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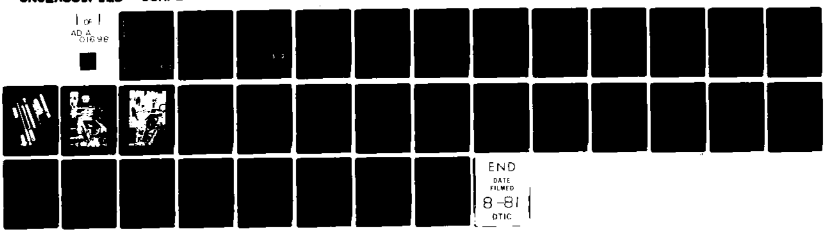

LEVEL II

AD A101698

81APB521

HIGH IMPULSE GUN AIRBORNE DEMONSTRATION

GAU-13/A WEAPON, FEED SYSTEM, GUN DRIVE AND ELECTRONIC CONTROLS

Edwin J. DePasqual

General Electric Company
Armament & Electrical Systems
Department

1 May 1981

The view, opinions, and/or findings contained in this report are those of the author(s) and should not be construed as an official department of the Army position, policy or decision, unless so designated by other documentation.

Final Report for Period 3 Aug 1979 — 31 Oct 1980

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Prepared for

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

A final test report is presented outlining gun and feed system considerations for integration and testing with the FORC recoil system. Gun modification, gun drive and feed system design efforts, and system testing is discussed.

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SUMMARY

The HIGAD test bed described in this report consists of a four barrel, GAU-8/A class, 30-mm Gatling type weapon with associated feeder and dual rate drive, and a microprocessor-controlled, hydraulically-operated recoil attenuation system. This recoil system is referred to as FORC (Force Optimized Recoil Control) and is ~~utilized~~ for the 360 shot-per-minute (spm) rate. A second recoil system is ~~utilized~~ for the higher rate of 720 spm. This system is a passive low force recoil system.

Complete interface requirements were established through many joint meetings between General Electric, Honeywell, and ARRADCOM. The resulting ~~very successful~~ test program has demonstrated flawless gun system performance in the HIGAD test bed. A total of 161 rounds were fired for set-up and checkout purposes at the General Electric Firing Range prior to delivery to ARRADCOM. At Rock Island, 972 rounds were accumulated on the gun system during evaluation of the FORC recoil system. The demonstrated performance of the gun and feed system will be an asset in the upcoming phases of high impulse gun integration.

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PREFACE

This final test report addresses General Electric's HIGAD contract efforts only. These efforts include the design, fabrication, and testing performed in the integration of the GAU-13/A weapon into the HIGAD test bed. A significant part of the contract effort also included on site technical support for the weapon systems operation. The technical representative provided assistance in evaluating test data as well. Highlights of the individual tests are given within the test schedule in Appendix A. The system fire test plan can be found in Appendix B.

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Section 1
INTRODUCTION

There are two major areas of the proposed weapon system requiring the maximum design effort in order to obtain project success. They are: 1) providing the necessary input signals to the recoil system microprocessor, and 2) providing a gun with a feed system and gun drive compatible with the overall operating requirements. The following sections detail the needs, and solutions taken in fulfilling the unique integration requirements of the HIGAD project.

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Section 2
ELECTRONIC CONTROL AND INPUT SIGNALS

The electronic controls for the gun and feed system portion of the HIGAD test bed are based around the control features of the GPU-2/A lightweight, 20-mm aircraft gun pod. The gun pod electronics consist of a battery, battery charger, and gun control. The gun control circuitry provides power to the gun drive motor, brake control, feeder control, and gun firing rate control. This unit was chosen for the HIGAD test bed because the control requirements for the gun pod were almost identical. The GPU-2/A is a dual firing rate system. It was also determined that the gun pod gun drive and motor had sufficient horsepower to drive the GAU-13/A 30-mm weapon at the 360 and 720 spm rates.

The test system requires many input signals pertaining to the gun operation sequence. To ensure reliable operation of the system, solid state proximity sensors are used to control and sequence the gun functions. The following signals were provided to either the gun control circuitry or the FORC recoil microprocessor.

Blast Deflector	—	Senses that each round has actually fired.
Sprocket Sensor	—	Senses feed system start-up.
Projectile Sensor	—	Located on unloading side of transfer housing to sense any unfired rounds
Safing Sector Signal	—	*Senses position of safing sector*
Safing Sector Motion	—	Indicates whether or not complete travel of safing sector has been made
Turnaround Torque	—	Senses torque on transfer loading and unloading sprocket shafts
Rotor Gear Tooth Signal	—	Senses rotor speed for rate control
Start Signal	—	Senses initiation of gun firing sequence

The various sensor outputs are integrated into the HIGAD test bed through an instrumentation junction box. A control electronics box provides switching capability for high and low firing rates along with master arm control functions. A schematic diagram for the HIGAD interface is shown in Figure 1.

GUN MODIFICATION

The present design of the GAU-13/A 30-mm, four barrel weapon is optimized for firing rates up to 2700 spm. This configuration has two disadvantages for the HIGAD test bed application. The gun bolt action at low firing rates is hindered because the locking sequence is not completed before the round is fired. The second disadvantage comes from the offset location of the firing barrel. An offset load is present in all Gatling guns due to the fact that the firing barrel is not on the center of gravity of the weapon. This disadvantage is accentuated in the HIGAD test bed because this offset has not been accounted for in the weapon mount. Both of these problems have been remedied with one design change.

