TECHNICAL PROPOSAL
Rev. A

GENERAL PURPOSE ARMOR MACHINEGUN

(GPAM)

7.62mm Fixed

Submitted to:

United States Army Weapons Command

Rock Island, Illinois

Colt Industries Colt's Firearms Division

TECHNICAL PROPOSAL

Rev. A

Copy #1

GENERAL PURPOSE ARMOR MACHINEGUN

(GPAM)

7.62mm Fixed

July 14, 1969

Revised July 25, 1969

Colt Industries **Colt's Firearms Division**

Colt Industries
Colt's Inc Firearms Division

150 Huyshope Avenue
Hartford, Conn., U.S.A. 06102
Tel. 203/278-8550

July 25, 1969

Commanding General
U.S. Army Weapons Command
Rock Island Arsenal
Rock Island, Illinois

ATTENTION: AMSWE-REF

SUBJECT: Revised Technical Proposal for General Purpose Armor Machine Gun

Gentlemen:

Enclosed herein you will find four revised copies of the subject proposal. The changes made to this proposal are minor in nature and should not affect the evaluation materially.

Should there be any questions concerning these changes, please contact me immediately.

Respectfully yours,

Lewis B. Sharp
Small Arms Sales Engineer

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Enc.

INDEX OF MODIFIED PAGES

The following pages were changed in order to fully clarify the technical proposal. The changes are indicated by vertical lines in the right hand margin of the pertinent page. Reference is made to the Technical Proposal, General Purpose Armor Machine Gun, dated July 14, 1969.

Colt Industries Colt's Firearms Division

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Colt Industries Colt's Firearms Division

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INTRODUCTION

SECTION I

INTRODUCTION

Colt's Firearms Division of Colt Industries is pleased to submit this proposal to supply two feasibility test prototypes of a General Purpose Armor Machine Gun to the United States Army Weapons Command, Rock Island, Illinois. This weapon is offered as a replacement for the M73 and M37 machine guns presently in use and is completely compatible with the mission requirements of the existing weapons systems.

Colt's Firearms recognizes the need for a versatile dual fed weapon system which will be compatible with the combat vehicles of the future. Due to the trend toward greater complexity in these vehicles, there is a paramount need for a 7.62 mm class machine gun which provides optimum reliability and maintenance free service. It is expected that many future applications will place the weapon in a semi-unaccessable location where continued dependable performance is a must. This circumstance has been considered in developing this design. Colt's proposes to supply two prototypes of this design for concept feasibility testing on 1 March 1970 in accordance with the price and terms included as Appendix D. In the event the government decides that the weapon should be fully developed as a result of these tests, Colt's Firearms is prepared to continue such development through initial production on a Government Funded basis.

The proposed weapon is a short recoil operated, muzzle boosted, link belt fed, air cooled machine gun. The bolt is held to the rear in the open bolt position by the sear. The weapon is fired from the open bolt position and utilizes an accelerator lever to assist bolt recoil. It can be fired either electrically or manually and is designed for either dual or single feed applications, either left or right hand, depending upon the vehicle and mission requirements. The GPAM is designed to provide a high level of performance and reliability for optimum combat effectiveness and long service life by use of simple rugged mechanisms which are readily producible. The simplicity of the proposed concept will facilitate training, maintenance and logistics. The proposed weapon is interchangeable with the M73 and M37 machine gun applications.

In general, Colt's candidate design for the General Purpose Armor Machine Gun combines the optimum in mechanical soundness with the performance traits indicated as most important to the user. The weapon will be capable of sustained opera under adverse conditions beyond any present design. The physical characteristics of the proposed weapon are listed in Table I and are illustrated in figures 1-1 and 1-2.

The name "Colt's" has been synonymous with the production of quality small arms for over 125 years and of reliable military weapons since the Civil War.

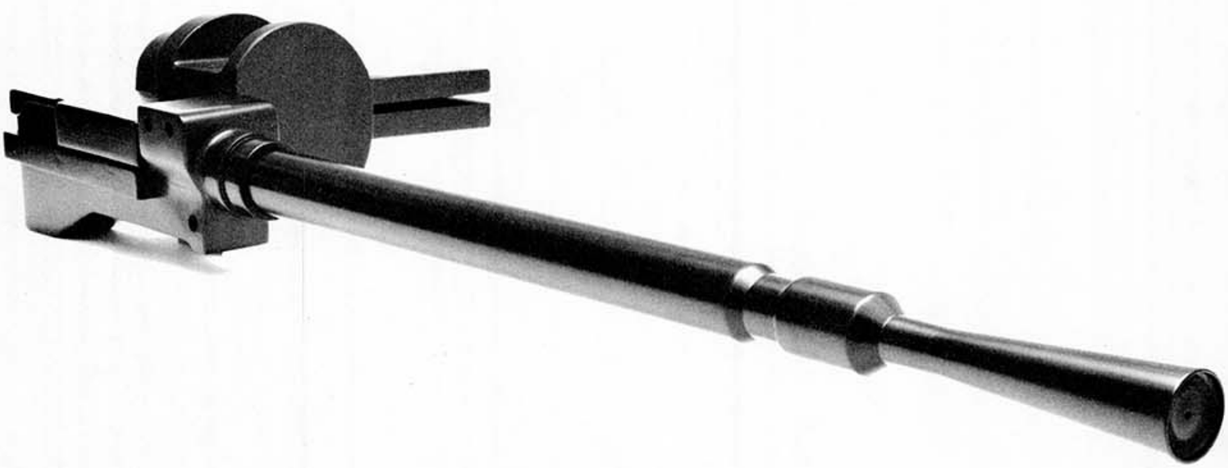
Colt's, in collaboration with Mr. John Browning, developed and produced the first automatic machine gun purchased by the United States Government, the gas-operated Model 1895 ("The Potato Digger"). Since that time, Colt's has participated in the continued development and production of the now famous Browning machine guns. During World War I and II and the Korean Conflict, Colt's was a leading producer of military small arms, ranging from the Cal .45 pistol to 37 mm cannon.

At present, Colt's is producing the M16 series rifle at a rate in excess of 50,000 units per month, meeting or exceeding every contractual delivery schedule.

Table I. Characteristics - GPAM

Caliber	7.62mm NATO
Ammunition	Ball, Tracer, Armor Piercing and Blank
Link	M13
Overall length	48.00 inches
Receiver length	12.10 inches
Barrel length	28.00 inches
Flash hider length	10.90 inches
Effective range	1100 meters
Rate of fire	454 rpm
Cooling	Air
Weapon cycle operating method	Short recoil with gas assist.
Feeding	Remote or manually operated dual feed capability as well as conventional single belt feed. Left or right hand feed with either system.
Operation	24 vdc solenoid or manual trigger.
Belt pull	18 lbs minimum.
Special Tools	None required for 1st Echelon Maintenance.
Weight	32 lbs (approx)

Single Feed Weapon System



Dual Feed Weapon System

Figure 1-1. Proposed General Purpose Armor Machine Gun - Wooden Mockup

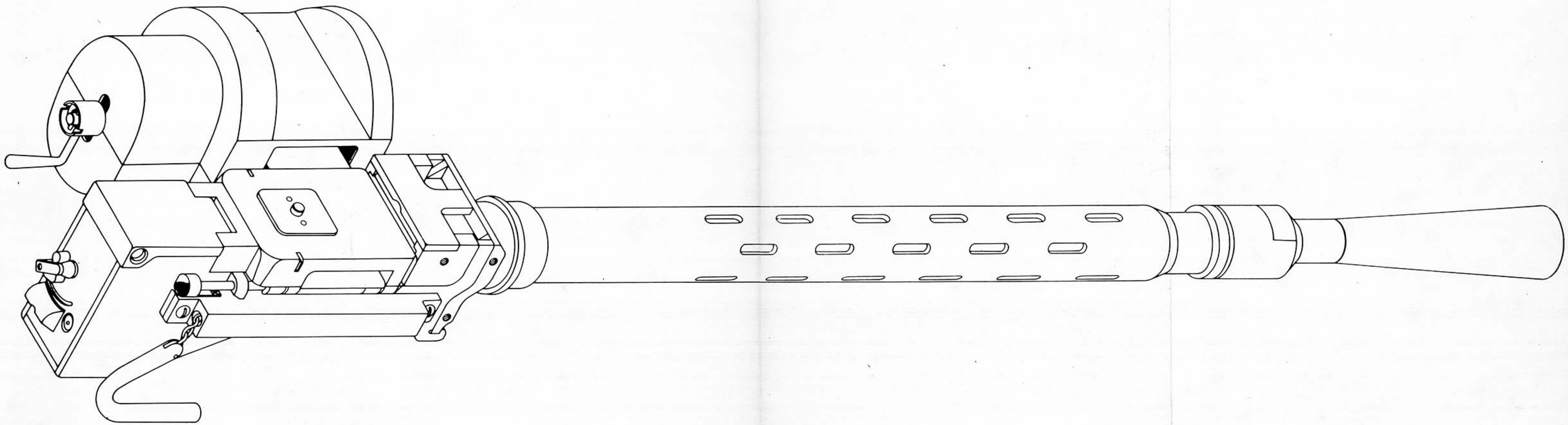


Figure 1-2. Colt's Proposed General Purpose Armor Machine Gun

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SECTION 2

DESIGN CONCEPT

SECTION II

DESIGN CONCEPTS

2.1 GENERAL

The weapon that is proposed by Colt's Firearms was conceived using the following as priorities:

Reliability

Performance

Maintainability

Ruggedness

Simplicity

The physical limitations imposed by the various vehicular requirements and the mission of the using units have been major considerations in developing this design concept. The proposed weapon features proven operating principles that enable achievement of a high level of performance in meeting the known mission and design parameters. The following dissertation outlines the major design considerations utilized to achieve the desired priorities.

2.1.1 AMMUNITION FEED SYSTEMS

The proposed machine gun is designed with a dual feed capability. It employs separate covers and feed trays for dual feed and single feed weapon system applications.

2.1.1.1 Single Feed A conventional single feed mechanism is offered to be used on the weapon when mission requirements do not require a dual feed capability or when a dual feed installation might be impractical due to space limitations. Direction of feed is optional, either left or right hand.

The single feed system, due to its relative simplicity and ruggedness, must be considered a degree more reliable and dependable than the dual feed cover and feed tray system. Therefore, in the event of damage to the dual feed system, the single feed cover and feed tray should be available to provide a back-up system for continued weapon operation with minimum weapon downtime.

2.1.1.2 Dual Feed The proposed weapon incorporates a remotely controlled dual feed assembly which allows for the selection of either of two ammunition belts to be fed into the weapon for firing. A manual override is incorporated for use when manual operation is desired. The dual feed weapon concept will enhance the mission effectiveness of the vehicle on which it is mounted. As with the conventional single belt feed system, the dual feed assembly can be mounted for either left or right hand feed.

2.1.2 LOCKING MECHANISM

The proposed weapon concept features a cam operated sliding block type of breech lock which inherently offers the strongest lock configuration. Cam operation provides positive and controlled locking and unlocking.

A safety feature of this lock design assures that locking always occurs prior to firing. Controlled unlocking dwell time, intrinsic in this design, aids in preventing gas contamination of the crew compartment.

2.1.3 RATE OF FIRE

The proposed weapon is designed to have a cylic rate of fire of 454 rounds per minute. This is a natural rate of fire and therefore a rate control device is not required. This rate of fire will provide:

(1) Adequate dispersion;

(2) Extended continuous or hot firing capability;

(3) Low loading impact of the recoiling mechanism and more efficient weapon operation with increased longevity of parts;

(4) An extended service life of the barrel through slow heat buildup;

The natural rate of fire will enhance the capability of this weapon system in the performanc of its armament roles of reconnaissance, supressive, anti-personnel, and anti-vehicle fire.

2.1.4 TOXIC GAS CONTAMINATION

The weapon was designed to minimize the flow of toxic gases into the crew compartment. The breech remains locked until the residual gas pressure has decreased to a safe level thereby preventing gas contamination of the vehicle compartment. Long barrel bearing surfaces with annular grooves are used to minimize gas escape through the rear barrel bearing surface. The weapon flash hider is designed to protrude beyond the front of the longest known mantlet tube thereby evacuating gases from the mantlet tube and barrel jacket and preventing flashback and the rearward flow of gases. This venturi effect will prevent flashback from the mantlet tube into the crew compartment.

2.1.5 WEAPON MOUNTING

The proposed weapon mounting configuration is compatible with the M73 Machine Gun mounts, and is also capable of being used in a flexible role on other vehicles. The recoiling group is buffed and held against the trunnion block by the combined force of the drive spring and the barrel return spring.

This design will provide low inherent mount sensitivity for reliable weapon performance in soft and rigid mounts.

The proposed design features a quick and simple detachment of the receiver group from the mounting block and thus aids in providing a quick change barrel capability. Barrel changes can be made from within the vehicle compartment and do not require the removal of the mounting block from its mount.

The receiver-mounting block joint and lock concept yields optimum receiver-to-jacket alignment. This alignment and the long distance between the barrel bearing surfaces is conducive to accurate delivery of fire.

The dual feed system is attached to the mounting block and is fastened to the receiver in a manner to allow rapid disengagement from the receiver. This feature provides positive and rugged system alignment and engagement and permits quick barrel change. Also, this concept permits retention of the dual feed system as part of the vehicle installation when the receiver group is not in place.

2.1.6 RECEIVER

The receiver is a U-shaped channel formed by rugged plate construction. The permanently joined trunnion block at the front of the receiver and the bridge across the top of the receiver mid section, along with the backplate, assures a strong rugged weapon design. All tracks on the receiver are intruding and are integral with the receiver for increased weapon longevity and mass producibility. Also, the two lug carrying side plates, which are permanently joined to the receiver exterior, increase the rigidity of the receiver. The design features an unobstructed and short ejection path to permit reliable and rapid exit of ejected cases. The assembled weapon configuration is designed for maximum protection from foreign elements.

2.1.7 CHARGER

The charger is mounted on the right side of the weapon, held in place by locking screws. This concept adds to the ruggedness of the weapon as well as to the simplicity of design. The absence of an open charger slot in the left side of the receiver eliminates weapon contamination by foreign material. A remote charging device can be installed in place of the manual charger.

2.1.8 BLANK FIRING ATTACHMENT

An adjustable blank firing attachment is provided for training purposes. This device is installed in place of the flash hider and is readily adjusted in front of the mantlet tube without the use of tools. The fine adjustment provided will encompass the wide range of pressure variations which are characteristic of blank ammunition.

The full power adjustment provides a safe limit of overpower from which adjustments can be made to decrease the muzzle boost. The full power setting is qualified to minimize the necessary amount of overpower, thereby preventing high stresses and resultant parts breakage. The heat sink principle with a self cleaning internal configuration provides an anti-fouling characteristic.

2.1.9 SEAR

The sear is designed so that the sear hook engages the bolt sear pads in a manner to more than provide positive searing. A positive engagement angle is provided to assure the return of the sear when the manual trigger is released from a partially depressed position.

2.1.10 INTERCHANGEABILITY

The weapon system is made up of the basic weapon and the dual feed system. These major components, i.e., dual feed and weapon, are interchangeable between weapon systems.

The weapon itself is designed to permit group interchangeability between weapons. Complete interchangeability of parts is achieved with the exception of the barrel extension group which is composed of the matched barrel extension and breech lock, permanently fastened together to achieve close control of weapon headspace. The weapon is designed so that there are no field adjustments required with the exception of the BFA. The backplate group is adjusted during initial assembly.

The proposed dual feeder is capable of either left or right hand operation with rearrangement of mechanical components only.

SECTION 3

DESCRIPTION & OPERATION

SECTION III

DESCRIPTION AND OPERATION

3.1 GENERAL DESCRIPTION

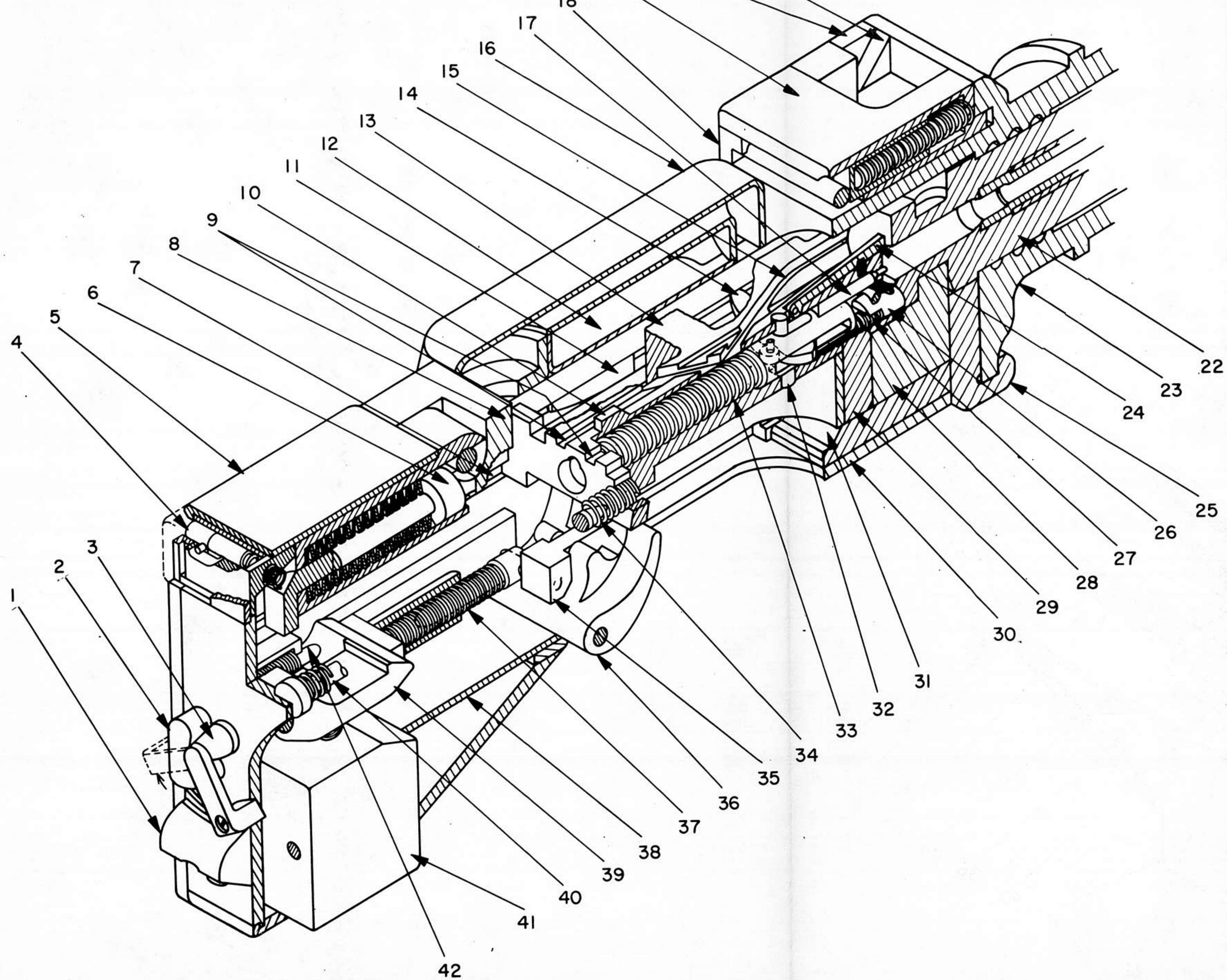
The proposed weapon (see figure 3-1) is a rugged, air-cooled weapon designed primarily for use on armored vehicles in place of the current weapons in use. The weapon is capable of dual feed by remote control as well as conventional feeding from either the left or right side and accepts disintegrating metallic link belts comprised of 7.62 mm NATO ammunition and M13 Links. The weapon has a short receiver, is short recoil operated with a muzzle boost assist, is fired from the open bolt position, and has a fixed headspace with a quick change barrel capability.

3.2 MAJOR ASSEMBLIES

The weapon system consists of the dual feed assembly, single or dual feed cover and tray assemblies, barrel and mounting block assembly, bolt assembly, barrel extension assembly, accelerator frame assembly, backplate assembly, buffer and coverplate assembly, charger assembly, the drive spring and drive rod group and the receiver assembly.

3.2.1 DUAL FEED SYSTEM

The dual feed system consists of the belt changing mechanism, drive motor, mounting frame, protection cover, the electronic control circuit and panel necessary for remote operation (see figures 3-2 and 3-3). The control circuit is fully discussed in Appendix C. The feed mechanism and drive motor are mechanically coupled and fit into the mounting frame as a unit. The belt changing mechanism and motor are encompassed in a light weight protection cover.



1. Backplate Protection Pad
2. Trigger
3. Safety
4. Buffer and Coverplate Retaining Plunger
5. Buffer and Coverplate Assembly
6. Buffer
7. Bolt Guide Slot
8. Receiver Bridge
9. Ejector Clearance Cuts
10. Buffer Pad
11. Cocking Cam
12. Feed Tray
13. Bolt
14. Cocking Lever
15. S-Shaped Cam Groove
16. Cover
17. Firing Pin
18. Mounting Block
19. Mounting Block/Receiver Retention Block
20. Receiver Trunnion Block
21. Trunnion Block Ramp
22. Barrel
23. Mounting Block
24. Rammer
25. Receiver Trunnion Block
26. Extractor
27. Extractor Spring
28. Barrel Extension
29. Breech Lock
30. Receiver
31. Breech Lock Cam
32. Striker Retaining Pin
33. Firing Pin Spring
34. Drive Spring
35. Barrel Extension Lug
36. Accelerator
37. Barrel Return Spring
38. Acceleration Frame
39. Sear
40. Drive Spring Guide Rod
41. Solenoid
42. Trigger Plunger

Figure 3-1. Cutaway View - GPAM

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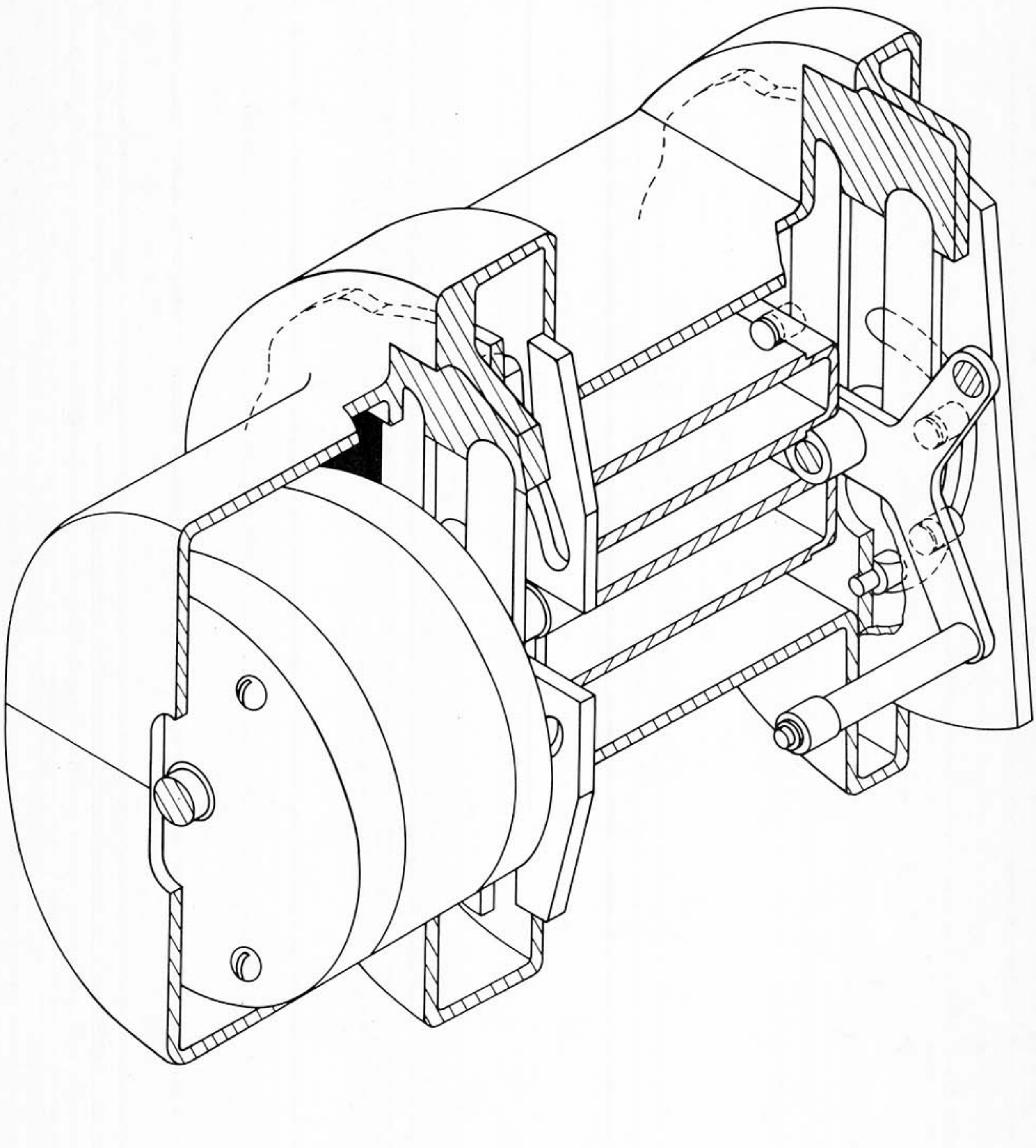
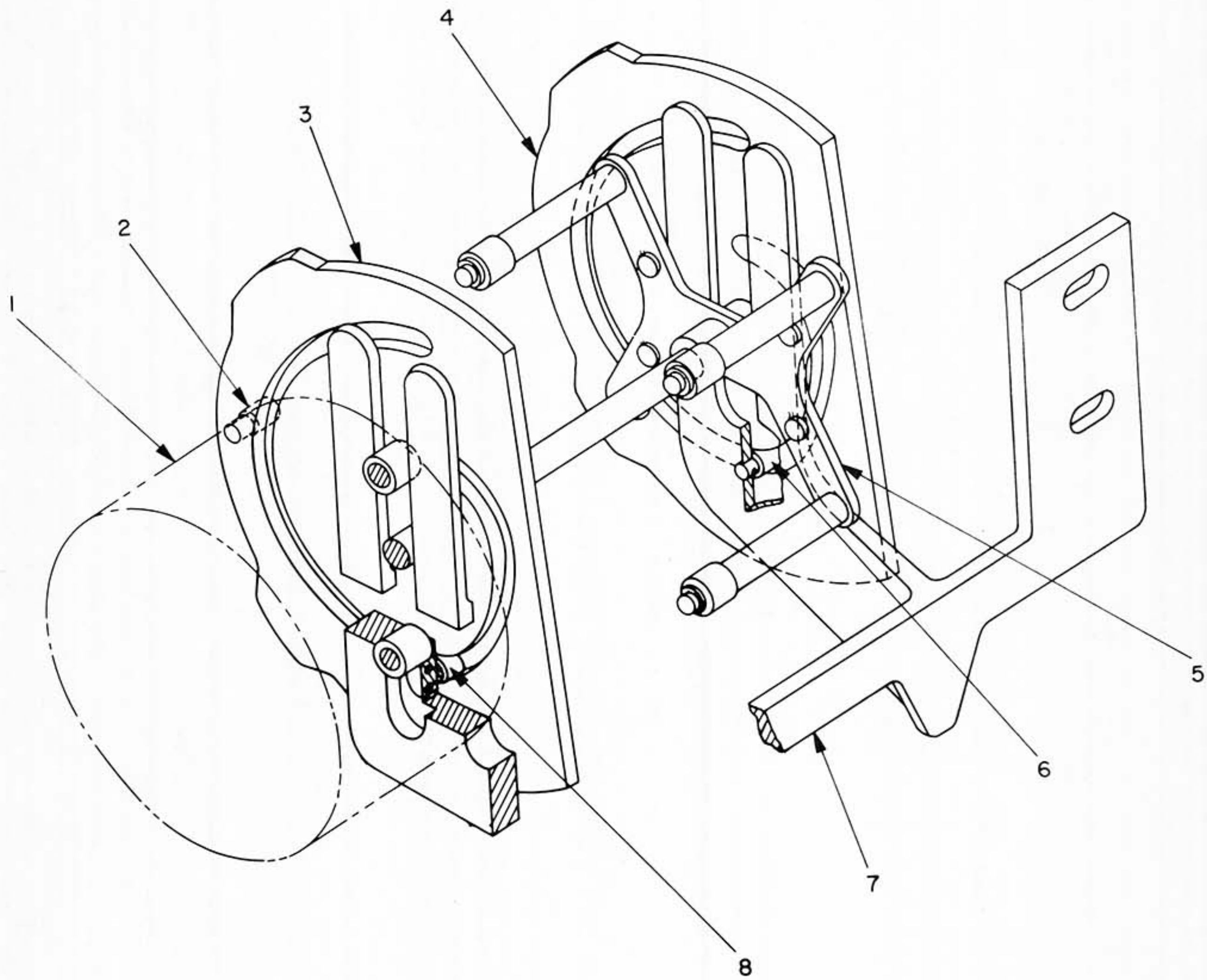


Figure 3-2. Cutaway View - Dual Feed System



1.	Drive Motor	5.	Chute Support
2.	Cam Roller	6.	Frame Roller
3.	Cam	7.	Dual Feed Mounting Frame
4.	Cam	8.	Frame Roller

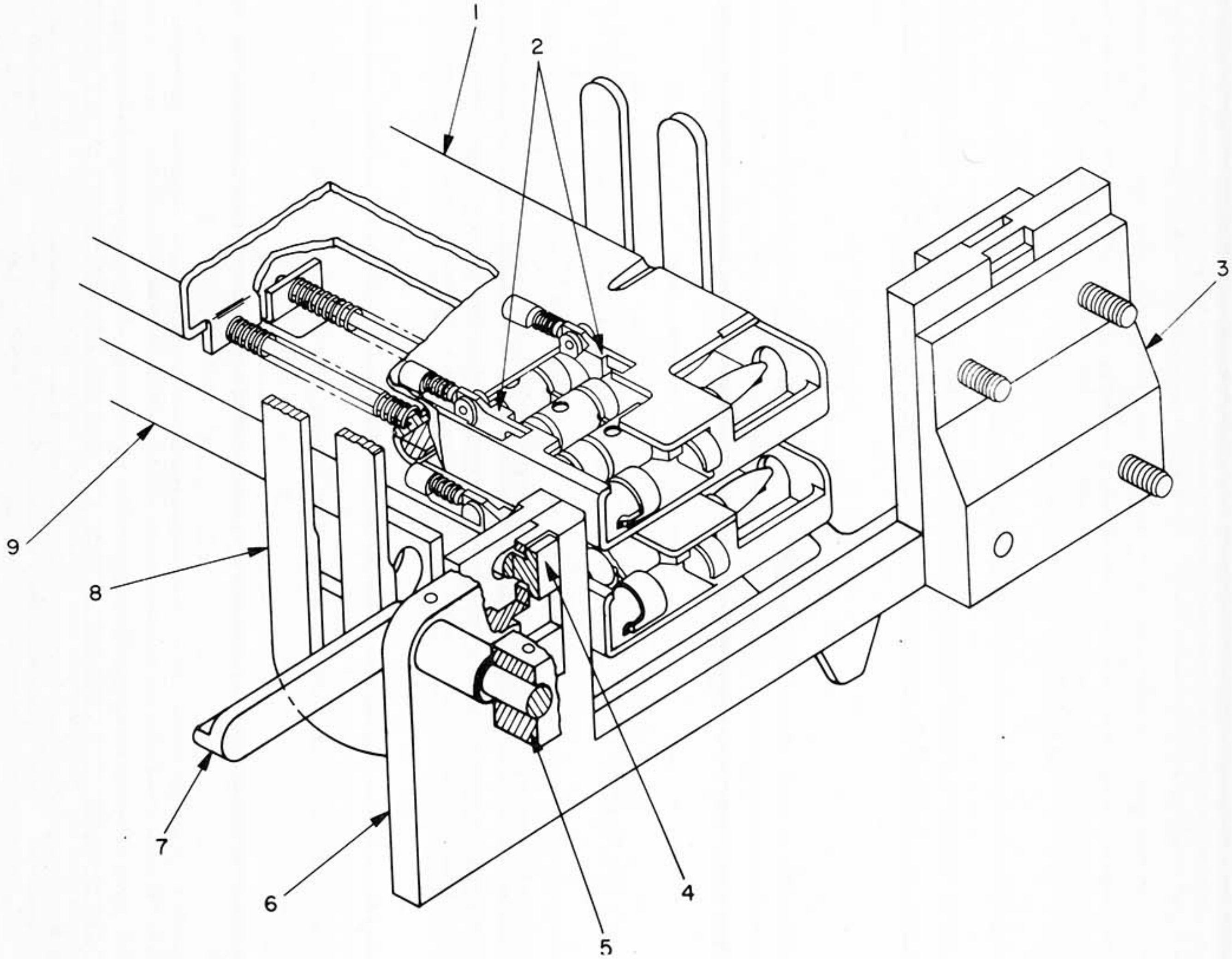
Figure 3-3. Cutaway View - Dual Feed System

The mounting frame (see figure 3-4) is fastened securely to the weapon mounting block and receiver. A quick disconnect lever at the receiver connection allows rapid disengagement from the receiver while the dual feed assembly remains securely attached to the mounting block.

