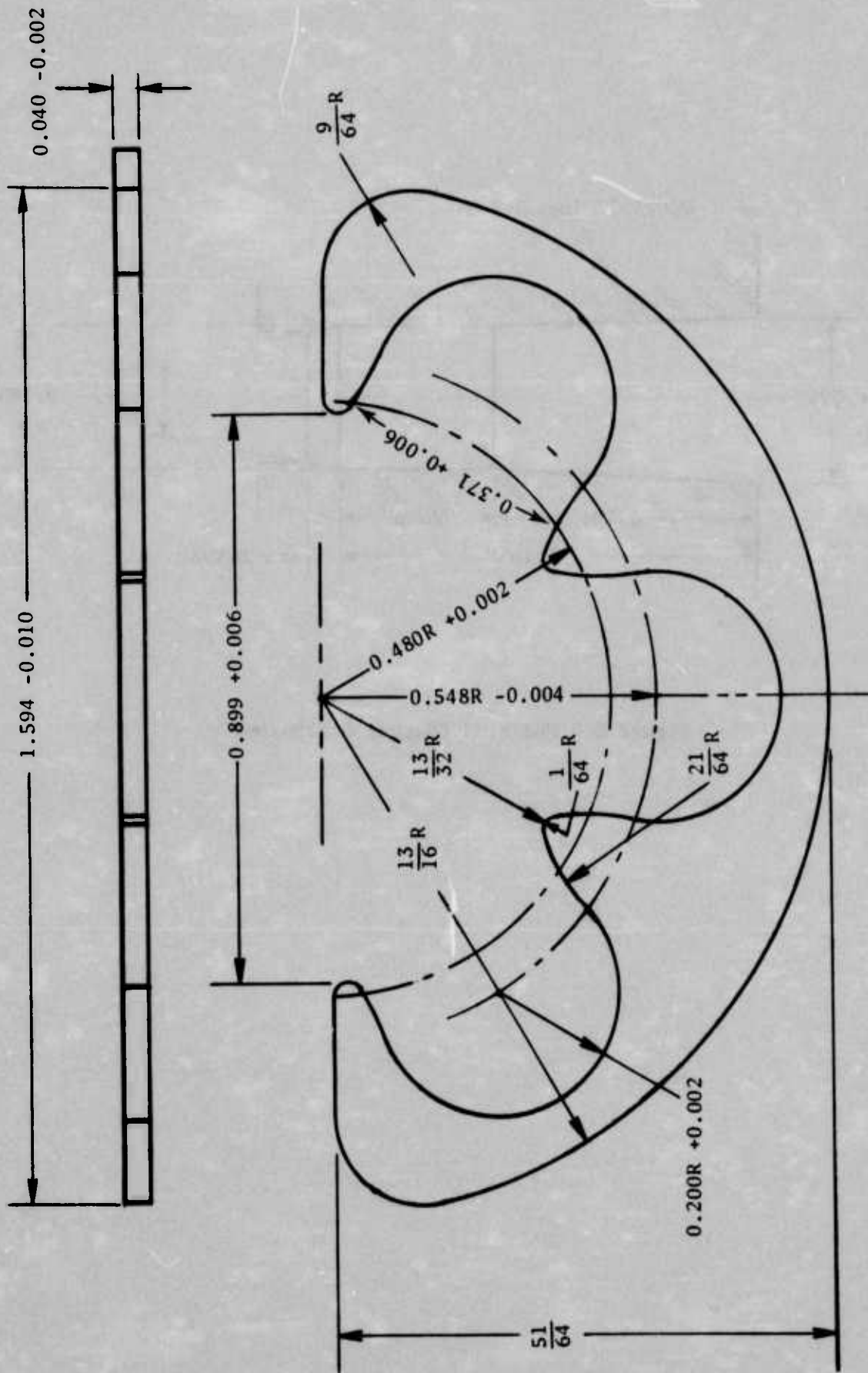


Figure 6. .45 ACP Half-Moon Clip Used in the M1917 Revolver



Figure 7. Interference Between Oversize
Half-Moon Clips and the Cylinder Retaining Nib During Ejection

No modification was made to the revolver barrel since the groove diameters required for the two calibers are almost identical, i.e., 0.358 inch for the 9mm versus 0.356 inch for the .38 Special. The normal rifling twist rate for 9mm ammunition is one turn in 10 inches, whereas it is one turn in 18-3/4 inches for the .38 Special. This difference in twist rate should not affect the stability of the 9mm bullets fired in the modified revolver.

