AD

EN-79-04

AUTOMATED CHROMIUM PLATING LINE FOR GUN BARRELS

JOSEPH M. BISH
and
JOHN D. ROWE

SEPTEMBER 1979

TECHNICAL REPORT

U.S. ARMY ARRCOM

ENGINEERING DIRECTORATE

DISTRIBUTION STATEMENT

Approved for public release; distribution unlimited.

ROCK ISLAND ARSENAL
ROCK ISLAND, ILLINOIS 61201

DISPOSITION INSTRUCTIONS:

Destroy this report when it is no longer needed. Do not return it to the originator.

DISCLAIMER:

The findings of this report are not to be construed as an official Department of the Army position unless so designated by other authorized documents.

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER EN 79-04	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) AUTOMATED CHROMIUM PLATING LINE FOR GUN BARRELS		5. TYPE OF REPORT & PERIOD COVERED Technical Report
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Joseph M. Bish and John D. Rowe		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS CDR, Rock Island Arsenal ATTN: SARRI-EN Rock Island, IL 61299		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS PRON A1-2-60517-03-M2-M2 AMS Code 3297.16.6786
11. CONTROLLING OFFICE NAME AND ADDRESS CDR, Rock Island Arsenal ATTN: SARRI-EN Rock Island, IL 61299		12. REPORT DATE September 1979
		13. NUMBER OF PAGES 21
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) UNCLASSIFIED
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

1. Chromium Plating
2. Small Caliber Gun Tubes
3. Electropolishing
4. Electroplating
5. Automated Plating Line

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

This project was undertaken to establish a prototype automated chromium plating line for processing small caliber gun tubes. The automated line consists of a loading rack, electropolish tank, cold water rinse tanks, hot water rinse tank, chromium reverse etch tank and a chromium plating tank. The process involves automatic transference of racks containing the gun tubes to the various tanks in accordance to a programmed cycle.

Parameters selected for the automated process were 2 asi and 4.5-minute process

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

20. (Cont)

time to remove approximately 1.0 mil of stock during electropolish; and 2.5 asi and 50-minute plating time to deposit 1.0 mil of chromium plate. The feasibility of the automated process was shown in that 12 out of 24 processed gun tubes were within the acceptable internal dimension range. Six additional gun tubes were within 0.1 to 0.2 mil of the acceptable bore diameter range. The quality of the chromium plate was satisfactory in all cases. The major difficulty in the automated process is the control of stock removal during the electropolish cycle. The elimination of the electropolish sequence is recommended with the use of rotary swaged gun tubes sized to pre-plating dimensions. (U) (Bish, Joseph M. and Rowe, John D.)

FOREWORD

This project was carried out under the title "Automation of Gun Barrel Bore Chromium Plating to Reduce Costs". This work was authorized as part of the Manufacturing Methods and Technology Program of the U.S. Army Materiel Development and Readiness Command and was administered by the U.S. Army Industrial Base Engineering Activity.

CONTENTS

	Page
DD FORM 1473	i
FOREWORD	iii
TABLE OF CONTENTS	iv
ILLUSTRATIONS	v
TABULAR DATA	vi
INTRODUCTION	1
PROCEDURE	1
DESCRIPTION OF APPARATUS	2
RESULTS AND DISCUSSION	5
SUMMARY	13
RECOMMENDATION	13
DISTRIBUTION	15

ILLUSTRATIONS

Figure		Page
1	Automated Plating Line Operation	3
2	Plating Fixture with Gun Tube Attached and Rotating Electrode (Shown Separately)	4
3	Automated Plating Line Showing Loading Station, Tanks, Hoist and Carriers	6
4	Control Panels for the Automated Plating Line	7

LIST OF TABLES

Table		Page
1	Thickness and Rate of Stock Removal in Electropolish Tank ..	9
2	Thickness and Rate of Chromium Deposition	10
3	Bore Diameters after Electropolish and Chromium Plating	11
4	Bore Diameters, Before and After Automation Process	12

INTRODUCTION

The transition to automated electroplating processing lines has been occurring in commercial organizations and within five years, some degree of automation will have become an essential part of all plating shops. Rising labor and material costs are compelling shop management to consider automation as a means of maintaining their business posture. With automation, the art of plating would be replaced by reproducible modern technology. Automation can also be used to handle complicated plating cycles which demand consistent pretreatments and bath dwell times. Some of the advantages of automated processing include increased productivity (average of 20%) due to greater efficiency, increased product reliability, and reduced consumption of chemicals. On the average, overall cost savings of 25% are obtained when automated processing procedures[1] are used.

The current method of applying chromium electrodeposits to gun tubes is a manual, batch operation. Each gun tube is racked, unracked and sized individually, twice during the process. Manual control of hoist and conveyance operation, bath dwell times and amperage control is required. The reduction of labor time, of the necessary high degree of operator skill and of operator subjectivity is desirable. Automated plating offers a potentially efficient method for mass or batch producing coated gun tubes.

The objectives of this project were to prepare a purchase description for the procurement of an automated chromium plating system, contract for the purchase of the automated equipment, install and test the equipment, and to establish procedures for chromium plating small caliber rifle bores. This work, conducted on a pilot line scale, was designed to provide information which will assist in the establishment of a full production scale operation.

PROCEDURE

The initial stages of the project involved survey of available equipment, actual procurement, and installation phases. The experimental work was divided into three process evaluation segments: the electropolish process, the chromium plating process, and finally, the automated process combining the electropolish and chromium plating sequence. The gun tubes used throughout this project were 5.56mm M16 rifle tubes made of Cr-Mo-V steel machined to final dimensions.

---

[1]Florence, C.D., "Automating Electroplating for Survival," Industrial Finishing, May 1972, pp 12-19.

The electropolish study was made to determine the rate of stock removal as a function of bath use. Conventional bath solution, current density (2.0 asi) and bath temperature (150°F) were used. The time to remove 1.0 to 1.2 mils per side as a function of bath use had to be determined. For the chromium plating study, plating times had to be established to deposit 1.0 to 1.5 mils of chromium per side. Process parameters of 2.5 asi current density, 138°F bath temperature and bath chemistry were kept constant throughout the study. After obtaining the required process times for electropolishing and chromium plating, evaluation of the automated process was conducted. Air gauge measurements of the internal bore dimensions were made throughout the effort.