The mounting frame consists of a mounting plate with two protruding slotted arms. The belt changing mechanism is mounted within these arms which guide the mechanism in its vertical movement.

The dual feed assembly mounts easily and quickly to the gun and allows for minor alignment adjustment, if required. The mounting hardware consists of a universal mounting plate and block that provides for mounting of the dual feed assembly on either side of the weapon. The dual feed assembly may be operated manually or from a control panel located in a remote position. This capability gives increased reliability to the system and allows the system to be used without external power. Manual operation is accomplished by using a hand crank on the rear of the dual feed assembly. The crank is normally in the disengaged position and must be pulled rearward, acting against a compression spring, to engage the motor drive shaft.

3.2.1.1 Belt Changing Mechanism. The belt changing mechanism is a comparatively simple device containing three moving groups: the motor and cam assembly, the upper feed chute assembly and the lower feed chute assembly. Rotary motion imparted by the motor to the cams, which are mounted on the motor drive shaft, impart simple linear motion to the system. The pro-



1. Upper Chute
2. Retaining Pawls
3. Universal Mounting Block
4. Adjustment Bolts
5. Receiver (Buffer and Coverplate Hinge)
6. Universal Mounting Plate
7. Quick Disconnect Handle (Unlocked Position)
8. Dual Feed Assembly Frame
9. Lower Chute

Figure 3-4. Cutaway View - Dual Feed System

per vertical, dwell, and horizontal motions are controlled be one cam profile, therefore there are no linear motion overlaps or interdependent sequence operations to jam the mechanism. Roller bearing type quides are used for the moving components because they are self cleaning and have low inherent frictional losses. The mechanism is guided vertically by slotted arms protruding from the mounting frame.

A cam is positioned on each side of the feed chute assemblies to provide symmetrical loading during vertical motion to assure proper feed chute/weapon cover alignment. The cams are similarly orientated and fastened to the drive shaft. Each cam is a flat plate with a cam slot machined into it. Two cam lobes protrude from the periphery of the cam and act upon the feed pawl positioning cam lever in the weapon cover.

The driven cams perform three functions:

(1) A fixed roller on the mounting frame extends through the cam slot on each cam. During cam rotation, these rollers act upon the cam forcing the cam, and therefore the chute assemblies, to move vertically. The feed chutes and the motor and cam assembly move or dwell as one unit guided by the two slotted arms of the fixed mounting frame.

(2) The peripheral cam lobes acting upon the feed pawl cam lever, raise the feed pawls in the cover for proper belt removal. The feed pawls are spring loaded in the engaged position so they return to that position when the cam lobes disengage the feed pawl cam lever.

(3) The cam chute roller, which extends from the cam face, engages the upper or lower chute cam slot during cam rotation. The cam chute roller

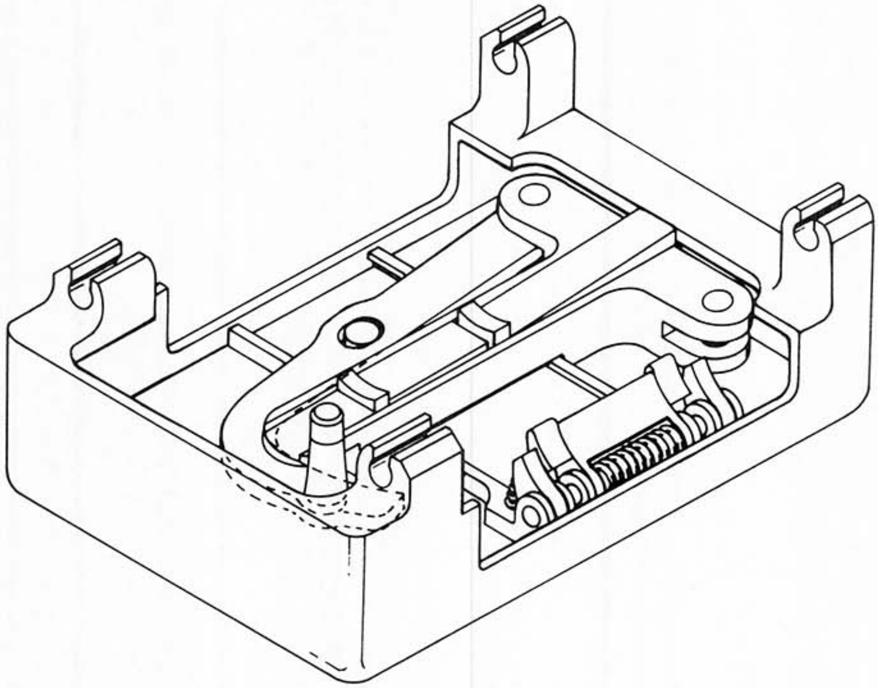
imparts horizontal motion to the chute. Refer to paragraph 3.3.1 for an operational description of the dual feed mechanism.

The feed chutes move horizontally on roller bearings guided by a skeletal support. The chutes are separated by rollers on the drive shaft which aid in positioning the chutes. Cam ears on the chutes are used to move the chutes horizontally when engaged by the cam roller. Each chute has a compression spring to maintain a small load on the system to assure positive positioning and to eliminate looseness of parts, avoiding wear from small vibrational loads. Retaining pawls in the chutes are used to maintain ammunition belt position.

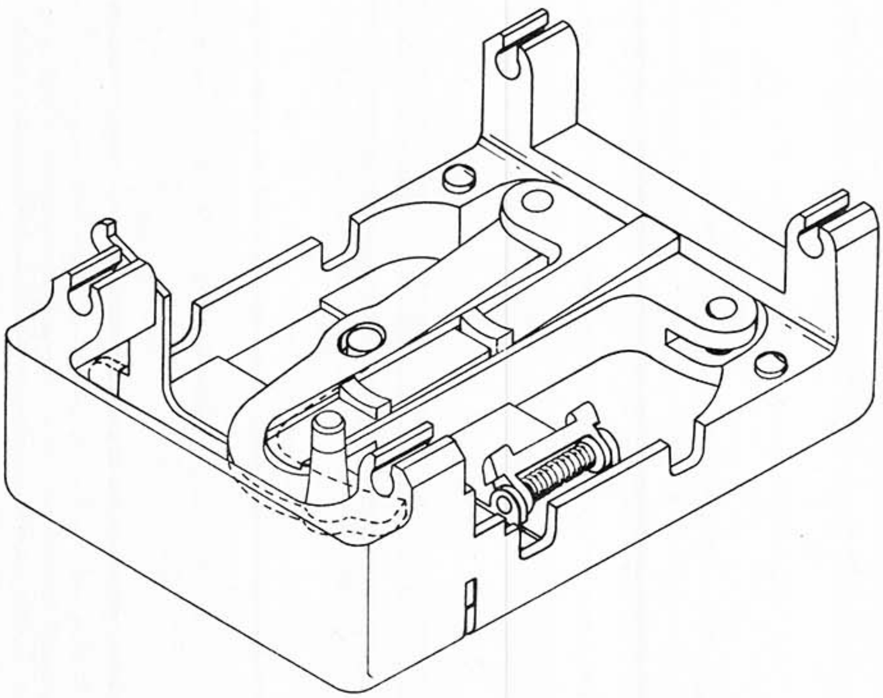
3.2.1.2 DC Drive Motor. The drive motor is a dc permanent magnet torque motor used to rotate a shaft on which two cams are mounted. The torque motor was chosen for its high reliability, high torque and low speed. It will develop peak torque at stall conditions and is highly controllable for accurate positioning of the feed mechanism. Changing direction is simply a matter of changing polarity of the control voltage.

3.2.2 COVER ASSEMBLIES

The cover assembly contains the mechanism which advances and retains the belted cartridge into position so that it may be stripped and chambered. It is mounted on top of the receiver with four mounting lugs designed for foolproof cover installation. Separate cover assemblies for dual feed and conventional feed applications are included in this design. Figure 3-5 shows the differences in their design. Both of these views show the feed pawl lever arm in the closed bolt position.



Single Feed



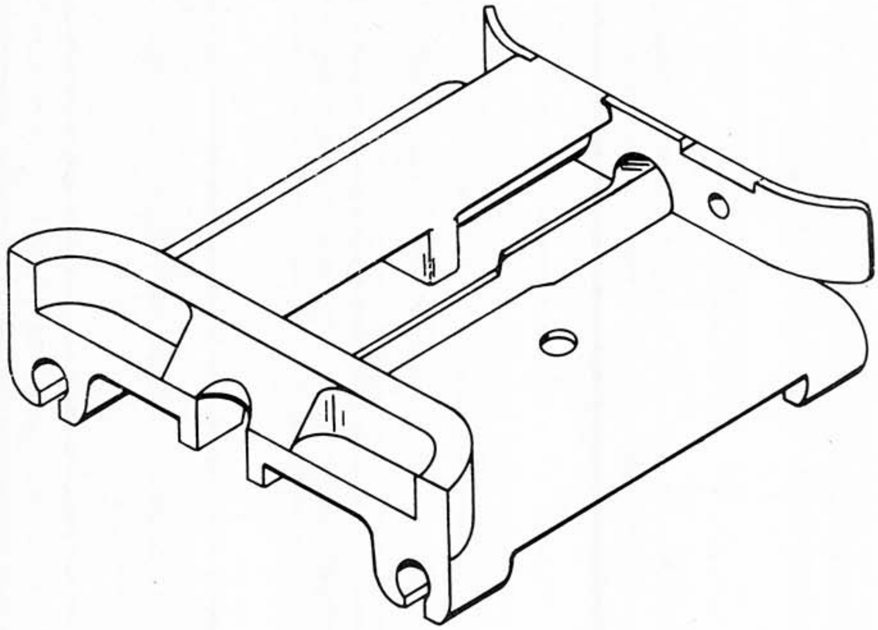
Dual Feed

Figure 3-5. Cover Assemblies

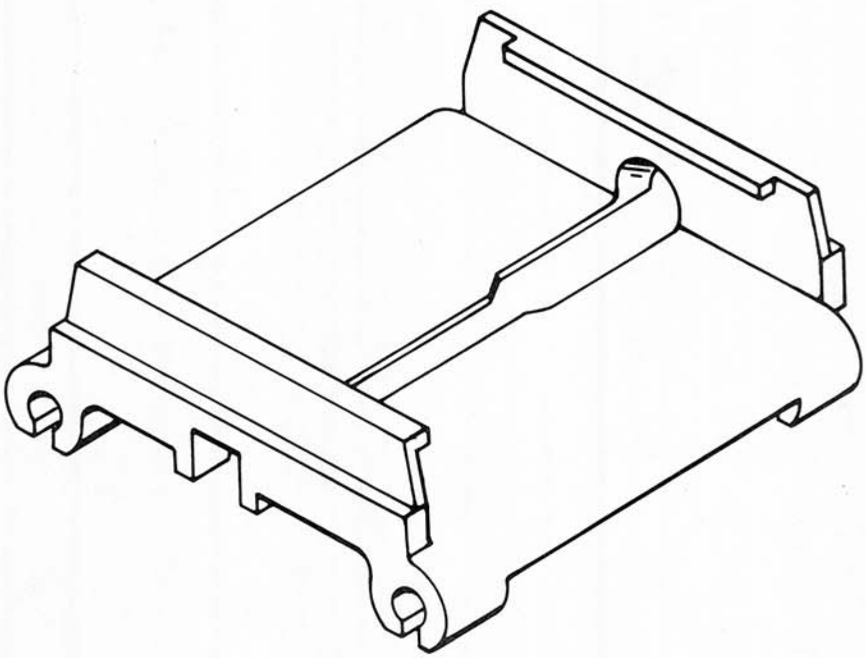
The dual feed cover assembly is essentially the same as the conventional cover in performing the basic feeding operations. Slight differences were incorporated to assure dependable feed chute insertion and withdrawal. A mechanism to raise and lower the feed pawl is activated by the feed pawl cam lobes to assist belt insertion, and to release the belt from the cover for chute removal. The retaining pawls are located in the chute assemblies, not the cover, so that the belts are always retained in the chutes. A spring loaded ball detent in the cover aids in feed chute positioning and retention. Refer to paragraph 3.3.2 FEED MECHANISM for the description of cover assembly and feed tray assembly operations.

3.2.3 FEED TRAY ASSEMBLIES

The feed tray (figure 3-6) is located on top of the receiver under the cover. It is positively oriented with the receiver and is designed for foolproof installation. The feed tray serves as a guide for the incoming ammunition belt and the outgoing links after cartridge stripping. A cartridge stop insert in the feed tray or in the dual feed chutes prevents the incoming cartridge in overriding the feed tray cartridge slot. The slot, combined with the feed tray provides a closed chute configuration for link ejection. The cartridge is guided through the feed tray slot into the barrel chamber. Fixed ejectors pads, securely fastened to the feed tray, protrude from the bottom of the feed tray to provide controlled engagement with the base of the cartridge case. Separate feed trays are also provided for single and dual feed applications. (See figure 3-5).



Single Feed



Dual Feed

Figure 3-6. Feed Tray Assemblies

The dual feed tray is designed so that it can accomodate the dual feed assembly feed chutes. Refer to paragraphs 3.3.2 FEED MECHANISM and 3.3.6 EJECTION for a description of feed tray functions.

3.2.4 BARREL AND MOUNTING BLOCK ASSEMBLY

The barrel is mounted within the barrel jacket and upon the bearing surfaces of the mounting block and jacket. These bearing surfaces are designed to give more than adequate circumferential support to the barrel as it reciprocates during the firing cycle. Annular grooves in the barrel bearings impede the flow of toxic gases to the crew compartment. A thick-walled jacket is employed to rigidly support the barrel without additional external support.

The receiver mounting/block engagement system is designed to provide exceptionally rigid assembly. The receiver is interlocked with the mounting block at three widely separated points. The receiver is locked to the mounting block by a spring loaded locking block.

The flash hider (figure 3-7) threads onto the front barrel jacket bearing and is retained by a staked retaining ring. The flash hider includes an internal booster configuration to provide a gas assist for weapon operation.

The barrel is designed to provide maximum accuracy and service life. This is achieved by a long heavy barrel configuration, chromium plated bore and bearing surface and a stellite liner. The rear end of the barrel has a shoulder which fits in the barrel extension yoke securing the barrel to the barrel extension. The yoke extends above the center of the barrel to furnish maximum bearing area contact and to provide optimum control of weapon headspace.

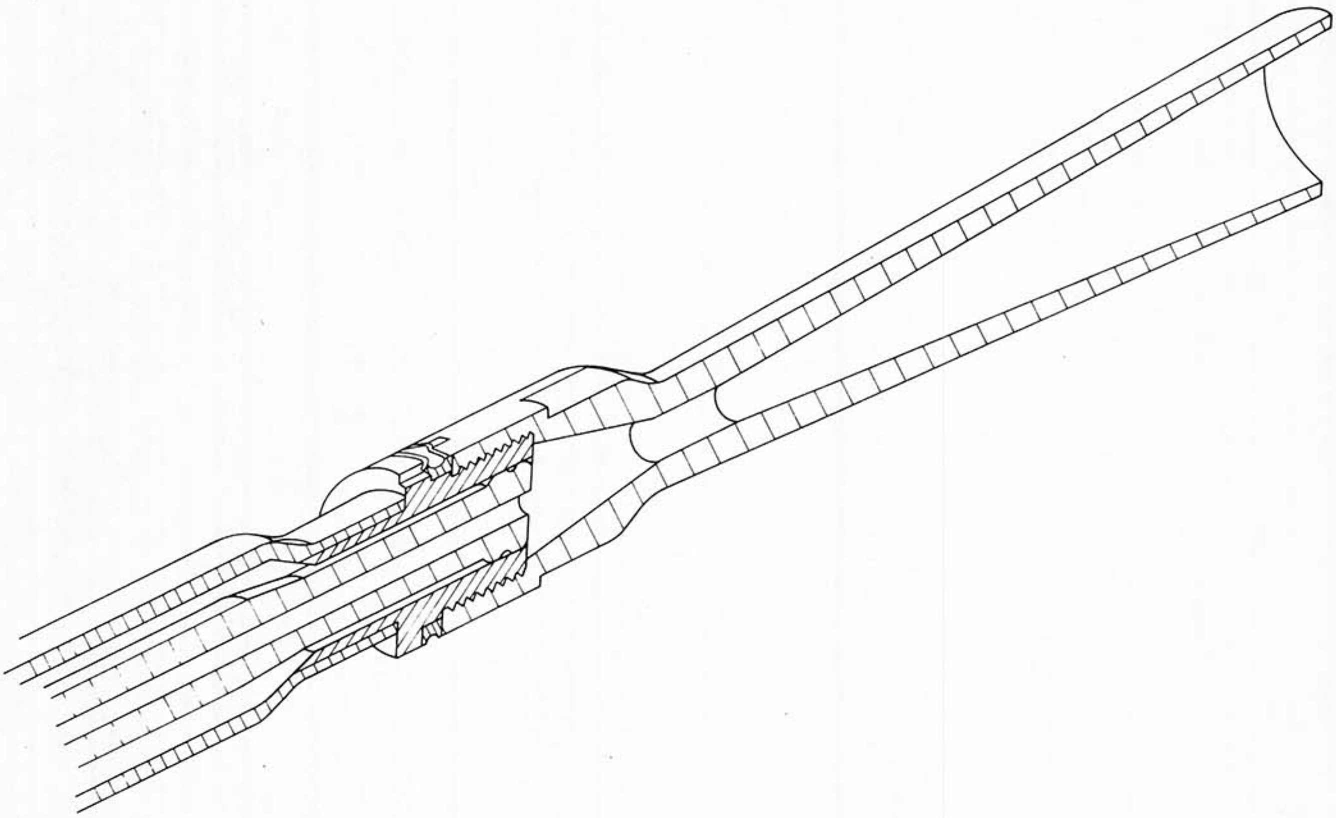


Figure 3-7. Barrel Muzzle - Flash Hider

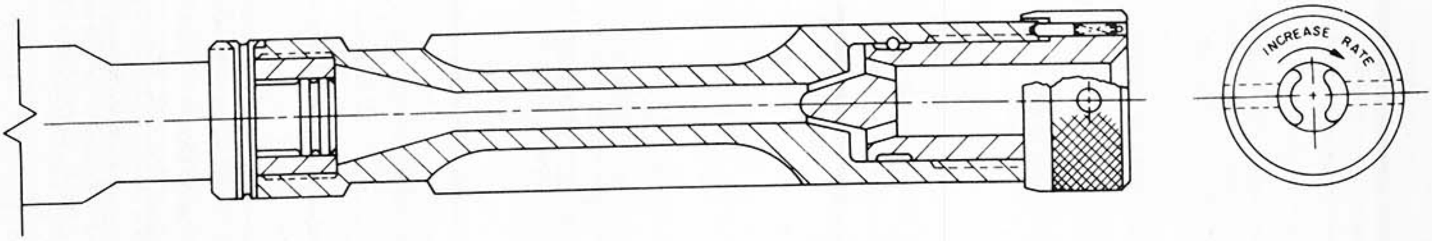


Figure 3-8. Blank Firing Attachment

The barrel design employs a large piston diameter for gas assist. The resultant piston area, combined with the muzzle boost configuration, will provide weapon/ammunition compatibility with the anticipated variations of impulse energy.

3.2.4.1 Blank Firing Attachment (BFA). A blank firing attachment is provided for use during training missions (see figure 3-8). The BFA is designed to attach to the muzzle end of the barrel jacket in place of the flash hider. Wrench flats are provided for ease of installation and removal. The BFA is basically an adjustable muzzle booster which allows the weapon to function normally when blank ammunition is used. An adjustable cap device is threaded into and pinned to the front end of the BFA. A spring loaded detent in the cap device engages detent holes in the BFA main body to provide positive stops for various "click" settings. When the cap device is threaded in and shouldered against the BFA body, maximum impulse is achieved due to the minimum gas vent area in effect, producing the highest average peak booster pressure. As the cap device is rotated counterclockwise through the "click" positions, the impulse is decreased because of increased venting. Gas is vented to the atmosphere through passages in the center of the rate control device.

A through hole in the diameter of the adjustable cap device provides a means of adjusting orifice settings when the area is heat saturated. By removing the adjustable orifice pin, the BFA can be separated into its component parts.

3.2.5 BOLT ASSEMBLY

The bolt (figure 3-9) is guided through its entire operating cycle by bolt lug slots in the receiver side plates. The top surface of the bolt contains ejector clearance cuts, the

S-shaped feed cam grooves, the bolt switch (not illustrated), the buffer pads and the cartridge rammer. The accelerator and sear mating contact surfaces are located on the lower rear portion of the bolt. The drive spring hole is in the right rear of the bolt and the charging slot is located on the right side. The firing pin, striker mechanism and extractor are assembled within the bolt. Refer to paragraph 3.3.3 through 3.3.6 for pictorial description of bolt operation.

3.2.6 BARREL EXTENSION ASSEMBLY

The barrel extension (figure 3-9) assembly consists of the barrel extension and the breech lock (see figure 3-1). The barrel extension is guided by slots in the forward locking cam, located on the forward receiver floor, and by the inner walls of the receiver. The barrel is secured to the barrel extension by the yoke on the front end of the barrel extension. The accelerator sear and the barrel return spring stud are mounted to a shank on the rear of the barrel extension.

3.2.6.1 <u>Breech lock.</u> The breech lock (see figures 3-1 and 3-9), which is an integral part of the barrel extension, rides up on the breech lock cam in the receiver base into the breech lock recess in the bottom of the bolt as the recoiling groups move toward the forward position. The mechanism is designed so that the barrel, barrel extension and bolt are interlocked a short distance before the forward position is reached.

On recoil, after a brief dwell, the breech lock is cammed down to the unlock position by the unlocking cams which contact the breech lock pins. The unlocking cams are fixed to the interior sidewalls of the receiver.

This simple type of breech lock provides positive, reliable and rigid locking.

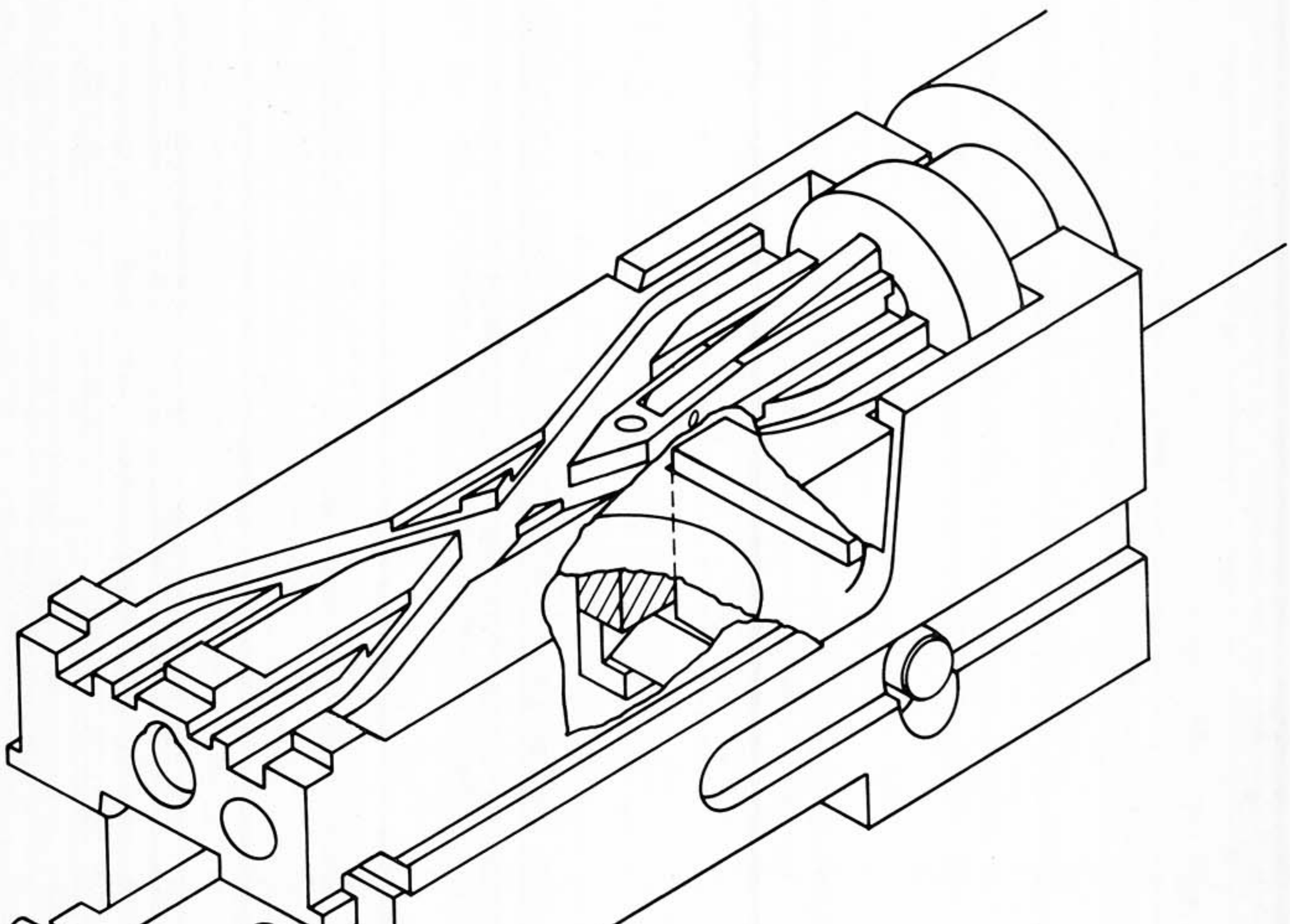


Figure 3-9. Recoiling Group - Locked Position

3.2.7 ACCELERATOR FRAME ASSEMBLY

The accelerator frame assembly consists of the frame, accelerator, barrel return spring group and the locking pin. It is mounted in the rear of the receiver, held in place by the receiver side wall channels and a spring loaded pin which protrudes into a hole in the receiver side plate.

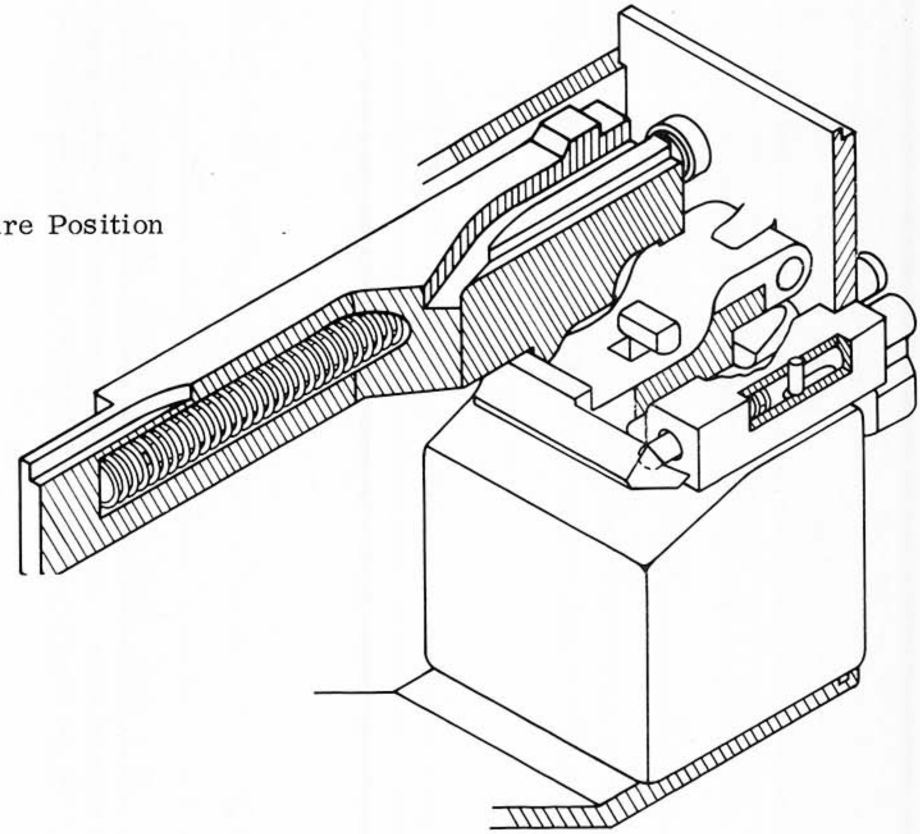
3.2.8 BACKPLATE ASSEMBLY

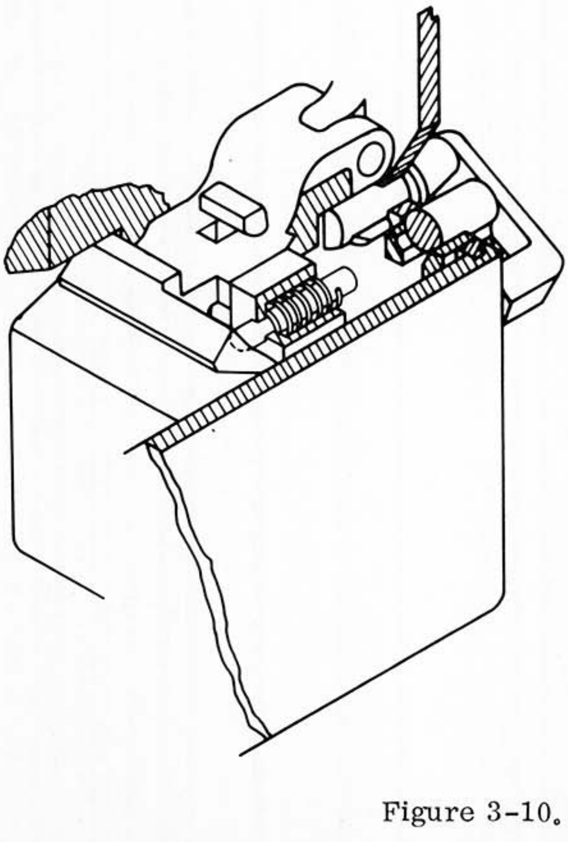
The backplate assembly is retained in the receiver by the buffer coverplate, the receiver bottom plate and guidance slots in the receiver sidewalls. The backplate assembly consists of the trigger, safety, and sear groups. A bumper pad on the surface of the backplate is provided to protect the manual trigger and safety lever.

3.2.8.1 Trigger Mechanism. The trigger bolt release mechanism consists of the manual trigger assembly and the solenoid (figure 3-10). The manual trigger is a spring loaded plunger located on the left side of the backplate. The plunger point, when the trigger is depressed, moves against the sear ramp surface, deflecting the sear downward, in turn, releasing the bolt. When the trigger is released, the trigger return spring returns the plunger away from the sear and the sear return spring, between the sear and the solenoid, returns the sear to the bolt engagement position.

The solenoid plunger, when the solenoid is energized, pulls the sear down, disengaging the sear from the bolt. During initial assembly of the backplate, a sear height adjustment is performed to assure maximum positive bolt to sear engagement. Two headed screws through elongated slots in the backplate, permit vertical positioning of the solenoid.

Bolt Seared - Fire Position





Bolt Seared - Safe Position

Figure 3-10. Back Plate Assembly

3.2.8.2 Safety Assembly. The safety is designed to lock the sear in the bolt engagement position when in the engaged position. When the safety lever is turned from the fire (F) to safe (S) position, two events occur: (1) the safety lever, in the S position only, covers the trigger providing both visual and touch sensory indications that the weapon is safe; (2) the safety extension pin blocks the sear to prevent downward movement keeping the sear in position so that depressing the manual trigger or actuating the solenoid will not release the bolt from the sear.