There were several deficiencies in the revolver (serial number 856591) and half-moon clips when they were received from the machine shop. The relief cut on the rear of the cylinder was the same depth as the thickness of the half-moon clips. This moved the 9mm cartridge primer too far forward of the firing pin for reliable ignition. In addition, there were annular machine marks in the aft reamed portion of the chambers which made extracting fired 9mm cases difficult, and the outer diameter of the half-moon clips was oversize so that the half-moon clips hung up on the cylinder retaining nib during ejection. Finally, the actual thickness of the clips was 0.031 inch versus the drawing requirement of 0.035 inch. These deficiencies were not considered serious enough to delay testing of the modification.

Smith and Wesson Revolver Modification

Midway through the testing of the Air Force modified revolver, Smith and Wesson provided the Air Force with a Model 15 revolver (serial number 6K22922) which had been modified to fire both 9mm and .38 Special ammunition. The Smith and Wesson modification consisted of providing the basic revolver action with two cylinders (one chambered in .38 Special and one chambered in 9mm) and two barrels (one with a 1-in-10-inch twist for 9mm and one with a 1-in-18-3/4-inch twist for .38 Special). The rear face of the 9mm cylinder was relieved to accept a set of half-moon clips. The ejector starwheel teeth were completely cut down so that it was impossible to chamber .38 Special ammunition in the 9mm cylinder and obtain proper headspace. Figure 8 shows both the Air Force and Smith and Wesson modified revolvers for comparison.

The Experimental Test Setup

The basic experimental test setup for firing the tests on both revolvers is shown in Figure 9. The wooden grips were removed from the revolver and the bare metal grip placed in the rubber jaw inserts of the machine rest (Ransom Rest manufactured by C'Arco). The machine rest was bolted to a steel table which in turn was bolted to the floor of the firing bay. A wooden stand for holding cardboard yaw cards was located downrange in the line of fire to measure group size. For each shot the hammer was cocked and the gun fired by a lever bearing on the trigger. The machine rest allowed the revolver to recoil in the vertical plane



SMITH & WESSON MODIFICATION

Note: .38 Special barrel and cylinder installed in revolver.
9mm barrel and cylinder shown to the right.



