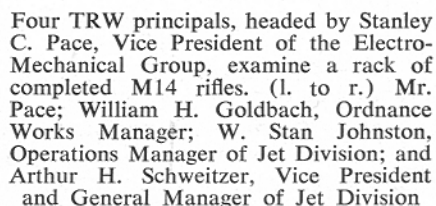
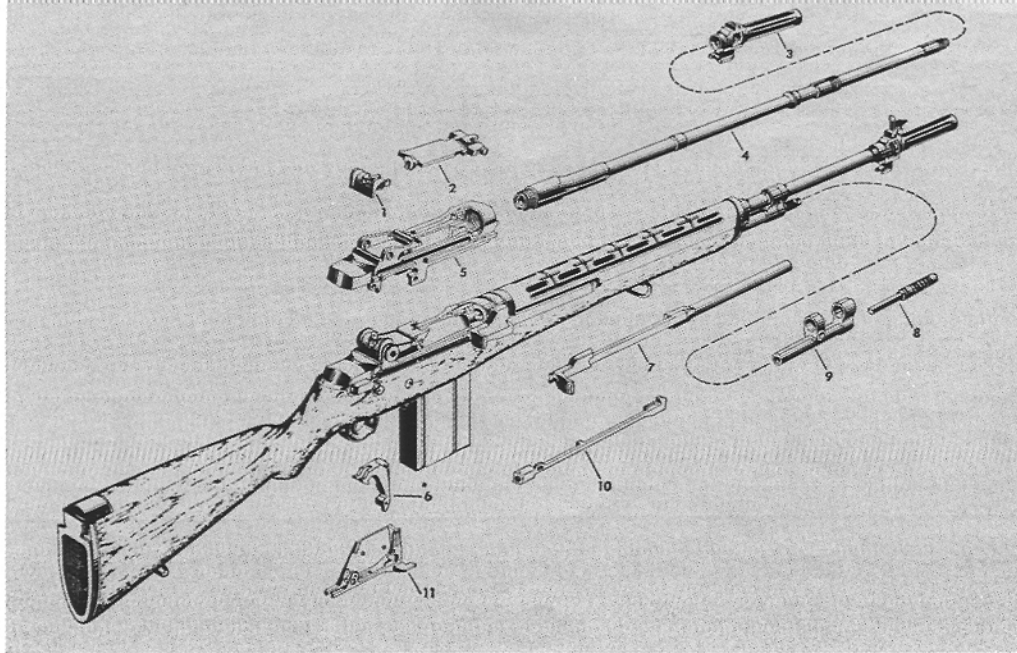


A third contractor with no previous riflemaking experience, Thompson Ramo Wooldridge Inc., began deliveries ahead of schedule

and E. H. HARRISON
Associate Technical Editor



"Careful planning and husbanding of



1. Rear sight base
2. Bolt
3. Flash suppressor
4. Barrel
5. Receiver
6. Hammer
7. Operating rod assembly
8. Piston
9. Gas cylinder
10. Connector
11. Trigger housing

Eleven major parts of M14 rifle which are manufactured by Thompson Ramo Wooldridge. Remaining parts are produced by subcontractors, with TRW as prime contractor responsible for the completed weapon

the Army's meager peacetime resources and the nature of this Nation's machine economy gave the American armies in Europe two good advantages over the German enemy. One of ours was the Garand semi-automatic rifle, which the Germans were never able to duplicate. It is interesting to trace the planning and decisions that gave us the Garand rifle and the tremendous small arms fire power that went with it, noting especially that the War Department program for the Garand rifle was strenuously opposed."