3.2.8.3 Sear. The sear is retained to the backplate by a solid pin. The sear hook on the front provides an ample positive engagement surface for bolt retention. The trigger cam surface is adjacent to the sear hook. The solenoid plunger is designed to cam the sear downward about the hinge pin when the solenoid is actuated.

3.2.9 BUFFER AND COVERPLATE ASSEMBLY

The coverplate houses the buffer that consists of a stack of Belleville washers which stop the recoiling bolt. The coverplate is attached to the receiver by a hinge pin and the coverplate is secured in position by spring loaded plungers.

3.2.10 CHARGER ASSEMBLY

The charger assembly is mounted on the right side of the receiver by two lock screws. The charger assembly consists of the charger body, spring retainer, compression spring and charging chain and handle. A pin, attached to the spring retainer, extends through a slot in the charger body and receiver.

The compression spring, between the rear of the charger and the spring retainer, maintains the spring retainer in the forward position. The charging chain, with a handle on the rear end, extends into the charger body, through the compression spring, and is connected to the spring retainer.

The bolt is charged to the sear position by pulling the charging handle fully to the rear. The charger pin engages a slot on the side of the bolt carrying the bolt rearward to the sear position. The charger pin will not interfere with bolt action during weapon operation. A remote charging device is readily adaptable to the weapon and would replace the manual charging action.

3.2.11 DRIVE SPRING AND GUIDE ROD

The guide rod head fits in a blind hole on the backplate and serves to retain and guide the drive spring. The drive spring is assembled over the guide rod and into a hole in the rear of the bolt.

3.2.12 RECEIVER ASSEMBLY.

The receiver assembly is of welded plate construction and is the support and guide for all the major weapon groups and assemblies. It houses the weapon action and slots in the receiver sideplates guide the component movement during weapon operation. A trunnion block at the front of the receiver positions, supports and retains the barrel mounting block assembly. The bottom of the receiver contains an ejection slot for the spent cases and a ramp and dwell area for the breech lock. Slots in the rear of the side plates and the bottom plate retain the backplate in rigid position. This assembly has high spring back behind it to hold the

3.3 OPERATIONAL DESCRIPTION

The following paragraphs are included to illustrate various weapon operations in order to more fully understand weapon component interaction.

3.3.1 DUAL FEED SYSTEM

The operation of the dual feed assembly is shown graphically in figure 3-11. (Refer also to figures 3-2 and 3-3.) It is important to notice the positioning of the frame roller (1), cam roller (2) feed pawl cam lobe (3) feed pawl cam lever (4) and the feed chutes (5 and 6). The views show the dual feed assembly mounted on the left side of the receiver as viewed from the rear. The centerline shown is that of the receiver.

View 1. The lower feed chute is in position. Further CCW rotation of the cam would be dwell with no motion imparted to the mechanism.

View 2. The 13° CW rotation from view 1 allows the feed pawl cam lobe (3) to contact and displace the feed pawl cam lever (4). Displacing the feed pawl cam lever lifts the feed pawl away from the ammunition belt, permitting belt and feed chute withdrawal. The feed chute has not moved, the cam roller (2) dwells in the feed chute cam slot during this rotation. Notice the additional raised surface of the feed pawl cam lobe (3), which keeps the feed pawl raised for adequate rotation to assure smooth chute withdrawal.

View 3. After rotating 63° CW, the cam roller (2), acting upon the feed chute cam slot, has completely withdrawn the feed chute from the weapon. The feed pawl cam lobe has rotated sufficiently to allow the feed pawl to return to its feeding position.

View 4. During CW rotation to 153°, the cam slot changes from a dwell shape to one that causes the mechanism to move downward with respect to the fixed roller (1) and weapon.

This view shows the "neutral" position, i.e., halfway between vertical engagement of either belt with the weapon.

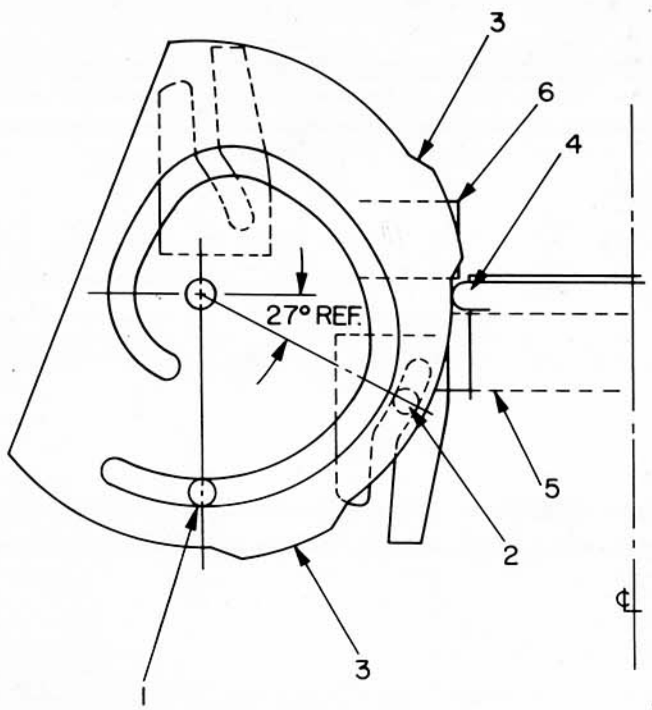
View 5. The rotation to 243° CW lowers the mechanism so that the upper feed chute is in proper position to be inserted into the weapon. The cam roller (2) is just contacting the upper feed chute cam slot, ready to impart horizontal motion to the feed chute. The frame cam (1) will dwell in the cam slot for the remainder of the CW rotation.

View 6. The upper feed chute at 293° CW rotation has been moved into position in the weapon by the action of the cam roller (2) on the feed chute (6) cam slot. The feed pawl cam lobe (3) has displaced the feed pawl cam lever (4). The raising of the feed pawl is not mechanically necessary due to its being spring loaded, but the cam action is required during the withdrawal of the feed chute.

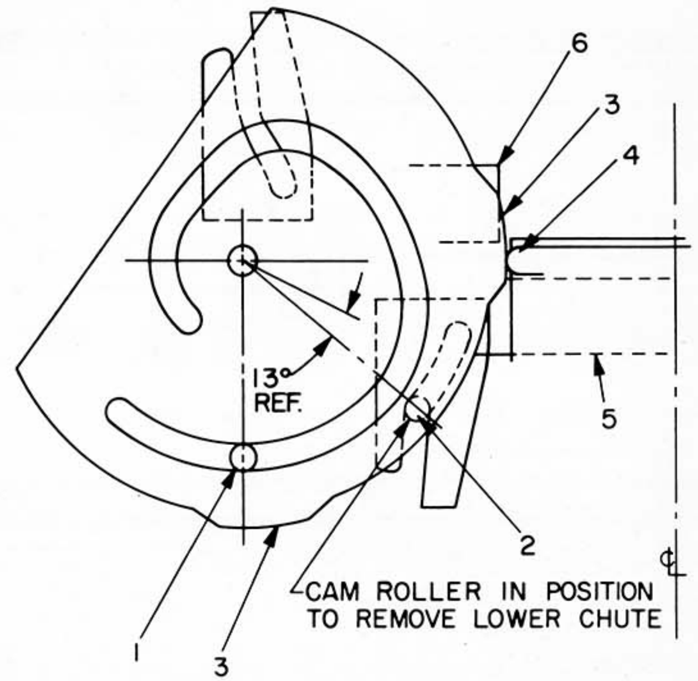
View 7. Rotating to 306° CW the mechanism dwells in the vertical plane, the cam roller (2) dwells in the feed chute cam slot while the feed pawl cam lobe (3) disengages the feed pawl cam lever (4) allowing the feed pawls to engage the positioned ammunition belt. The weapon is now loaded. Changing from the upper to lower belts is the reverse of that detailed above.

3.3.2 WEAPON FEED MECHANISM OPERATION

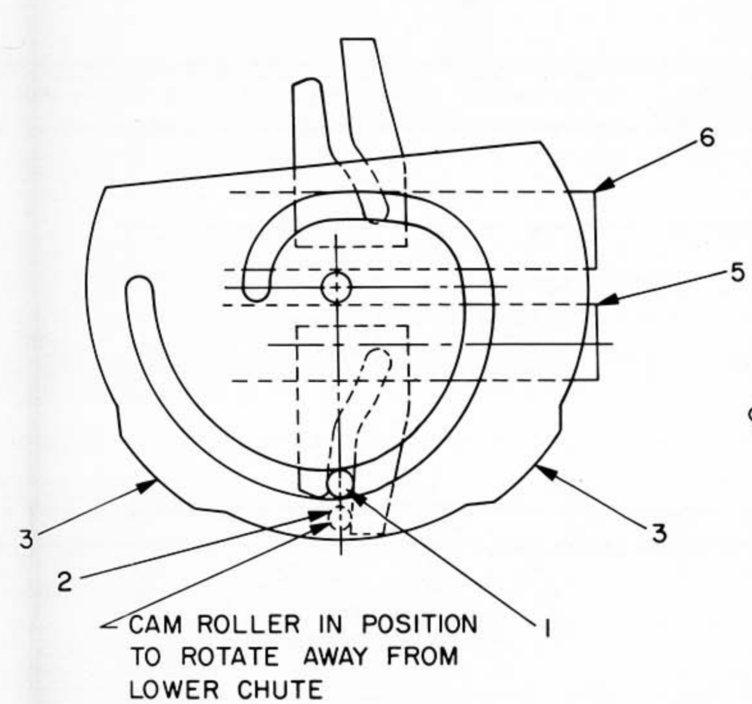
The feed system consists of the feed tray and the cover. The cover (figure 3-5) contains the mechanism which advances the belted cartridge into position to be stripped and chambered. The feed lever is pivoted from the T-shaped support. The cam follower in the opposite end of the feed lever from the pivot is driven by the S-cam groove in the top of the bolt. The motion of the feed lever against the studs in the feed slide assembly causes transverse movement of the feed slide in the feed track assembly. As



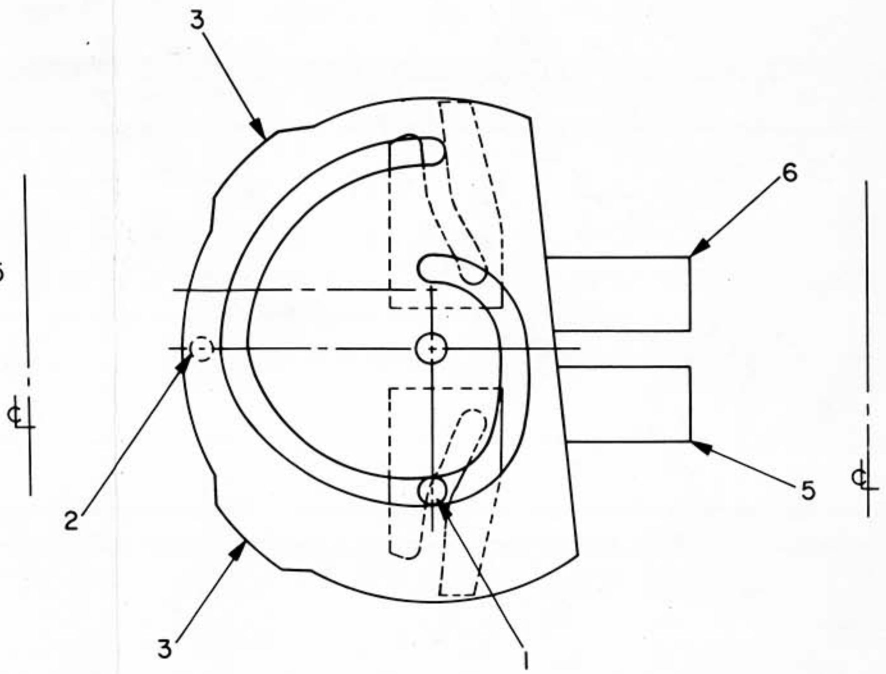
VIEW 1 - LOWER BELT IN POSITION



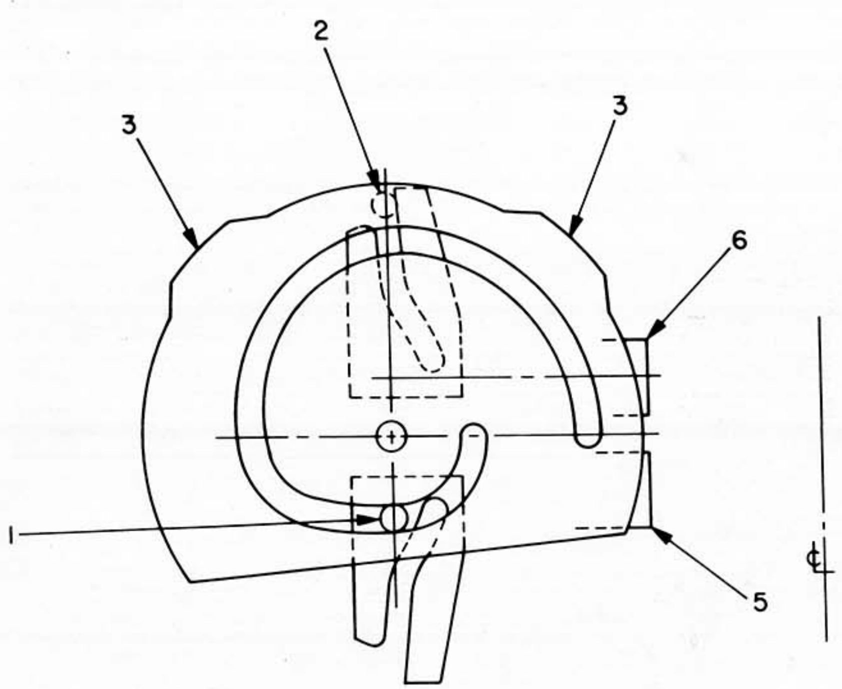
VIEW 2 - 13° CW - FEED PAWL LIFTED BEFORE LOWER CHUTE REMOVAL



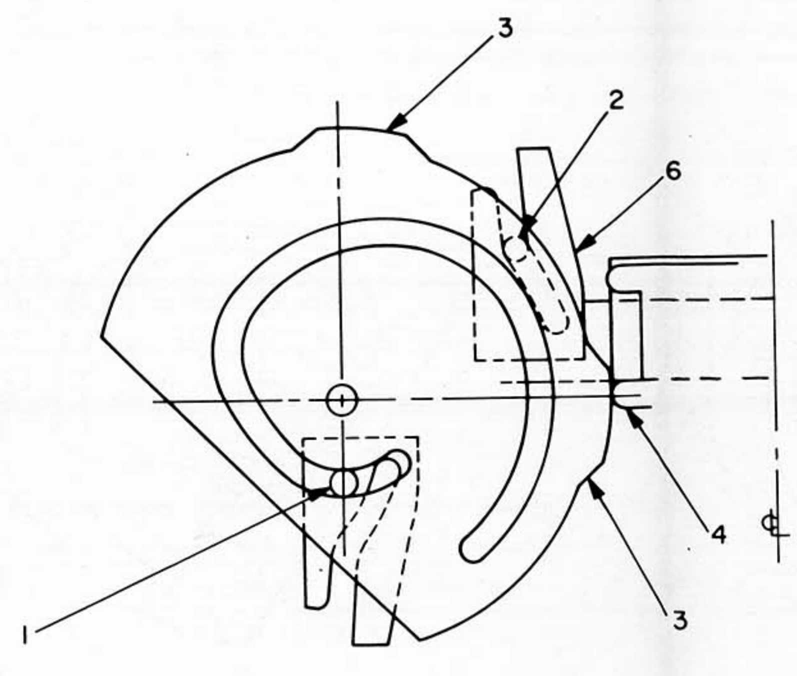
VIEW 3 - 63° CW - COMPLETE REMOVAL OF LOWER CHUTE



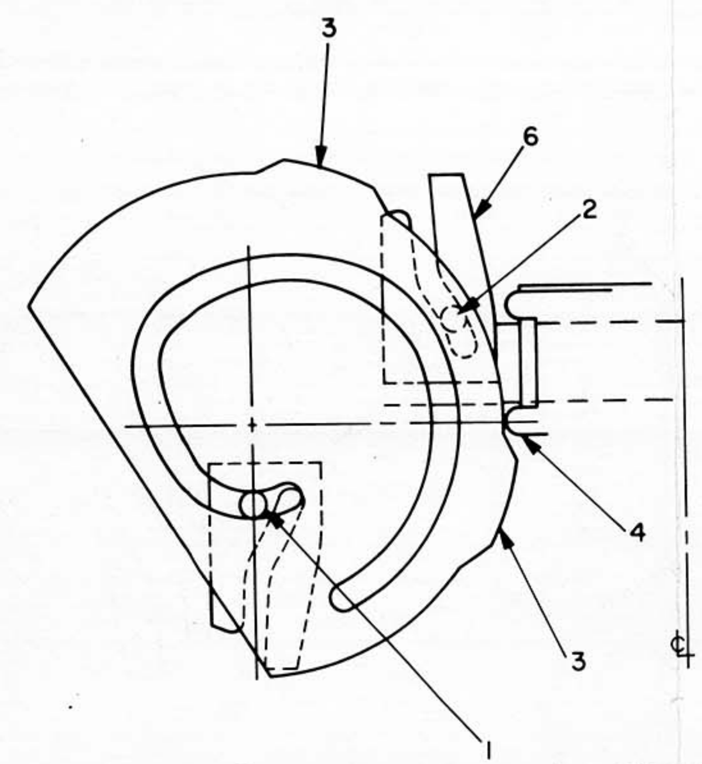
VIEW 4 - 153° CW - LOWERS THE MOTOR AND BOTH CHUTES AS A UNIT TO NEUTRAL



VIEW 5 - 243° CW - UNIT LOWERED - UPPER CHUTE READY TO START HORIZONTAL MOVEMENT



VIEW 6 - 293° CW - UPPER CHUTE ENGAGED FEED PAWL LIFTED



VIEW 7 - 306° CW - FEED PAWL IN POSITION (UPPER BELT IN POSITION)

1. Frame Roller
2. Cam Roller
3. Feed Pawl Cam Lobe
4. Feed Pawl Cam Lever
5. Lower Feed Chute
6. Upper Feed Chute

Figure 3-11. Dual Feed Operational Diagram the bolt recoils, the feed pawls move the ammunition into the weapon positioning the leading round so that it may be stripped from the belt. The retaining pawls are deflected as the next to the leading cartridge passes by and then spring back behind it to hold the belt in position. As the bolt counter-recoils, the feed pawls are actuated by the feed lever and are moved into position to pick up the next round.

3.3.3 CHAMBERING

Chambering begins as the leading cartridge is stripped from the belt. As the bolt moves forward, the rammer contacts the base of the cartridge, stripping it from the link. As the cartridge is driven forward it is guided downward toward the chamber by the feed tray cartridge ramp. The base of the cartridge rides down the face of the rammer and the bolt ramming lugs. During the final stage of this downward movement and just prior to reaching the fully chambered position, the base depresses the extractor to the point where the cartridge is allowed to move into position against the face of the bolt.

After the cartridge has been fully seated in the chamber the rammer is above the cartridge, and the extractor, which is part of the bolt assembly, is in the extracting groove of the cartridge.

3.3.4 FIRING MECHANISM OPERATION

The firing mechanism consists of the firing pin, firing pin spring, cocking lever, cam follower, and the cocking cam on the receiver sidewall (see figure 3-1).

The firing mechanism is in a relaxed position when the bolt is seared and the firing pin spring is under initial compression only (see figure 3-10).

After triggering, as the bolt moves forward from the sear position, the cocking cam engages the cocking lever (pinned to and moving forward with the bolt). The lever is

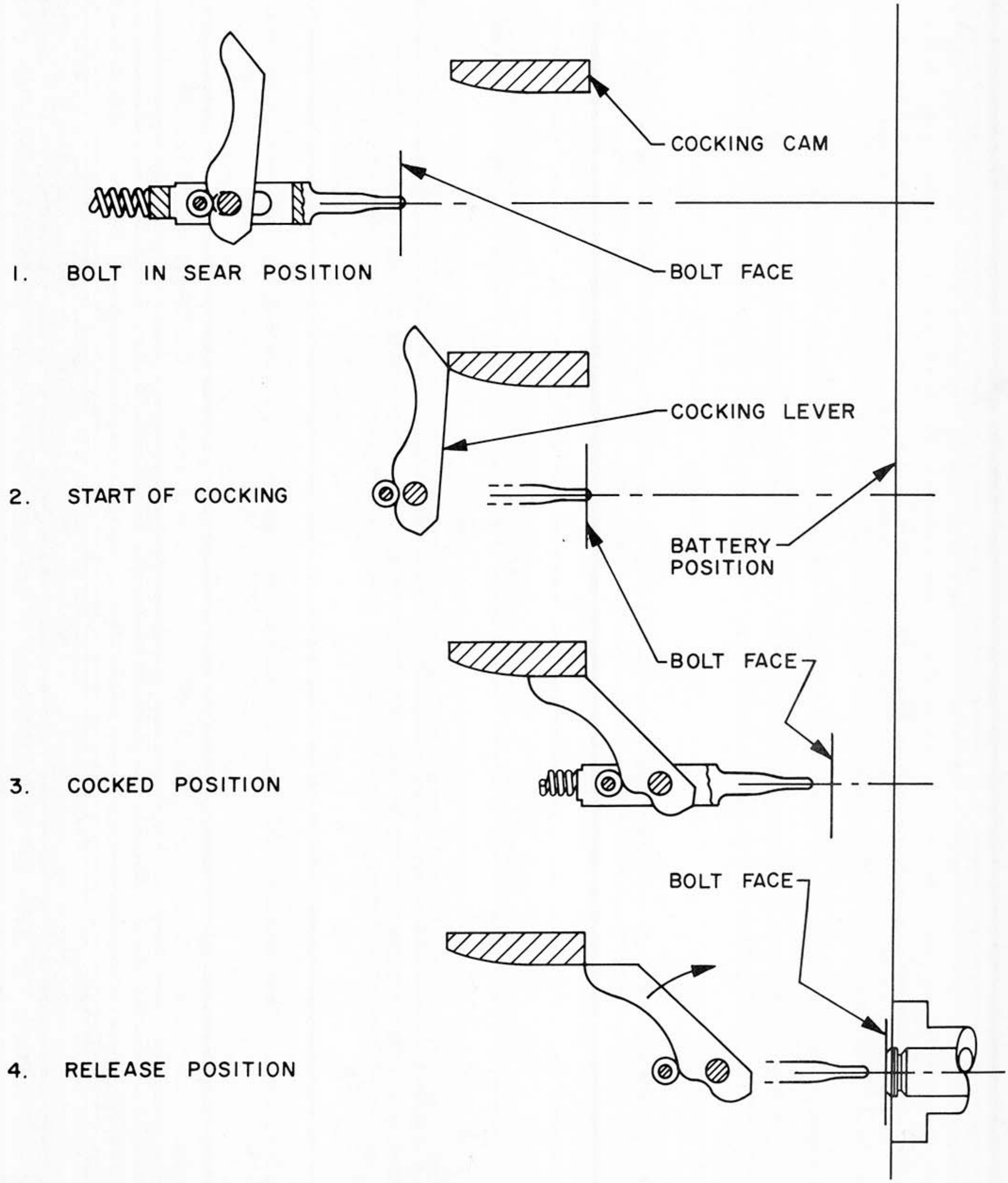


Figure 3-12. Firing Mechanism - Counter Recoil Cycle

deflected compressing the firing pin spring and cocking the firing pin (2, figure 3-12). The firing pin is held for a short time in the fully cocked position (3, figure 3-12) until the cocking lever reaches the firing pin release point on the cocking cam (4, figure 3-12). Upon release the compressed firing pin spring drives the firing pin forward firing the cartridge.

During the recoil cycle, the cocking lever is cammed by the receiver cocking cam and is returned to its relaxed position by the partially compressed firing pin spring.

Design features related to the firing mechanism which assure maximum safety during the weapon's cycle of operation are:

(1) The firing pin is released after breech locking during the counter recoil cycle.

(2) The firing pin cannot protrude from the bolt face during feeding and chambering except when the breech lock is engaged locking the bolt and the barrel and barrel extension together.

3.3.5 EXTRACTION

The extractor, located in the front end of the bolt, is a spring loaded pivot arm with a claw at the front end. During chambering the extractor is displaced by action of the cartridge on the extractor.

When the cartridge is chambered, the extractor engages the cartridge extractor groove containing the cartridge rim between the extractor and the bolt ramming lugs aided by the force of the extractor spring. When the bolt is unlocked, the extractor extracts the cartridge from the chamber and carries it back until the cartridge is completely removed from the barrel.

3.3.6 EJECTION

After the cartridge has been extracted from the barrel it is carried rearward by the bolt/extractor movement during recoil until it strikes the ejectors. The cartridge case is pivoted about the extractor claw and ejected down and out of the weapon.

The ejectors are protrusions from the bottom of the feed tray which extend into clearance cuts in the bolt. They are designed to engage the upper portion of the cartridge so that they impart the necessary downward motion to the extracted cartridge.

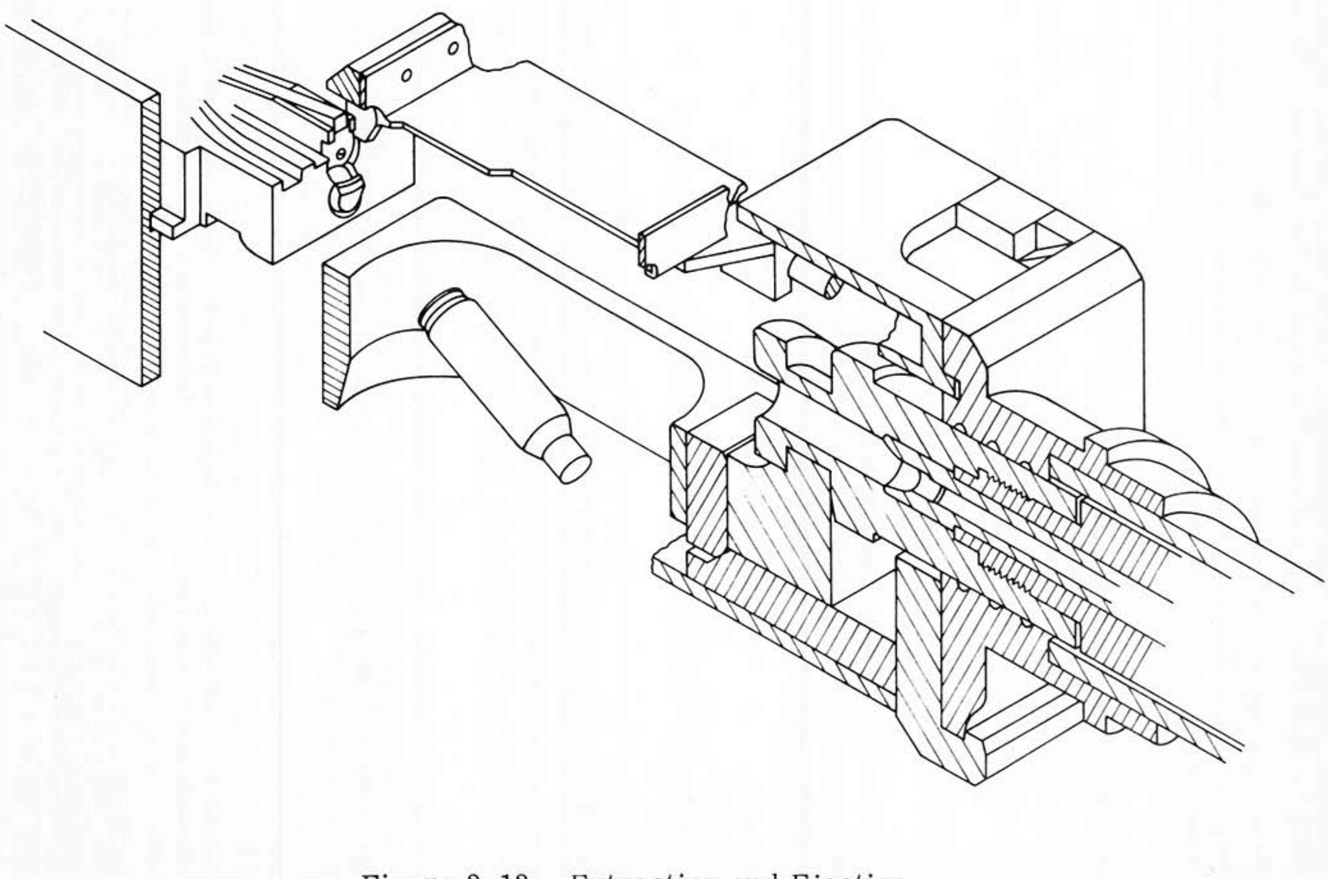


Figure 3-13. Extraction and Ejection

3.4 OPERATIONAL CYCLE

3.4.1 WEAPON SYSTEM LOADING

Prior to performing any loading operation, charge the weapon and place the safety lever in the (S) safe positon.

3.4.1.1 Dual Feed Belt Changing Mechanism Loading. The dual feed mechanism should be in a neutral position during loading, i.e., neither chute engaged with the weapon, and the weapon dual feed cover and tray must be used.

The dual feed mechanism is loaded by attaching the ammunition belts in the ammunition box or boxes to the dual feed mechanism feed chutes. The ammunition belts are fed through their respective chutes until the lead cartridge hits the chute round stop. At this point the feed chute holding pawls in each chute engage the next to the lead cartridge and hold the belts in the chutes.

The dual feed belt changing mechanism is now ready for weapon loading by engaging either of its two chutes with the weapon. This can be accomplished either manually or by remote electrical control. Once this is accomplished the weapon is ready for arming.

3.4.1.2 Conventional Single Belt Weapon Loading. When using a single belt feed to load the weapon, i.e., the dual feed belt changing mechanism is not a part of the system, the conventional tray and cover must be used.

The weapon is loaded by pivoting the feed cover up and away from the feed side. The ammunition belt is positioned in the feed tray so that the lead cartridge is in contact with the feed tray round stop. The ammunition belt must be held in position until the feed cover is closed and the feed cover holding pawls hold the belt in position. The weapon is now ready for arming.

3.4.2 COUNTER RECOIL CYCLE

After arming the trigger is actuated to disengage the sear from the bolt. The compressed bolt drive spring accelerates the bolt forward. During its forward movement the bolt cartridge rammer strips the cartridge from the link and drives it towards the chamber. Also, the cocking lever is displaced by the cocking cam and the firing pin is cocked. The accelerator pads on the bolt contact the tips of the accelerator releasing the barrel extension from its sear position. The accelerator, driven by the bolt and compressed bolt return spring, aids in driving the barrel extension and barrel forward until the bolt contacts the barrel extension. When this occurs the bolt and barrel extension and barrel move forward together. During this final forward movement and prior to firing pin release, the breech lock in the barrel extension locks the moving component together. Just prior to the locked components reaching their extreme forward position, the cocked firing pin is released. The cartridge is fired while the recoiling group is in a dwell period in its foremost ("battery") position.

3.4.3 RECOIL CYCLE

When the cartridge is fired the resulting impulse forces the recoiling group (barrel, barrel extension, and bolt) rearward. During this movement the barrel return spring is compressed. During the first phase of this movement feeding is initiated. Also, after adequate dwell, the breech lock disengages the bolt. The barrel extension contacts the curved surface of the accelerator, causing the accelerator to rotate. The tips of the accelerator engage the accelerator pads, and, as the barrel extension further rotates the accelerator, an accelerating force is imparted to the bolt, driving the bolt rearward. Case extraction begins at this point.

The barrel extension is stopped by the accelerator frame and seared in the rear position by the sear lug on the accelerator. This action also keeps the barrel return spring compressed.

The bolt, as it continues to recoil, causes completion of the feeding and ejection cycles and compresses the drive spring against the backplate. The bolt, after passing the sear position near the extent of its rearward travel, strikes the buffer and completes the recoil cycle. The bolt then moves forward in the first phase of counter recoil to the sear position where it stops if the sear is not actuated. If the sear is actuated, the weapon will continue operation until all ammunition is expended or the trigger mechanism is deactivated.