DESCRIPTION OF APPARATUS

The automated plating system was procured from the Udylite Corporation (now Oxy Metal Industries Corp.), Detroit, Michigan. The automated plating line consists of processing tanks, a hoist used to lift and transfer work to various processing tanks, and automated controls. Figure 1 shows the processing sequences for the automated plating line. Note that the hoist is located over the cold rinse tank while the carriers are located in the chromium plating tank and load position at the start of the automated process. The order of operation is shown in Figure 1 starting with the load position (station 1) and finishing at the same location. This process differs from routine chromium plating of gun tubes in that no measurements of stock removal after electropolish are taken during the automated process.

The automated chromium plating equipment consists of a single lift, automated hoist with a capacity for 700 pounds of rack and load. The hoist transfer drive has two-speed options with a single speed lift drive system. A control panel for automatic, semi-automatic, and manual operation is provided. Carriers which support the rack and load for hoist pick-up are equipped with 300-ampere capacity bars designed for mounting fixtured gun barrels. The carriers are furnished with gear train (for electrode rotation) and electrode terminals for each barrel, i.e., a separate anode pick-up and a common cathode pick-up. Racks are transferred to the various tanks following a preprogrammed cycle. Dwell times in each tank are variable and depend upon the selected production rate.

The solid state programmer hoist control uses a photoelectric tape reader to read coded instructions from an 8-channel punched numerical-control tape. The program control tape is coded using a Teletype ASR 33 or ASR 35 unit which employs an 8-channel ASC II tape coding system.

The gun tubes are racked with the muzzle-end up in a rotating electrode fixture (see Figure 2). This fixture consists of lead-tin coated steel electrode and wound with a Teflon rod spacer. The electrode is