AIR FORCE MODIFICATION

Figure 8. Exterior Views of the Modified Revolvers

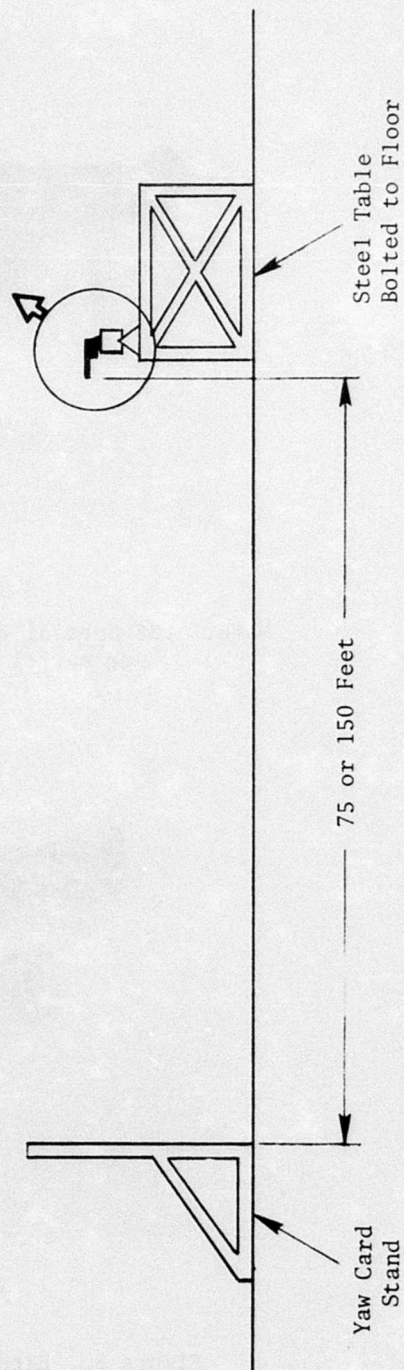
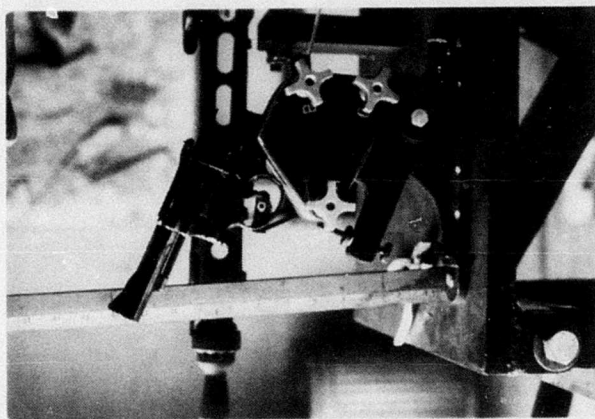


Figure 9. Test Setup for Firing Modified Revolvers

against the resistance of a friction disc in the rest (see inset, Figure 9). After each shot the revolver was returned to firing position against a positive stop and the sequence repeated.

To obtain bullet velocity measurements the revolver was hand held and fired through the ballistic chronograph system in the Armament Laboratory's Interior Ballistics Laboratory.

SECTION III

SUMMARY OF TESTING - AIR FORCE MODIFIED REVOLVER

Total Rounds Fired

An unknown number of .38 Special rounds had been fired through the revolver prior to modification. During the course of the testing a total of 383 9mm rounds and 61 .38 Special rounds were fired.

Gun/Ammunition Functioning

Functioning of the modified revolver with .38 Special ammunition was flawless. Despite the slight stretching of the rear of the cartridge case shown in Figure 10, ejection was easy. There was no evidence of any case splitting or cracking in the stretched area since the case wall thickness is very heavy near the base. When firing the 9mm ammunition, the revolver experienced a 28.6 percent rate of misfires (failure to fire on first trigger pull) and a 4.4 percent rate of complete failures to fire (on repeated trigger pulls). This was directly traceable to light firing pin strikes caused by the incorrect cylinder relief cut depth. When the 0.038 inch thick Smith and Wesson half-moon clips were used in place of the 0.031 inch thick Air Force clips, all 9mm rounds fired on the first trigger pull. Ejection of the fired 9mm cases was difficult due to the rough machine marks in the rear of the chambers.

Mechanical Condition

A major concern during the testing was to determine the effect of the higher pressure of the 9mm cartridge (39,000 psi versus 16,000 psi for the .38 Special) on the structural integrity of the revolver cylinder and frame.

The external dimensions of the revolver cylinder and the internal dimensions of the revolver frame opening were measured prior to beginning testing. Measurements were made with a micrometer dial caliper. After firing 323 9mm rounds and 37 .38 Special rounds the measurements were repeated. There were no indications that the cylinder increased in size or that the frame opening had stretched. There were no visual indications of cracking or failure of any parts.

Bullet Velocity

Bullet velocity was measured as 1206 ft/sec for 9mm military ball ammunition (lot RR-137530) manufactured in 1945. Bullet velocity for .38 Special M41 ball ammunition (lot WCC6059) was measured as 758 ft/sec.