3.5 FIELD STRIPPING PROCEDURE

Prior to field stripping the dual feed belt changing mechanism must be in a neutral position, i.e., neither feed chute is engaged with the weapon, and it must be unlocked from the receiver. The dual feed belt changing mechanism, however, remains attached to the mounting block. If a conventional single belt feed mode is in use, this belt must be disengaged. Any electrical connections to the weapon itself must also be broken.

a. After the weapon has been cleared, return the bolt to the forward position.

b. Pull the locking block on top of the mounting block to the rear to unlock the receiver. While holding this lock to the rear and supporting the receiver with the other hand, allow the receiver to drop out of engagement with the mounting block.

c. Pull the barrel to the rear removing it from the jacket assembly.

d. Push the feed cover hinge rods forward until they lock in the disengaged position. Remove the cover and feed tray.

e. Depress the buffer cover plate locking plungers and rotate the buffer cover plate up to its fully open position.

f. Remove the drive spring and rod assembly.

g. Remove the backplate assembly by lifting it straight up out of the receiver.

h. Pull the charging handle to the rear to unlock the bolt assembly from the barrel extension. Remove the bolt assembly.

i. If desired, depress the accelerator frame locking detent and pull the accelerator frame and barrel extension out the rear of the receiver.

Reassembly of the weapon is accomplished by reversing the above procedures.

Colt Industries Colt's Firearms Division

SECTION 4

MANAGEMENT

SECTION 4

MANAGEMENT

Colt's Firearms will manage the effort described in the proposal using the Project Management Team concept which has proven successful in the development and manufacture of other weapon systems.

The key man in this program will be the Project Manager - GPAM Weapon System. He will be responsible for the principle decisions in design, engineering and manufacturing. He will also be responsible for achievement of objectives set forth by company management and stated contractually.

The following functions will support the program to the extent required:

Manufacturing - Establish and implement fabrication schedule.

Design Engineering - Establish design and make design changes when necessary.

Purchasing - Procure items from qualified vendors.

Human Engineering - Assure a man-integrated weapon system.

Field Engineering - Support field test of the weapon system.

Quality Control - Assure the quality and performance of the weapon system.

The personnel in this program at present are highly qualified in arts related to the design, test and analysis of new weapon systems. They are familiar with the history of the current weapons used as vehicular machine guns, the user's needs, and the reasons for the requirements stated for the proposed weapon system.

The resumes of these key people are contained in this section.

<u>Technik Inc.</u>

In addition to the personnel and facilities available at Colt's Firearms Division in Hartford, the personnel and facilities of Colt's affiliate, Technik Inc., are also available. They will be utilized during the weapon system design and development to perform in-depth mathematical analyses of those parameters vital to weapon function to assure a high degree of reliability and longevity.

Technik Inc. is located in Jericho, New York and is the advanced technology operation of Colt's Firearms. Technik Inc. was founded by Dr. Melvin Zaid who was its president for seven years prior to aquisition by Colt's. His abilities assure a technical effort commensurate with the tasks outlined herein.

A majority of Technik's past contacts have been in the field of Ordnance, principally Small Weapons Systems including, recently, M16 Weapon/ammunition interface investigations. Its primary customers are Frankford and Picatinny Arsenals.

MILESTONE CHARTS

The milestone charts (figures 4-1 and 4-2) are included to inform the government as to the objectives and planned level of effort.

Colt Industries — Colt's Firearms Division

WILLIAM H. GOLDBACH

President - Military Arms Division
Colt's Firearms Group
Colt Industries

EDUCATION

BBA - John Carrol University
Post Graduate - Wooster College, University of Iowa

EXPERIENCE

Colt's Firearms

Mr. Goldbach has had extensive management experience at Colt's, being responsible for meeting technical, schedule and cost objectives for the M16 Automatic Rifle, XM148 Grenade Launcher and the MK-56 Naval Gun Mount. His knowledge of all phases of weapon system management is particularly valuable in directing an existing weapons manufacturing team to solve new development tasks.

TRW

As Ordnance Works Manager, Mr. Goldbach actively supervised all phases of M14 rifle production and other ordnance products. Prior to this assignment, he was divisional Industrial Engineering Manager for three plants in the TRW Jet Engine complex and was also responsible for the start-up of several automotive and jet engine parts facilities.

Mr. Goldbach taught cost improvement and work simplification courses early in his career, and is the author of several related articles in the field.

SOCIETIES

IMS (Award Winner)
ASTME (Past Chapter Chairman) (Handbook Chairman)
A.O.A., A.U.S.A., S.A.M., U.S.A.F.A.

DALE W. ANDERSON

Product Engineer
Military Engineering - Small Arms Section

EDUCATION

BSME University of Missouri (PI TAU SIGMA, TAU BETA PI)
MSME Scheduled 8/69 Rensselaer Polytechnic Institute (Hartford Branch)

EXPERIENCE

Colt's Firearms (March 1969 -)

Mr. Anderson is involved with the design of feed systems for automatic weapons. He has also redesigned an experimental burst mechanism in preparation for mass production and has performed studies in relation to M16 rifle revision.

Pratt and Whitney Aircraft (November 1966 - Feb 1969)

Mr. Anderson was involved with applications and new technology designs for both Industrial Gas Turbines and Advanced Military Engines. He utilized computer programs in the design of various turbine engine components.

John Deere Tractor Works

Mr. Anderson worked in both the current and new product areas of the John Deere Tractor Works. He was involved with engine design, power train design and chassis development. He prepared layouts for experimental build proposed tractor designs, analyzed and designed various power train components and engine accessories.

SOCIETIES

National Society of Professional Engineers
American Society of Mechanical Engineers

SETH BREDBURY

Chief, Ordnance Test Section
Military Engineering - Small Arms Section

EDUCATION

BSME Massachusetts Institute of Technology

EXPERIENCE

Colts Firearms (1968 -)

Mr. Bredbury supervises the personnel in the test and evaluation activities in support of the development of small arms weapons.

U. S Naval Ammunition Depot, Oahu, Hawaii (1966-1968)

Mr. Bredbury served as Test Engineer in the Quality Evaluation Laboratory at USNAD. He designed tests and test equipment, devised test procedures and analyzed test results for the Auxiliary Power and Terminal Guidance Units for SUBROC. The organizational mission of the lab was stockpile surveillance of nuclear antisubmarine missiles.

Springfield Armory (1964 to 1966)

Mr. Bredbury was a test engineer in the Research and Development Division. He performed developmental tests and evaluations of prototype domestic and foriegn weapon and weapon mounting systems. He performed extensive tests on the 30 mm XM130 Weapon System.

Colt Industries Colt's Firearms Division

C. WILLIAM BRITCHER

Materials Manager

EDUCATION

BSME - Polytechnic Institute of Brooklyn
MS - Administration - New York University
Licenced Professional Engineer - New York State

EXPERIENCE

Colt's Firearms (1963 -)

Mr. Britcher is the Materials Manager responsible for the purchasing functions and production control connected with the military operations of Colt's Firearms. Previously, he was Manager of Industrial Engineering, having formed and staffed the IE department. He was responsible for preparation of long range business plans, engineering expense reports and labor forecasts. He also supervised the layout of a 200,000 square foot plant expansion for the best man/machine and material flow efficiency.

Stanley Tools (1962 - 1963)

Mr. Britcher was the Manager of Industrial Engineering and as such initiated a corporate training program in MTM specifically aimed at the preparation for a plant relocation. He set up a methods improvement program and predetermined standards to take advantage of the new layout. In conjunction with the Controller and Product Line Manager, he prepared a long range business plan for a major product line.

Republic Aviation Corp. (1958 - 1962)

Mr. Britcher was Business Systems Supervisor responsible for the installation of an integrated system of collecting and processing various shop data using transmitters similar to the IBM 1030 reader. The system was used both for labor time reporting and for order dispatching. He had the complete responsibility from the initial planning through the training of shop people. He completed several other projects including requirements planning, engineering accountability and master scheduling. He also made effective use of PERT in project control.

Mergenthaler Linotype Company (1949 - 1957)

Mr. Britcher was the Chief Industrial Engineer, supervising manufacturing engineering, timestudy, special machinery design and procedures design. Previously he served in the following capacities; methods engineer, quality control engineer, production engineer, administrative engineer and manufacturing engineering supervisor.

SOCIETIES

American Institute of Industrial Engineers (Past Chapter President)

National Association of Purchasing Management

WILLIAM H. CRAVEN

Vice President, Military Manufacturing

EDUCATION

B. S. Iowa State College
Graduate of U. S. Merchant Marine Acamedy

EXPERIENCE

Colt's Firearms

Mr. Craven is responsible for all manufacturing functions of Colt's military operations. These functions include machining, assembly, manufacturing engineering and industrial engineering. Mr. Craven has an outstanding record for meeting difficult assignments.

Ingersoll Milling Machine Company

Mr. Craven was responsible for product engineering, quality control, purchasing, manufacturing, production control and division accounting. He was effective in establishing significant cost reductions by standardizing product design, purchase of new equipment and developing an outstanding manufacturing organization.

ROBERT D. FREMONT

Manager
Military Engineering - Small Arms Section

EDUCATION

Itasca Junior College
University of Connecticut, School of Engineering

EXPERIENCE

Colt's Firearms

Mr. Fremont is responsible for all aspect of weapons design and development for military usage. He is responsible for the engineering improvements made to and modifications of Colt's M16 rifle in order to continually meet changing military requirements. Mr. Fremont's experience is unique in that it covers essentially every facet of small arms production, from concept through design, development, tooling and processing, purchasing, quality control, manufacturing and test and evaluation.

Cadillac Gage Company

Mr. Fremont, as Project Engineer, contributed substantially to the design and development of the Stoner Weapons System, first developed in 7.62 mm NATO caliber (designated the S-62) and then in 5.56 mm and designated the S-63. In addition, from 1962 to 1964 he managed the development facility.

Armalite Division, Fairchild Engine and Airplane Corporation

Mr. Fremont was Project Engineer on the AR-15 as adopted by the Air Force (M16 Army designation). He served as Liaison Engineer and Consultant representing Fairchild Engine and Airplane Corporation assisting in the establishment of production of the AR-15 at Colt's Firearms. Additionally, as a Project Engineer, he was responsible for the AR-10A, an improved version of the AR-10 manufactured by the Dutch government.

SOCIETIES

ASSOCIATION OF THE UNITED STATES ARMY
Army Ordnance Association
U. S. Air Force Association

Colt Industries Colt's Firearms Division

DANIEL E. GROVE

Manager, Quality Control

EDUCATION

Aeronautical Engineering Graduate	Academy of Aeronautics, New York
Business Administration Course	Alexander Hamilton Institute

Basic and advanced courses in Statistical Quality Control

EXPERIENCE

Colt's Firearms

Quality Control Manager - Responsible for Inspection, Firing Range and Final Examination, Quality Assurance Engineering and the Standards (Metrology) Laboratory. Credited with developing the high degree of quality awareness and low manufacturing rejects on all Colt products, both commercial and military.

Revere Corporation of America

Quality Control Manager - Responsible for all phases of Quality Control relating to the manufacture of mechanical and electro-mechanical components for the electronics and missile industry.

Aero Supply Manufacturing Company

Chief Test Engineer - Handled all production and qualification testing of pneumatic, hydraulic and fuel system components for the automotive and aircraft industry.

Chance Vought Aircraft

Supervised the structural, hydraulic and fuel system tests conducted on aircraft components.

SOCIETIES

American Society for Quality Control (Senior Member and Past Chairman)

KANEMITSU ITO

Field Engineer
Military Engineering - Small Arms Section

EDUCATION

Associate of Arts and Chemistry - San Mateo College

EXPERIENCE

Mr. Ito is responsible for field surveillance of testing and analysis of all military weapons produced by Colt's. In addition he is available for technical field assistance to the military, including product demonstrations and individual instructions. Prior to joining Colt's, he was a Weapon Development Consultant, maintaining close liaison with Ft. Benning, USCONARC, and the Pentagon.

hesse-Eastern

Mr. Ito was responsible for the organization of a test range facility and for all test reports. He was intimately involved with the ordnance items such as Off Root Mine, Big Brother, Extended Ranges of LAW, and the Portable Barrage Rockets.

ARACON Laboratories

Mr. Ito was the Range Test Engineer for development items such as the Anti-Tank Rocket (PIGMI) and Angle Sensor.

U. S. Army

From 1942 to 1962, Mr. Ito was a career officer in the U. S. Army and attained the rank of Major. He served in various capacities in infantry field commands and staff evaluation boards for ordnance items, including Chairman of the Machine Gun Committee and Executive Officer, Mortar Committee of the Weapons

Department at Ft. Benning. Mr. Ito was Operations Officer with the 1st Armored Rifle Battalion, 58th Infantry at Ft. Benning supporting armored equipment, instruction and demonstrations. At the Arctic Test Board, Fort Greely, Alaska, 1956-1960, Mr. Ito was a Test Officer where he gained vast technical experience and knowledge in the use and development of prototype fuzes, mines, grenades, ammunition, machine guns, rifles and recoilless weapons at various sub-zero temperatures and testing to determine suitability of equipment and ordnance items. During the winter test season of 1958, he participated in the initial arctic test of SPIW. He also was responsible for all testing of 40 mm grenade ammunition and launchers and participated in the Optimum Fragmentation Program.

WILLIAM J. JARRETT

Chief-Applied Research And Test Branch
Military Engineering - Small Arms Section

EDUCATION

BSME - University of Hartford
Purdue University
Certificate - U.S. Army Management and Engineering Training Agency

EXPERIENCE

Mr. Jarrett directs the applied research activities in support of the design, development and test of military small arms weapons systems. These activities include the parameters involving stress, dynamics and kinematics of weapon concepts, and the evaluation and preparation of the technical aspects of new hardware proposals.

Springfield Armory

Mr. Jarrett's last assignment was Group Leader, Design Support Group, Research and Engineering Division, directing the design support activities, acting as a consultant to the Chief-Weapons Development Branch and serving as a member of the AMC Engineering Design Handbook Advisory Group. The Design Support Group provided analytical and experimental support to the weapon design engineering groups during the development of a weapon system from concept to type classification.

Support activities were performed for the following machine guns:

7.62 mm M37 GPMG	Cal. 50 T176 Tank MG	15 mm XM122 Spotting MG
7.62 mm T197/M73 Tank MG	Cal. 50 T175/M85 Tank MG	20 mm T222 SRAA MG
7.62 mm T161/M60 GPMG	Cal. 50 XM121 Spotting MG	

SOCIETIES

Registered Professional Engineer, Massachusetts #19767

RELATED PUBLICATIONS

Technical Report No. SA-TR1- 7025,
Development of a Stellite - Lined, Chromium Plated Barrel for 5.56 mm Machine Gun
Springfield Armory

Trunnion Reactions and Vibrational Characteristics of the 7.62 mm M60 Machine Gun in Light Weight Aircraft Mounts (Springfield Armory Report, 1962, unpublished)

Colt Industries | Colt's Firearms Division

JOHN K. JORCZAK

Design Engineer
Military Engineering - Small Arms Section

EDUCATION

BSME Western New England College

EXPERIENCE

Colt's Firearms

Mr. Jorczak is the Design Engineer assigned to the component development of the GPAM. Previously he was assigned to the conceptual development of various externally-powered automatic weapons. He is responsible for the design and development of the Stowage Buttstock for the M16 rifle, coordinating the pilot production with vendors and maintaining liaison with military and civilian agencies. He has conducted design studies on the XM148 and the CGL-5 40 mm grenade launcher and designed a battle sight for use with any grenade launcher mounted on the M16 rifle.

Springfield Armory

Mr. Jorczak conducted engineering investigations into the problem areas that arose during field use of the M73 machine gun and other various weapons. He was responsible for the redesign of marginal components to improve operation and reliability with adaptability to mass production the prime concern.

Mr. Jorczak was also responsible for coordinating the engineering aspects of the M73 Machine Gun solenoid development contract, carrying the program through type classification He also served as Project Engineer for NATO standardization of the 7.62 mm M13 cartridge link.

PUBLICATIONS

Technical Report No. SA-TR3-1912, Development of an Antifouling Booster for the M73, 7.62 mm, Fixed Machine Gun, Sophinos, N., Cabay, R.J., Jorczak, J.K., Springfield Armory, 15 June 1965.

Technical Report No. SA-TR15-2102, Evaluation of the STANAG 2329; Links for Disintegrating Belts for use with NATO 7.62 mm Rounds, John K. Jorczak, Springfield Armory, 9 April 1965.

MISCELLANEOUS

Patents Pending:

Battle Sight for an Auxiliary Projectile Launcher

Cartridge Case Extractor Tool

ARTURO A. MONTEROS

Stress Analyst Engineer
Applied Research and Development Engineer
Military Engineering, Small Arms Section

EDUCATION

MSME and MSAE - University of Cordoba, Argentina
Advanced Engineering - University of Cordoba

Post Graduate Studies

Diplomas: Material Science (University of Cordoba)
Industrial Management (Technological University)
Linear Programming (Technological University)

Certificates: Numerical Methods in Engineering (Technology University)
Guided Missiles (Superior School of Aeronautics)
Material Science (University of Cordoba)

EXPERIENCE

Colt's Firearms (April 1969 -)

Mr. Monteros has performed stress and mechanical analysis on various advanced automatic and non automatic small arms weapons. He is also studying weapon heat transfer characteristics by both experimental and analytical methods. Using a theoretical approach, he is developing analytical equations and computer programs to solve the problems of temperature distribution. These efforts are oriented towards developing a new philosophy regarding weapons development, and through the use of the modern technology to advance the state of the art.

Combustion Engineering

Mr. Monteros was a stress analyst involved in performing piping stress and flexibility analyses of steam power generation units utilizing computer operations to perform the recessary complex calculations.

Allied Control Corp.

Mr. Monteros was a development engineer responsible for the study of the fluid mechanics of production and prototype values. In addition, he was concerned with applications of fluidics.

Dinfia (Cordoba, Argentina)

Mr. Monteros was a stress analyst involved in the analysis of various aircraft components. He was also involved in patent examination and the translation of technical documents into Spanish from English, French and Italian. Additionally, he was a Research Assistant performing acoustic studies of air motor propellers, fans and blades and was Assistant Project Engineer of a Hovercraft Vehicle program, responsible for coordination of the project groups.

SOCIETIES

Society for Experimental Stress Analysis

Consejo Profesional de Ingenieria Aeronautica

Asociasion Profesional de Ingenieros Especialistas

NICHOLAS SOPHINOS

Senior Design Engineer
Military Engineering - Small Arms Section

EDUCATION

BBA Northeastern University (Engineering and Business)
University of California (Mechanical Engineering -- 3 yrs.)
Graduate Journeyman Toolmaker
Certified Instructor--Automatic Weapons-USMC
Registered Professional Engineer - Commonwealth of Massachusetts #22192

EXPERIENCE

Colt's Firearms (1966-)

Mr. Sophinos is the Senior Design Engineer responsible for the development of the GPAM. Previously, he was responsible for the design of an externally powered, non-rotating, multiple barrel gun system. Mr. Sophinos was technically responsible for design changes and product improvements of the 40 mm XM148 grenade launcher. He designed and developed a new 400 meter sight for the XM148 which was recommended for field use by the Test and Evaluation Command in July, 1967. Additionally, he has designed retrofit package for the XM148 for evaluation by the military and has made major contributions in assisting in the preparation of drawings for the M16 Rifle Technical Data Package.

Springfield Armory (1939-1966)

Significantly, for six years Mr. Sophinos was technically responsible for the design changes and product improvements of the M73 and M73E1 Machine Guns. This included making design changes for pre-production weapons, preparation of the product drawings and detailed preparation of the technical data for procurement. Major design achievements include a barrel with improved chamber configuration, an interchangeable backplate assembly and an anti-fouling booster.

As M13 Link Product Engineer, Mr. Sophinos, for seven years, was responsible for the product drawing and design finalization. He was technically involved with all user applications of the M73 Machine Gun and the M13 Link, and he maintained liaison with companies and government agencies which designed mounts for the various application of the M73 Machine Gun. Additional engineering assignments included production engineering and product improvement of the M60 Machine Gun and the M91 Tripod Mount for the M60 Machine Gun.

From 1950 to 1954, Mr. Sophinos was Assistant Foreman and Foreman of the Springfield Armory Apprentice Machine Shop and School.

PUBLICATIONS

Technical Report, No. SA-TR3-1912, Development of an Antifouling Booster for the M73, 7.62 mm. Fixed, Machine Gun., Sophinos, N.; Cabay, R. J.; Jorczak, J. K.; Springfield Armory, 15 June 1965.

SOCIETIES

Senior Member--American Society of Tool and Manufacturing Engineers (ASTME)

National Society of Professional Engineers

MISCELLANEOUS

Letters of Commendation

7th Army Combined Arms School (Germany)
Technical Secondary Armor Support for the
M60E1 Tank Demonstration for NATO

Commanding General, Rock Island Arsenal
Value Engineering Task on M73 Machine Gun

Commanding Officer, Springfield Armory
Outstanding Performance of Duties in Connection with the M73 Machine Gun Program.

Colt Industries Colt's Firearms Division

JAMES TAYLOR

Electrical Engineer
Military Engineering - Small Arms Section

EDUCATION

BS Trinity College
BSE Trinity College - Honors in Engineering

EXPERIENCES

Colts Firearms (Dec. 1968 -)

Mr. Taylor is responsible for the design and operation during use of electrical and electronic equipment used during weapons test and evaluation. He is also responsible for the design and analysis of electrical and electronics equipment utilized in advanced weapon concepts.

Westinghouse, Modular Electronics Division (June 1968 - Sept. 1968)

Mr. Taylor was a graduate student trainee involved in testing applications of digital prototypes, testing of integrated circuits for A.C. and D.C. temperature controls, and in the use of computers for circuit testing.

DR. MELVIN ZAID

President - Technik Inc.

EDUCATION

B.S. Mechanical Engineering	Stanford Univ. "with great distinction"
M.S. Engineering Mechanics	Stanford University
Mechanical Engineering	Mass. Inst. of Technology
Doctor of Science	Mass. Inst. of Technology
Post-Doctoral Courses	N.Y. Univ. & Brooklyn Polytechnic

Studies under Timoshenko, Goodier, Hodge, Reissner, C.C. Linn, etc.

EXPERIENCE

President of Technik Incorporated - May 1959 to present

Work in fields of Recoilless Rifle, Ultra-High Pressure Vessel (300,000 psi), Radar Structures, Small Arms Weapons Systems, Ultra-High Speed Particle Penetration, and other Mechanical Analysis and Design areas.

Research Scientist and Consultant - 6 1/2 yrs., Sperry Gyro Co. RCA, Republic Aviation, Bulova R&D, Stanford, MIT, Ford Instrument, Fairchild Camera and Inst. Corp., Stratos, Parameters, Inc. Original work in plasticity, elasticity, stress, shock and vibrations, dynamics, terminal ballistics, mechanical analysis.

Head, Applied Mechanics Dept. - Bulova R&D Labs. - 2 1/2 years

Responsible for direction and detailed work in Applied Mechanics and Mathematics, including stress, vibration, missile kinematic and dynamic analysis, heat conduction, elasticity, etc.

Engineer, Frankford Arsenal - 4 years

Projectile stress, thickwalled cylinders, plastic flow.

PATENTS

1. Angle of Attack Indicator

2. Dispersion Correction System (missile)

3. Hydraulic Integrator and Differentiator

PAPERS

34 in National and International Journals

SOCIETIES

Phi Beta Kappa, Sigma Xi, Tau Beta Pi, A.S.M.E., Committee Member S-8 Committee on Shock & Vibration sponsored by S.A.E., Reviewer for Journal of Applied Mechanics (ASME), Standard Oil of Indiana Fellow, M.I.T. Fellow, Who's Who in World Aviation.

HOWARD JASLOW

Chief, Analytical Engineering
Technik, Inc.

EDUCATION

B.A.E.	Polytechnic Institute of Brooklyn
M.S. Physics	Adelphi University

EXPERIENCE

Senior Engineer - Technik, Inc. - Actively engaged in and maintaining complete supervision of a small arms weapons program (contract DA-36-038-ORD-21260-M) and its associated problem areas such as saboting techniques. Further supervisory duties include all the internal and external gas dynamic and ballistic analyses performed at Technik, Inc. In particular, these analyses (performed with current theoretical and empirical techniques) include the mutual aerodynamic interference of several bodies, the evaluation of design parameters in attaining hypervelocity projectile speeds employing unsteady gas dynamic analyses and internal ballistics including combustion theory. Additional research activities include hypersonic similitude, shock waves, and the gas dynamic studies of similarity techniques for predicting the gas dynamic behavior of the muzzle blast region.

Senior Aero and Gas Dynamicist - Republic Aviation and North American Aviation - 5 years - Concerned with the calculation of the aerodynamic characteristics of various aircraft such as the F-100, F-105, F-108, B-70, X-15, VTOL and STOL, and the specification of appropriate wind tunnel testing.

SOCIETIES

American Institute of Aeronautics and Astronautics
American Association for the Advancement of Science

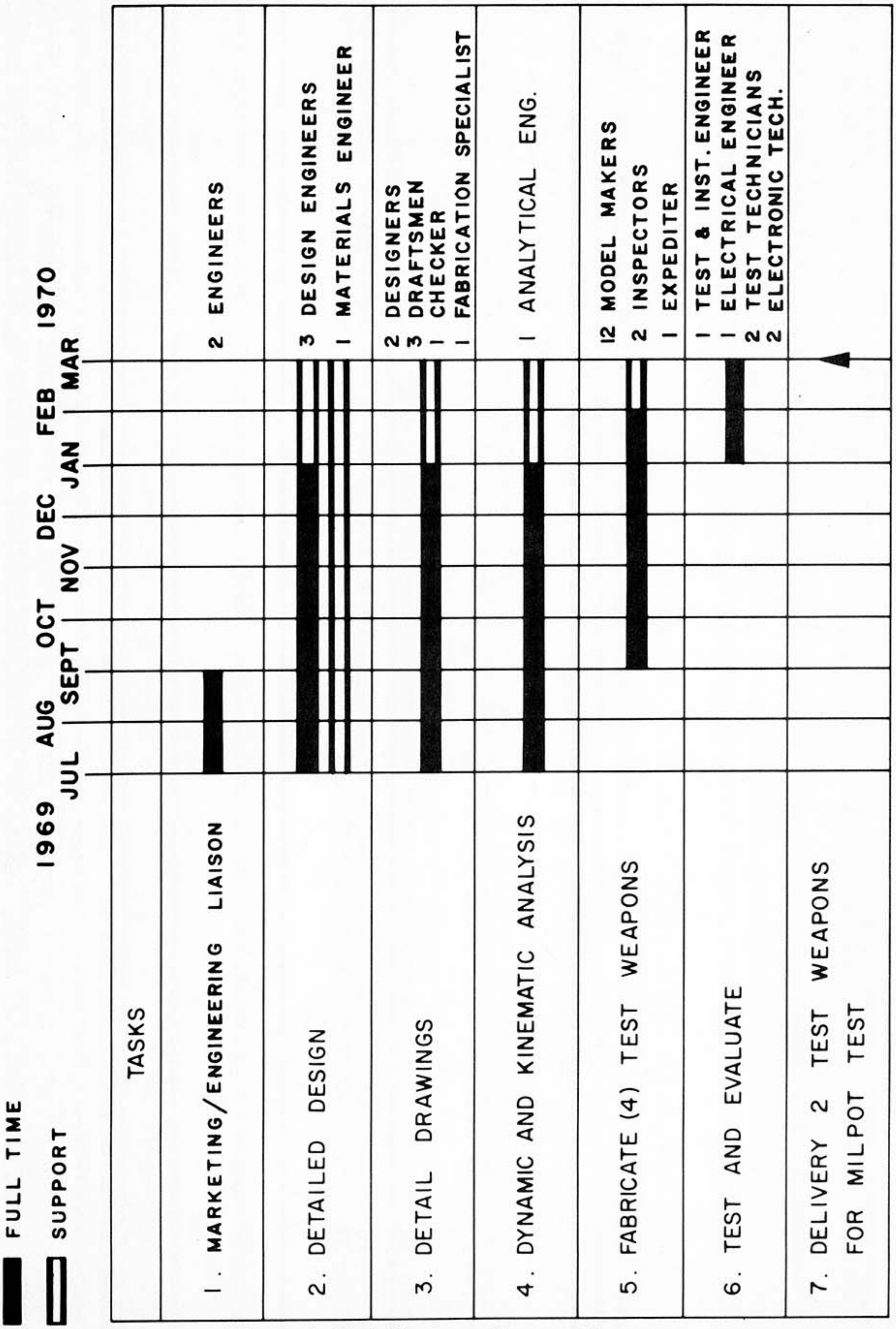


Figure 4-1. Milestone Chart - Phase I

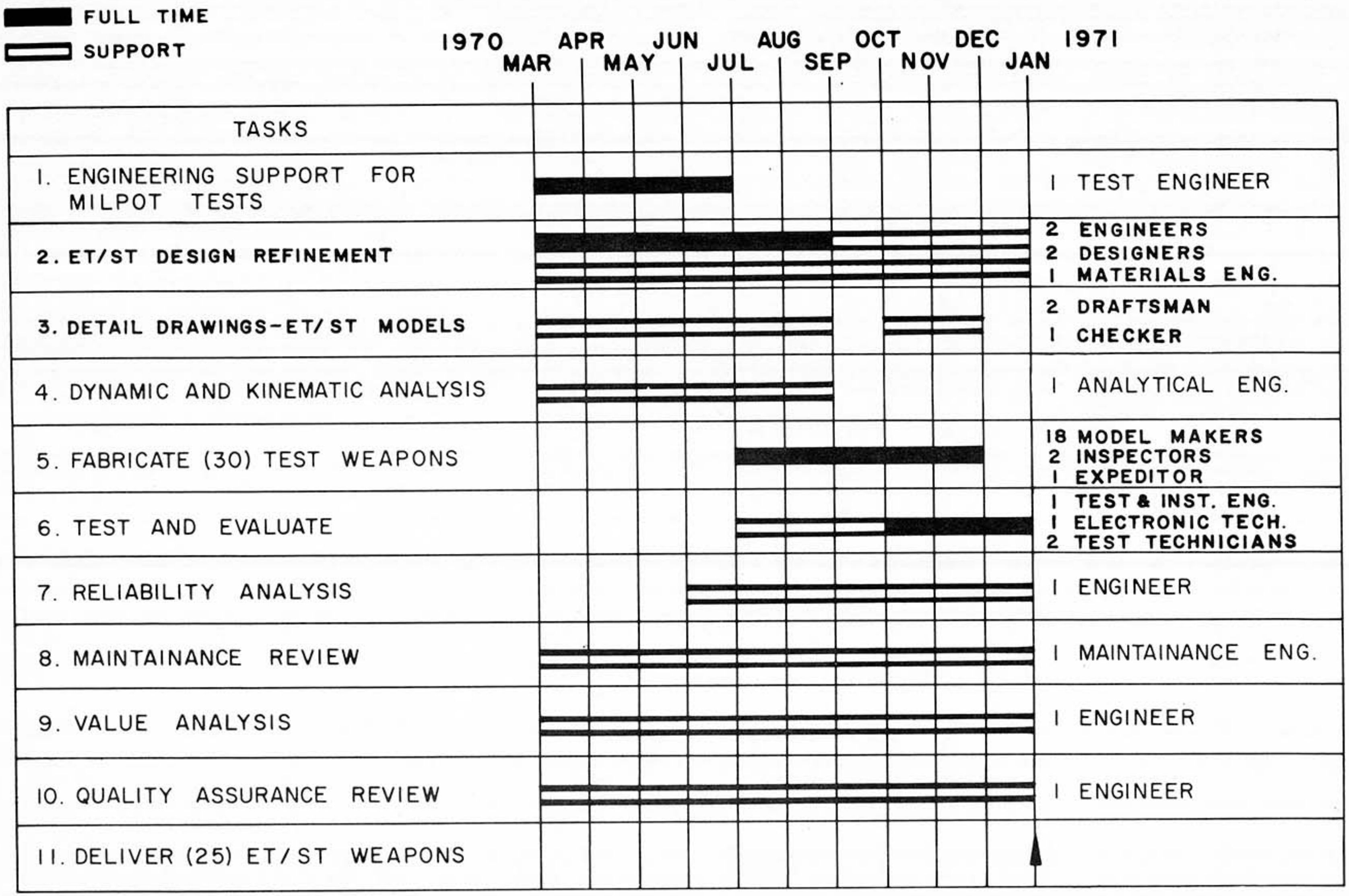


Figure 4-2. Milestone Chart - Phase II

SECTION 5

RELATED EXPERIENCE

SECTION V

RELATED EXPERIENCE

HISTORICAL EXPERIENCE

Colt's has been involved with the development and production of automatic small arms ever since John Browning turned to Colt's to produce the world's first successful automatic gas-operated machine gun in 1890. This weapon, the Colt Model 1895 was the first automatic machine gun purchased by the United States Government. At the start of World War I, Colt's was given a contract for 1500 of these same weapons, the only change being the incorporation of an interchangeable barrel.