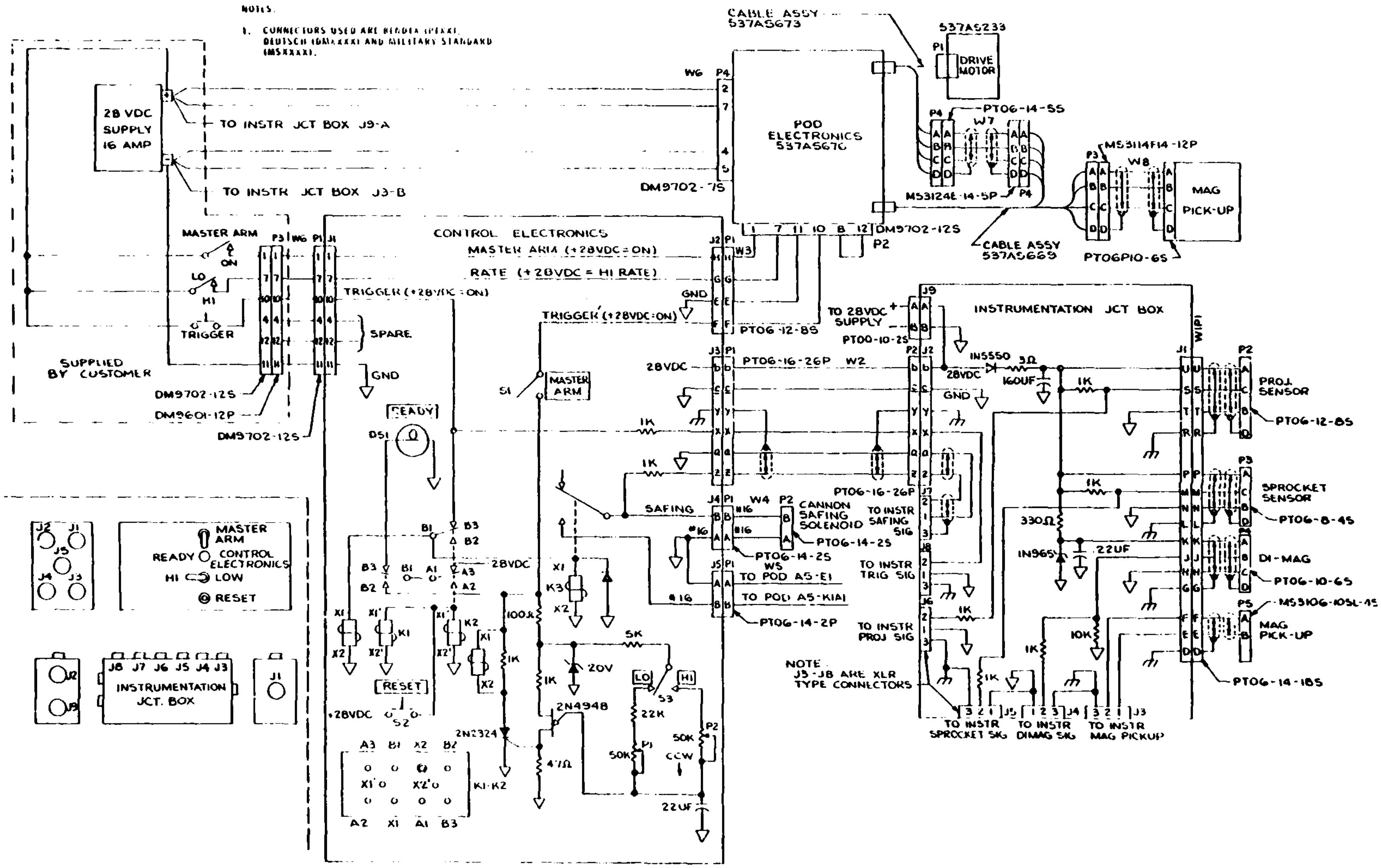

Figure 1. HIGAD Interface Schematic Diagram

By changing the sear point on the firing cam from 29.5 degrees to approximately 3 degrees before top-dead-center (TDC), the problems associated with low firing rates are eliminated. This allows for additional locking time before pressure, and places the peak pressure position at 0 degree TDC which eliminates side loading. This firing position is optimized for the best performance based on firing rates of 360 and 720 spm. This modification has been accomplished through design and use of a new firing cam and safing sector. Figure 2 shows a cross sectional view of the firing and safing cam assembly. Minor modifications to the receiver housing were also made to accommodate mounting features for the safing solenoid in its new location.

Some additional modifications to the receiver housing were made to provide mounting bosses for the closed loop conveyor chute. Ten small round bosses were welded onto the housing to provide this support.