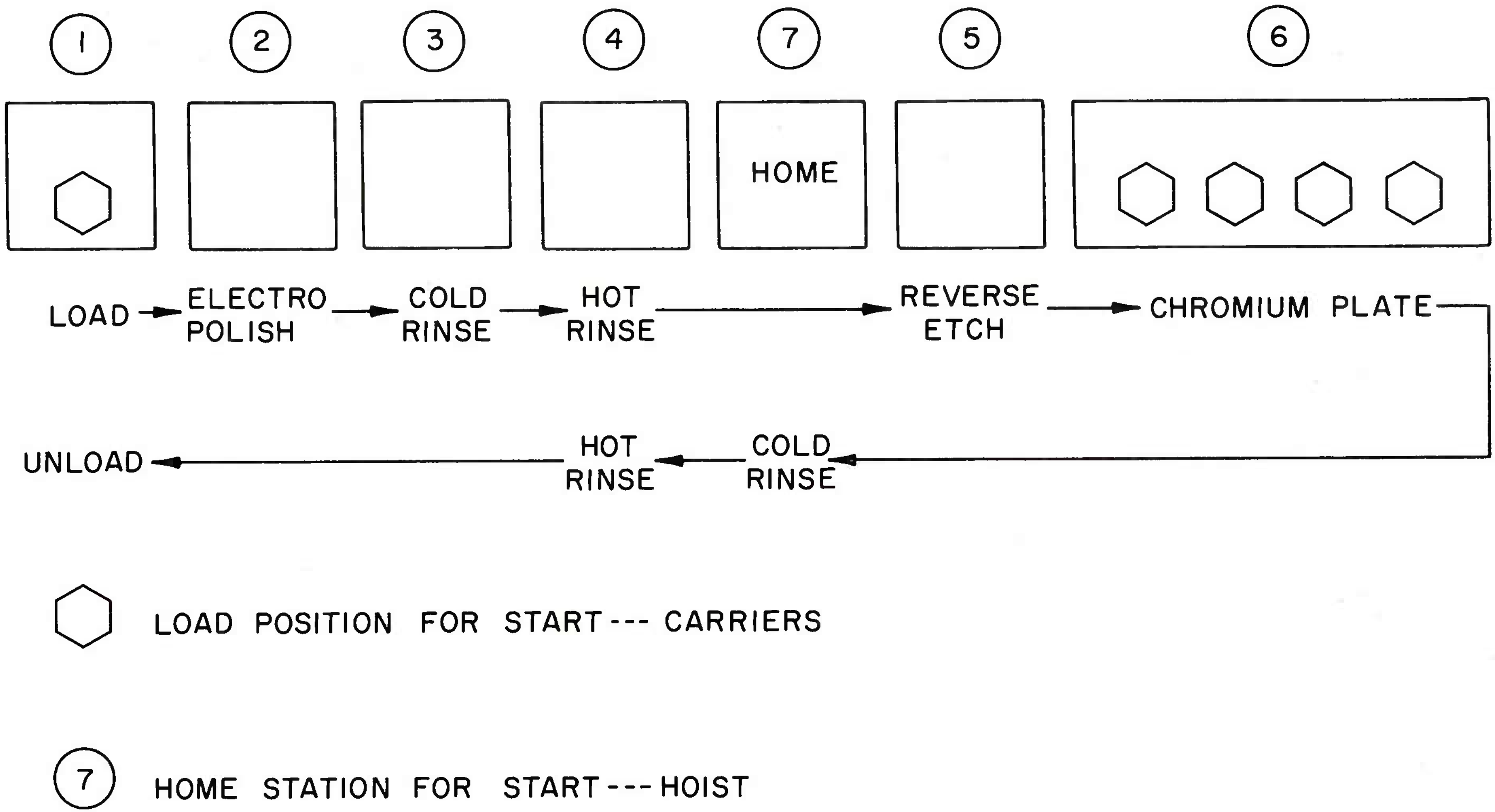

FIG. I AUTOMATED PLATING LINE OPERATION

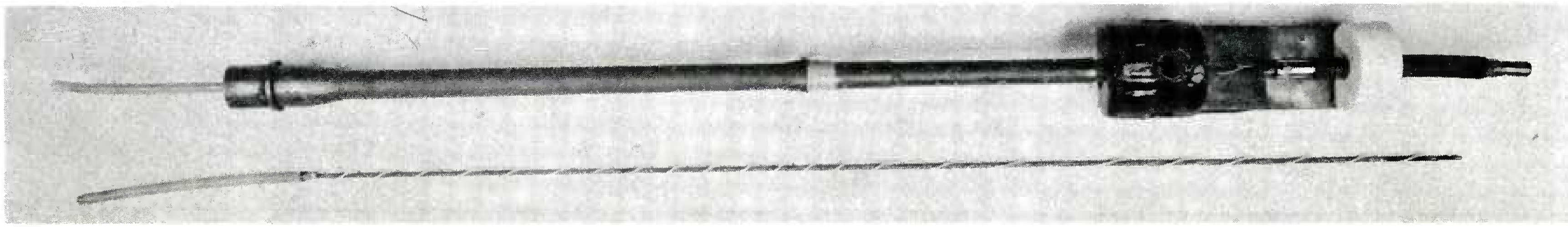

FIGURE 2. Plating Fixture with Gun Tube Attached and Rotating Electrode (Shown Separately).

mechanically rotated within the bore by means of a flexible cable attached to an electric drive motor. The rotating electrode fixture was developed at this Laboratory[2] and adapted to the 5.56mm system. The self-centering nature of the rotating electrode eliminates the necessity for operator alignment. The rotating electrode is utilized in both electropolishing and chromium plating operations.

Figure 3 shows two M-16 rifle barrels (A) being lowered into the chromium plating tank. Attached to the carrier is a fixture containing the rotating electrode. On the top center of the electropolish tank (B) is the power source for rotation of the anodes. Figure 3 also shows a complete view of the automated plating line except for control panels. The arrangement of tanks from left to right include electropolish (B), cold water rinse (C), hot water rinse (D), cold water rinse (E), chromium reverse (F), and chromium plating (G, 4 stations). On the extreme left is the loading rack (H) where electrodes, racks, and gun barrels are attached or removed from the carriers. Overhead the tracks and hoists (I) used to move the carriers from one tank to another can be observed.

Figure 4 illustrates the control panels for the automated plating line. The panel on the left is the rectifier (A). Each set of controls contain an ammeter, voltmeter and timer. There are two sets of controls each for the electropolish and chrome reverse and eight sets of controls for the chromium plating tanks. To the right of the rectifier is the automated control for the hoist (B). During automatic operation all movements of the hoist are controlled by the programmed tape instructions read by the tape reader. The hoist operates continuously without attendance by an operator. The hoist can be operated in both semi-automated or manual operation by use of a "Wobble Stick" on the console.

The automatic operation may be interrupted during any part of the operation and switched to manual operation. Also the automatic operation can be controlled in a single step mode. In this operation each step of the automated process is activated by pushing the "Step Tape" button. In the third panel from the left (C) are located the controls for the operation of exhaust fan, air make-up units and fume scrubber (see Figure 4). On the far right are the controls for the rotation of the anodes (D).

RESULTS AND DISCUSSION

A. Electropolish Process

Because the M16 rifle tubes are machined to final dimensions, the determination of conditions for the removal of 1.0 to 1.2 mils per

---

[2] Sale, D. H., "Chromium Plating of Caliber .17 (4.32mm) Barrels" RE-TR-71-49, AD 729360, July 1971.