Figure 5-1. Colt Machine Gun Model 1895, as Modified in 1914

At the outbreak of World War I, John Browning, in collaboration with Colt's Patent Firearms Manufacturing Co., which had exclusive concession to manufacture weapons under Browning's patents, concentrated their efforts towards the development of a recoil operated machine gun suitable for mass production. Browning had constructed and tested a recoil operated weapon almost twenty years previously but due to the lack of government funding the project sat on the back shelf until needed. This weapon, the Cal .30 Model 1917, along with the simultaneously developed Browning Automatic Rifle (B.A.R.), were adopted by the government as the most effective guns of their type--the outstanding features were reliability and simplicity of design.

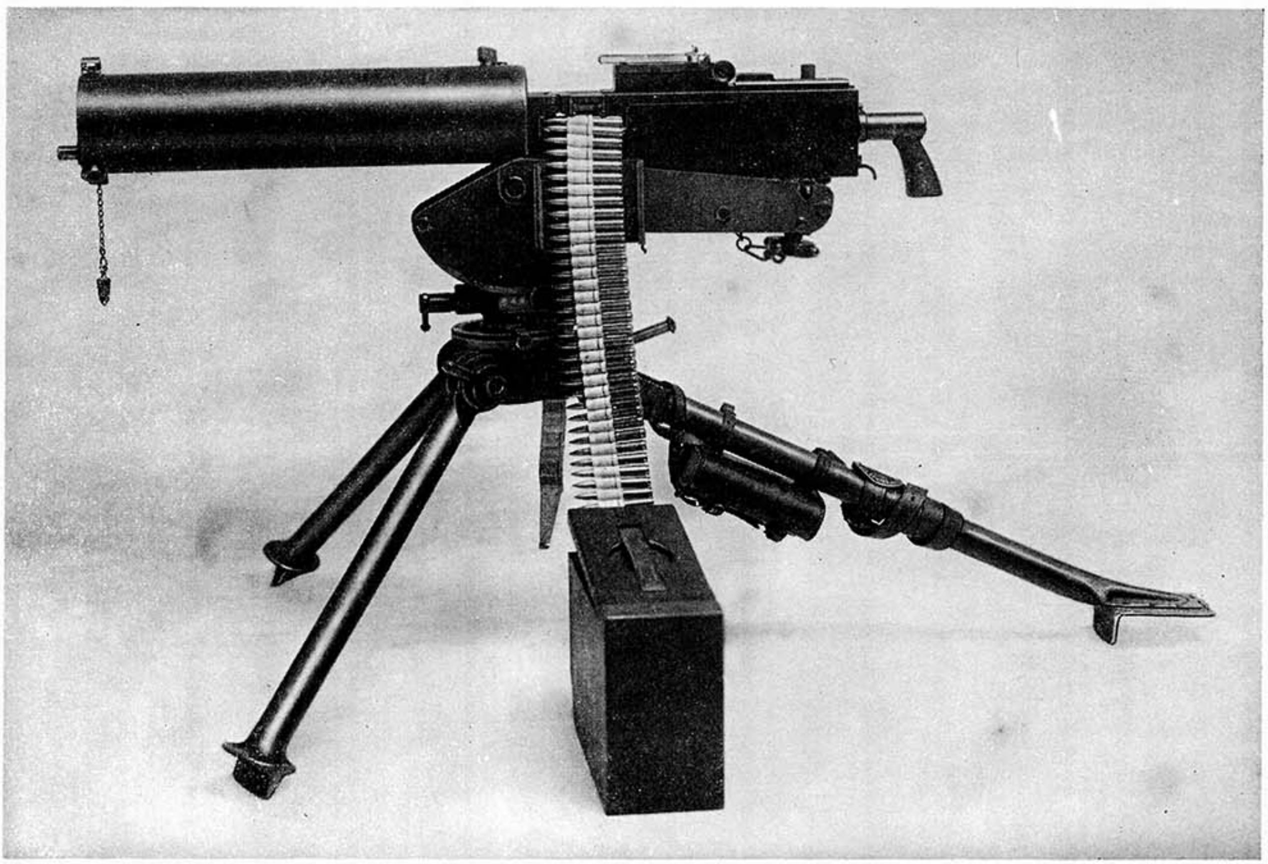


Figure 5-2. Browning Machine Gun, Model 1917, Cal .30

In addition, Colt's has been involved in the development and production of the following military weapons:

37 mm Cannon

Prior to World War II, Colt's, in collaboration with Mr. John Browning, developed this weapon which soon after Pearl Harbor went into large scale production at Colt's. A combined monthly production rate of the aircraft and anti-tank versions reached 2,500 units. This rate was sustained for the duration of the war.

.50 Caliber Machine Gun

This well known weapon, also developed in collaboration with John Browning, was produced by Colt's at a rate of up to 14,000 units per month during World War II. Still operational with our Armed Forces, the Browning .50 caliber machine gun was last manufactured by Colt's during the Korean War.

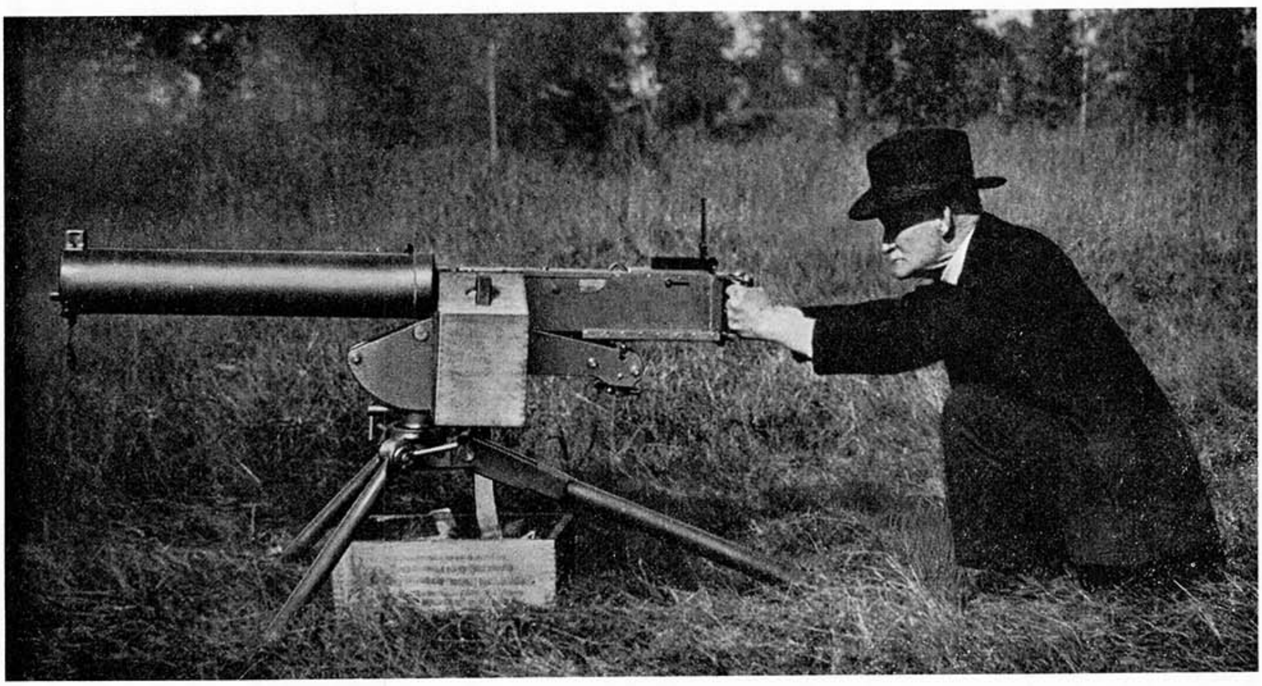


Figure 5-3. John M. Browning firing the .50 Caliber Machine Gun in Colt's Pasture

.45 Caliber Automatic Pistol

Attesting to its reliability and effectiveness as a man-stopper, the Colt .45 Automatic has been in continuous use as the official U. S. Army side arm since its introduction in 1911. During the war years, production reached 20,000 per month.

Figure 5-4. .45 Caliber Automatic Pistol

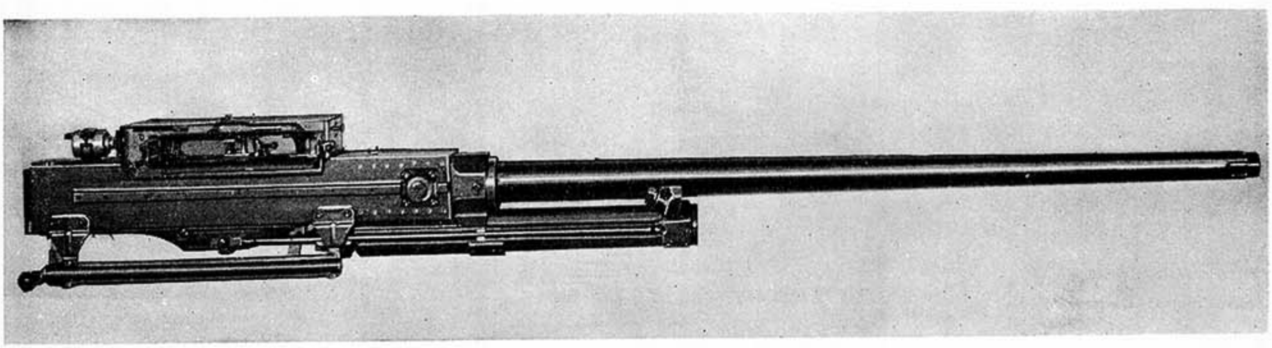


Figure 5-5. 37mm Automatic Aircraft Cannon, M4

RECENT EXPERIENCE

M16 Rifle

Currently, Colt's is the prime manufacturer of the M16 rifle, delivering in excess of 50,000 units monthly. Colt's has consistently met or exceeded contractual delivery requirements. Many original contributions, both in configuration and manufacturing, were made by Colt's in the evolution of the AR-15 to its present form. These included a submachine gun version of the AR-15, prototype versions of the weapon adopted to fire different caliber ammunition, and a new barrel manufacturing process. Colt's produced the Technical Data Package used by all manufacturers of the M16 rifle and retains control of this data in its role as a Weapon Engineering Agency for the government.

Figure 5-6. Colt AR 15 Rifle (M16A1)

CGL-4 Grenade Launcher

Recognizing the tactical advantage of providing the Squad with an area fire capability without sacrifice in point target fire power, Colt's engineers undertook the development of a light weight (2.5 lbs.) 40 mm Grenade Launcher which could be easily attached to the rifle. This was the first 40mm launcher capable of being attached to the M16A1 rifle that was purchased by the government.

Caliber .223 Ammunition Developments

Using hand loaded .223 cases and Government furnished projectile components, Colt's has developed a flechette round for the rifle which reaches an acceptable muzzle velocity. The ability to fire indescriminately mixed .223 ball, tracer and flechette rounds without malfunction has been demonstrated in the M16.

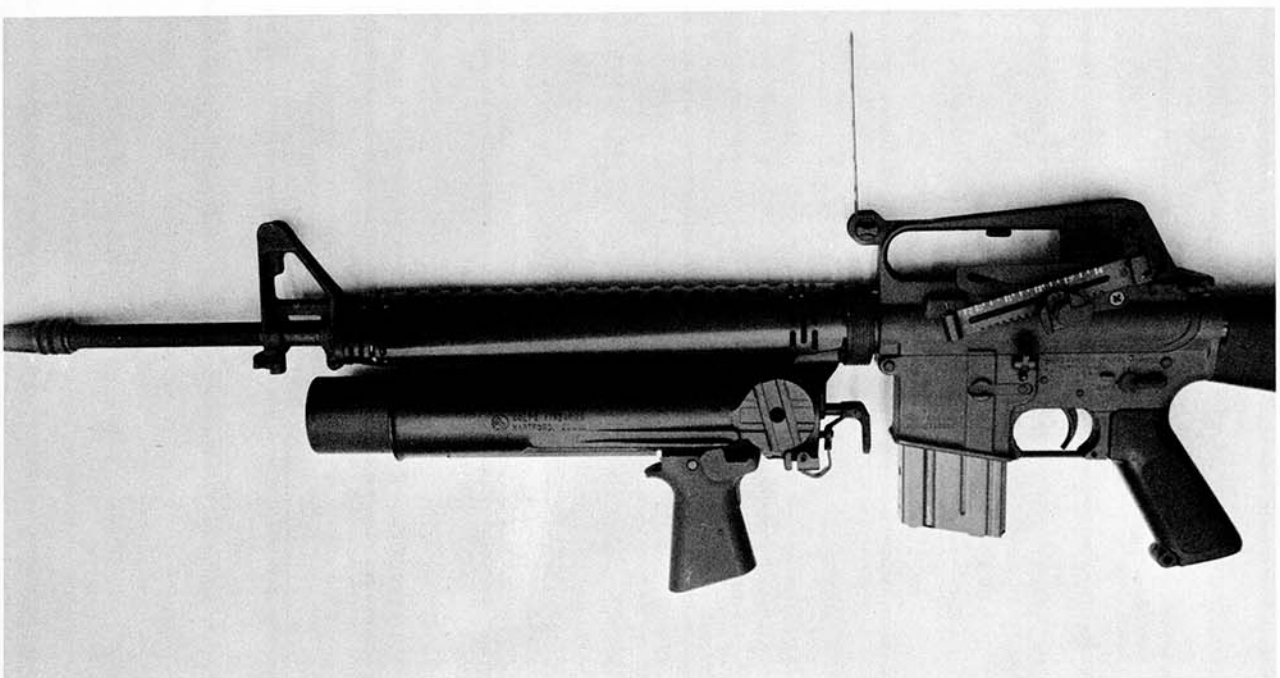


Figure 5-7. M16 Rifle with CGL-4 Grenade Launcher (Modified)

M16 Rifle Buttstock

Colt's has developed a new buttstock for the M16 Rifle featuring a compartment for the stowage of weapon cleaning equipment. The buttstock shell is filled with a closed cell polyurethane foam. Cored holes in the foam are provided for the receiver extension and the stowage compartment. A metal latch plate housed in the rubber buttsplate provides access to the compartment. All components of the buttstock are replaceable.

30 Round Magazine

The 30 round magazine, developed by Colt's, is the result of the armed forces desire for a larger magazine which would yield greater fire power for the M16 rifle. The magazine is a lightweight unit constructed of aluminum with a plastic follower. The plastic follower eliminates the corrosion problem which is inherent with metal followers, thereby simplifying cleaning of the magazine. In addition the plastic follower has demonstrated superior wear characteristics as compared to the metal follower. The magazines are currently under test by various military agencies.

Salvo Squeezebore (SSB)

Colt's Firearms is involved in a continuing program of development and demonstrations of the Salvo Squeezebore. This concept permits firing a salvo of three to six spin-stabilized, high-velocity bullets through a single barrel at each discharge of a firearm. When applied to a machine gun, the rate of delivery and saturation speed is therefore from three to six times the rate of fire of the weapon. Salvo Squeezebore is covered by a Secret U.S. Patent (Se No. 129,401/1961), therefore, a complete description cannot be given in this document.

PERFORMANCE

Colt's has a substantial history of excellent contractual performance. Pertinent to this program are the following fixed-price contracts:

M16 .223 Caliber Automatic Rifle

Contract DA-11-199-AMC-508(W) $26 Million
November 1963 to August 1966
140,000 units delivered to Rock Island ahead of schedule.

XM148, 40 mm Grenade Launcher

Contract DA-11-199-AMC-663(W) $3.2 Million
January 1966 to February 1967
19,000 units
Initial on-time delivery in July 1966 to Rock Island.

XM16E1 .223 Automatic Rifle

Contract DAAF03-66-C-0018 $46 Million
December 1965 to December 1967
400,000 units
Deliveries to Rock Island ahead of schedule.

XM16E1 Spare Parts

Contract DAAF-3-66-C-0020 $3.2 Million
Currently fulfilling requirements for various Spare Parts to Rock Island.

Commando Submachine Gun

Contract DA-11-199-AMC-678(W) $0.5 Million
March 1966 to December 1966
2,800 units
First delivery to Rock Island in September 1966.

Salvo Squeezebore

Contract N60921-69-C-0109 $35,000
Currently supplying 25,000 units of Salvo Squeezebore .50/.30 Ammo, 7 Taper Barrels and 7 Inhibitor Bars.

Colt's also is presently delivering 50,000 M16 rifles a month under letter contract DAAF03-69-C-0021 and is delivering M16 spare parts and magazines under various other letter contracts.

SECTION 6

FACILITIES

SECTION VI

FACILITIES

6.1 GENERAL

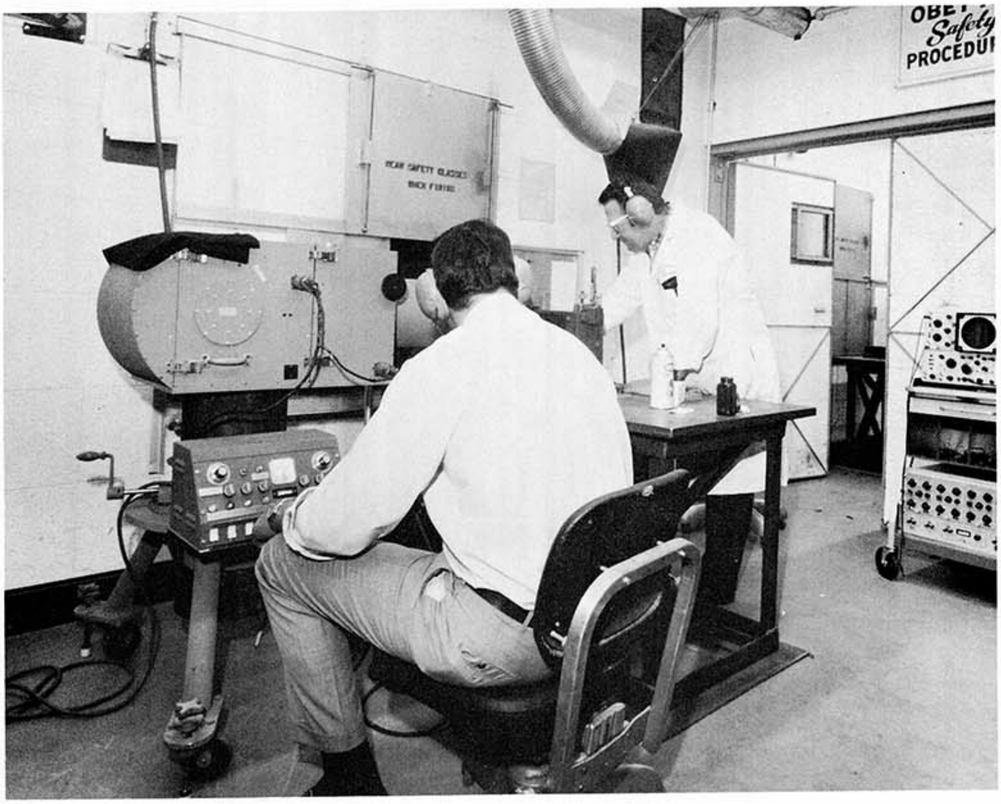
Colt's Firearms Division of Colt Industries is completely equipped to develop, test and produce military small arms weapons systems.

6.1.1 RESEARCH AND DEVELOPMENT FACILITIES

Included in this area are the R&D test range, the research lab, the model shop and the instrumentation necessary to perform dynamic and kinematic analysis of theoretical models and actual hardware.

6.1.1.1 R&D Test Range. (See figure 6-1) Colt's engineers have available to them a two butt research and development test range for use in the study of weapon design. The range is arranged and equipped so that one butt can be isolated and the weapon under test remotely fired. Rigid mounting tables and rigid or damped weapon mounts are available to provide a controlled stage for displacement time photography.

The Displacement-Time camera (figure 6-2) in the R&D Test Range was designed and built by Colt's military engineering group to satisfy their particular requirements. It is used as a tool to aid in breaking down the operational cycle of the weapon under test into its various phases and to study dwell and unlocking times, buffer energy absorbtion, frictional energy losses, etc. This camera is an invaluable tool in the development of new weapons systems.



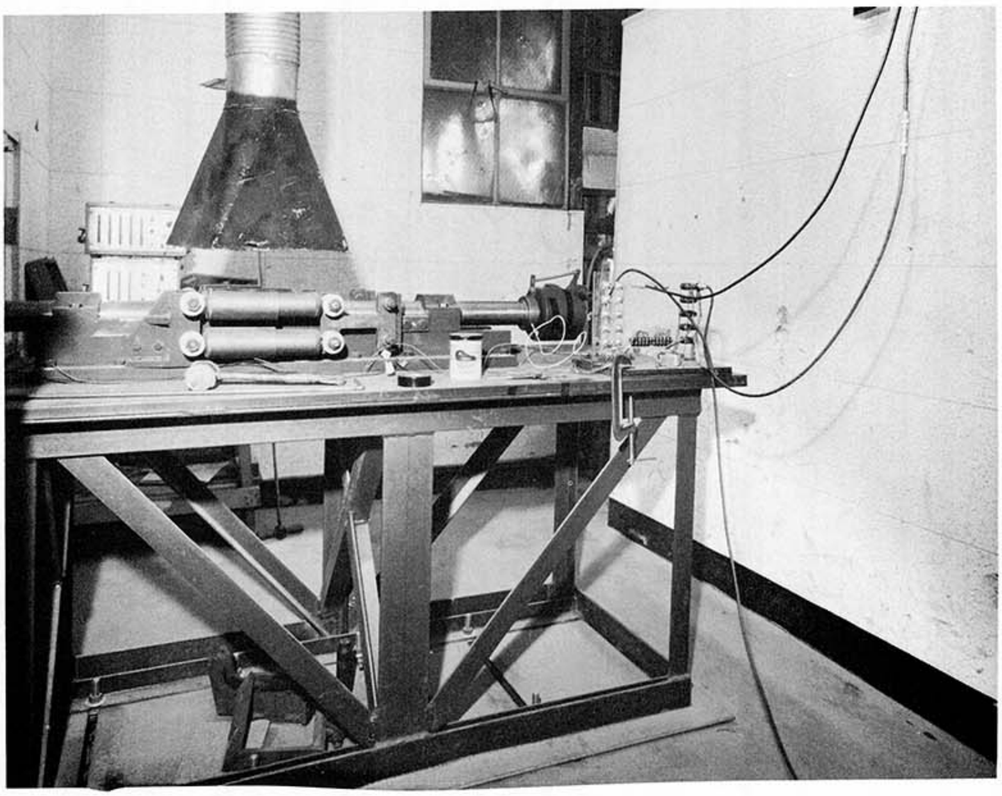


Figure 6-1. R&D Test Range

A photo lab (figure 6-3) adjacent to the R&D range provides the test engineers and technican with rapid processing of D-T photograph so that retesting, if necessary, can be accomplished before teardown of the test setup. An automatic processor-printer unit complements the other equipment in the R&D Range.

6.1.1.2 Model Shop. The model shop (see figure 6-4) is equipped to handle all phases of development work, from wooden mockups to functioning weapons and special tools. The shop is equipped to handle limited production when required. The Yankee craftmen and the equipment they employ make this shop one of the foremost in the weapons industry. A partial listing of model shop equipment is given in Table 6-1.

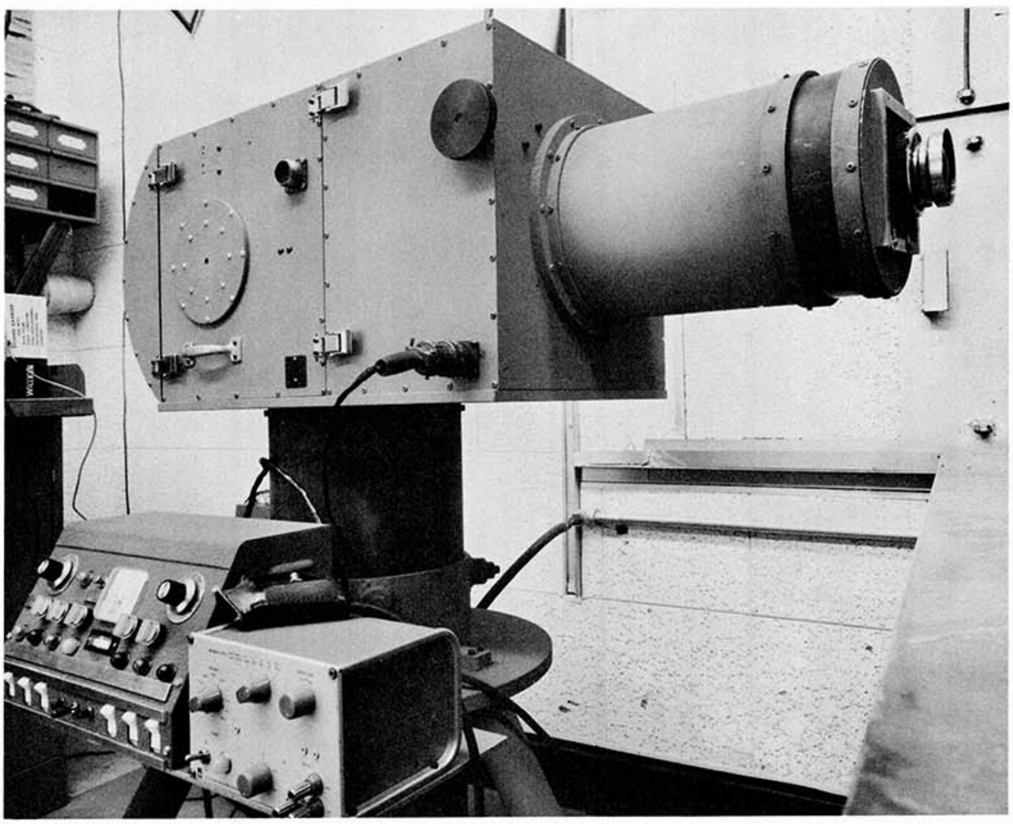


Figure 6-2. Displacement-Time Camera

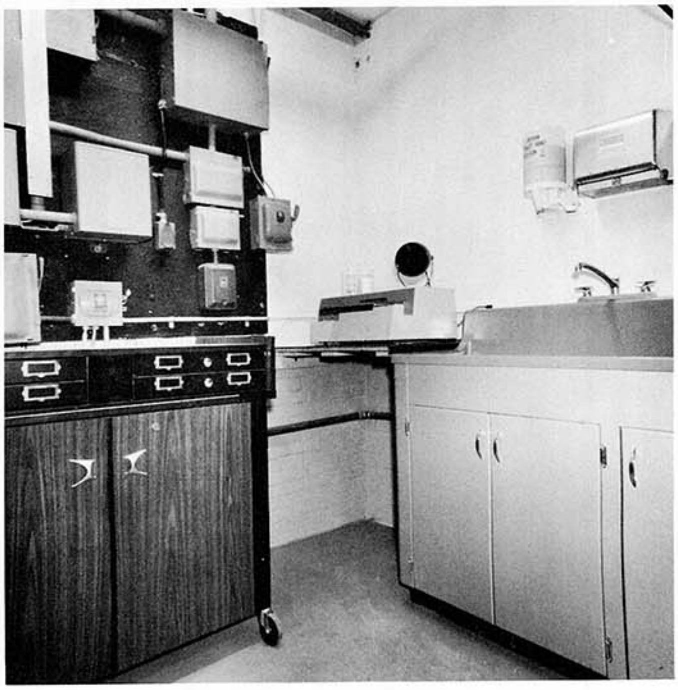


Figure 6-3. Photo Lab

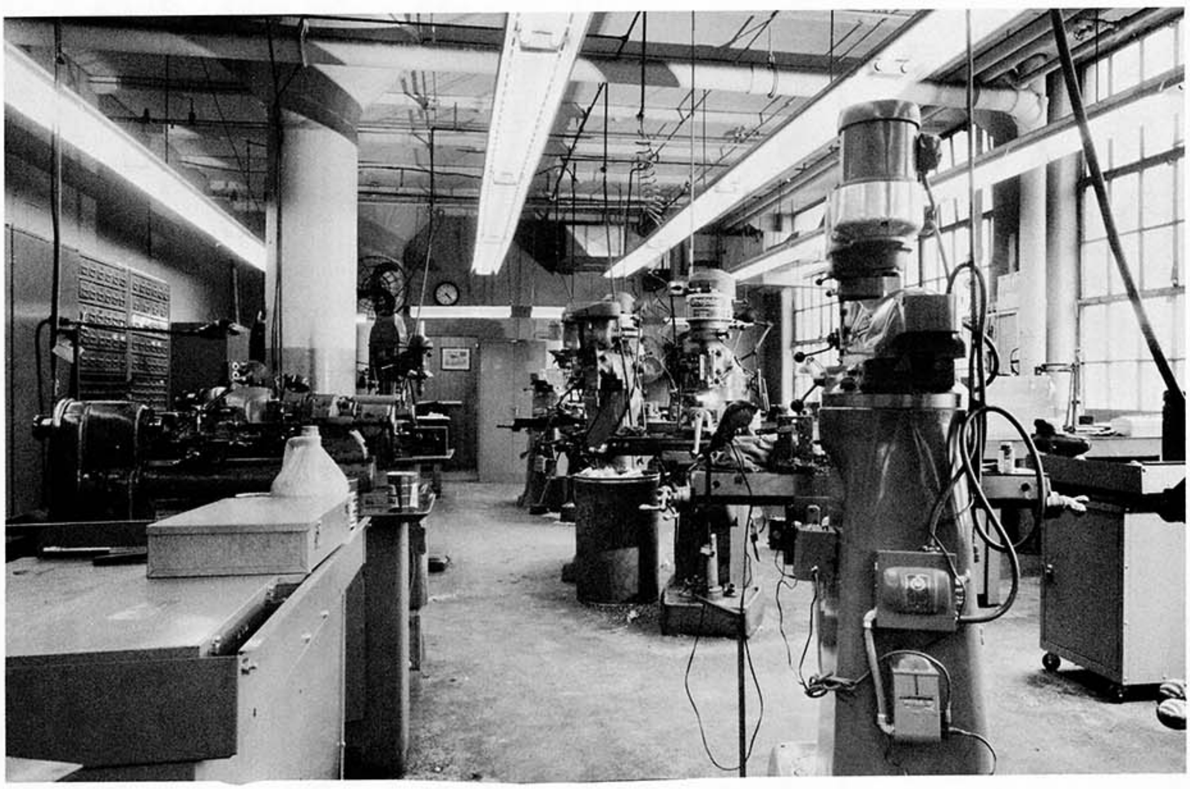


Figure 6-4. Model Shop

6.1.1.3 Research Lab. The research lab is equipped with modern electronic, mechanical and optical test equipment to be used separately or in conjunction with other equipment to perform the evaluations necessary in weapon design, development and improvement programs. In addition, solid-state table top CRT-readout type calculators and a desk top computer are available to solve involved or repetitive calculations.

The availability of this modern equipment allows the engineer to routinely solve involved problems.

6.1.2 TEST FACILITIES

In addition to the test equipment available in the R&D facilities, facilities are available to test hardware for endurance, reliability and maintainability.

6.1.2.1 50-Yard Test Range. The 50-yard test range (see figure 6-5) is used to proof test various small arms weapons, to test weapon-cartridge combinations and to conduct ballistics tests on new cartridge designs. A 16mm camera, with speeds up to 8,000 frames per second, is used for visual study of weapon functions. The camera has a built-in one millisecond marker which allows the observation and correlation of round movement with mechanism synchronizations. Several EPUT meters and associated photo-electric screens are available for measuring projectile velocities. A pyrometer with fast response and temperature range to 600°F (±1.5%) is used to measure barrel temperatures under sustained fire.