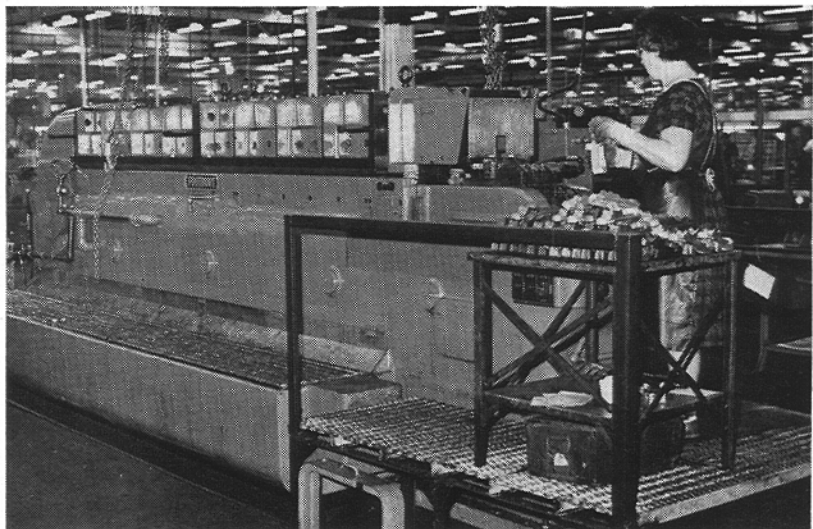
Gen. Marshall then contrasted the U. S. and the German solutions to the requirement for small arms effectiveness, and commented: "Our superiority in infantry fire power, stemming from the use of the semi-automatic rifle, was never overcome." (*The Winning of the War in Europe and the Pacific—Biennial Report, Chief of Staff, by George C. Marshall.*)

The M1's military success was repeated in the Korean War.

Since then it has shown itself, when adjusted for the purpose, to be an excellent long-range target rifle. It is interesting that the special fitting and adjustment for this purpose have no adverse effect on its endurance and suitability for Service use.

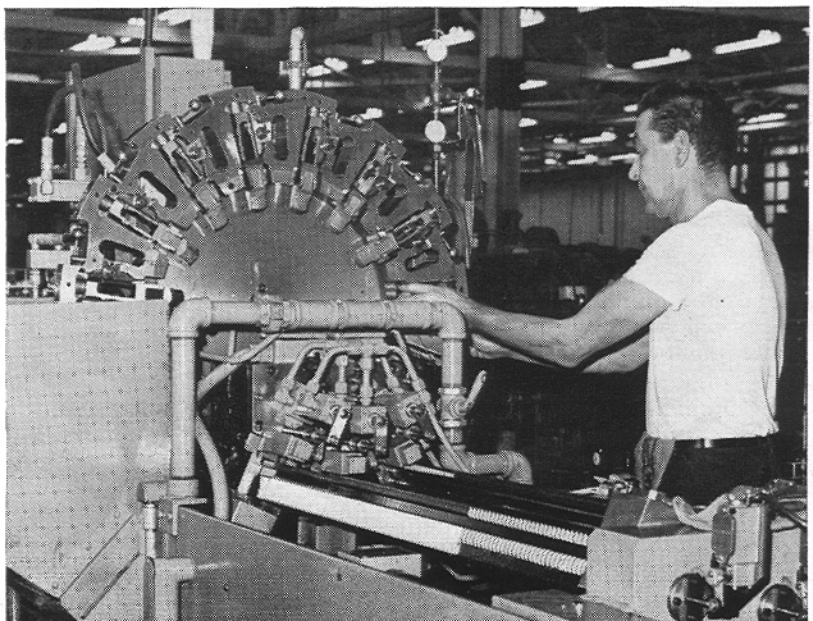
Combat troops considered that 2 features of the M1—its magazine capacity of only 8 rounds, and its lack of a full-automatic feature—were definite shortcomings. Its weight of nearly 10 lbs. was also criticized, though to men in battle this was a far less important consideration than magazine capacity and automatic fire.

Steps were begun during World War II to remedy these shortcomings. While this could have been accomplished by modifications to the existing rifle, a



First operation in TRW's receiver line is continuous chain broaching, with a Footburt 144" chain broach. This is a technique common to production of jet engine components, in which TRW is a world leader. Advantage is that more surfaces can be machined at one pass than on conventional broaches

Colonial pull-type broach cutting magazine slot of M14 receiver. The 15 stations on this machine illustrate advantages of continuous broaching



greater effort was made and new rifles were manufactured, though on the M1 basic design. The resulting T20 series of rifles contained 20-round magazines, a switch permitting semi-automatic or full-automatic fire at will, and a muzzle brake to decrease recoil and help to hold the muzzle down during full-automatic fire. These rifles enjoyed considerable success. Undoubtedly they would have been manufactured and used in quantity if the war had continued beyond 1945. But a more comprehensive solution was desired, and this admittedly partial solution was dropped in 1947.