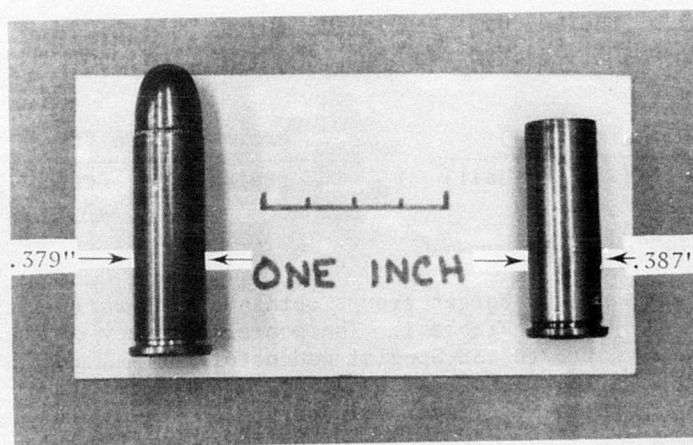


Figure 10. .38 Special Ammunition Before and After
Firing in the Air Force Modified Revolver

Recoil

The subjective evaluation of the person conducting the hand-held velocity firings was that the 9mm ammunition produced greater recoil than the .38 Special wadcutter ammunition. This was expected since recoil is proportional to bullet momentum (mass x velocity) and the relative recoil should vary as shown below:

$$\frac{\text{Recoil (9mm ball)}}{\text{Recoil (.38 wadcutter)}} \approx \frac{115 \text{ grains} \times 1206 \text{ ft/sec}}{148 \text{ grains} \times 671 \text{ ft/sec}} = 1.4$$

The recoil of the 9mm ball ammunition should also be about 39 percent greater than for the standard .38 Special M41 ball ammunition as shown below:

$$\frac{\text{Recoil (9mm ball)}}{\text{Recoil (.38 M41 ball)}} \approx \frac{115 \text{ grains} \times 1206 \text{ ft/sec}}{132 \text{ grains} \times 758 \text{ ft/sec}} = 1.39$$

Bullet Accuracy

The sizes of the target groups obtained with various types of ammunition are summarized in Table 1. The poorer accuracy of the 9mm military ammunition compared to .38 Special wadcutter and M41 military ball ammunition prompted a look into the conditions experienced by the 9mm bullet during firing in the modified cylinder.

As can be seen from Figure 5, the 0.356 inch diameter 9mm bullet must jump a distance of 0.4 inch in an oversized diameter (0.380 inch) hole. It was postulated that the bullet could become severely yawed in this oversized section leading to poor accuracy. To test this hypothesis, a small lot of both 9mm and .38 Special military ball ammunition was broken down into components. The 9mm bullets and powder were loaded into the primed .38 Special cases and the .38 Special bullets and powder were loaded into the primed 9mm cases (Figure 11). Firing these modified cartridges would subject the .38 Special bullets to the jump condition and remove the jump from the 9mm bullets. Table 1 shows that the jump degrades the accuracy of the .38 Special bullets (compare tests 1B and 1C) and the lack of jump improves the accuracy of the 9mm bullets (compare tests 1D and 1E). The magnitude of the degradation/improvement indicates that factors other than jump affect bullet accuracy in the modified revolver.

Half-Moon Clip Life

The 17 half-moon clips made for testing lasted an average of 6.4 firings before one or more of the three cartridge detents failed to securely hold the 9mm cartridge. The clip life ranged from one to 16