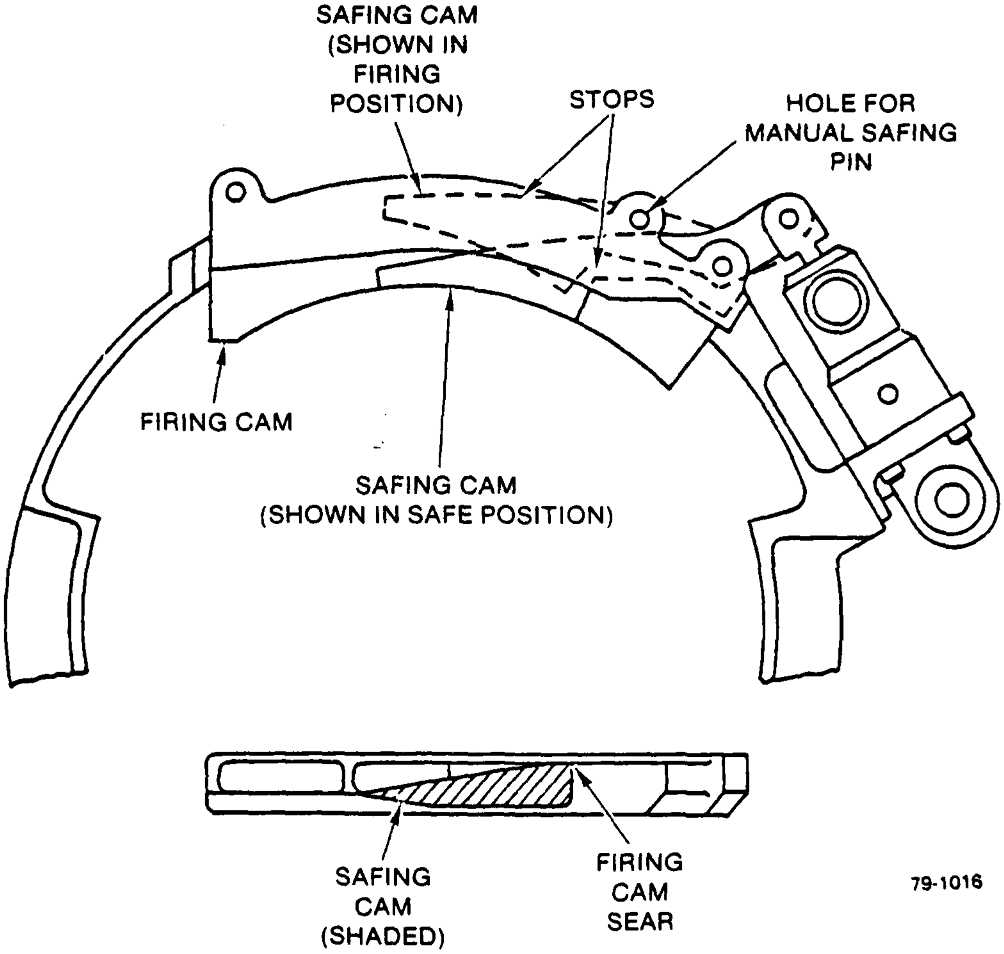

Figure 2. Firing and Safing Cam Assembly

CLOSED LOOP FEED SYSTEM

In order to accommodate the relatively large gun excursions it became necessary to depart from previous closed loop feeder designs. The original feed system consisted of a series of conveyor elements in a flexible track or chuting to form a continuous loop in which all the rounds were stored. This type of chuting will not withstand gun firing accelerations over the 4 to 10 inches of motion expected. Flexible chuting will most likely be subject to fatigue failures and lack of round control will cause jams. A modified feed system design was adopted to function with the increased recoil travel.

The new design is basically the same as the original in concept. The flexible chuting has been replaced with rigid chuting forming a loop around the gun housing. This design affords the maximum stiffness and hence, better control of the rounds as they move through the system.

A maximum of 15 rounds can be stored in the feed conveyor. There are a total of 19 round spaces counting the four empty barrels. For purposes of the HIGAD test, a 10 round burst length was selected. Ten round bursts provided ample firing data and allowed more test cycles due to the limited supply of ammunition.

While the system represents a heavy alternative in feeder design, it has served as a cost effective solution for the HIGAD test bed requirements.

GUN DRIVE MECHANISM

The primary goal in providing a gun drive mechanism for the HIGAD test bed was to furnish a dual rate of fire. Firing rates of 360 and 720 spm were established by earlier studies, based on frequency effects on the AH-1G airframe. A need for a rate tolerance of ±5 percent also had an effect on the drive design. Use of the previously proposed pneumatic device was declined for two reasons. The controls on the air motor have a specified rate tolerance in the neighborhood of ±6 percent at 3600 spm. It was not known what the performance would be at rates below 1000 spm. The second reason centered around the fact that the available air drives were configured to provide reverse clearing. This was not compatible with the HIGAD testing since too much modification would be necessary.

The gun drive design chosen involved modifying an existing gear drive utilized in another GAU-13/A application. The end result was a universal gearbox having potential for many output speed combinations. This was accomplished by taking the existing compact gearbox design and laying the gear centerlines along the same plane. An output shaft can be taken off of each gear pass, each having a different output speed. A simple rectangular gearbox housing and cover was also designed to package the reconfigured gear train, shown in Figure 3.

HIGH RATE RECOIL ATTENUATION

A low force recoil system was furnished by General Electric for the purpose of testing at the higher rate of fire, 720 spm. This is a passive system that was designed and built with funding from an independent research and development program. While this recoil system was optimized for the 720 spm rate, it was analyzed and tested for 360 spm as well.