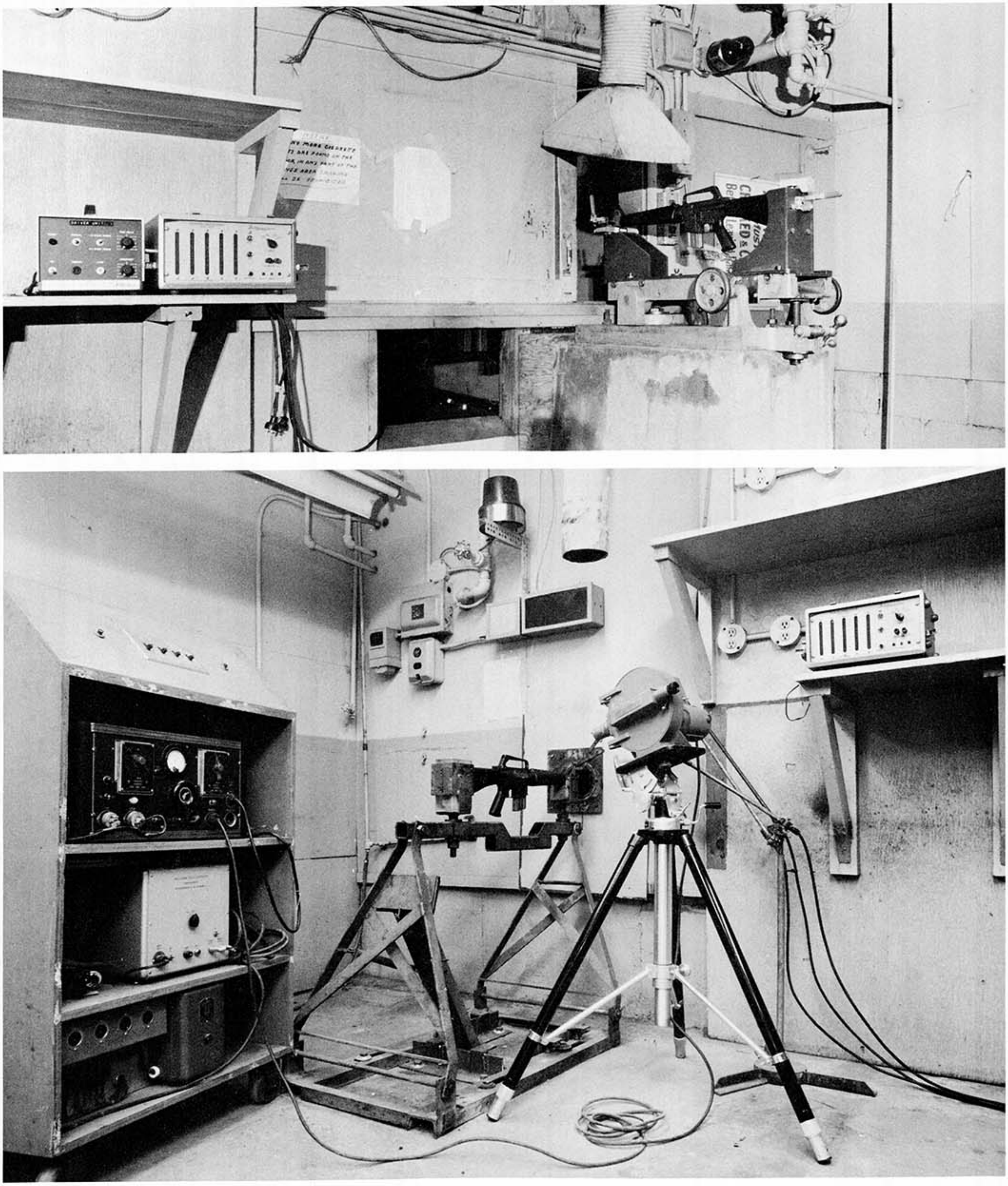


Figure 6-5. 50 yd Test Range

6.1.2.2 Endurance and Acceptance Test Range. One of the countries most modern indoor endurance and acceptance test ranges is located in Colt's West Hartford facility (see figure 6-6). A closed circuit television system brings a visual display of each target to the range technician's side. Targets are changed and carefully positioned automatically from a console at the firing station. A trolley system permits positioning of targets at predetermined distances for trajectory plotting.

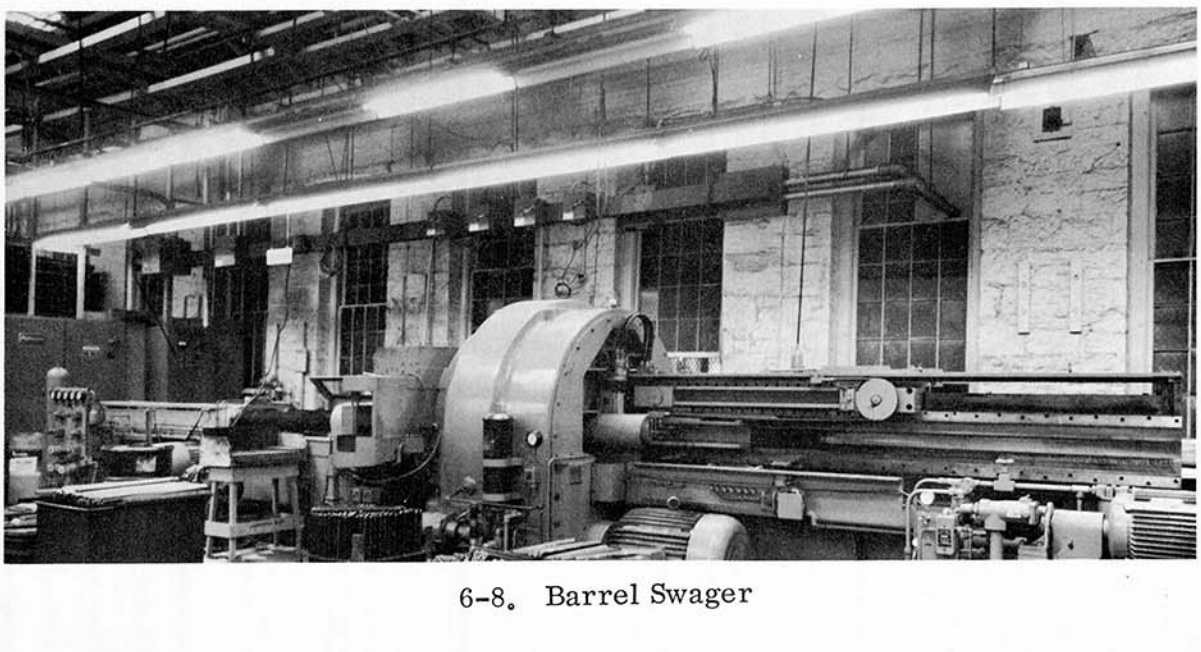
Two outdoor ranges are available which allow line-of-sight or high trajectory firing to a range of 1000 meters. Both of these ranges are within 45 minutes of Colt's main plant.

Figure 6-6. Endurance and Acceptance Test Range

MANUFACTURING FACILITIES

Colt's Firearms has been a leading manufacturer of quality firearms for well over a century. Its manufacturing facilities are outstanding and together with the qualified vendors in the surrounding area has won a world-wide reputation for its products.

6-7. Manufacturing Engineering



6-8. Barrel Swager

Figure 6-9. M16 Upper Receiver Machining Area

Figure 6-10. M16 Final Inspection Area

APPENDIX A

BALLISTICS DATA

APPENDIX A

BALLISTICS DATA

The design of this weapon is based upon the ballistics performance of the NATO M80 Ball round because the principle roles of this machine gun will be those in which this ammunition is used. Flexibility was built into the machine gun by the inclusion of the muzzle booster. This permits ammunition/weapon compatibility to be maintained not only with the present types of ammunition (ball, armor piercing and tracer), but also with future developments in hyper-velocity finned-stabilized types of armor penetrating projectiles.

Table A-1 and figures A-1 and A-2 give the ballistic characteristics of the NATO Cal 7.62 mm M80 cartridge.

TABLE A-1 NATO CAL 7.62MM M80 CARTRIDGE DATA

Caliber	7.62mm
Case	7.62 NATO
Projectile	Gilding Jacket, Lead Cored
Projectile Weight	149 - 3 grains
Propellant Type	Ball
Propellant Charge Weight	47 grains
Ratio - C/M Propellant Charge Weight to Projectile Weight	.309
Primer	FA 34
Bore Area	0.073 in.^{2}
Case Volume	0.218 in.^{3}
Equivalent Chamber Length	3.00 inches
Total Travel	20.5
Total Gun Volume	1.72 in.^{3}
Final Expansion Ratio	7.89
Propellant Ignition Time	----
Projectile Residence Time	0.95 millisec.
Action Time	0.004 Sec. max.
Max Chamber Pressure	50 K psi
Velocity	2850 fps (calculated value)
Impulse	2.8 lb. sec.

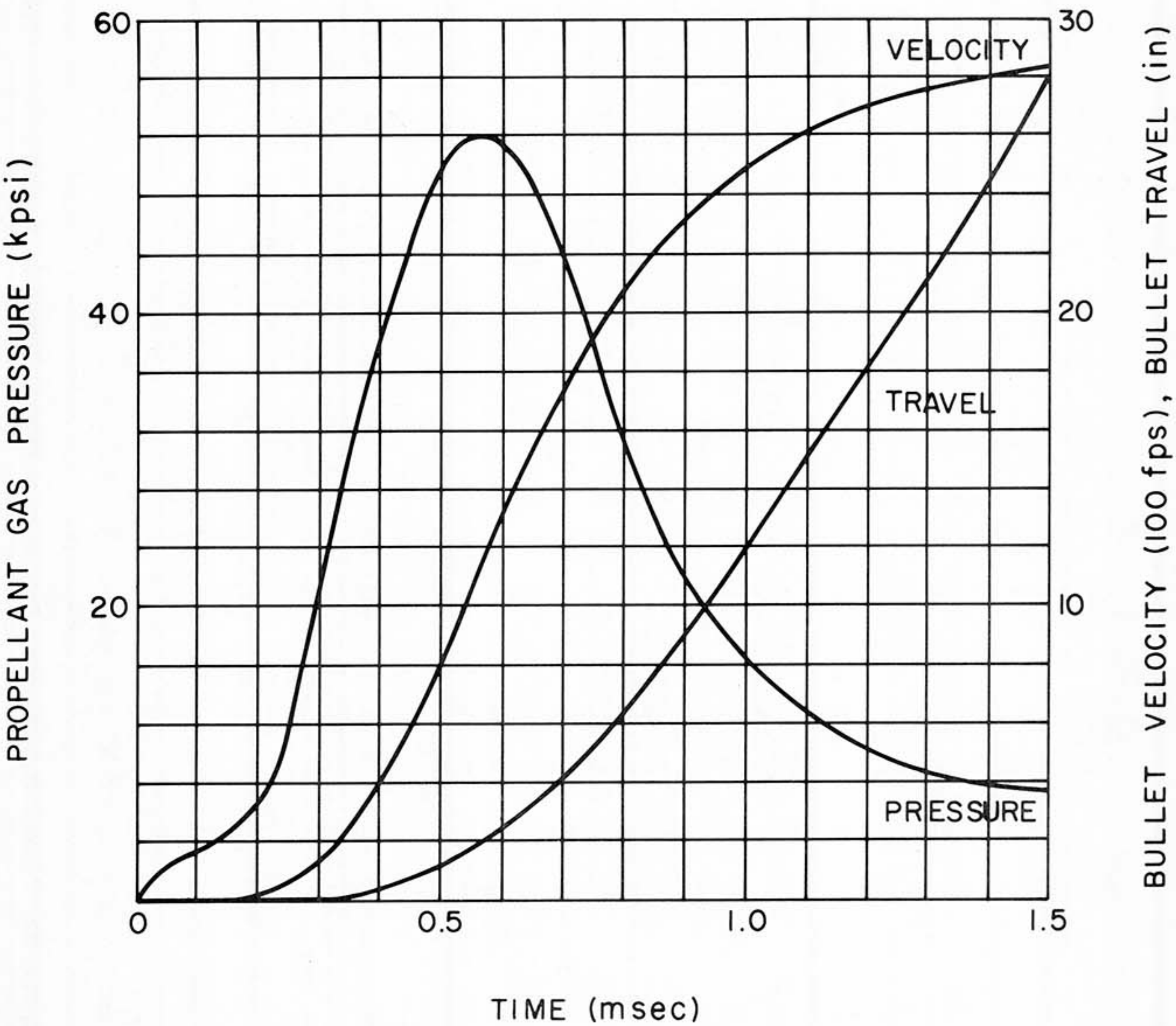


Figure A-1. Interior Ballistics Curves, 7.62mm NATO (Pressure-Time)

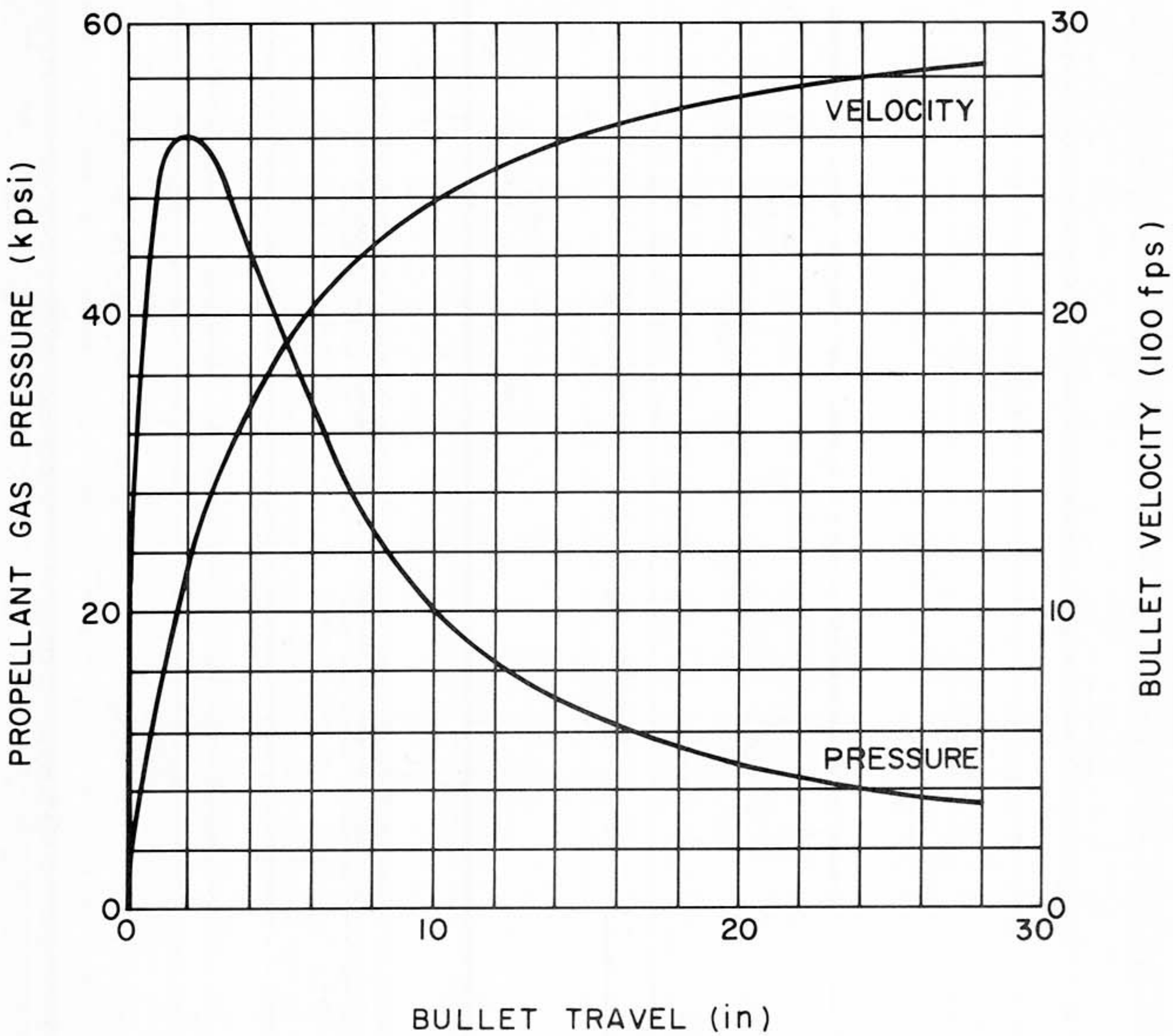


Figure A-2. Interior Ballistics Curves, 7.62mm NATO (Pressure-Travel)

Colt Industries Colt's Firearms Division

APPENDIX B

DESIGN ANALYSIS

APPENDIX B

DESIGN ANALYSIS

B.1 ANALYSIS OF OPERATIONAL CYCLE

In order to establish design feasibility, analytical studies were made of the various phases of the weapon operational cycle, and the strength of the breech locking elements. The phases of the operational cycle studied were:

Phase	Operation
I	Initial recoil under the firing impulse.
II	Accelerator action on the bolt assembly by the barrel and barrel extension assembly.
III	Recoil travel of the bolt assembly after accelerator action and prior to bolt buffer contact.
IV	Recoil and counter recoil travel of the barrel and barrel extension assembly during barrel buffering action
V	Recoil and counter recoil travel of the bolt during buffer action.

The continuation of counter recoil is the reverse of Phase III, Phase II and Phase I in that order.

Preliminary calculations were made using an IBM 1130 digital computer to solve the differential equations of motion and to establish a calculated displacement - time curve of the bolt and the barrel extension motion while locked together and while separated by the accelerative action of the accelerator. The final recoil and the counter recoil paths of both the bolt and the barrel extension were also developed by the computer. Velocity-time and energy-time values were also obtained from the computer run and an evaluation was made of the available energy for performing the various phases of the operational cycle.

During Phase I of the operational cycle, the bolt and the barrel and barrel extension are locked together for a travel of 0.650 in. where complete unlocking occurs. The time required to travel this distance is 6.3 m sec. The time required for the residual chamber pressure to reach atmospheric pressure was calculated by use of the Vallier equation to be 4.17 m sec. A comparison of the 4.17 value with the travel time to complete unlocking of 6.3 m sec indicates favorable timing for minimum gasing since case extraction will occur at an even later time.

During Phase II, the bolt is separated from the barrel extension and accelerated rearward by the accelerator. An energy transfer between the barrel and barrel extension and the bolt is effected with the barrel and barrel extension losing velocity and the bolt gaining velocity. A simplifying assumption was made during the initial computer run that a linear acceleration existed between the end points of the accelerative action. The resulting velocities were established by the kinetic energy available. Another assumption was also made that during this phase of the operational cycle the energy required for feeding an 18.0 lb belt load is removed from the system. The remaining energy provides a bolt velocity of 216 in/sec which initiates Phase III. The optimum accelerator cam will be developed to provide the most efficient energy transfer.

It should also be noted that rebound of the bolt during counter recoil contact with the barrel extension is inhibited by the action of the accelerator which traps the bolt and effects a gradual transfer of energy.

The remaining phases of the operational cycle were treated mathematically as shown in the analysis data sheets. A tabulation of velocities and energies at respective displacements of the operational assemblies is also given.

D-T Data

Displacement in. Recoil	Operational Event	Assembly Velocity in/sec	Remaining Energy in-lb
0.25	Start of belt feed	133	249
0.50	Start of unlocking	131	240
0.650	End of unlocking and start of acceleration	129	234
1.180	End of bolt acceleration	216	127
4.32	Start of ejection	126	44
4.62	Sear position	110	34
4.74	Buffer contact	103	29
Counter Recoil			
4.32	Start of stripping	124	42
2.70	Start of cocking	176	86
0	In-battery contact	36	15

TIME OF DURATION OF RESIDUAL PRESSURE

$T_T \quad = \quad T_r + T_e$

where:

$T_T \quad = \quad$ Total residual time

$T_r \quad = \quad$ Bullet residence time

$\quad = \quad 1.5$ m sec

$T_e \quad = \quad$ Time to exhaust barrel (Vallier equation) in m sec

$$= \frac{M_c}{AP} (9400 - V_m) \times 10^3$$

where:

$M_c \quad = \quad$ Mass of propellant charge

$\quad = \quad$ 47 grains

$A \quad = \quad$ Bore area

$\quad = \quad .073 \text{ in}^2$

$P \quad = \quad$ Chamber pressure at muzzle exit

$\quad = \quad$ 7000 psi

$V_m \quad = \quad$ Muzzle velocity

$\quad = \quad$ 2850 fps

$$T_e = \frac{\left(\frac{47}{7000 \times 32.2}\right)}{(.073)\ (7000)} (9400-2850) \times 10^3$$

$\quad = \quad 2.67$ m sec

$T_T \quad = \quad 1.50 + 2.67$

$\quad = \quad 4.17$ m sec

CYCLIC RATE DISCUSSION

Even though the theoretical analysis shows a firing rate of 532 rpm, the actual cyclic rate of this weapon is expected to be considerably closer to 450 rpm since most of the energy losses in the system during counter-recoil were not considered, i.e., spring surge, impacts, etc.

A comparison of the ratio of counter-recoil to recoil time of the bolt as exhibited on the theoretical D-T curve presented was made with the same value as that exhibited by an existing weapon of the same type, i.e., short recoil.

The ratio of bolt counter-recoil time to recoil time on the existing weapon was 1.8 to 1 compared to 1.1 to 1 as depicted by the theoretical D-T curve of the proposed GPAM.

If the 1.8 value were superimposed upon the counter-recoil portion of the theoretical D-T curve, the complete cycle time would be considerably extended and would be approximately 132 m sec and the cyclic rate would be 454 rpm.

Colt's believes the actual cyclic rate of the weapon will be between the theoretical rate of 532 rpm and the estimated and probably more realistic cyclic rate of 454 rpm and, in all probability, much closer to the latter.

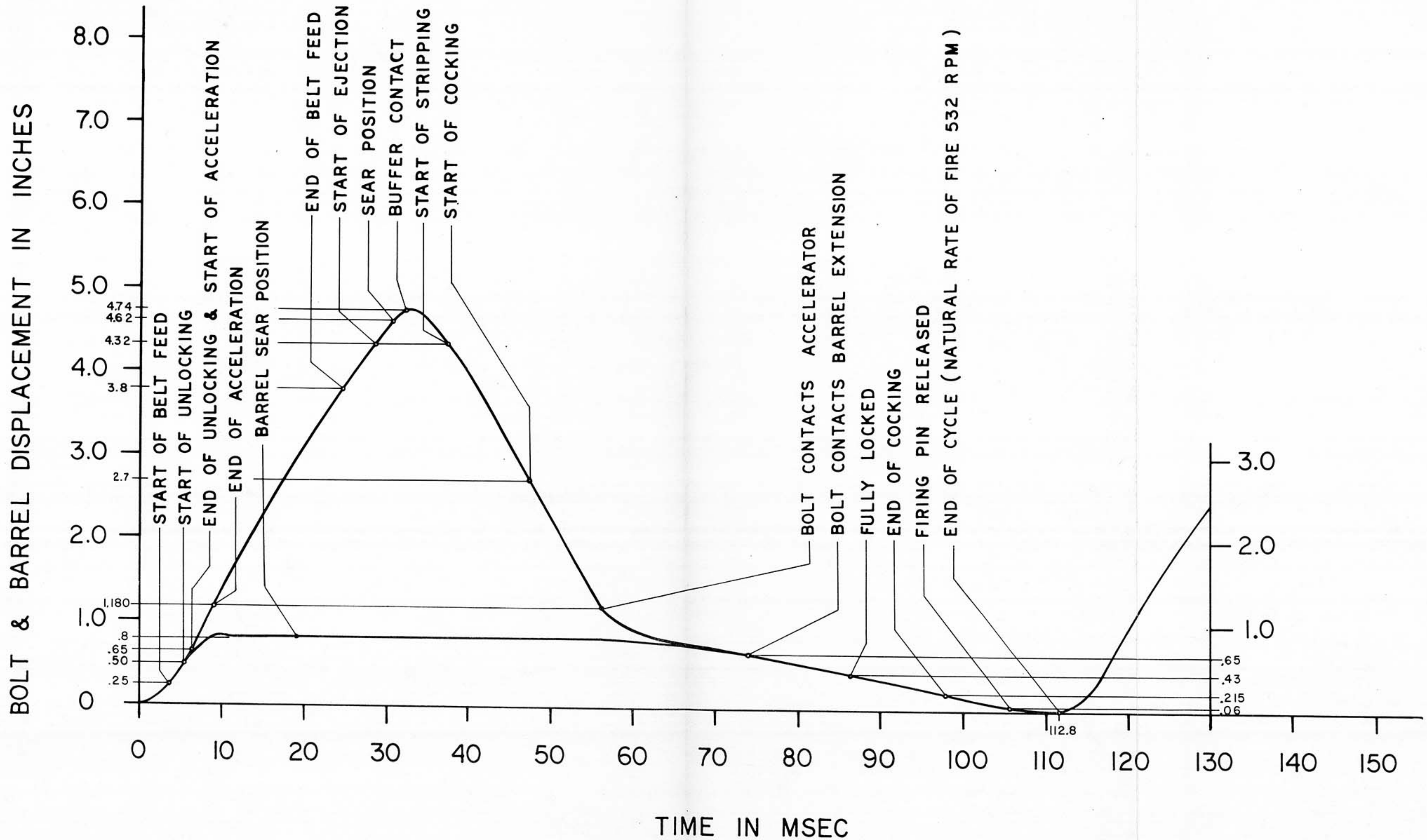


Figure B-1. Theoretical Displacement - Time Curve

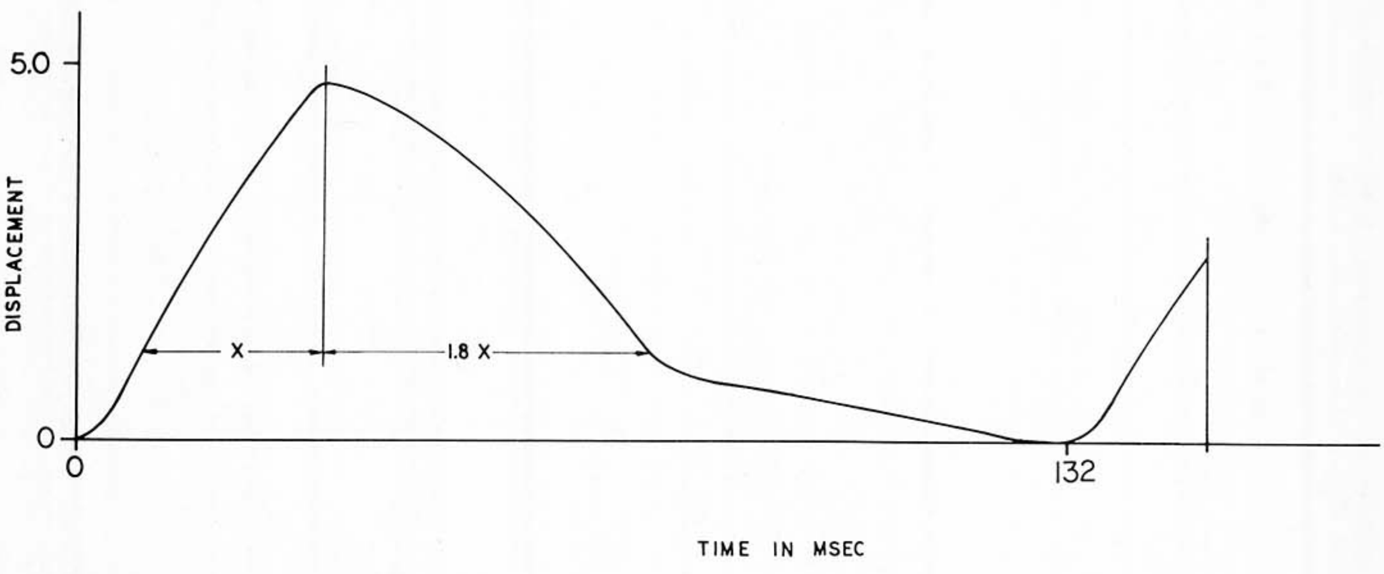
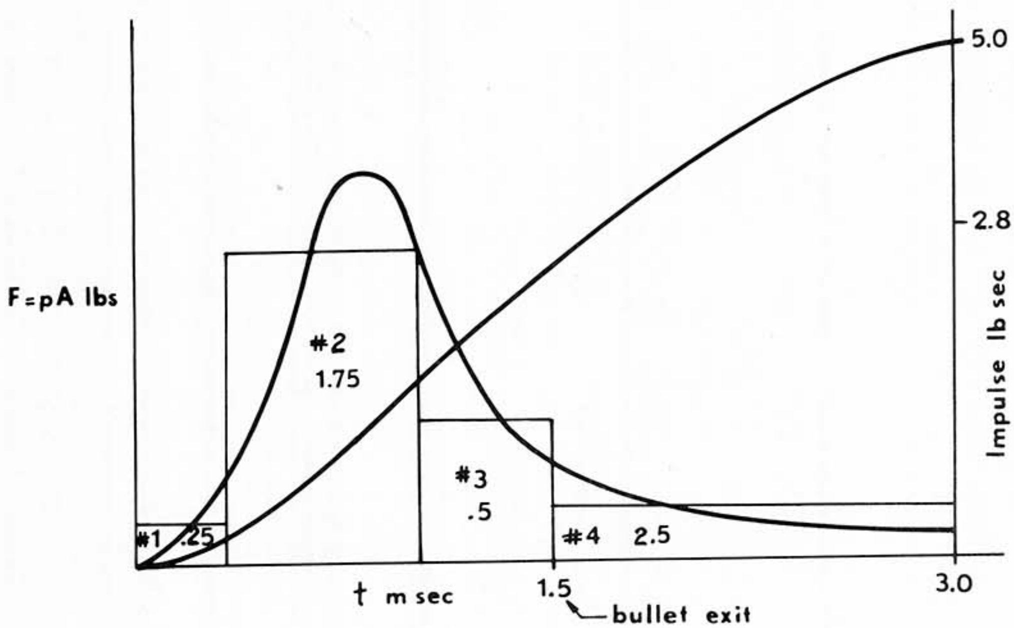


Figure B-2. Anticipated Displacement-Time Curve

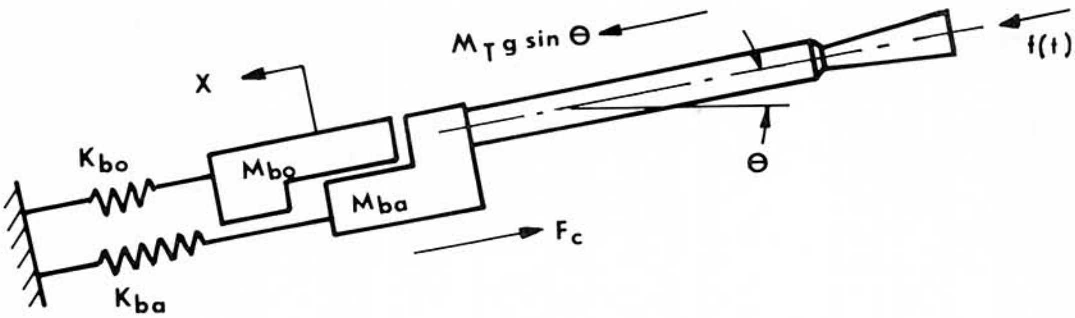
RECOIL ACTUATION IMPULSE

f(t) = Recoil impulse due to bullet and powder gas motion and gas pressure acting in muzzle booster.



In order to simplify the calculations, the recoil actuation impulse was divided piecemeal into a series of rectangular pulses, the values of which were determined graphically. Rectangular pulses #1, #2, and #3 are given by the motion of the bullet and the powder gases up to the time of bullet exit. Rectangular pulse #4 represents the impulse due to the exiting powder gases and gas pressure in the muzzle booster.

PHASE I -



M_{bo} = Mass of bolt

$\frac{2.12 \text{ lb}}{386 \text{ in/sec}^2} = 0.0055 \text{ lb-sec}^2/\text{in}$

M_{ba} = Mass of barrel and barrel extension

$\frac{8.72 \text{ lb}}{386 \text{ in/sec}^2} = 0.0226 \text{ lb-sec}^2/\text{in}$

M_T = Total mass of inertia group
= $M_{bo} + M_{ba}$
= $0.0055 + 0.0226 = 0.0281 \text{ lb-sec}^2/\text{in}$

K_{bo} = Spring rate of drive spring
= 5.00 lb/in.