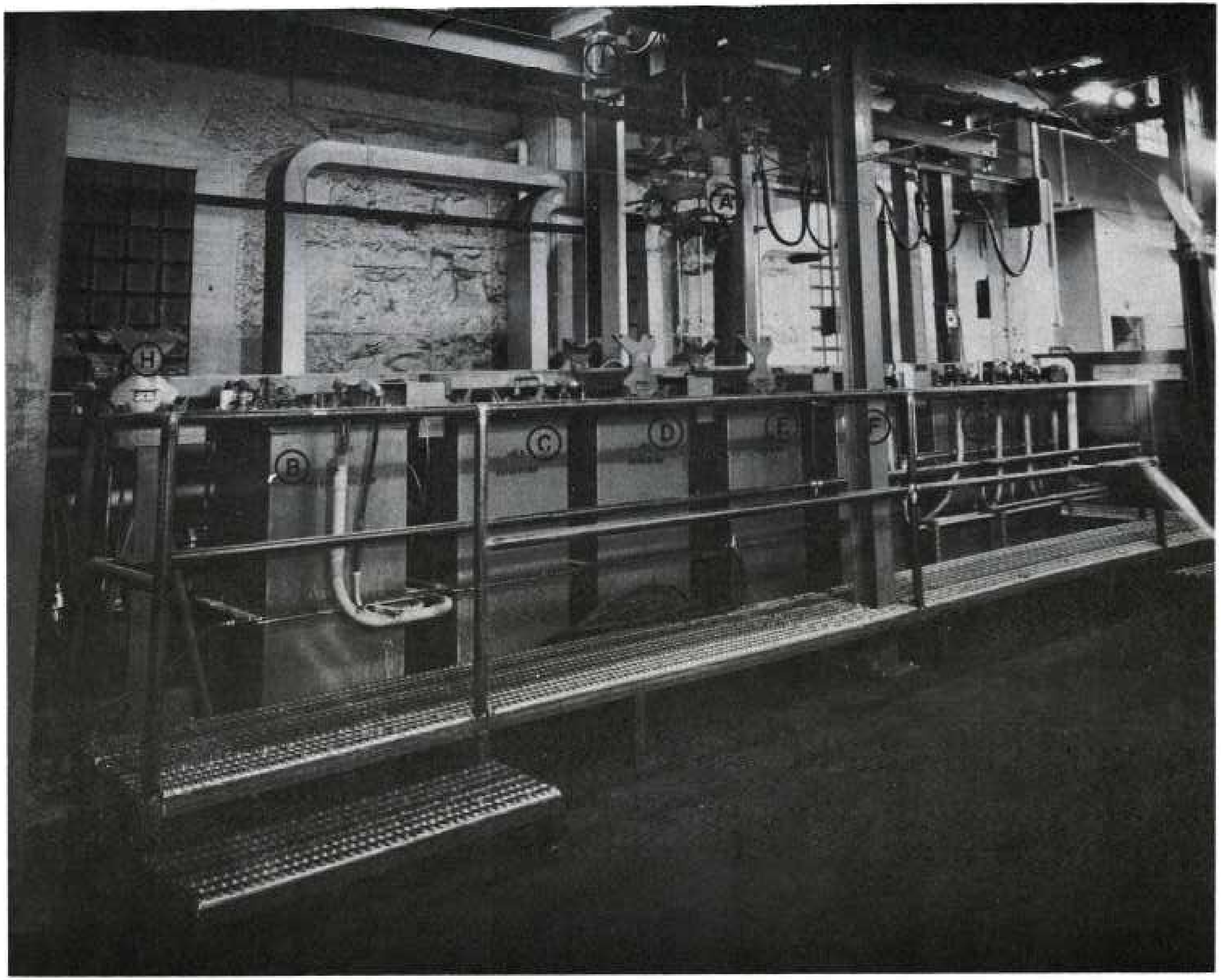

FIGURE 3 Automated Plating Line Showing Loading Station, Tanks Hoist and Carriers.

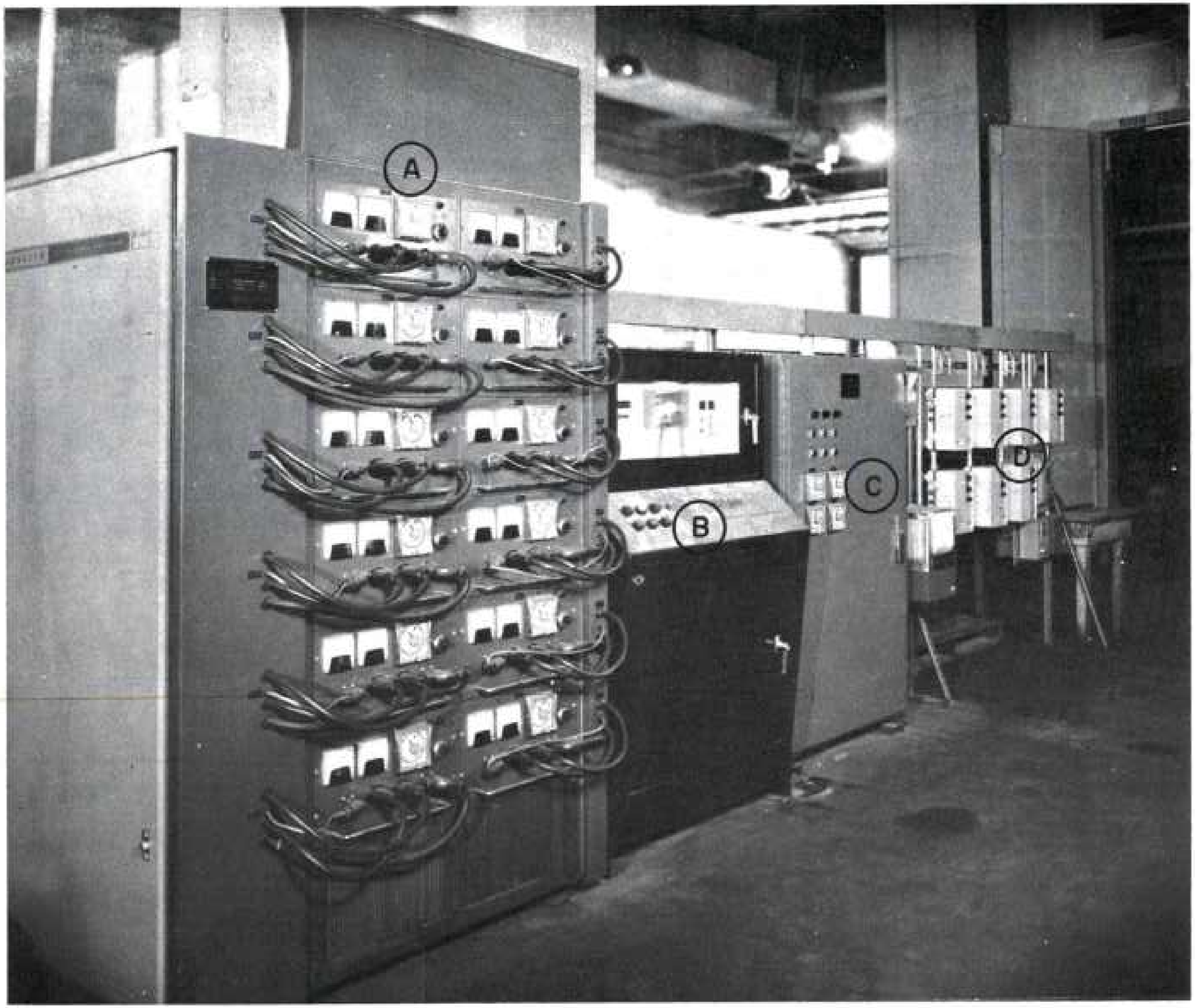

FIGURE 4 Control Panels for the Automated Plating Line.

side of stock in the electropolish process was necessary. Twenty-four 5.56mm gun tubes were electropolished for various time durations. The tubes were processed in pairs starting with 10 minutes for the first pair and then the time interval was decreased incrementally to 4.5 minutes for last pair (see Table 1). After each electropolish, measurements were made on muzzle end and process time adjusted for succeeding runs. The average rate of stock removal increased from 0.16 mil /minute/side for the initial gun tubes to 0.28 mil /minute/side for the last gun tubes. It was observed that a steady-state rate could not be obtained even after the electropolishing of 24 gun tubes. Based on these findings, the process times selected for the automated sequence study were 6.5 minutes for the initial pair and decreasing to 4.5 minutes for the tenth pair of gun tubes. The conventional 150°F bath temperature and 2.0 asi current density were maintained for the automated cycle.