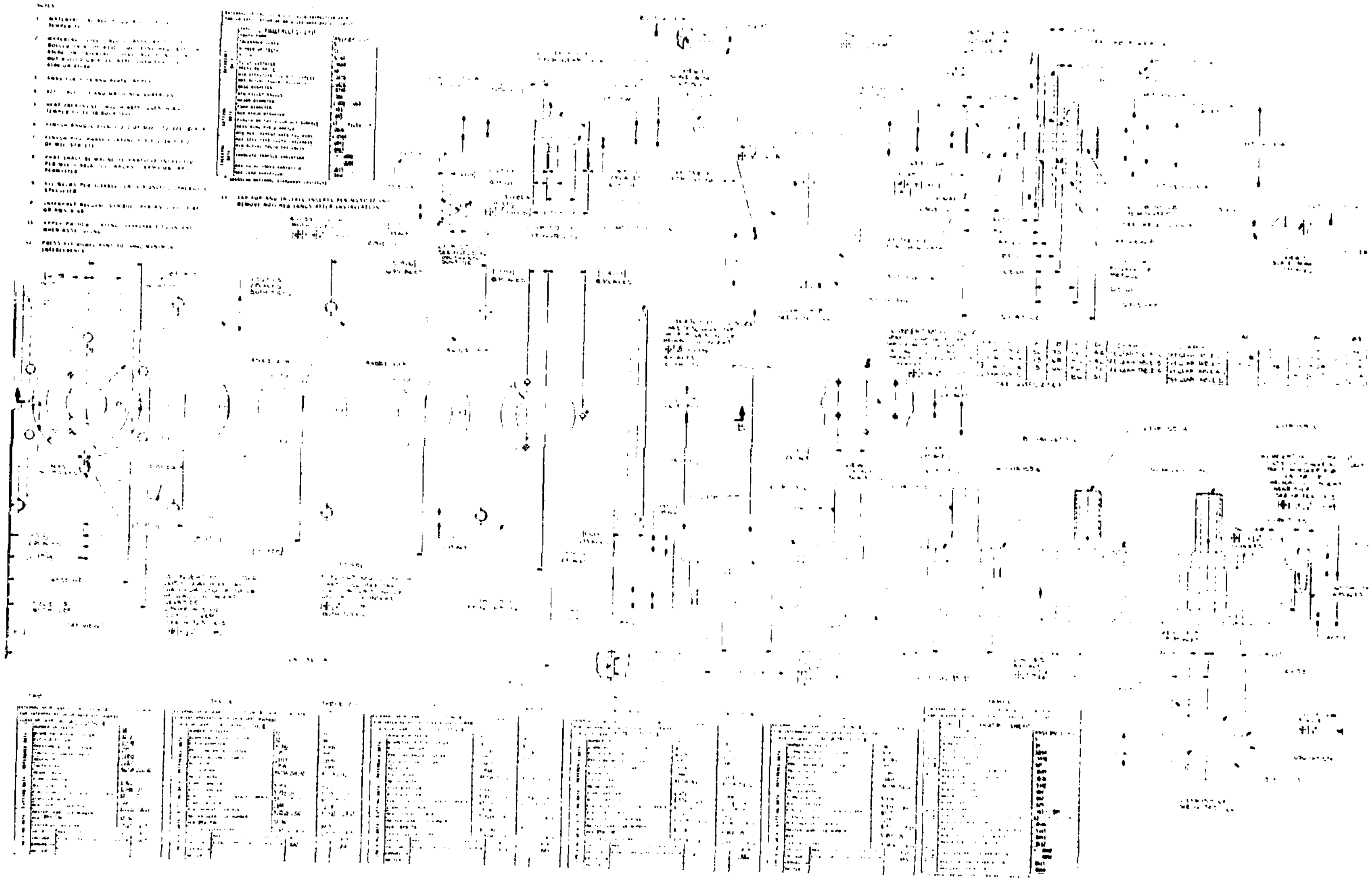

Figure 3. 430 Test Gearbox

The recoil adapter, slider, and attaching hardware were designed to mount within the Honeywell designed cradle so as not to interfere with any of the FORC hydraulic equipment. Details of the recoil adapter and slider assemblies are shown in Figure 4.

GENERAL ELECTRIC TESTS

The GAU-13/A gun and feed system shown in Figure 5 was mounted on a framed structure for initial test cycling and fire testing at General Electric. Prior to live firing, dry cycling was done to verify the presence and intensity of the various signals and sensor outputs. Cycling time was also used to roughly calibrate the electronic rate control and burst timing sequence.

On October 9, 1979, four proof rounds were fired after which the breech bolts were mag particle inspected and approved. On the following two days, a total of 161 rounds were fired successfully with no gun or system stoppages. Appendix I contains specific test results. Having obtained satisfactory results for both 360 spm and 720 spm rates the system was readied for shipment to Honeywell Defense Systems Division; Hopkins, Minnesota on February 13, 1980. Honeywell provided further system integration with their FORC recoil system before sending the system to the U.S. Army for the formal testing phase.

GOVERNMENT TESTING

The formal testing phase was completed at the U.S. Army Armament Research and Development Command's Ware Simulation Center, Rock Island, Illinois. General Electric personnel were present for all formal testing to provide assistance where necessary. A total of 972 rounds were fired through this phase of testing. The gun and feed system performed flawlessly through this phase as well.

Appendix A also contains specific results of these tests.