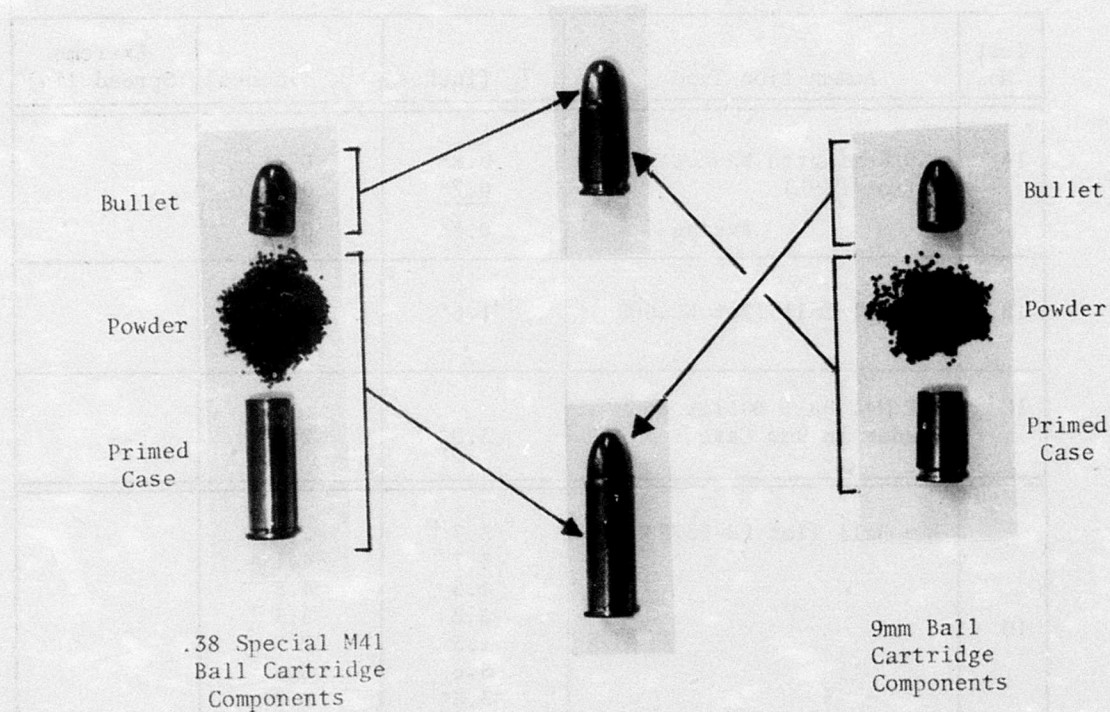


Figure 11. Special Ammunition Used to Test Effect of Bullet Jump on Accuracy

firings as shown in Table 2. The short life of the clips was attributed to improper heat treatment. The Air Force clips were heat treated to a hardness of Rockwell C35 whereas the specifications for the original .45 ACP clip (Figure 6) call for Rockwell C45 to C50.

TABLE 1. ACCURACY OF AIR FORCE MODIFIED REVOLVER
(12-Round Groups at 150 Feet)

Test No.	Ammunition Type	σ_x (inches)	σ_y (inches)	Extreme Spread (in)
1A	.38 Remington Wadcutter (lot P19L) Average	0.8* <u>0.7*</u> 0.8*	0.8* <u>0.8*</u> 0.8*	--
1B	.38 M41 Ball (lot WCC6028)	1.6*	1.4*	--
1C	.38 M41 Ball Bullet & Powder in 9mm Case	3.0*	2.4*	--
1D	9mm Ball (lot RR-137530) Average	3.7 3.7 4.5 3.2 1.3 5.6 <u>3.8*</u> 3.7	2.1 4.1 4.8 5.3 2.3 5.5 <u>5.8*</u> 4.3	--
1E	9mm Ball Bullet & Powder in .38 Case	1.8*	2.8*	--

* Scaled from 75 to 150 ft

TABLE 2. HALF-MOON CLIP LIFE

<u>Clip No.</u>	<u>Times Fired</u>
1	10
2	10
3	3
4	No Data
5	2
6	7
7	3
8	9
9	9
10	10
11	3
12	2
13	2
14	1
15	13
16	16
17	2
Average	6.4

SECTION IV

SUMMARY OF TESTING - SMITH AND WESSON MODIFIED REVOLVER

Total Rounds Fired

An unknown number of .38 Special and 9mm rounds had been fired through the revolver prior to receipt by the Air Force. During the course of the Air Force testing a total of 174 9mm rounds and 84 .38 Special rounds were fired.