K_{ba} = Spring rate of barrel return spring
= 4.00 lb/in.

f(t) = Recoil impulse due to bullet and powder gas motion and gas pressure acting in muzzle booster
= 5.0 lb-sec

F_c = Friction forces assumed constant
= 5.0 lb

Θ = Angle of elevation or depression $+60^\circ$, 0°, -50°

$M_T g \sin\Theta$ = Gravitational forces in elevated and depressed firing
= 9.39, 0, 8.31 lb.

PHASE I (cont.)

x_1 = Precompression of drive spring
= 2.2 in.

x_2 = Precompression of barrel return spring
= 5.0 in.

K_T = Total spring rate, springs in parallel
= 9.00 lb/in.

$$M_T\ddot{x} = K_{bo}\ (x + x_1) + K_{ba}\ (x + x_2) + f(t) + M_T g \sin \Theta - F_c$$

initial conditions:

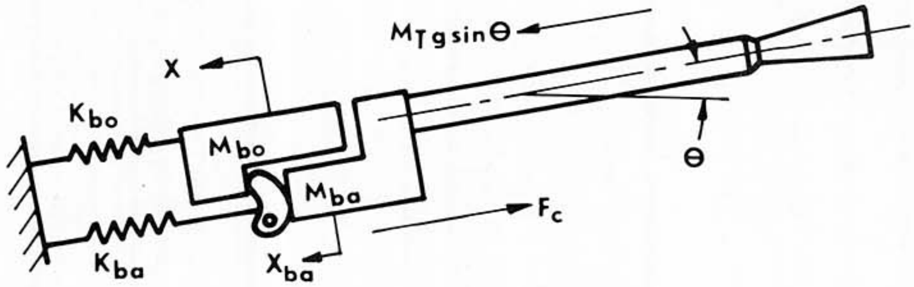
$x = 0$ $\dot{x} = 0$ $t = 0$

limits:

$0 \leq x \leq 0.650$ and return

Solution x vs t msec
v vs t msec
Energy vs t msec

PHASE II



$$M_{ba}\ddot{x} = M_{bo} R_{(x_{ba})}\ddot{x} + x_{ba}\left(R_{(x_{ba})} K_{bo} + K_{ba}\right) + K_{bo} x_1 + K_{ba} x_2 + M_T g \sin\Theta - F_c$$

where

$R(x_{ba})$ = Camming ratio (bolt travel/barrel travel) of the accelerator as a function of x_{ba} & x_{bo}, i.e., $f\left(\frac{x_{bo}}{x_{ba}}\right)$

x_{ba} = Travel of bolt during accelerator action

x_{bo} = Travel of barrel during accelerator action

initial conditions:

$x_{ba} = x$ phase I $\qquad \dot{x} = \dot{x}$ phase I

C = Cam contour equation

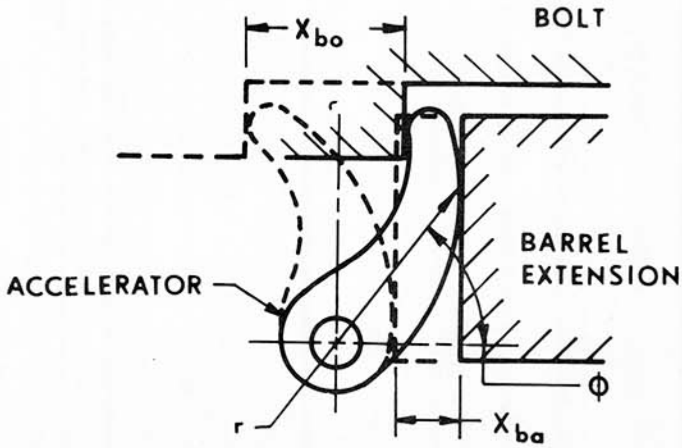
$C = g''(R_{x_{ba}})$ or $C = h(r, \phi)$

where

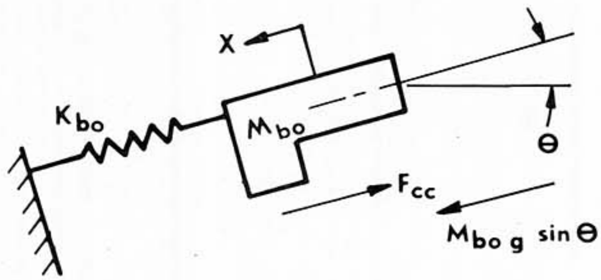
$r = k(x_{bo}, x_{ba})$

limits:

$0.650 \leq x_{ba} \leq 0.80$ and return



PHASE III



$$M_{bo}\ddot{x} + K_{bo}(x + x_1) - M_{bo}g \sin\Theta + F_{cc} = O$$

F_{cc} = friction of bolt
= 2.0 lb (assumed constant)

x_1 = precompression of bolt drive spring
= 2.2 in.

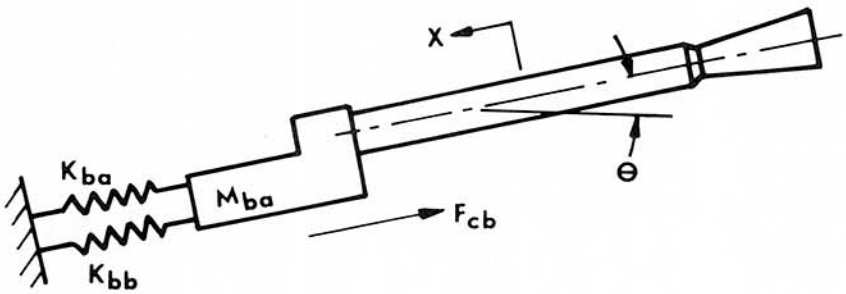
initial conditions:

$x = x_{bo}$ phase II $\qquad \dot{x} = \dot{x}_{bo}$ phase II

limits:

$1.18 \leq x \leq 4.74$

PHASE IV



Recoil travel of barrel during buffering

$$M_{ba}\ddot{x} + K_{bb}x_3 + K_{ba}(x + x_2) - M_{ba}g \sin \Theta + F_{cb} = 0$$

K_{bb} = Spring rate of barrel stop

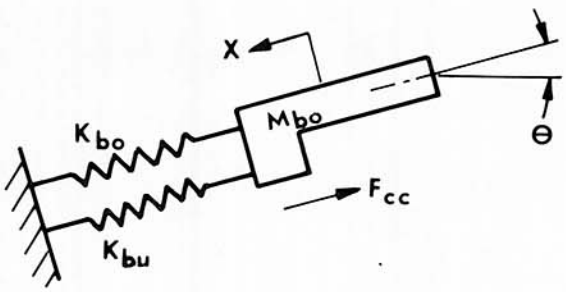
x_3 = Buffering travel

F_{cb} = Friction of barrel
3.0 lb (assumed constant)

limits

$0.80 \leq x \leq 0.85$ and return

PHASE V



$$M_{bo}\ddot{x} + K_{bu}x_4 + K_{bo}(x + x_1) - M_{bo}\, g \sin\Theta + F_{cc} = 0$$

K_{bu} = Spring rate buffer

x_4 = Buffer travel

F_{cc} = Friction
2.0

limits

$4.74 \leq x \leq 4.84$ and return

Note: Spring efficiency = 0.7

B.2 STRESS ANALYSIS

The determination of stresses of all components subject to various loading conditions must be a major consideration in developing a GPAM which would exhibit reliable function over a long service life.

Following is a stress analysis of the breech locking elements which consist of the bolt, barrel extension and breech lock. These components were selected for analysis because they are the most critical to weapon operation. The stress calculations are based on the criterium of maximum stresses and are reasonably conserative in order to assure safety and reliability without overdesign and extra weight. The calculations are preliminary in nature. However, in the final design, fillet radii and tolerances will be considered.

TABULATED DATA - BREECH LOCKING ELEMENTS

Component	Material & Hardness	Type of Stress	Calculated Maximum Stress (psi)	Ultimate Stress ** psi	Safety Factor
Breech lock	AISI 4340 Rockwell C50	Bearing	52,500	242,000	4.6
		Shear	21,477	*138,000	6.4
		Flexural	31,238	242,000	7.8
		Combined	39,885	242,000	6.1
Barrel Extension	AISI 4340 Rockwell C42	Combided (Tensile)	44,137	193,000	4.4
		Shear	6,848	*110,000	16.0
Bolt	AISI 4340 Rockwell C42	Combined (Compression)	49,085	193,000	3.9

** Ultimate tensile stress values were determined from quenched and tempered graph for AISI 4340 material, page 231 of ASME Handbook on "Metals Properties" First Edition - 1954.

* Ultimate shear stress values are determined by multiplying 0.57 times the ultimate tensile stress value.

DEFINITION OF SYMBOLS USED IN CALCULATIONS

A_b = Cross sectional area of bolt in inches^2.

A_c = Cross sectional area of a 7.62 mm cartridge at maximum internal diameter = 0.144 in^2

A_E = Cross sectional area of the barrel extension in inches^2.

A_L = Area of breech lock in inches^2.

A_S = Shear area of breech lock and barrel extension in psi

b = Distance from point of load to centroid of section in inches.

c = Distance from neutral axis to outer cross sectional fiber in inches.

F = Load due to chamber pressure = 10,080 lbs.

I = Area moment of inertia in inches^4.

I_c = Area moment of inertia with respect to the centroidal axis in inches^4.

M = Bending moment in inch-pound

P = Applied load in pounds

P_M = Maximum design chamber pressure of a 7.62 mm cartridge = 70,000 psi

S_b = Bearing stress for axial loads in psi

S_c = Combined stress in psi

S_F = Flexural stress for transverse loads in psi

S_N = Normal stress for axial loads in psi

S_S = Average shear stress for transverse loads in psi

$S_{S\,(max)}$ = Maximum shear stress in psi

Y_i = Vertical distance from P to neutral axis of each element.

DETERMINATION OF RESULTANT FORCE FROM CHAMBER PRESSURE

Determination of the Maximum Internal Cross Section Area of 7.62 mm Cartridge (Drawing D10521997, Rev. L, 31 March 1968, Frankford Arsenal)

Outside diameter = 0.454 in.

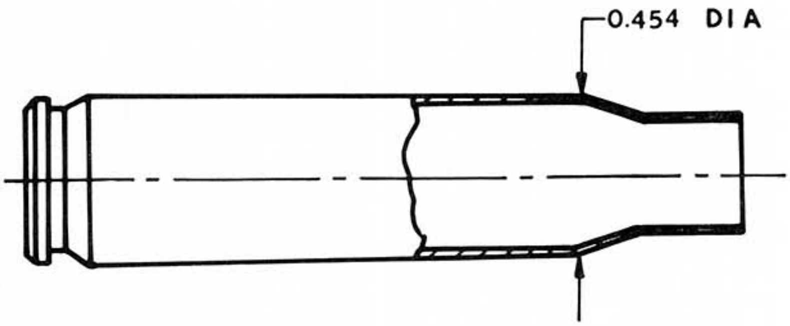
2 x wall thickness = 0.026 in.

Internal diameter = 0.428 in.

A_c = Maximum internal cross sectional area

$= \pi\ (0.428)^2/4$

$= 0.144\ in^2$



Minimum wall thickness 0.013

Figure B-2-1

Force Due to Chamber Pressure (F)

$F = P_M A_c$ where

$P_M = 70,000$ psi

$A_c = 0.144\ in^2$

$F = (70,000)(0.144)$

$= 10,080$ lbs

I. BREECH LOCK

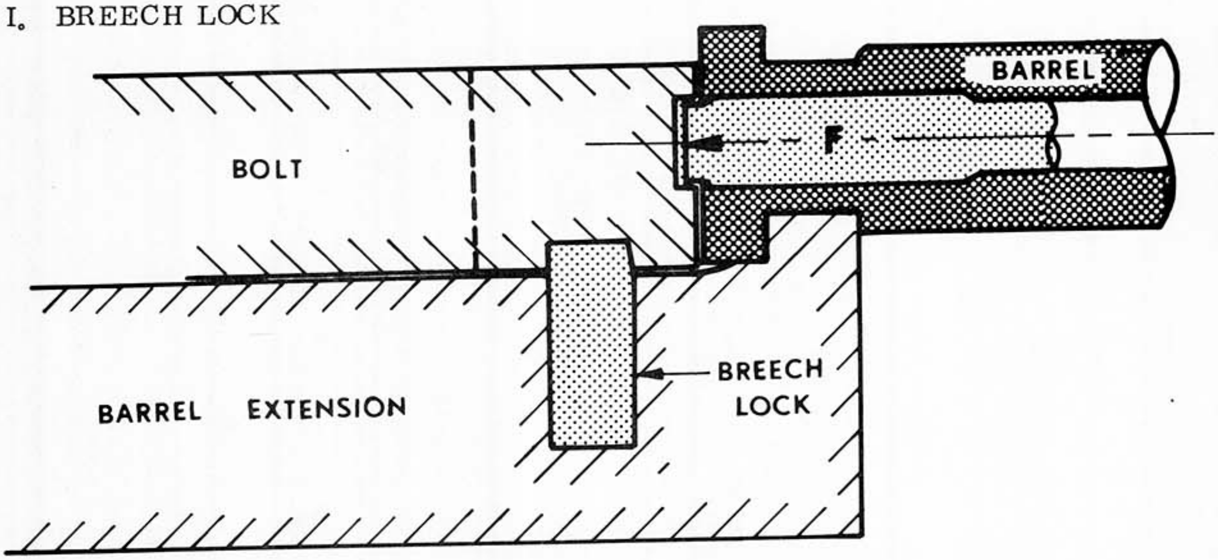


Figure B-2-2

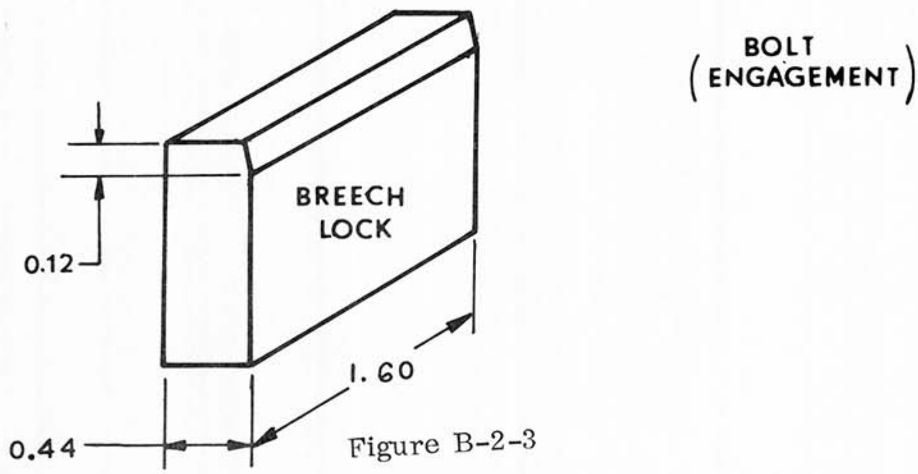


Figure B-2-3

Bearing Stress (S_b)

S_b = P/A_L where P = F = 10,080 lbs.

A_L = $1.60 \times 0.12 = 0.192$ in^2

S_b = 10,080/0.192

= 52,500 PSI

Maximum Shearing Stress ($S_{S(max)}$)

$S_{S(max)}$ = $1.5\ P/A_S$ where $P = F = 10,080$ lbs.

A_S = $(1.60)\ (0.44) = 0.704\ in^2$

$S_{S(max)}$ = $1.5\ (10,080)/0.704$

= 21,477 PSI

Flexural Stress (S_F)

S_F = Mc/I

Assuming 0.04 Clearance Between Bolt and Barrel Extension

D = $0.04 + 0.12 = 0.160$

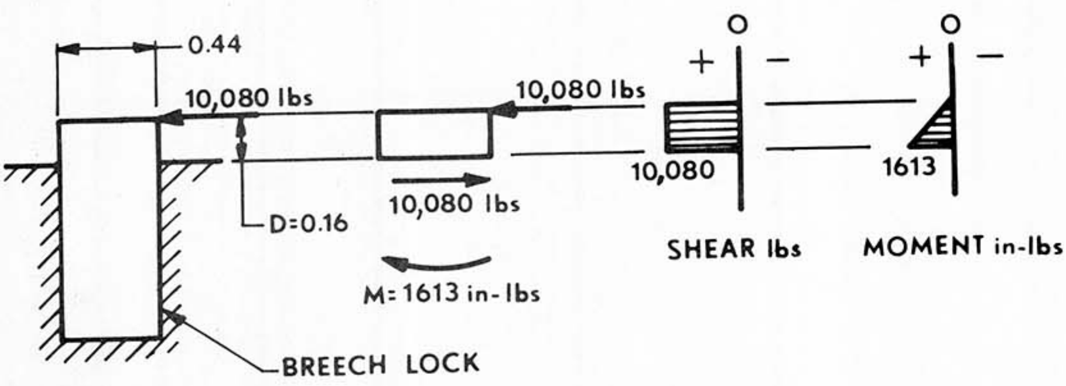


Figure B-2-4

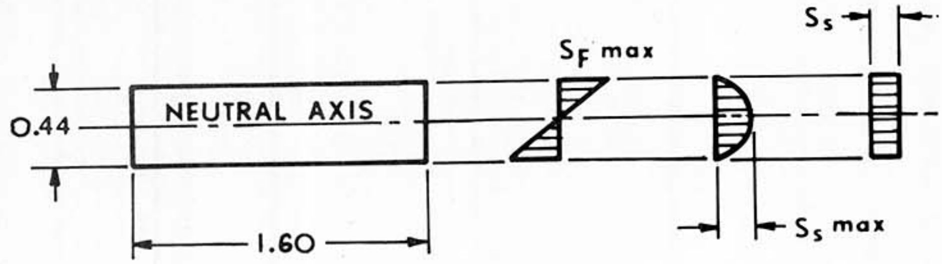


Figure B-2-5

$$M = PD$$

$$= (10,080)\ (0.160)$$

$$= 1613 \text{ in-lb}$$

$$I = (1.60)\ (0.44)^3/12$$

$$= 0.01136 \text{ in}^4$$

$$c = 0.44/2$$

$$= 0.22 \text{ in}$$

$$S_F = (1613)\ (0.22)/0.01136$$

$$= 31,238 \text{ PSI}$$

<u>Combined Stress (S_c)</u>

$$S_c = \sqrt{S_F^2 + 3\ S_S^2} \quad \text{where}$$

$$S_F = 31,238 \text{ PSI and}$$

$$S_S = P/A_S$$

$$P = F = 10,080 \text{ and } A_S = 0.704 \text{ in}^2$$

$$S_S = 10,080/0.704 = 14,318 \text{ PSI}$$

Therefore,

$$S_c = \sqrt{(31,238)^2 + 3\ (14,318)^2}$$

$$= 39,885 \text{ PSI}$$

II. BARREL EXTENSION

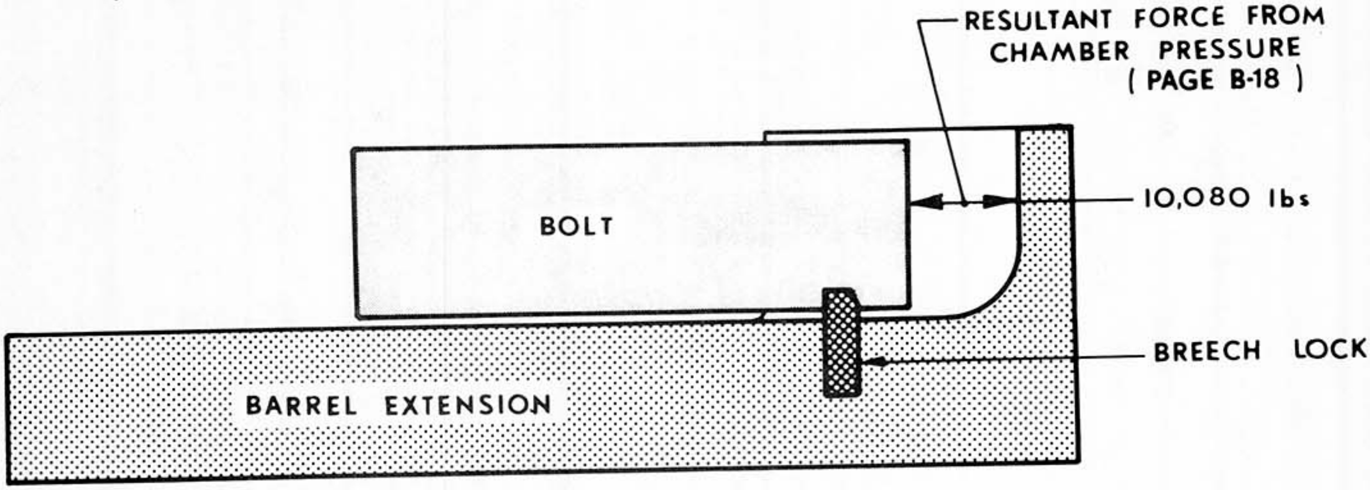


Figure B-2-6

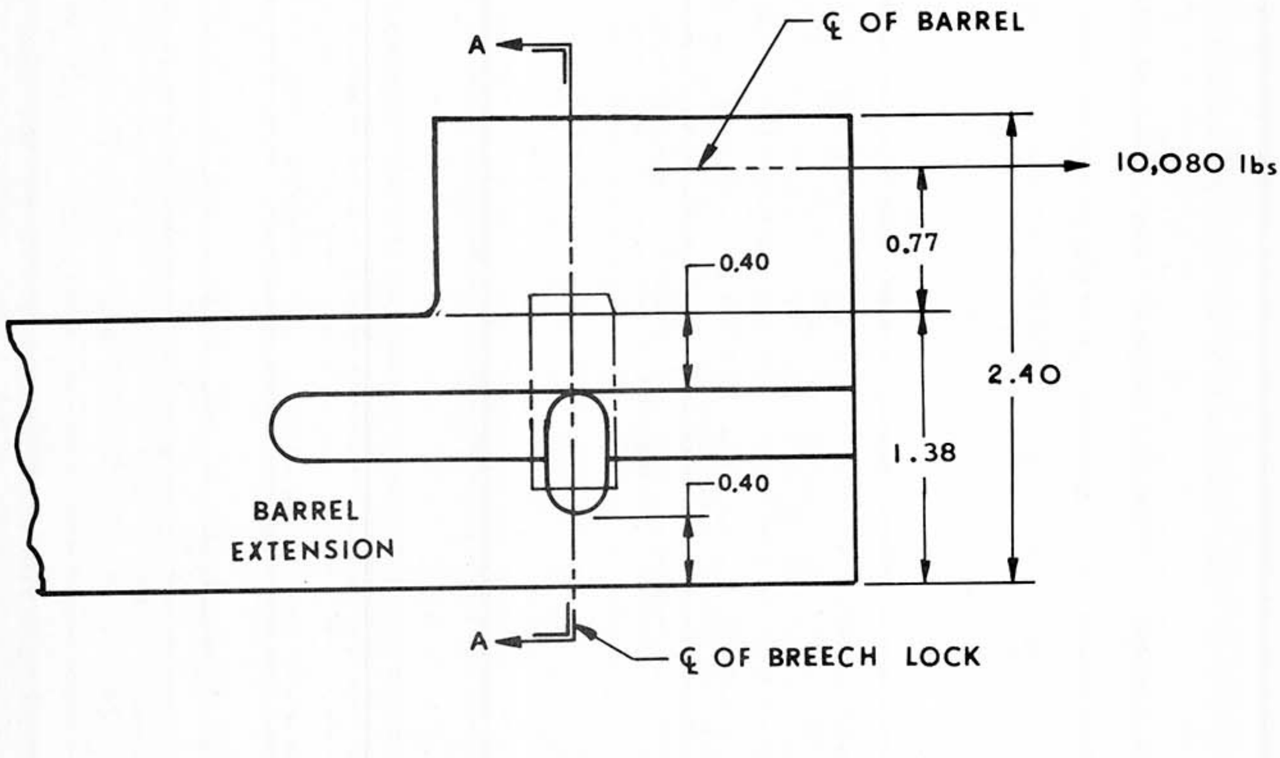


Figure B-2-7

$I_c = I + Ad^2$

$= \left[(0.15)(1.02)^3/12 + (0.29 + 0.40 + 0.51 - 0.52)^2 (1.02)(0.15)\right.$

$+ (0.25)(0.40)^3/12 + (0.29 + 0.20 - 0.52)^2 (0.25)(0.40)$

$\left.+ (0.25)(0.40)^3/12 + (0.29 + 0.20 + 0.52)^2 (0.25)(0.40)\right]$

$= 0.1888 \text{ in}^4 \; ; \quad 2I_c = 0.3776 \text{ in}^4$

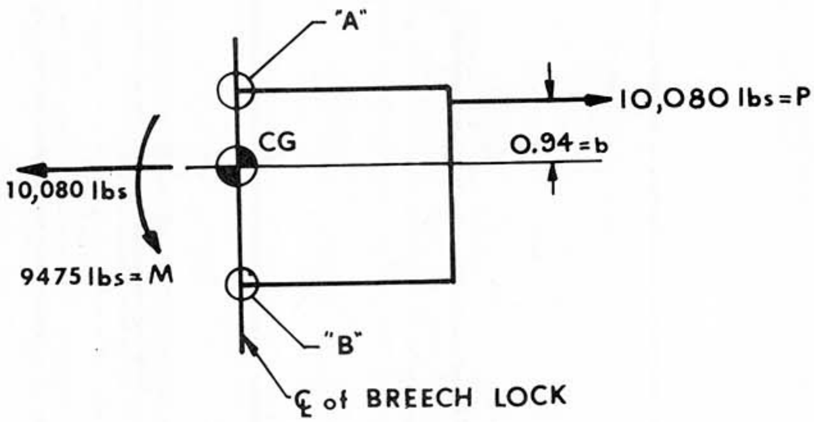


Figure B-2-9

$S_c = S_F + S_N$ where

$S_F = Mc_1 / 2I_c$ and $-Mc_2 / 2I_c$

$S_N = P/A_E$

$M = P \times b$

$= (10,080)(0.94)$

$= 9475$ in lb

S_c at "A" $= \left[+ (9475)(1.19)/0.3776\right] + \left[10,080/0.706\right]$

$= (+)\ 44,137$ PSI (Tension)

S_c at "B" $= \left[- (9475)(1.21)/0.3776\right] + \left[10,080/0.706\right]$

$= (-)\ 16,084$ PSI (Compression)

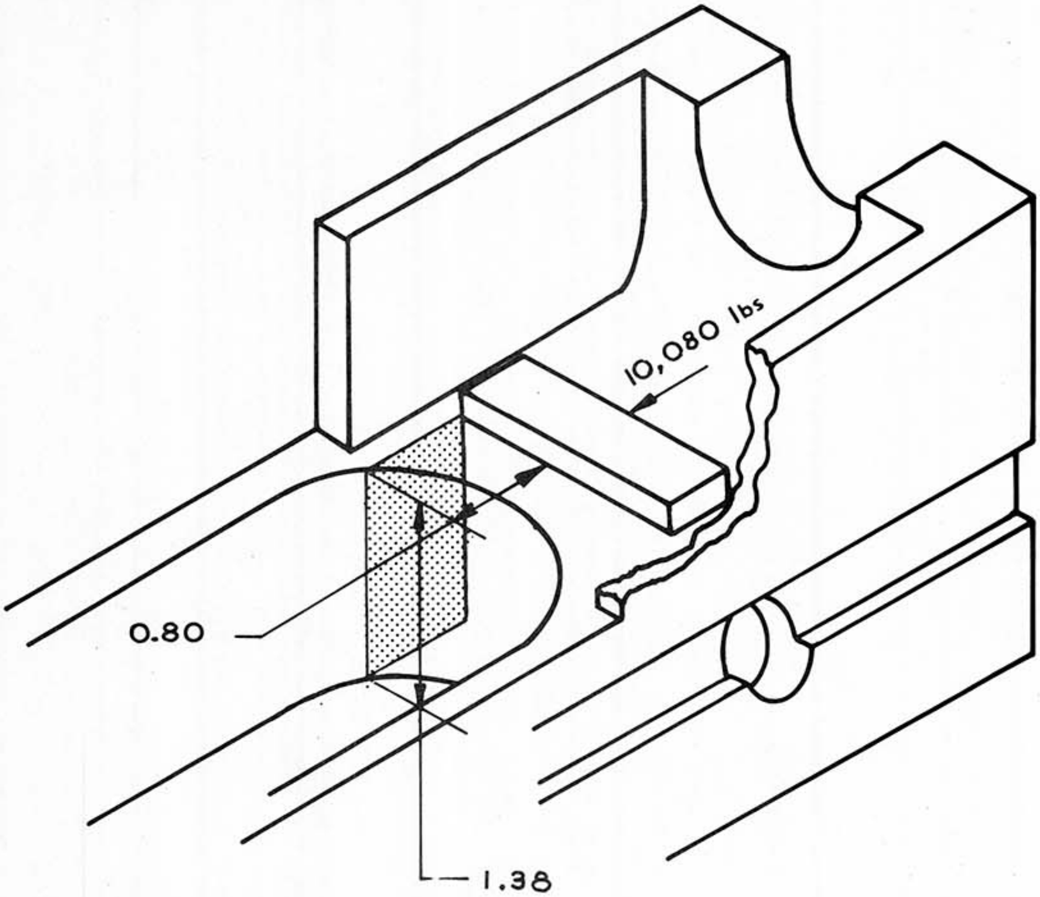


Figure B-2-10

Maximum Shearing Stress ($S_{S(max)}$)

$S_{S(max)}$ = $1.5\ P/A_S$

P = 10,080 lbs

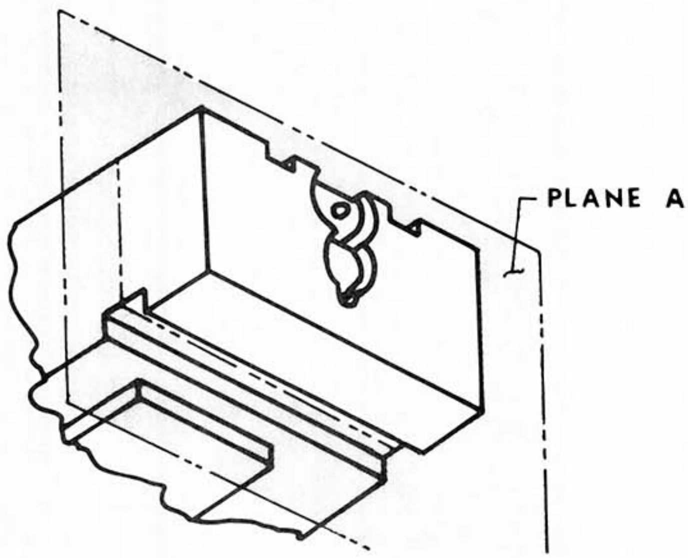
A_S = 2 (0.8) (1.38)

= 2.208 in^2

$S_{S(max)}$ = (1.5) (10,080)/2.208

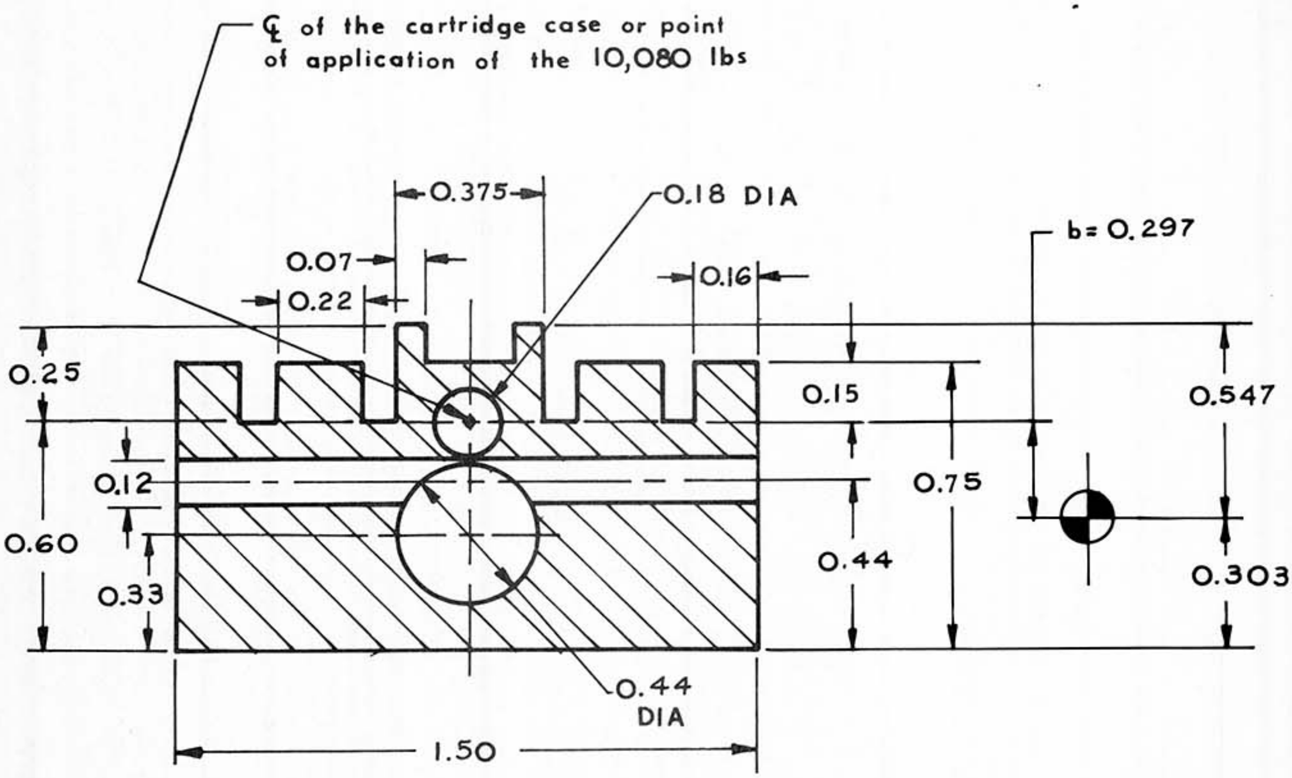
= 6,848 PSI

III. BOLT



Bottom View of Front of Bolt

Figure B-2-11



Plane A thru Bolt Recess

Figure B-2-12

$A_1 = (1.50)(0.60) = 0.90 \text{ in}^2$

$A_2 = [(2)(0.22) + 2(0.16) + 0.375]\ 0.15 = 0.170 \text{ in}^2$

$A_3 = 2(0.07)(0.25 - 0.15) = 0.014 \text{ in}^2$

$A_{0.44 \text{ dia.}} = \pi (0.44)^2/4 = -0.152 \text{ in}^2$

$A_{0.18 \text{ dia.}} = \pi (0.18)^2/4 = -0.025 \text{ in}^2$

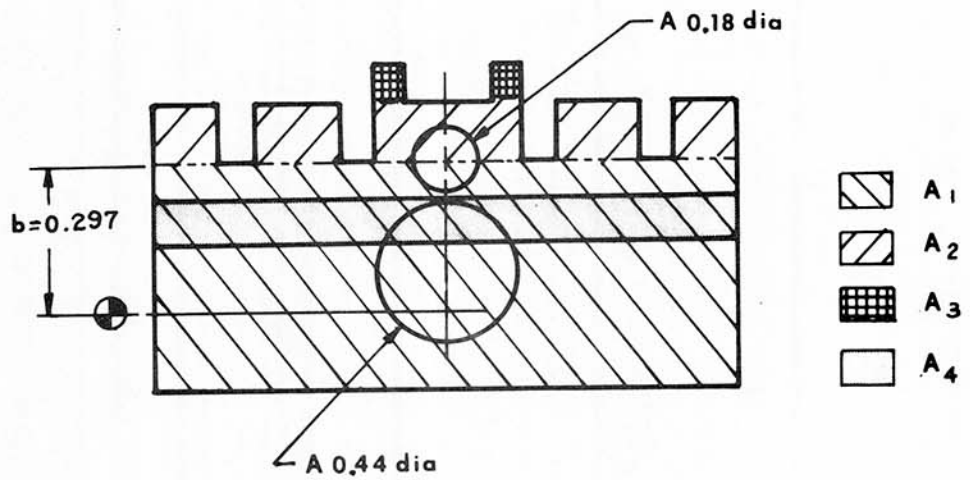
$A_4 = (0.12)(1.50) = -0.18 \text{ in}^2$

TOTAL AREA $= \Sigma A_i = A_b = 0.727 \text{ in}^2$

$b = [0.30 A_1 + 0.075 A_2 + 0.20 A_3 + 0.27 A_{0.44 \text{ dia}}$

$+ (0.60 - 0.44) A_4]/A_b$

$= 0.297 \text{ in}$



NOTE The segment of the 0.44 diameter circle has been deducted twice. However its area and moment of inertia are negligible and also give conservative results.