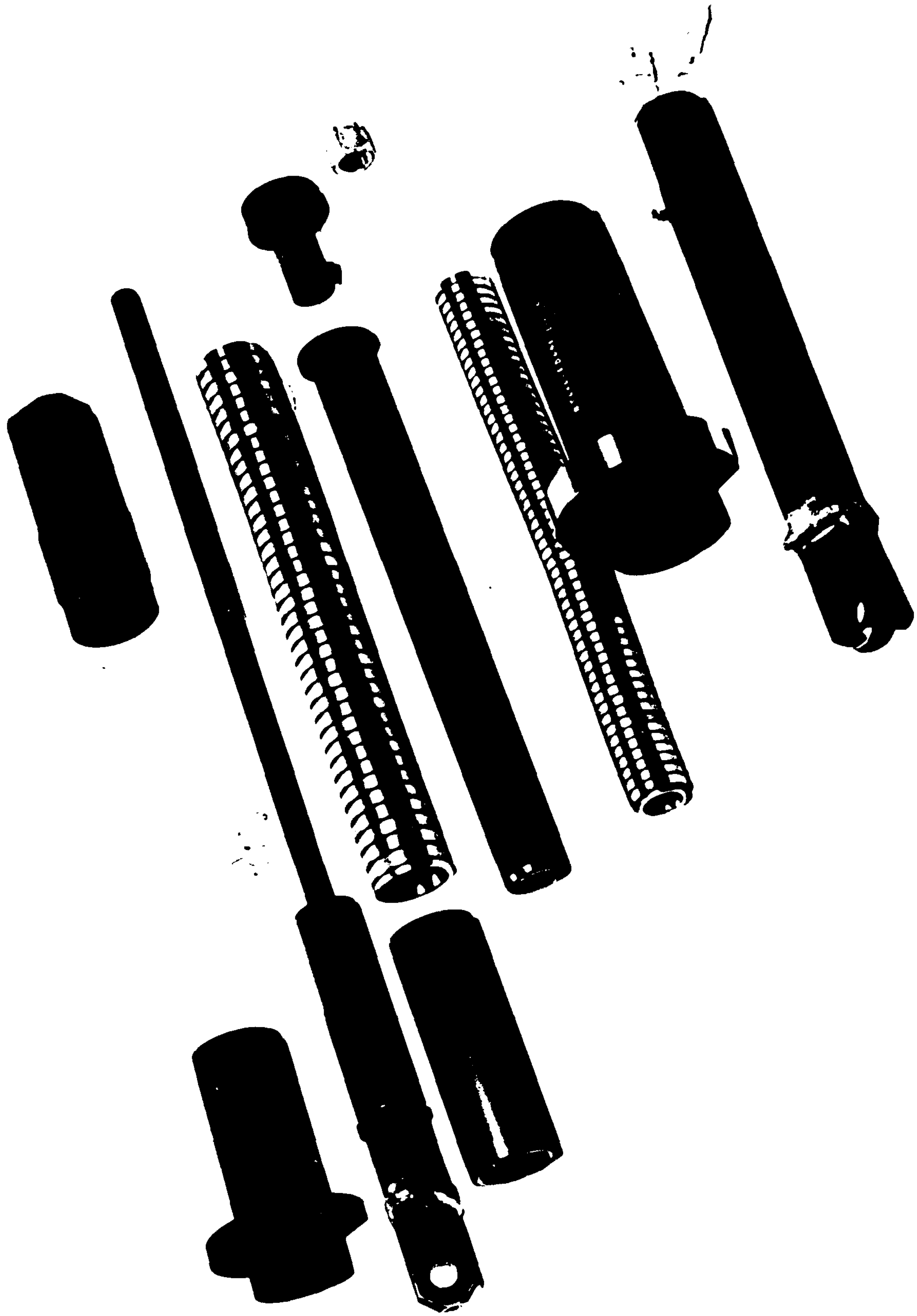

Figure 4. Recoil Adapter and Slider Assemblies

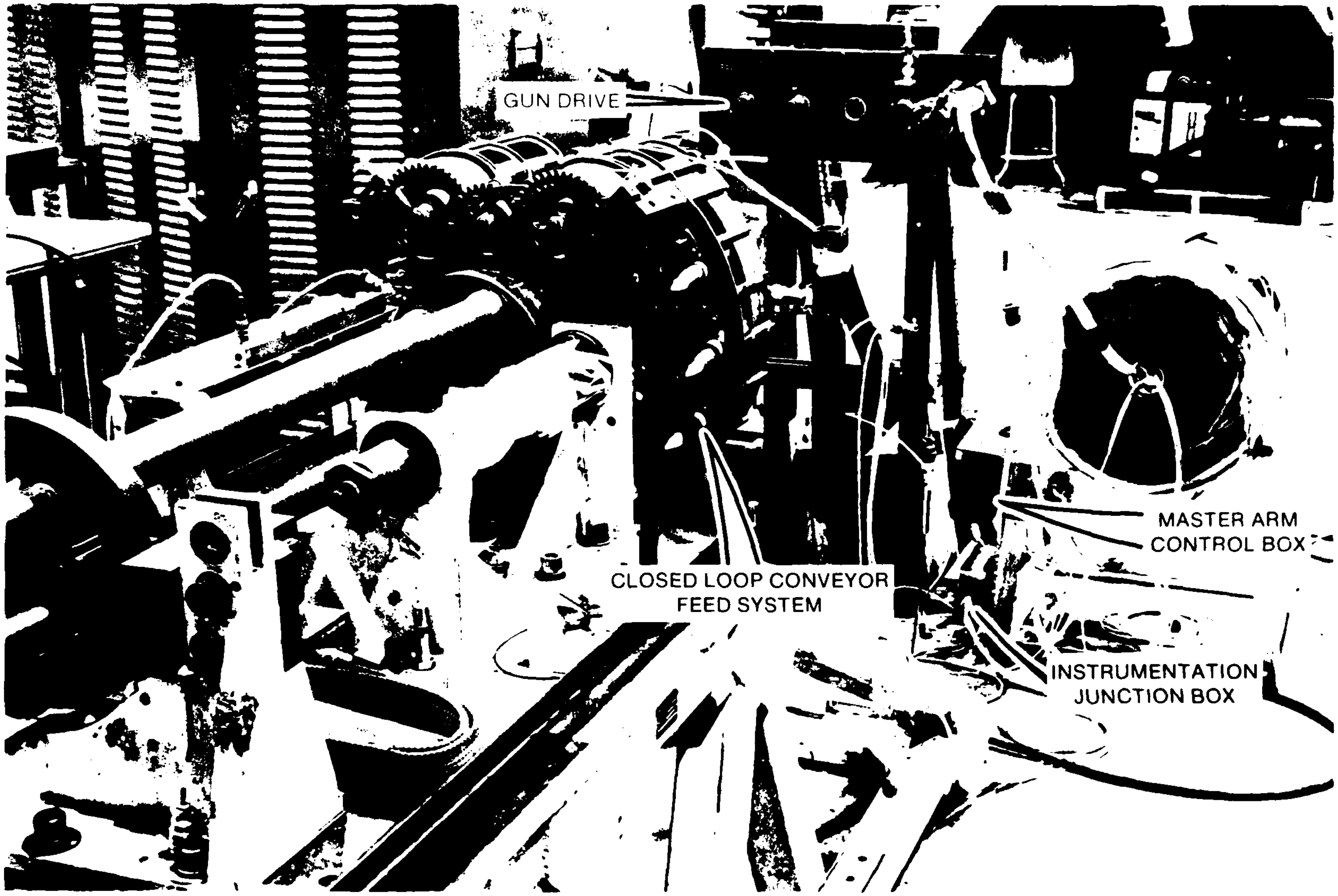

Figure 5. GAU-13/A Weapon and Feed System (Sheet 1 of 2)