B. Chromium Plating Process

The purpose of the next evaluation was to determine parameters necessary for obtaining a chromium plate of 1.0 to 1.5 mils per side, the requirements for the manufacture of 5.56mm gun tubes. A current density of 2.5 asi and 138°F bath temperature were determined to be satisfactory for use in the chromium-reverse and chromium-plating operation. Measurements were taken and adjustments in plating time were made to obtain desired thicknesses of chromium deposits. Calculations made on the rate of chromium deposition (see Table 2) indicated a range of 1.1 to 1.8 mils per hour. The variation in the rate of plating may be due to fluctuating efficiency of the fixtures in conducting the current, especially the rotating contacts. Tubes processed in 65-80 minutes resulted in as-plated diameters below the required minimum diameter (0.2190 inch), due to excessive buildup of the chromium plate. Several of the gun tubes electroplated between 50 and 60 minutes measured within the range of .2190 - .2200 inch, the requirement for finished 5.56mm gun tubes. From the results (see Table 2), it was determined that a 50 minute plating time for the automated runs would yield the desired after-plating dimensions. Table 3 lists the bore diameters after electropolishing and after chromium plating.

C. Automated Process

The process was automated using 24 additional gun tubes. Process parameters selected for the electropolishing step were current density of 2 asi, bath temperatures of 150°F, and processing times starting at 6.5 minutes and decreasing to 4 minutes for the tenth pair of gun tubes. A 50 minute processing time was selected for the chromium plating using 2.5 asi and 138°F bath temperature. Measurements were made on gun tubes before electropolish and after completion of the chromium plating. No measurements could be taken after electropolish during the automated cycle. Table 4 gives information on diameter measurements and electropolish times. Twelve of the 24 gun tubes processed measured within the required range of 0.2190 to 0.2200 inch. Six additional gun tubes were within 0.1 to 0.2 mil

TABLE I

THICKNESS AND RATE OF STOCK REMOVAL IN

ELECTROPOLISH TANK

Gun Tube Number	ID Before Electropolish (Inches)	ID After Electropolish (Inches)	Thickness of Stock Removed (Mils)	Average Removal Rate per Min. (Mils)	Time of Electropolish (Minutes)
1	0.2194	0.2226	1.60	0.16	10.0
2	0.2194	0.2226	1.60	0.16	10.0
3	0.2195	0.2222	1.35	0.15	9.0
4	0.2195	0.2223	1.40	0.15	9.0
5	0.2195	0.2221	1.30	0.16	8.0
6	0.2195	0.2221	1.30	0.16	8.0
7	0.2195	0.2224	1.45	0.21	7.0
8	0.2195	0.2224	1.45	0.21	7.0
9	0.2196	0.2216	1.00	0.17	6.0
10	0.2196	0.2218	1.10	0.18	6.0
11	0.2196	0.2222	1.30	0.22	6.0
12	0.2196	0.2222	1.30	0.22	6.0
13	0.2196	0.2220	1.20	0.22	5.5
14	0.2196	0.2218	1.10	0.20	5.5
15	0.2197	0.2223	1.30	0.24	5.5
16	0.2197	0.2220	1.15	0.21	5.5
17	0.2197	0.2223	1.30	0.26	5.0
18	0.2197	0.2219	1.10	0.22	5.0
19	0.2197	0.2223	1.30	0.26	5.0
20	0.2197	0.2222	1.25	0.25	5.0
21	0.2197	0.2217	1.00	0.22	4.5
22	0.2197	0.2218	1.05	0.23	4.5
23	0.2197	0.2223	1.30	0.29	4.5
24	0.2197	0.2222	1.25	0.28	4.5

TABLE 2

THICKNESS AND RATE OF CHROMIUM DEPOSITION

Gun Tube Number	Plating Time (Minutes)	Thickness* (Mils)	Plating Rate (Mils per Hour)
1	80	2.5	1.9
2	80	2.0	1.5
7	80	2.0	1.5
8	80	2.6	2.0
4	80	2.2	1.6
15	80	2.0	1.4
17	72	1.9	1.5
19	72	0.2	0.2
23	65	2.2	2.0
3	60	1.7	1.7
11	60	1.7	1.7
12	60	0.9	0.9
20	60	1.9	1.9
24	60	1.6	1.6
5	60	1.8	1.8
9	50	1.7	2.0
13	50	0.7	0.8
16	50	1.8	2.2
18	50	1.9	2.3
10	50	1.9	2.3
14	50	1.8	2.1
22	50	1.3	1.5
21	50	1.4	1.7

* Measurements made at the muzzle.

TABLE 3

BORE DIAMETERS AFTER ELECTROPOLISH AND CHROMIUM PLATING

Gun Tube Number	After Electropolish Inches*	After Chromium Plating Inches
1	0.2226	0.2175
2	0.2226	0.2186
7	0.2224	0.2185
8	0.2224	0.2190
4	0.2223	0.2187
15	0.2223	0.2184
17	0.2223	0.2185
19	0.2223	0.2220
23	0.2223	0.2178
3	0.2222	0.2188
11	0.2222	0.2188
12	0.2222	0.2205
20	0.2222	0.2184
24	0.2222	0.2192
5	0.2221	0.2184
9	0.2221	0.2187
13	0.2220	0.2207
16	0.2220	0.2183
18	0.2219	0.2200
10	0.2218	0.2187
14	0.2218	0.2195
22	0.2218	0.2188
21	0.2217	0.2193

*Measurements made at the muzzle.