$I_1 = (1.50)\,(0.60)^3/12 + (0.30 - 0.297)^2\,(0.90) = 0.0270\ in^4$

$I_2 = \left[2\,(0.22) + 2\,(0.16) + 0.375\right]\,(0.15)^3/12 + (0.297 + 0.075)^2\,(0.17) = 0.0238\ in^4$

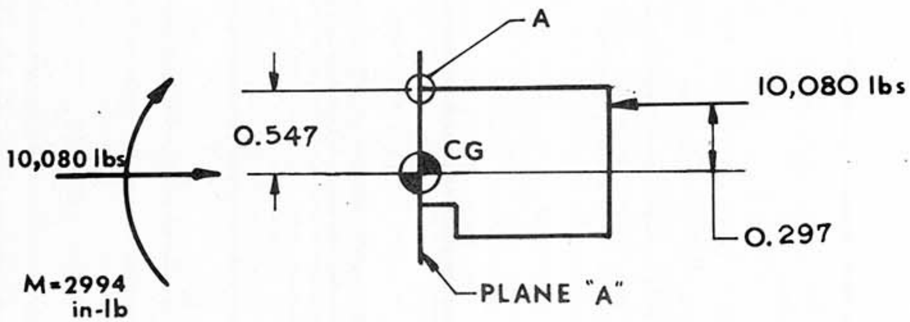
$I_3 = 2\,(0.07)\,(0.01)^3/12 + (0.297 + 0.15 + 0.05)^2\,(0.014) = 0.0035\ in^4$

$I_{0.44\ dia.} = 3.1416\,(0.44)^4/64 + (0.297 - 0.27)^2\,(0.152) = -0.0019\ in^4$

$I_{0.18\ dia.} = 3.1416\,(0.18)^4/64 + (0.297)^2\,(0.025) = -0.0023\ in^4$

$I_4 = (1.50)\,(0.12)^3/12 + (0.60 - 0.44 - 0.297)^2\,(0.18) = -\ 0.0036\ in^4$

$I_c = \Sigma I_i = 0.0465\ in^4$



Free Body Diagram of Bolt

$M = 10,080\,(0.297) = 2994$ lb-in.

$c = 0.547$ in

$S_c = S_B + S_N$ where

$S_F = Mc/I_c$ and $S_N = P/A_b$

$S_c = \left[2994\,(0.547)/0.0465\right] + \left[10,080/0.727\right]$

$= 49,085$ PSI Compression at "A"

B.3 RELIABILITY - ANALYSIS

Even though formal activities in reliability studies, value analysis, and maintainability reviews are not shown in Phase I of the program these studies will be initiated under the design support activities and later enlarged into formal areas of investigations in Phase II of the program. Emphasis will be placed upon collecting data during evaluative and developmental testing for application to mathematical models.

Colt Industries Colt's Firearms Division

APPENDIX C

CONTROL CIRCUIT

APPENDIX C

CONTROL CIRCUIT

C.1 GENERAL DESCRIPTION

The controller is a sequential circuit which, based upon combinations of input, generates output signals which remotely determine the status of the weapon being controlled. Control modes are provided for disarming, charging, arming, and belt changing.

The control panel allows complete communication between operator and system. Indicating switches permit both mode identification and mode changing at the operator's option; however, where safety is a factor, the mode changes are conditional upon the status of the weapon. The control panel provides the following:

ARM/DISARM Indicating Switch - Selection of armed or disarmed state with identification of each.

BELT 1/BELT 2 Indicating Switch - Initiation of belt change sequences with identification of each belt in position.

CHARGE Indicating Switch - Initiation of charging sequence with identification that charging has been effected.

NEUTRAL Indicator - Identification that the weapon has been locally set to the neutral position.

C.2 OPERATION

Figure C-1 is a simplified flow chart of the control which illustrates its operation. Initializing circuitry is provided which will drive the system to the disarmed state when power is first applied. The belt change sequence may be initiated from a disarmed state by depressing the BELT 1/BELT 2 indicator when a positive change identification is present. Depressing the BELT 1/BELT 2 indicator, without a belt being engaged, will result in BELT 1 moving into position. During the process of changing belts, the BELT 1/ BELT 2 indicator will go out and the NEUTRAL indicator will flash, assuring the operator that the change is in progress. When the belt change has been effected, BELT 1/BELT 2 will indicate which belt is in position. Following the new belt identification, the control arms the weapon. When arming is complete, ARM/DISARM will change to an ARM indication. The operator may release the BELT 1/BELT 2 indicator at any time during or after the sequence with no effect on the operation.

The belt change sequence may also be initiated from the armed state by depressing the BELT 1/BELT 2 indicator. The control will first automatically disarm the weapon. If a positive charge identification is present when the weapon is disarmed, the sequence will proceed as described in the previous paragraph. If no charge is indicated, the control will cause latching in the disarmed state. In order for this sequence to be completed, it is required that the BELT 1/BELT 2 indicator be depressed when disarming is completed. If it is released before disarming has been effected, the control will cause latching in the disarmed state. The balance of the sequence can then be initiated by depressing BELT 1/BELT 2 a second time.

The charging sequence can be initiated only in the disarmed state, and if the weapon has no positive charge or neutral identifications. The sequence is initiated by depressing the CHARGE indicator. When positive charge identification is received, the charge signal is removed and the weapon remains disarmed.

The operator may release the CHARGE indicator at any time during or after the sequence with no effect.

C.3 THEORY OF OPERATION

Figure C-2 is a simplified diagram of the control which illustrates the overall logic. The inputs shown are both operator selections and status signals fed back from the weapon. The states are the outputs of the latching or delay devices. The outputs are the signals transmitted from the control to the weapon.

The input combinational circuit performs the logical function illustrated in C-3 upon the inputs and the states. A decision is therein made regarding the next states. As the states change, the conditions of the new states are fed back to the input combinational circuit forming new bases for the decision.

Decoding of the states is performed by the output combinational circuit whose logic diagram is illustrated in Figure C-4. The function of the decoding circuiting is to make decisions regarding which control outputs are to be transmitted to the weapon. The states of the system form the bases for the decoding decisions.

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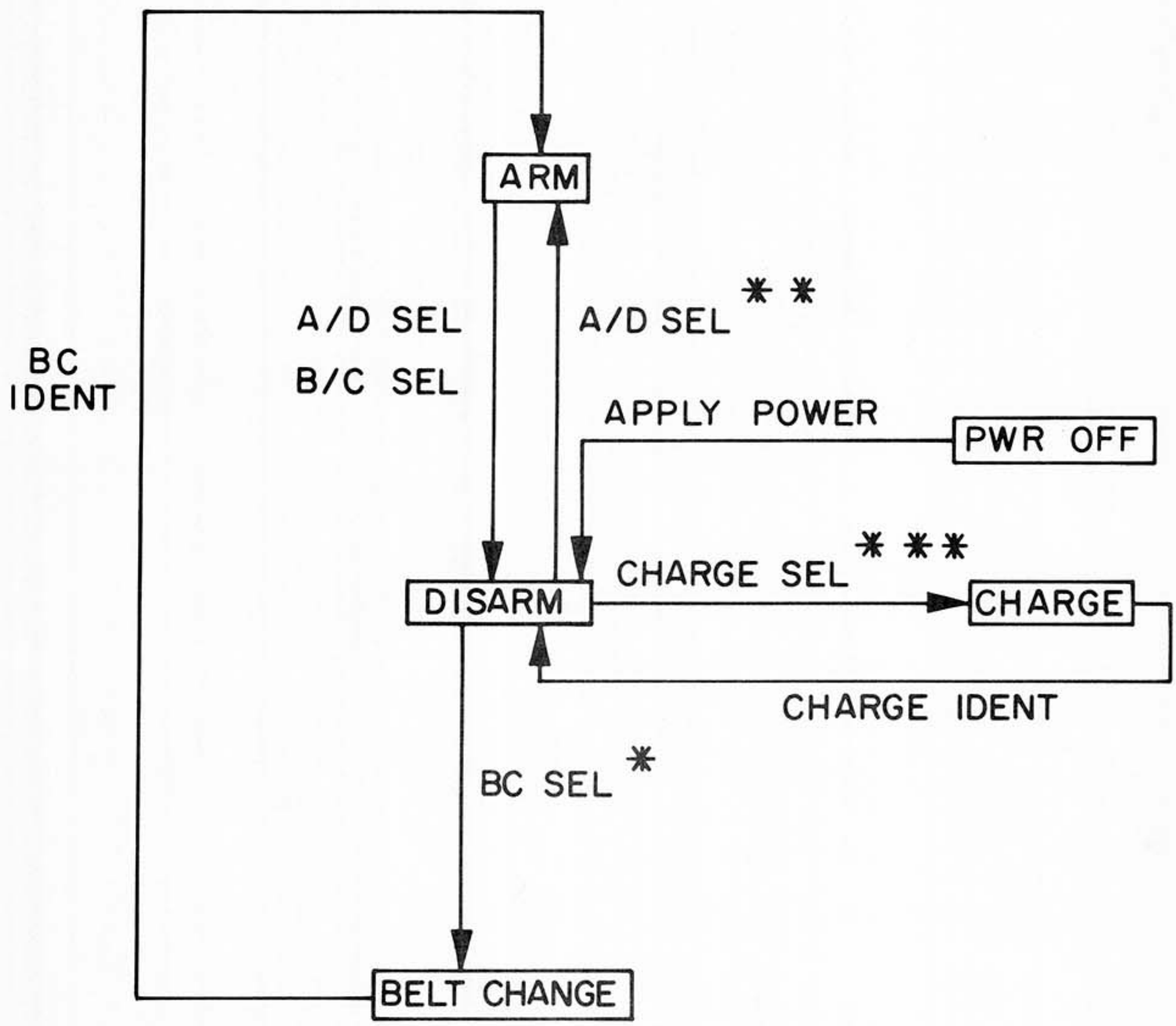
LIST OF SYMBOLS:

A.	Input:	Bl_i	-	Belt One Identification
		$B2_i$	-	Belt Two Identification
		B_s	-	Belt Change Switch
		D_s	-	Arm/Disarm Switch
		D_i	-	Disarm Identification
		C_s	-	Charge Switch
		C_i	-	Charge Identification
		N_i	-	Neutral Identification
B.	States:	F(N)	-	Output of N^{th} Latching Device
C.	Next States:	F'(N)	-	Input of N^{th} Latching Device
D.	Outputs:	Bl	-	Signal to Cause Change to Belt One
		B2	-	Signal to Cause Change to Belt Two
		A	-	Signal to Cause Arming
		D	-	Signal to Cause Disarming
		C	-	Signal to Cause Charging

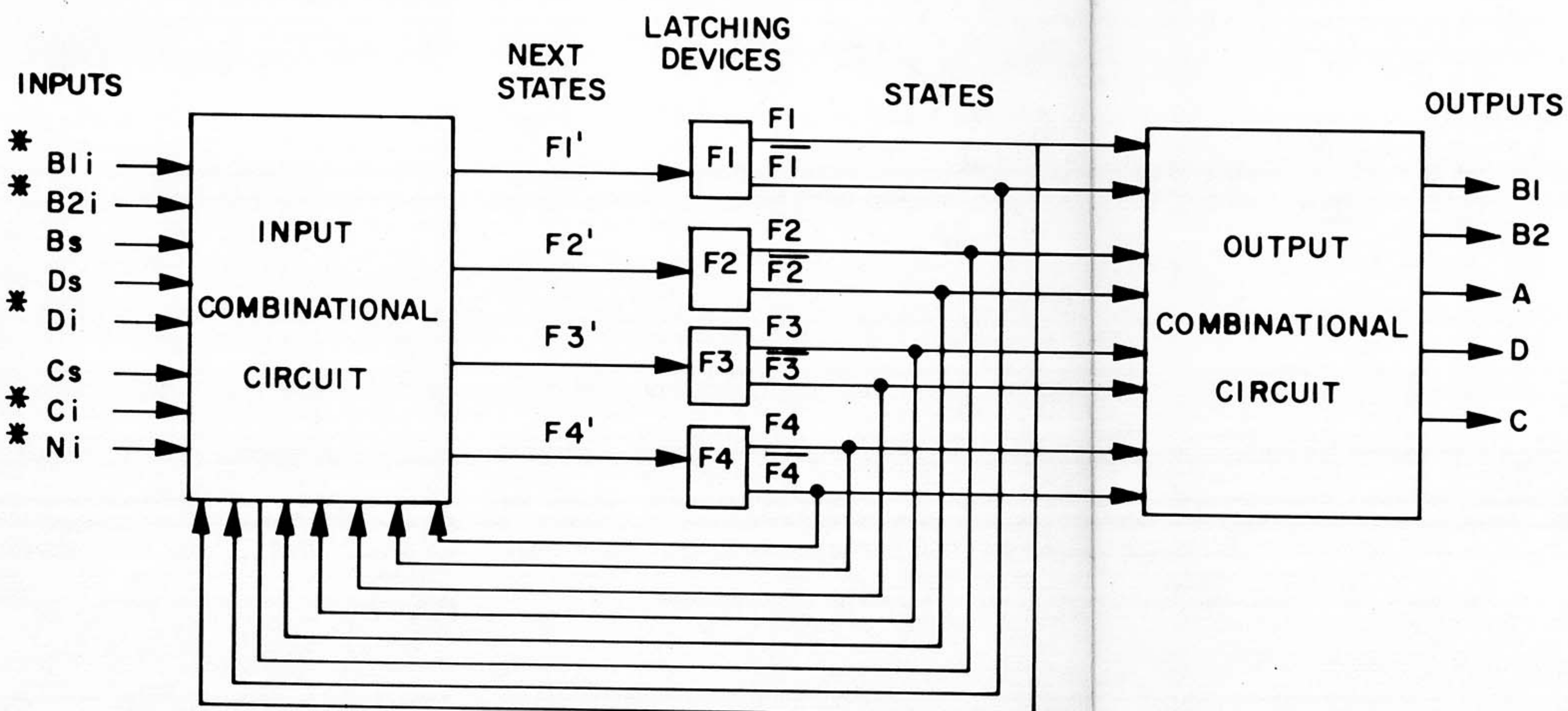
AND Gate

OR Gate



* Condition: Positive Charge Identification
** Condition: Positive Belt and Charge Identification
*** Condition: Neither Charge nor Neutral Identification

Figure C-1. Simplified Flow Chart



* Status Signals from Weapon

Figure C-2. Simplified Logic Diagram

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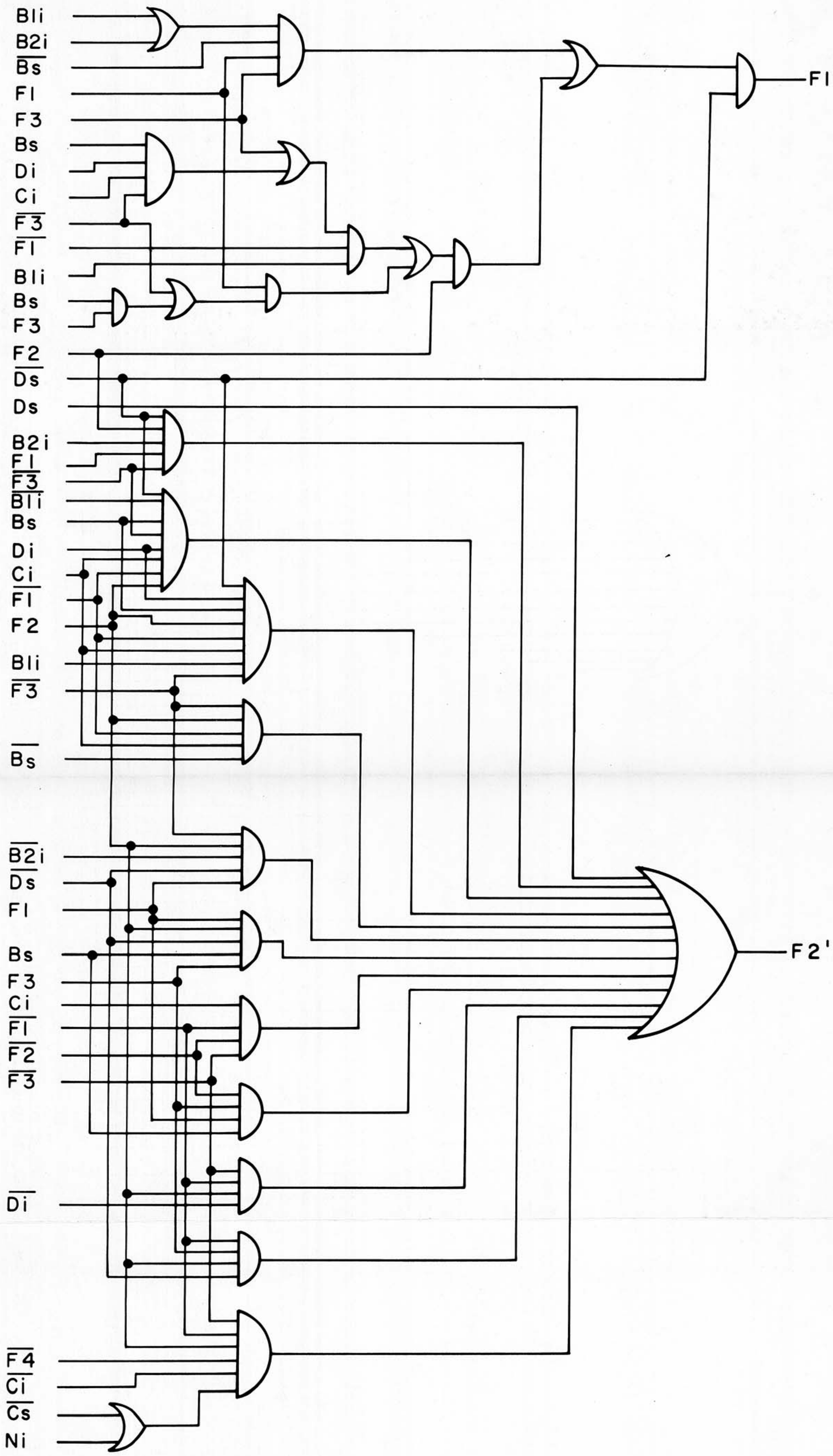

Figure C-3. Input Combinational Circuit (Sheet 1 of 3)

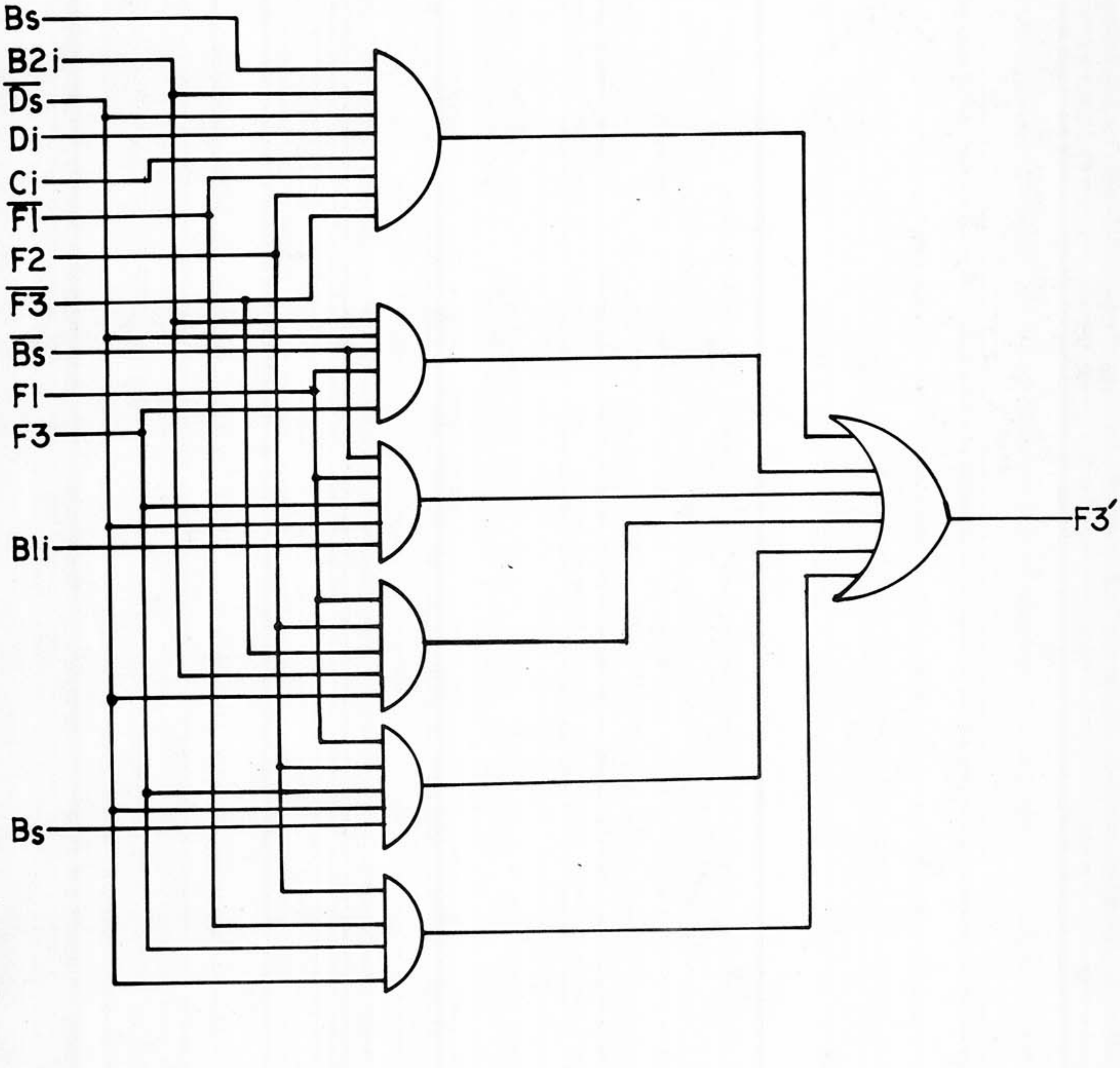

Figure C-3. Input Combinational Circuit (Sheet 2 of 3)

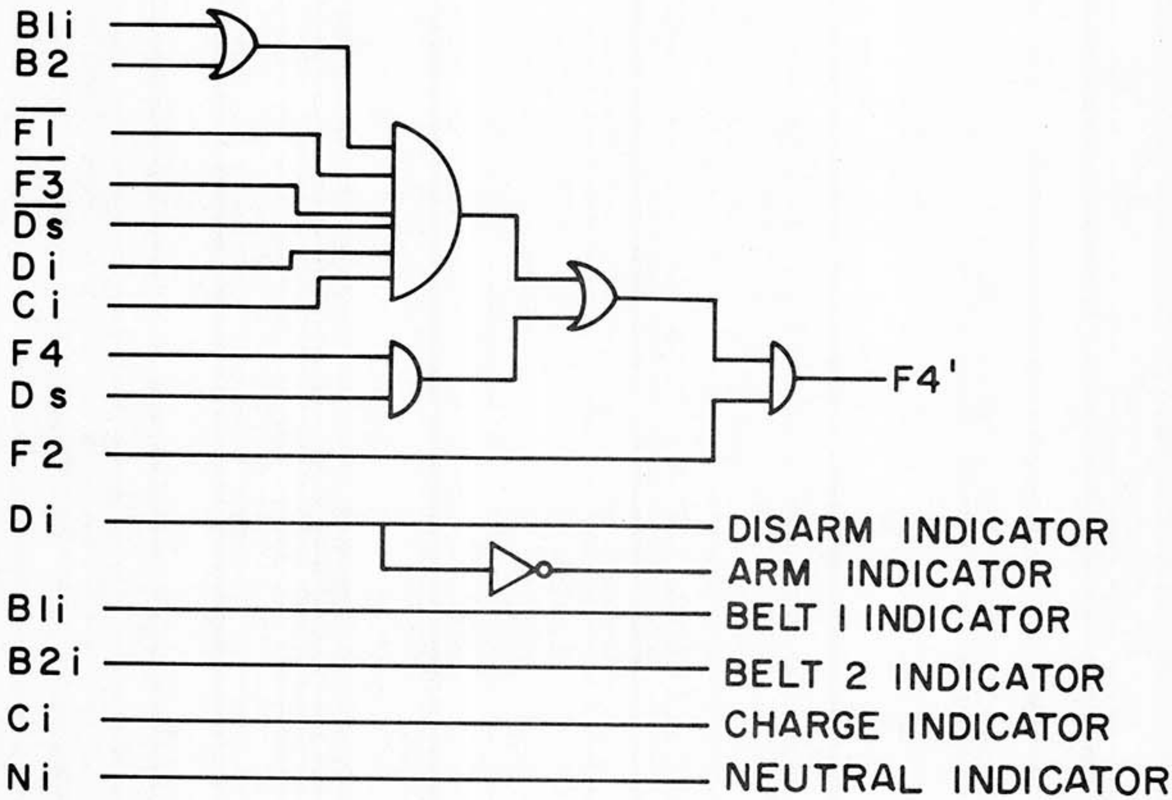

Figure C-3. Input Combinational Circuit (Sheet 3 of 3)

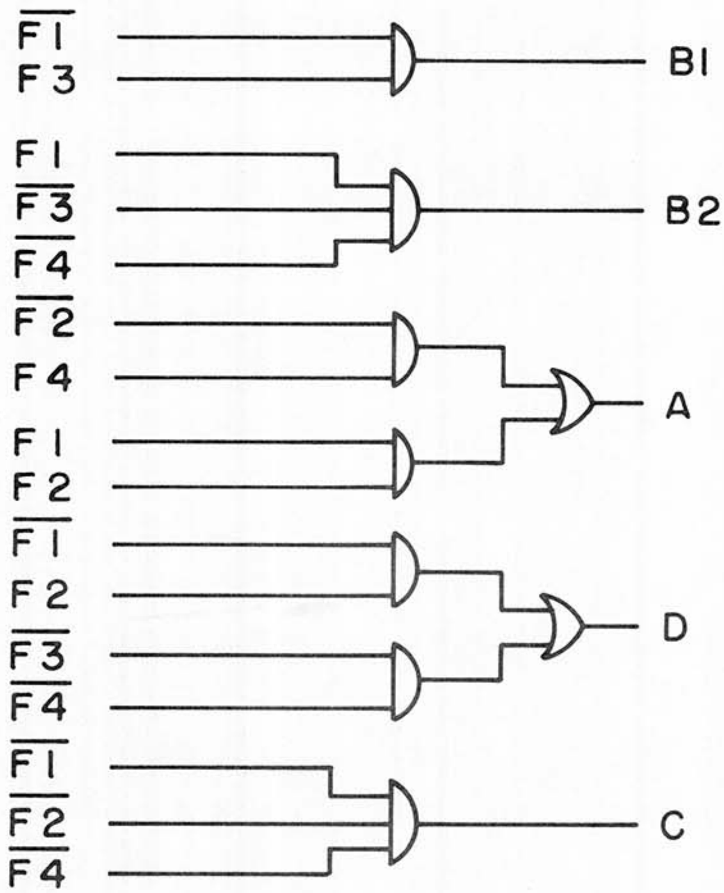

Figure C-4. Output Combinational Circuit

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APPENDIX D

TERMS & CONDITIONS

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APPENDIX D

TERMS AND CONDITIONS

PROPOSED TERMS

Colt's Firearms proposes to supply two (2) prototype 7.62mm Armor Machine Guns as illustrated herein for concept feasibility evaluation by the Government. These guns will be working prototypes capable of demonstrating the soundness of Colt's concept for a highly reliable and durable replacement for the current Tank Machine Guns. The prototypes which are to be supplied will be compatible with the remote dual feed system illustrated in the technical proposal. The feasibility prototypes, however, will be supplied with a feed tray which incorporates both left and/or right hand single link belt feed. The proposed total contract price which includes all fees for these two (2) prototype machine guns is $99,500.

The delivery of the prototypes will be on 1 March 1970, FOB Colt's plant, Hartford, Connecticut.

This proposal is valid in all its terms and conditions for sixty (60) days from its date.

Since this is a proposal for a supply contract for prototypes, Colt's envisions a follow-on contract for Engineering development of this concept at which time the Government would receive the rights.