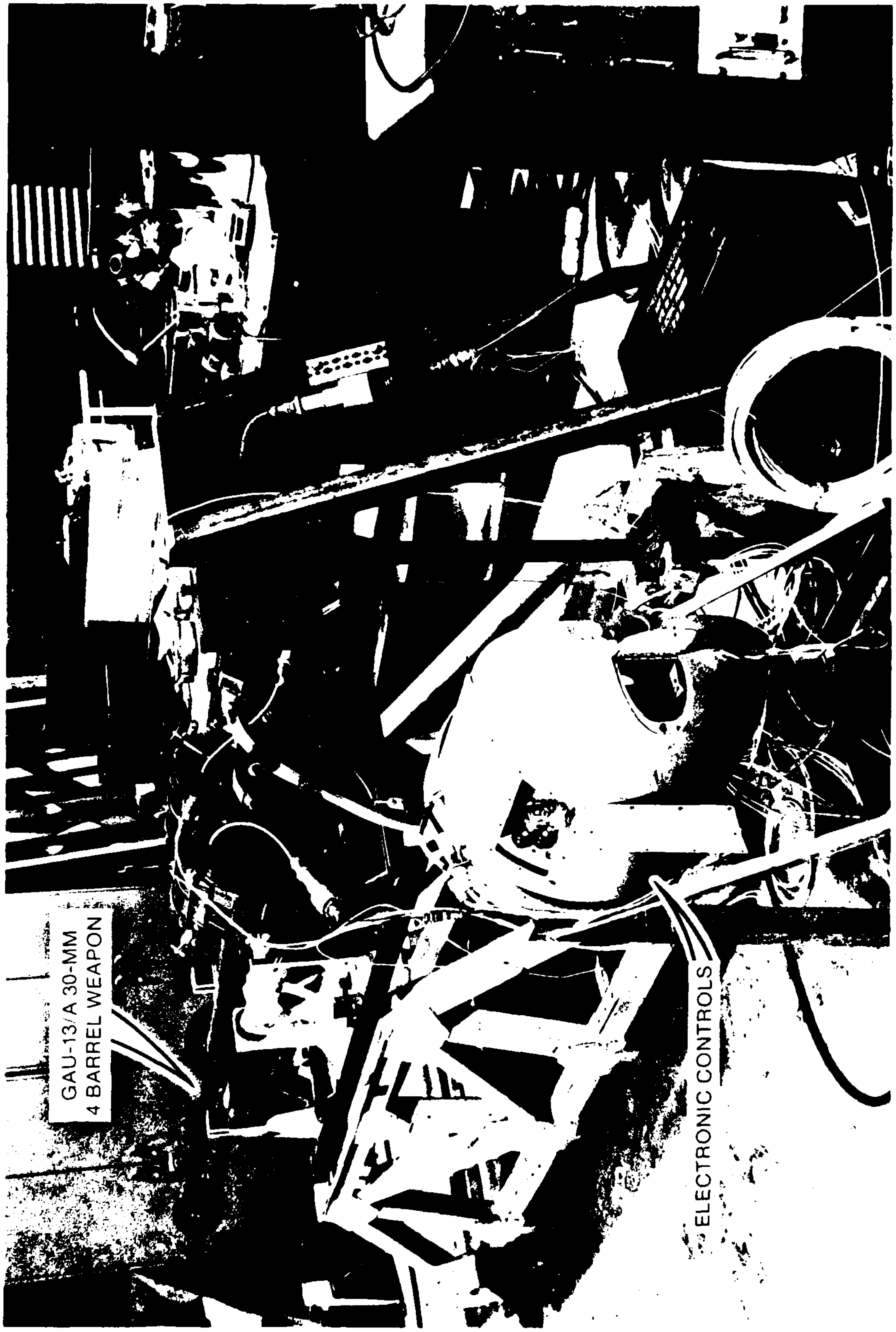

Figure 5. GAU-13/A Weapon and Feed System (Sheet 2 of 2)

Section 3
CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

The data presented in this report are a summary of the testing conducted. All performance goals involving the gun and feed system were successfully demonstrated. The hardware performed so reliably that the planned scheduled maintenance was not necessary. Excellent ballistic accuracy results were also observed.

General Electric recognizes the need for an application of a high impulse weapon system for the attack helicopter role. This successful demonstration at this early stage of a feasibility program is sure to have a marked effect on the success of the whole project.

RECOMMENDATIONS

Further efforts into high impulse weapon integration leading to actual flight testing will require some additional hardware refinements. The following recommendations should be accomplished prior to, or at least concurrently in the upcoming phase of study.

a) Provide a compact replacement for the gun control electronics

b) Provide a lightweight gun drive mechanism that will attach to the gun

APPENDIX A
TEST SCHEDULE

TEST SCHEDULE

Date	*Burst #*	*Rate (spm)*	*No. Rounds Fired*	*Cum. No. Rounds Fired*	*Remarks:*
			LOCATION: UNDERHILL, VERMONT		
10/ 9/79	B1	720	1	1	Proof round 2.35 in. recoil
	B2	720	3	4	Proof rounds, rounds yawed
10/11/79	B3	710	1	5	Ammo lot AJD 19-2
	B4	—	0	5	No fire, chng. soft start
	B5	700	1	6	
	B6	700	4	10	
	B7	700	4	14	Brake off
	B8	700	10	24	Nicks on base of cases
	B9	700	10	34	Nicks on base of cases
	B10	720	10	44	Nicks on base of cases
	B11	720	10	54	Changed transfer unit timing to correct
	B12	710	10	64	
	B13	370	10	74	Low rate, no trigger release, cycle to check
10/12/79	B14	715	10	84	
	B15	720	10	94	
	B16	720	7	101	Burst interrupted by electrical problem
10/15/79	B17	370	10	111	Low rate
	B18	370	10	121	Low rate
	B19	370	10	131	Low rate
	B20	720	10	141	
	B21	720	10	151	
	B22	720	10	161	
			LOCATION: ROCK ISLAND, ILLINOIS		
4/30/80	B1	360	1	1	G.E. recoil system set-up and
	B2	360	1	2	check-out bursts
	B3	360	3	5	
5 1 80	B4	360	5	10	
	B5	360	5	15	Slow counter recoil
	B6	360	5	20	Check mount for binding
	B7	360	5	25	5 round bursts to check for repeatability

TEST SCHEDULE

Date	*Burst #*	*Rate (spm)*	*No. Rounds Fired*	*Cum. No. Rounds Fired*	*Remarks:*
	LOCATION: ROCK ISLAND, ILLINOIS (CONTINUED)				
	B8	360	10	35	
	B9	360	10	45	
	B10	360	10	55	
	B11	360	5	60	
	B12	360	5	65	
	B13	720	5	70	Baseline high rate
	B14	720	5	75	
	B15	720	10	85	
	B16	720	10	95	
	B17	720	5	100	
7/ 1/80	B18	360	1	101	Honeywell recoil system checkout
	B19	360	0	101	System abort, fwd, vel. slow
	B20	360	1	102	Dump valve malfunction
	B21	360	1	103	Single round to test dump valve operation many test cycles between bursts
	B22	360	1	104	
	B23	360	1	105	
	B24	360	1	106	
	B25	360	1	107	
	B26	360	1	108	
	B27	360	1	109	1 nofire/safing sector open
	B28	360	2	111	
	B29	360	2	113	1 no fire/electrical malfunction
	B30	360	2	115	1 no fire/electrical malfunction
	B31	360	2	117	1 no fire/electrical malfunction
	B32	360	2	119	1 no fire/electrical malfunction
7/ 2/80	B33	360	1	120	Abort signal given after fireout
	B34	360	2	122	
	B35	360	3	125	
	B36	360	4	129	
	B37	360	5	134	
	B38	360	4	138	1 no fire/change to soft start
	B39	360	5	143	Lowered velocity gain
	B40	360	0	143	No fire, 5 loaded fwd. velocity abort, adjust soft start
	B41	360	0	143	1 no fire/abort

Remaining test data are contained in U.S. Army documentation at the Ware Simulation Center, Rock Island, Illinois.