Gun/Ammunition Functioning

The revolver and ammunition experienced no failures to fire. The Smith and Wesson half-moon clips held the cartridges very rigidly. As a result, some of the clips would not let the cartridges line up with the cylinder chambers. In this case, as shown in Figure 12, the cartridges and clip would not fully chamber and the cylinder could not be closed. The clips experiencing this problem were not used in the testing. The fired 9mm cases were slightly more difficult to eject than the fired .38 Special cases.

Mechanical Condition

No measurements were made during the tests. However, there were no visible indications of any cracks or parts failures.

Bullet Velocity

No bullet velocity measurements were taken during the tests.

Recoil

Neither qualitative nor quantitative evaluations of revolver recoil were made during the test.

Bullet Accuracy

The sizes of the target groups obtained with various types of ammunition are summarized in Table 3. The change in barrel rifling twist from one turn in 10 inches to one turn in 18-3/4 inches appeared to have an insignificant effect on the accuracy of both the .38 Special ammunition (compare tests 3A and 3B) and the 9mm ammunition (compare tests 3C and 3D).

Half-Moon Clip Life

None of the four clips used in the testing showed any signs of losing their springiness or ability to retain the cartridges.



Figure 12. Failure of a Half-Moon Clip to Fully Chamber in the Smith and Wesson Modified Revolver

TABLE 3. ACCURACY OF SMITH & WESSON MODIFIED REVOLVER
(12-Round Groups at 150 Feet)

Test No.	Ammunition Type/Barrel Twist	σ_x (inches)	σ_y (inches)	Extreme Spread (in)
3A	.38 Western Super Match (lot 87HH3B) 1-in-10-inch twist	1.1	1.3	4.8
		0.6	1.0	3.0
		<u>1.1</u>	<u>1.2</u>	<u>4.6</u>
		0.9	1.2	4.1
	Average			
3B	.38 Western Super Match (lot 87HH3B) 1-in-18-3/4-inch twist	0.6	1.1	4.3
		0.7	1.1	3.4
		0.7	1.2	4.3
		<u>0.7</u>	<u>0.8</u>	<u>3.1</u>
	Average	0.7	1.1	3.8
3C	9mm Ball (lot RR-137530) 1-in-10-inch twist	3.2	2.6	11.1
		4.2	2.5	13.9
		<u>3.8</u>	<u>2.5</u>	<u>12.5</u>
		3.7	2.5	12.5
	Average			
3D	9mm Ball (lot RR-137530) 1-in-18-3/4-inch twist	3.7	2.5	14.0
		3.4	4.9	18.0
		3.9	2.9	13.0
		<u>3.6</u>	<u>2.7</u>	<u>12.9</u>
	Average	3.7	3.3	14.5

SECTION V

OBSERVATIONS

1. The Air Force modified revolver was capable of firing both .38 Special and 9mm ammunition from the same modified cylinder.
2. The fired .38 Special cases were slightly stretched near the base but there were no case failures or gas leakage.
3. Recoil is slightly greater when firing 9mm ammunition than when firing .38 Special ammunition.
4. The 9mm ball ammunition provides a bullet velocity of 1206 ft/sec versus 758 ft/sec for .38 Special M41 ball. The 9mm bullet has 121 percent greater muzzle energy than the .38 Special M41 ball bullet.
5. The 9mm ball ammunition (manufactured in 1945) is about half as accurate as the .38 Special ammunition (manufactured in 1966) when both are fired in the Air Force modified revolver. The accuracy of the 9mm ball ammunition fired in the Air Force modified revolver is comparable to the accuracy obtained firing .45 ACP ball ammunition in a standard issue M1911A1 automatic pistol. (NOTE - In a separate test program the average extreme spread at 150 feet for four standard M1911A1 pistols was measured as 12.4 inches).
6. The Smith and Wesson modified revolver was capable of firing both .38 Special and 9mm ammunition through the use of interchangeable cylinders.
7. When firing 9mm ball ammunition, both the Air Force and Smith and Wesson modified revolvers had comparable accuracy (compare tests 1D and 3D).
8. When firing .38 Special wadcutter ammunition, both the Air Force and Smith and Wesson modified revolvers had comparable accuracy (compare tests 1A and 3B).
9. The barrel rifling twist rate (1 in 10 inches versus 1 in 18-3/4 inches) had no significant effect on the accuracy of the Smith and Wesson modified revolver firing either .38 Special or 9mm ball ammunition (compare tests 3A and 3B and tests 3C and 3D).