TABLE 4

BORE DIAMETERS, BEFORE AND AFTER AUTOMATION PROCESS

Gun Tube Number	Before Electropolish Air Gauge Muzzle (Inch)	After Chromium Plating Air Gauge Breech (Inch)	After Chromium Plating Air Gauge Muzzle (Inch)	Time in Electropolish (Minutes)
25	0.2197	0.2170	0.2170	6.5
26	0.2197	*	*	6.5
27	0.2197	0.2203	0.2196	6.5
28	0.2197	0.2201	0.2200	6.5
29	0.2197	0.2193	0.2190	6.5
30	0.2197	0.2193	0.2190	6.5
31	0.2197	0.2201	0.2194	6.5
32	0.2198	0.2203	0.2195	5.5
33	0.2198	0.2186	0.2190	5.5
34	0.2198	0.2197	0.2192	5.5
35	0.2198	0.2194	0.2191	5.5
36	0.2198	0.2190	0.2190	5.5
37	0.2198	0.2188	0.2190	5.0
38	0.2198	0.2193	0.2188	5.0
39	0.2198	0.2190	0.2194	5.0
40	0.2198	0.2192	0.2194	5.0
41	0.2199	0.2197	0.2194	4.5
42	0.2199	0.2197	0.2190	4.5
43	0.2199	0.2195	0.2195	4.5
44	0.2199	0.2195	0.2195	4.5
45	0.2200	0.2195	0.2188	4.0
46	0.2200	0.2193	0.2190	4.0
47	0.2200	0.2189	0.2192	4.0
48	0.2200	0.2193	0.2193	4.0

*No chromium plate

of the acceptable range for bore dimensions. Five of these gun tubes had insufficient taper. In general, the appearance of the chromium plating was satisfactory.

Since each electropolish and chromium bath formulations produce a variation in stock removal and rate of chromium deposition, respectively, these rates must be determined individually for particular bath chemistries before this process can be automated. A sufficient number of gun tubes must be electropolished before the rate of stock removal reaches a steady-state value. A check on the rate of stock removal after each additional 50 gun tubes are electropolished is also recommended. Measurements should also be made at regular intervals on the finished chromium plated gun tubes to determine if the bore diameters are in the acceptable range. In order to control the amount of stock removal in the electropolish and thickness of chromium plate, it may be necessary to change processing times during the automated process. Obtaining information on stock removal rates may not be an easy task since it requires several gun tubes and a number of runs. With the advent of newer gun tube fabrication processes as rotary swaging, the electropolishing sequence can now be eliminated for a majority of gun systems. Pre-plating dimensions and desired rifling contours can be obtained with rotary forging. With the elimination of electropolishing, automation of chromium plating of gun tubes would be an easy task. However, in order for the process to be cost-effective, a large quantity of gun tubes must be produced, e.g., buy quantities >200,000.

SUMMARY

Automated plating of small caliber gun tubes has been shown to be feasible. Optimum parameters for electropolishing and chromium plating were determined by processing twenty-four 5.56mm M16 gun tubes. Conventional current densities, bath solutions, and bath temperatures were acceptable for use in the electropolishing and plating operations. It was necessary to reduce the electropolish dwell times with the number of gun tubes processed. Dwell times for both the electropolish and electrodeposition operations had to be determined independently. Rates of stock removal must be determined for specific production cycles. A sufficient number of gun tubes must be processed to determine the steady state rate of electropolish. Elimination of the electropolishing step as currently practiced with rotary swaged gun tubes would substantially reduce the difficulties in automated processing.

RECOMMENDATIONS

1. The electropolish operation be eliminated through the use of rotary swaged gun tubes which have been formed to pre-plating dimensions.

2. Automated chromium plating of small caliber gun tubes be implemented to full scale production when buy quantities are sufficient (>50,000 bbls) to make automated processing cost effective.

3. For automated processing, each electrode circuit (for each gun tube) should have a fail-safe system whereby undesirable current density does not occur.

DISTRIBUTION

		Copies
A.	**Department of Defense**	
	Defense Documentation Center ATTN: TIPDR Cameron Station Alexandria, VA 22314	12
B.	**Department of the Army**	
	Commander U. S. Army Materiel Development and Readiness Command ATTN: DRCRD-E DRCRP-I DRCQA-E 5001 Eisenhower Avenue Alexandria, VA 22333	 1 1 1
	Commander U. S. Army Materiel Development and Readiness Command Scientific and Technical Information Team - Europe ATTN: DRXST-STL Dr. Richard B. Griffin APO New York 09710	1
	Commander U. S. Army Armament Command ATTN: DRSAR-PPI-K DRSAR-PPI-WW DRSAR-RDP DRSAR-SC DRSAR-QAE Rock Island, IL 61201	 1 1 1 1 1
	Director U. S. Army Materials and Mechanics Research Center ATTN: DRXMR-M Watertown, MA 02172	1
	Director U. S. Army Maintenance Management Center ATTN: DRXMD-A Lexington, KY 40507	1

DISTRIBUTION

	Copies
Commander U. S. Army Electronics Command ATTN: DRSEL-PP/I/IM Fort Monmouth, NJ 07703	1
Commander U. S. Army Missile Command ATTN: DRSMI-IIE DRSMI-PRT Redstone Arsenal, AL 35809	 1 1
Commander U. S. Army Tank-Automotive Command ATTN: DRSTA-RK DRSTA-RCM.1 Warren, MI 48090	 1 1
Commander U. S. Army Aviation Systems Command ATTN: DRSAV-ERE P. O. Box 209 St. Louis, MO 63166	1
Commander U. S. Army Troop Support Command ATTN: DRSTS-PLC 4300 Goodfellow Blvd. St. Louis, MO 63120	1
Commander Ballistic Missile Defense Systems ATTN: BNDSC-TS P. O. Box 1500 Huntsville, AL 35804	1
Project Manager Munition Production Base Mod Picatinny Arsenal Dover, NJ 07801	1
Commander Harry Diamond Laboratories ATTN: DRXDO-RCD 2800 Powder Mill Road Adelphi, MD 20783	1