APPENDIX B
FIRE TEST PLAN

M30 4 BBL, LOW RATE OF FIRE

RECOIL TEST PLAN

PREPARED BY: Ron Snyder
Des Spec

APPROVED BY: Andy Johnson
Des Engr

INTRODUCTION

This test plan and safety procedure has been written specifically for the 4-30 Honeywell Recoil Adapter Test.

The procedures outlined within are merely a guideline and may be modified by the test engineer as conditions may warrant.

In the event of a gun malfunction it must be understood that all conditions cannot be covered by a check list and that the sole responsibility to clear a hot gun not covered by the procedures outlined within, lie with the test engineer.

It is recommended that before each days firing and at points periodically throughout the test that Section I inspections be made to further insure safety of personnel and the reliability of the gun system.

EQUIPMENT

The following equipment will be used for the recoil adapter test.

1. Gun, 4-30 30mm 4 barrel gun.
2. One instrumentation test console/with 28 VDC supply.
3. Transfer unit assembly.
4. Feed and element by pass chute.
5. Electronic control unit and interface boxes necessary for instrumentation.
6. GAU-8/A Phase I test stand modified.
7. 36 dummy rounds of GAU-8/A ammunition.
8. Low rate of fire recoil assemblies.
9. Batteries to supply drive motor power.

INSTRUMENTATION

The following instrumentation will be recorded and reduced to specific values.

1. Muzzle blast
2. Sprocket sensor
3. Projectile sensor
4. Element sprocket, feed
5. Element sprocket, unload
6. Safing sector signal
7. Safing sector motion
8. Gun drive torque
9. Gun speed thru rotor gear.
10. Trigger signal

<u>NOTE</u> * The above items are essential to the test at the Honeywell installation.

11. Peak and average recoil force

12. Recoil motion

13. Vertical recoil force at adapter

14. Transverse recoil force at adapter

15. Recoil forces at the fwd mount

16. Vertical force at the fwd mount

17. Transverse force at the fwd mount

TEST PROCEDURE

Sect A. High Pressure Test

A1 Comply with Section I & II of this test plan

A2 Load (1) one high pressure round per Section III of this test plan

A3 Fire (1) one high pressure round per Section IV of this test plan

A4 Repeat steps 2 & 3 until (1) one high pressure round has been fired in each barrel.

A5 Disassemble gun and mag particle inspect the (4) four body bolts and and the breech rotor for cracks

A6 Return gun to firing configuration

Sect B. Low Rate of Fire Recoil Adapter Test

B1 Comply with Section I & II of this test plan

B2 Load (2) two TP rounds per Section III

B3 Fire (2) two rounds in accordance with Section IV of this test plan

B4 Insure all instrumentation is recording accurately and all functions are recorded

B5 Load (2) two TP rounds per Section III

B6 Fire (2) two rounds in accordance with Section IV of this test plan

B7 Refer to Table A for further test requirements.

NOTE: At the end of each burst, the chuting assembly must be checked for proper interface and broken parts and a general inspection of the entire gun system is recommended.

TABLE A

BURST #	QTY TO FIRE	TOT ACCUMULATIVE ROUNDS
7	4	12
8	4	16
9	8	24
10	8	32
11	12	44
12	12	56
13	16	72
14	16	88
15	16	104

This will complete the testing required by this test plan.

Additional testing if required will be performed at the discretion of the test engineer.

SECTION I

After installation of the gun system in the test stands has been completed and prior to loading and/or firing, it is recommended that the following checks, inspections and/or adjustments be made.

A. GUN

1. Check that safing pin is installed in safing cam.
2. Check for completeness of assembly and security of all mounting hardware.
3. Check for lubrication.

B. AMMO HANDLING SYSTEM

1. Check for security of all hardware for mounting transfer unit, and lock rings installed in chuting.
2. Check for completeness of assembly of chuting and element belt.
3. Check security of gearbox to transfer unit coupling.
4. Check all pins are aligned and installed in drive shaft.
5. Check for completeness of assembly and security of all mounting hardware.
6. Check for lubrication.

C. ELECTRIC DRIVE SYSTEM

1. Check for security of all mounting hardware.
2. Check that master arm is in off position.
3. Connect drive shaft to gun.

D. SYSTEM OPERATIONAL CHECK

1. Insure master arm is off.
2. Manually release brake on drive motor.
3. Insert four (4) dummy rounds in conveyor elements.
4. Manually, slowly cycle system in forward direction until 4 dummy rounds have completely cycled through system and are located back at point loaded.

NOTE

IF AT ANY TIME DURING STEP 5 ABOVE UNUSUAL NOISES ARE HEARD OR BINDING, HIGH TORQUE OR STOPPAGE OCCURS, FURTHER CYCLING OR ATTEMPTS TO CYCLE WILL BE TERMINATED UNTIL PROBLEM HAS BEEN DETERMINED AND CORRECTIVE ACTION HAS BEEN TAKEN. THE DECISION TO CYCLE IS THE SOLE RESPONSIBILITY OF THE TEST ENGINEER.

5. Inspect dummy rounds for abnormal nicks, dents, scratches, etc.

E. SYSTEM FUNCTIONAL CHECK

1. Insert 12 dummy rounds in carriers.
2. Manual rate select lo-rate.
3. Cycle system at half rate.
4. Check system and dummy rounds.
5. Manual rate select hi-rate.
6. Cycle system at full rate.
7. Check system and dummy rounds.
8. Down load dummies.

NOTE

PART E, SYSTEM FUNCTIONAL CHECK MAY BE MODIFIED OR ELIMINATED AT THE DISCRETION OF THE TEST ENGINEER.

1. Visually inspect system and drive assembly for loose connectors and hardware, abnormal wear, and completeness of assembly.
2. Apply MIL-G-23827A to sliding spline shaft.
3. Visually inspect for security of connectors, electrical gun control unit and magnetic pickups.

SECTION II

PRELOADING

A. 4 BBL GUN

Prior to each complement or each days firing, it is suggested that the following preventative maintenance tasks be performed.