SECTION VI

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

1. Both the Air Force and Smith and Wesson revolver modifications are feasible and safe.
2. Both the Air Force and Smith and Wesson modified revolvers have comparable accuracy and performance.

Recommendations

Any future work in modifying .38 Special Model 15 revolvers to fire 9mm ammunition should use the Air Force developed concept since it is less complex in design.

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Hq USAF/SAMI	1	Harry Diamond Labs/AMXDP-TC	1
Hq USAF/XOXFCM	1	DDC/TC	2
Hq USAF/XOOWA	2	USAFTFWC/TA	1
AFSC/IGFG	1	Comdr/Nav Wpns Lab	1
AFSC/SDWM	1	Watervliet Ars/SARWV-RDT-L	1
Hq AFSC/DLCAW	1	Plastec/Picatinny Ars	1
AFML/DO/AMIC	1	USNWC/Code 51102	1
AFIT/LD	1	Honeywell, Inc	1
ASD/YEM	10	AERO	1
ASD/ENYS	1	Alpha Rsch Inc	1
ASD/ENAZ	1	Ogden ALC/MMNOP	2
AFFDC/PTS	1	AF Spec Comm Ctr/SUR	2
TAC/DRA	1	Hq Dept of the Army/DAMA-WSA	1
SAC/LGWC	1	Picatinny Ars/SARPA-FR-S-A	1
Hq SAC (NRI/STINFO Lib)	1	US Atomic Energy Comm/Lib	1
WRAMA/MMEBL	1	AEDC/ARO, Inc/Lib/DLCS	1
CIA/CRE/ADD/Publications	2	USA Material Sys Analy Agcy/	
AFWL/LR	2	AMXSY-DA	1
AUL/AUL-LSE-70-239	1	US Army Material Comd/AMCRD-WN	1
Redstone Science Info Ctr/Doc Sec	2	Naval Wpns Eval Fac/Code WE	1
USA Wpns Comd/SAPRI-LW-A	1	Chief of Nav Opns/OP-982E	1
AMSXY-DD	1	Naval Rsch Lab/Code 2627	1
AMXGY-A	1	Cal Inst of Tech/Jet Prop Lab	5
AMXBR-TB	1	USAF TAWC/AY	1
Frankford Ars/Lib, K2400	1	TAWC/TRADOCLO	1
Picatinny Ars/SARPA-TS	1	AFATL/DL	1
USN Wpns Lab/9X	1	AFATL/DLB	1
USN Nav Ord Lab/Tech Lib	2	AFATL/DLY	1
Nav Ord Stn/Tech Lib	1	AFATL/DLOU	1
Nav Wpns Stn/20323	1	AFATL/DLOSL	2
Nav Sys Ctr/Tech Lib, 154	1	AFATL/DLYV	1
USN Wpns Ctr/Code 533	2	AFATL/DLDL	1
Comdr USNWC/Code 4565	1	AFATL/DLDA	1
AF Wpns Lab/Tech Lib	1	AFATL/DLDE	1
Nav Air Sys Comd/Code AIR-5323	1	AFATL/DLDT	1
Office Nav Rsch/Code 473	1	ADTC/WE	1
NASA STINFO FAC/Acquisitions Br	1	AFATL/DLDG	10
Univ of Cal/Chem Dept/L-402	1	ASD/ENYEHM	1
Univ of Cal/Tech Info Dept L-3	1		
Los Alamos Science Lab/Rpt Lib	1		
Chem Prop Info Agcy	2		
Battelle Mem Inst/Rpts Lib	1		
Infrared Info Analy Ctr/			
Univ of Mich	1		
Inst for Def Analy/Class Lib	1		
Sandia Labs/Div 5625	2		