DISTRIBUTION

	Copies
Commander US Army Natick Research and Development Command ATTN: DRXNM-EM Kansas Street Natick, MA 01760	 1
Commander US Army Air Mobility R&D Labs ATTN: SAVDL-ST Fort Eustis, VA 23604	 1
Commander Rock Island Arsenal ATTN: SARRI-AOE SARRI-APP Mr. V. Long Rock Island, IL 61201	 1 1
Commander Watervliet Arsenal ATTN: SARWV-PPP-WP SARWV-PPI-LAJ SARWV-QA Watervliet, NY 12189	 1 1 1
Commander Picatinny Arsenal ATTN: SARPA-MT-C SARPA-QA-T-T SARPA-C-C Dover, NJ 07801	 1 1 1
Commander Frankford Arsenal ATTN: SARFA-T1000 SARFA-QA SARFA-N5400 Bridge & Tacony Streets Philadelphia, PA 19137	 1 1 2
Commander Edgewood Arsenal ATTN: SAREA-QA Aberdeen Proving Ground, MD 21010	 1

DISTRIBUTION

	Copies
Director U. S. Army Industrial Base Engineering Activity ATTN: DRXIB-MT Rock Island Arsenal Rock Island, IL 61201	2
Director USDARCOM Intern Training Center ATTN: DRXMC-ITC-PPE Red River Army Depot Texarkana, TX 75501	1
Commander U. S. Army Tropic Test Center ATTN: STETC-MO-A (Technical Library) APO New York 09827	1
Commander Anniston Army Depot ATTN: DRXAN-DM Anniston, AL 36201	1
Commander Corpus Christi Army Depot ATTN: DRXAD-EFT Corpus Christi, TX 78419	1
Commander Fort Wingate Depot Activity ATTN: DRXFW-M Gallup, NM 87301	1
Commander Letterkenny Army Depot ATTN: DRXLE-M DRXLE-MM Chambersburg, PA 17201	1 1
Commander Lexington-Blue Grass Army Depot ATTN: DRXLX-SE-1 Lexington, KY 40507	1

DISTRIBUTION

	Copies
Commander New Cumberland Army Depot ATTN: DRSAR-ISS-A New Cumberland, PA 17070	1
Commander Pueblo Army Depot ATTN: DRXPU-ME DRXPU-SE Pueblo, CO 81001	1 1
Commander Red River Army Depot ATTN: DRXRR-MM Texarkana, TX 75501	1
Commander Sacramento Army Depot ATTN: DRXSA-MME-LB Sacramento, CA 95813	1
Commander Seneca Army Depot ATTN: DRXSE-SE Romulus, NY 14541	1
Commander Sharpe Army Depot ATTN: DRXSH-SO DRXSH-M Lathrop, CA 95330	1 1
Commander Sierra Army Depot ATTN: DRXSI-DQ Herlong, CA 96113	1
Commander Tobyhanna Army Depot ATTN: DRXTO-ME-B Tobyhanna, PA 18466	1

DISTRIBUTION

	Copies
Commander Tooele Army Depot ATTN: DRXTE-SEN DRXTE-EMD Tooele, UT 84074	 1 1
Commander Badger Army Ammunition Plant Baraboo, WI 53913	1
Commander Holston Army Ammunition Plant Kingsport, TN 37660	1
Commander Indiana Army Ammunition Plant Charleston, IN 47111	1
Commander Iowa Army Ammunition Plant Burlington, IA 52602	1
Commander Joliet Army Ammunition Plant Joliet, IL 60434	1
Commander Lone Star Army Ammunition Plant Texarkana, TX 75501	1
Commander Louisiana Army Ammunition Plant P. O. Box 30058 Shreveport, LA 71161	1
Commander Milan Army Ammunition Plant Milan, TN 38358	1
Commander Newport Army Ammunition Plant Newport, IN 47966	1

DISTRIBUTION

	Copies
Commander Radford Army Ammunition Plant Radford, VI 24141	1
Commander Ravenna Army Ammunition Plant Ravenna, OH 44266	1
Commander Riverbank Army Ammunition Plant Riverbank, CA 95367	1
Commander Scranton Army Ammunition Plant Scranton, PA 18501	1
Commander Sunflower Army Ammunition Plant Lawrence, KS 66044	1
Commander Twin Cities Army Ammunition Plant New Brighton, MN 55112	1
Commander Volunteer Army Ammunition Plant ATTN: SARVO-T P. O. Box 6008 Chattanooga, TN 37401	1

C. Department of the Navy

Officer in Charge U. S. Navy Materiel Industrial Resources Office ATTN: Code 227 Philadelphia, PA 19112	1

D. Department of the Air Force

Commander Air Force Materials Laboratory	
ATTN: LTE	1
LTM	1
LTN	1
Dayton, OH 45433	

DISTRIBUTION LIST UPDATE

- - - FOR YOUR CONVENIENCE - - -

Government regulations require the maintenance of up-to-date distribution lists for technical reports. This form is provided for your convenience to indicate necessary changes or corrections.

If a change in our mailing lists should be made, please check the appropriate boxes below. For changes or corrections, show old address *exactly* as it appeared on the mailing label. Fold on dotted lines, tape or staple the lower edge together, and mail.

☐ Remove Name From List

Old Address:

☐ Change or Correct Address

Corrected or New Address:

COMMENTS

____

____

____

____

____

Date: ________________ Signature: ________________________

Technical Report #

SARRI Form 900-643 (One-Time) (1 Feb 75)

AD____________________Accession No.______________
CDR, Rock Island Arsenal
ATTN: SARRI-EN
Rock Island, IL 61299

AUTDMATED CHRDMIUM PLATING FOR GUN BARRELS
Joseph M. Bish and John D. Rowe

Report EN 79-D4, Sep 79, 21 p. incl. illus. tables, (PRDN A1-2-6D517-03-M2-M2, AMS Code 3297.16.6786)
Unclassified report.

This project was undertaken to establish a prototype automated chromium plating line for processing small caliber gun tubes. The automated line consists of a loading rack, electropolish tank, cold water rinse tanks, hot water rinse tank, chromium reverse etch tank and a chromium plating tank. The process involves automatic transference of racks containing the gun tubes to the various tanks in accordance to a programmed cycle.