1. Lubricate gun with MIL-G-23827A, tracks, cocking pins, lock - unlock rollers only.
2. Prior to each days firing and prior to loading visually inspect gun for loose hardware, broken safety wire and/or abnormal wear.

NOTE

STEP 2 ABOVE DOES NOT REQUIRE ANY DISASSEMBLY.

3. Comply with latest parts life replacement schedules.

B. AMMO HANDLING SYSTEM

Includes elements, links, chuting and transfer unit. Prior to each days firing or each complement it is suggested that the following preventative maintenance tasks be performed.

1. Visually inspect system for loose hardware, broken safety wire, abnormal wear, broken or mission retainer rings damaged or broken tabs or guides, and security of drive shaft to gearbox and transfer unit.
2. Apply MIL-G-23827A to all exposed gears, and element tracks on chuting.
3. Comply with latest parts life replacement schedules.

C. ELECTRIC DRIVE SYSTEM

Prior to each days firing or each complement it is suggested that the following preventative maintenance tasks be performed.

SECTION III

LOADING

WARNING

ALL SAFETY AND OPERATION PROCEDURES WILL BE RIGIDLY ADHERED TO DURING LOADING, AND FIRING OF AMMUNITION.

AMMUNITION IS PERCUSSION FIRED AND MUST NOT BE DROPPED. PERSONNEL WILL NOT HANDLE MORE THAN TWO (2) LOOSE ROUNDS AT A TIME.

ELECTRICAL POWER MUST BE OFF DURING LOAD PROCEDURE.

1. Inspect ammunition for damage and record lot number in log book.
2. Make certain that all electrical switches are in proper position for loading gun system.
3. Check gun to ensure safing pin and streamer is installed in safing sector.
4. Brake on electric drive off to allow rotation of gun system manually.
5. Insert ammunition one (1) round at a time in elements until desired quantity is loaded.
6. Brake on electric drive to on position.

SECTION IV

FIRING

PRE-FIRING PROCEDURE

1. Safing pin installed.
2. Drive shaft checked.
3. Transfer unit bolted and safety wired.
4. System complete, timed, and all timing pins disengaged.
5. Tie downs checked for security.
6. Boresight tools removed, if applicable.
7. Brake on.
8. Down range clear of personnel and unnecessary equipments.
9. Obtain permission to fire.

FIRING PROCEDURES

1. Alert personnel to evacuate surrounding area.
2. Safing sector safety pin removed.
3. Master arm on.
4. Fire when instrumentation and test engineer are ready.

POST FIRING PROCEDURES

1. Master arm off.
2. Verify all rounds have fired by instrumentation read out before entering test cell.
3. Install gun safing pin in safing sector.
4. Visual check of equipment.
5. Release brake on electric drive motor.
6. Remove spent cases from elements.

SECTION V

HOT GUN CLEARING PROCEDURE

NOTE

THIS CHECKLIST IS NOT INTENDED TO COVER ALL THE CIRCUMSTANCES WHICH MAY OCCUR DURING A GUN JAM BUT SHOULD BE USED AS A GUIDELINE TO SAFE THE GUN AS SOON AS POSSIBLE, TO PREVENT INJURY TO PERSONNEL AND FURTHER EQUIPMENT DAMAGE.

IN THE EVENT OF A STOPPAGE

1. Shut off all electrical power to drive system

   CAUTION: DO NOT ATTEMPT TO REVERSE SYSTEM USING REVERSE SWITCH - FURTHER DAMAGE TO GUN SYSTEM MAY OCCUR.

2. Wait 30 minutes before entering lane.
3. Enter lane and disconnect electrical connector to motor.
4. Manually release brake.
5. Install safing pin.
6. If safing pin can be installed, determine proper clearing procedure based on engineering instructions.

   NOTE: Engineering instructions will be based on the following criteria:

1. The position of any live rounds in the gun and the safety to personnel clearing the stoppage.
2. The location of the stoppage, gun transfer unit, or feed system.
3. The amount of damage in any of the above components.
4. If the gun can be rotated, and in which direction.
5. Any further damage which might occur from clearing the stoppage.

   CAUTION: IF SAFING PIN CANNOT BE INSTALLED GUN IS CONSIDERED HOT AND EXTREME CARE MUST BE TAKEN DURING CLEARING.

HOT GUN CHECKLIST

3 PEOPLE MAXIMUM TO CLEAR JAM

1. Determine position of live rounds in gun.

   NOTE: Any bolt which is in the firing safing cam area may or may not have fired the round it is carrying. To determine if the round has been fired;

   A. Using an inspection mirror, look into safing cam opening and determine if cocking pin has fallen.

   B. If cocking pin has fallen insert rod into corresponding barrel to further insure round has been fired.

   C. If round has been fired, safe gun using steps 2 thru 5 inclusive.

2. Manually release brake on electrical motor.
3. Slowly rotate gun forward until safing cam drops in.
4. Install safing pin.
5. Gun may be cleared as previously outlined.

   CAUTION: IF COCKING PIN HAS NOT FALLEN AND IS NEAR POINT OF SEAR, ANY FORWARD ROTATION OF GUN MAY RESULT IN ROUND BEING FIRED.

   A. Insert bar thru barrels standing on right side of gun and pull down turning gun in reverse direction.

   B. Install safing pin and refer to previously outlined clearing procedures.

   CAUTION: IF GUN CANNOT BE ROTATED, USE STEPS 6 THRU 15.

6. Exercise care to prevent barrels from being rotated, disconnect drive shaft and remove drive stand assembly.
7. Apply rotational pressure in a reverse direction on barrel cluster.
8. Loosen pins and bolts securing chuting to transfer unit.

9. If gun rotates, safing pin should be installed and normal clearing procedures followed.

10. If safing pin cannot be installed, remove elements and chuting unit.

11. Loosen bolts securing transfer unit to gun. Remove completely two bolts on each side forward transfer unit, and drive shaft assembly.

12. Attempt to rotate gun in reverse direction and install safing pin.

13. Clear gun using previously outline procedures.

NOTE: If safing pin still cannot be installed, conditions warrant strictly a judgement on how to safe the gun from this point.

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