Parameters selected for the automated process were 2 asi
(cont.) over

UNCLASSIFIED

1. Black Coatings
2. Stainless Steel
3. Precipitation Hardening
4. Black Chromium Plating
5. Zinc Phosphate Coating
6. Iron-Chromium-Nickel Alloys

DISTRIBUTIDN
Copies available from DDC

AO____________________Accession No.______________
CDR, Rock Island Arsenal
ATTN: SARRI-EN
Rock Island, IL 61299

AUTOMATED CHROMIUM PLATING FOR GUN BARRELS
Joseph M. Bish and John D. Rowe

Report EN 79-04, Sep 79, 21 p. incl. illus. tables, (PRON A1-2-60517-03-M2-M2, AMS Code 3297.16.6786)
Unclassified report.

This project was undertaken to establish a prototype automated chromium plating line for processing small caliber gun tubes. The automated line consists of a loading rack, electropolish tank, cold water rinse tanks, hot water rinse tank, chromium reverse etch tank and a chromium plating tank. The process involves automatic transference of racks containing the gun tubes to the various tanks in accordance to a programmed cycle.

Parameters selected for the automated process were 2 asi
(cont.) over

UNCLASSIFIED

1. Black Coatings
2. Stainless Steel
3. Precipitation Hardening
4. Black Chromium Plating
5. Zinc Phosphate Coating
6. Iron-Chromium-Nickel Alloys

DISTRIBUTION
Copies available from DDC

AD____________________Accession No.______________
CDR, Rock Island Arsenal
ATTN: SARRI-EN
Rock Island, IL 61299

AUTDMATED CHRDMIUM PLATING FDR GUN BARRELS
Joseph M. Bish and John D. Rowe

Report EN 79-D4, Sep 79, 21 p. incl. illus. tables, (PRON A1-2-60517-03-M2-M2, AMS Code 3297.16.6786)
Unclassified report.

This project was undertaken to establish a prototype automated chromium plating line for processing small caliber gun tubes. The automated line consists of a loading rack, electropolish tank, cold water rinse tanks, hot water rinse tank, chromium reverse etch tank and a chromium plating tank. The process involves automatic transference of racks containing the gun tubes to the various tanks in accordance to a programmed cycle.

Parameters selected for the automated process were 2 asi
(cont.) over

UNCLASSIFIED

1. Black Coatings
2. Stainless Steel
3. Precipitation Hardening
4. Black Chromium Plating
5. Zinc Phosphate Coating
6. Iron-Chromium-Nickel Alloys

DISTRIBUTIDN
Copies available from DDC

AD____________________Accession No.______________
CDR, Rock Island Arsenal
ATTN: SARRI-EN
Rock Island, IL 61299

AUTOMATED CHROMIUM PLATING FDR GUN BARRELS
Joseph M. Bish and John D. Rowe

Report EN 79-04, Sep 79, 21 p. incl. illus. tables, (PRDN A1-2-6D517-03-M2-M2, AMS Code 3297.16.6786)
Unclassified report.

This project was undertaken to establish a prototype automated chromium plating line for processing small caliber gun tubes. The automated line consists of a loading rack, electropolish tank, cold water rinse tanks, hot water rinse tank, chromium reverse etch tank and a chromium plating tank. The process involves automatic transference of racks containing the gun tubes to the various tanks in accordance to a programmed cycle.

Parameters selected for the automated process were 2 asi
(cont.) over

UNCLASSIFIED

1. Black Coatings
2. Stainless Steel
3. Precipitation Hardening
4. Black Chromium Plating
5. Zinc Phosphate Coating
6. Iron-Chromium-Nickel Alloys

DISTRIBUTIDN
Copies available from DDC

and 4.5-minute process time to remove approximately 1.0 mil of stock during electropolish; and 2.5 asi and 50-minute plating time to deposit 1.0 mil of chromium plate. The feasibility of the automated process was shown in that 12 out of 24 processed gun tubes were within the acceptable internal dimension range. Six additional gun tubes were within 0.1 to 0.2 mil of the acceptable bore diameter range. The quality of the chromium plate was satisfactory in all cases. The major difficulty in the automated process is the control of stock removal during the electropolish cycle. The elimination of the electropolish sequence is recommended with the use of rotary swaged gun tubes sized to pre-plating dimensions.

and 4.5-minute process time to remove approximately 1.0 mil of stock during electropolish; and 2.5 asi and 50-minute plating time to deposit 1.0 mil of chromium plate. The feasibility of the automated process was shown in that 12 out of 24 processed gun tubes were within the acceptable internal dimension range. Six additional gun tubes were within 0.1 to 0.2 mil of the acceptable bore diameter range. The quality of the chromium plate was satisfactory in all cases. The major difficulty in the automated process is the control of stock removal during the electropolish cycle. The elimination of the electropolish sequence is recommended with the use of rotary swaged gun tubes sized to pre-plating dimensions.

and 4.5-minute process time to remove approximately 1.0 mil of stock during electropolish; and 2.5 asi and 50-minute plating time to deposit 1.0 mil of chromium plate. The feasibility of the automated process was shown in that 12 out of 24 processed gun tubes were within the acceptable internal dimension range. Six additional gun tubes were within 0.1 to 0.2 mil of the acceptable bore diameter range. The quality of the chromium plate was satisfactory in all cases. The major difficulty in the automated process is the control of stock removal during the electropolish cycle. The elimination of the electropolish sequence is recommended with the use of rotary swaged gun tubes sized to pre-plating dimensions.

and 4.5-minute process time to remove approximately 1.0 mil of stock during electropolish; and 2.5 asi and 50-minute plating time to deposit 1.0 mil of chromium plate. The feasibility of the automated process was shown in that 12 out of 24 processed gun tubes were within the acceptable internal dimension range. Six additional gun tubes were within 0.1 to 0.2 mil of the acceptable bore diameter range. The quality of the chromium plate was satisfactory in all cases. The major difficulty in the automated process is the control of stock removal during the electropolish cycle. The elimination of the electropolish sequence is recommended with the use of rotary swaged gun tubes sized to pre-plating dimensions.