It was considered necessary to standardize on a cartridge shorter, lighter, and more convenient than the .30-'06, which had been designed at the beginning of this century for the smokeless powders available at that time. A new cartridge was required for mechanism compactness in the weapons foreseen.

One solution to this problem, which was recognized by all the principal nations, was a low-powered cartridge. The Soviet Union armed its troops with the SKS short rifle and AK assault rifle, both made for the Soviet 7.62 mm. short cartridge. It fires a 122-gr. bullet at 2400 f.p.s. A British crash program brought forth a short .280 cartridge and a semi-automatic rifle for it. The U. S., however, rejected any cartridge of limited effectiveness, since it required one cartridge for all shoulder weapons, and also all ground machine guns unless a different cartridge were to be used for these.

These considerations resulted in the U. S. development of a cal. .30 cartridge about 1/2" shorter than the .30-'06 but of substantially the same power in Service loadings. In its finished form, the T65E3, this was accepted in December 1953 by the NATO nations as their common cartridge, under the designation 7.62 mm. NATO cartridge. It may be manufactured with different powders, bullets, etc., by the various nations, so long as the product functions in all standard weapons of that caliber throughout NATO.

In early 1954, the FN rifle for this cartridge was adopted by Great Britain, Belgium, Canada, and Australia. This excellent rifle was developed by Fabrique Nationale d'Armes de Guerre, the Belgian Government plant for manufacturing military and commercial small arms. It incorporated design features taken from inventions in several countries. The rifle was modified by each country adopting it, though without changing its essential character.

The United States was alone in already possessing a good self-loading

Continued on following page

Why Thompson Ramo Wooldridge?

The RIFLEMAN team asked Mr. S. C. Pace, Group Vice President of Thompson Ramo Wooldridge, why his establishment decided to go into the rifle manufacturing business. Certainly there is nothing in the history of Thompson Ramo Wooldridge to indicate such an interest, at least directly. Mr. Pace answered very frankly, as follows:

"The Electro-Mechanical Group within Thompson Ramo Wooldridge is the industry's largest supplier of jet engine components, and a large variety of other components connected with aircraft. We have been leaders in this field dating from World War II. This has been very precise and high-quality work, and at the same time high-production work. It absorbed a considerable part of our energy, financial effort, and capability for planning and expansion to grow with the aircraft.

"Then in 1957 the aircraft business peaked out and started sliding off. This caused, of course, an excess capacity to be available. On the other hand we found that the missile and space business, which we penetrated and continue to penetrate, did not provide the type of work which this Group needed, which was primarily manufacturing. In the missile and space field, we found, most of the work was research, development, and making up prototypes. There were a few, but a small number, of production-type orders. So we found that although we were acquiring sales dollars and employment, it was new employment of engineering and technical people, and sales dollars of laboratory work and prototype shop work. This Group has always been strong on low cost, high-precision production work. We wanted to continue our aircraft work, and also our missile and space work, but recognized that these would not make up for the decline in aircraft.

"So we started searching quite broadly, both functionally and also among the different users of precision electrical and mechanical equipment. We found there were several opportunities in the Army ordnance field. A lot of research and development is done within the Army. Then production is placed on competitive contract with the most capable producers, a type of contracting with which we were quite familiar.

"Among the first major items that came to our attention was the M14 rifle. At first we were quite reserved as to whether it was suitable for us. As it turned out, the more we studied it, and got the detailed requirements and looked at them at close range, the more we found it was an extremely

good thing for our manufacturing background, experience, and capability. So we put a considerable effort into the program to lay out a process, manufacturing facilities, etc., so that we could make a good proposal to the Army. We are very pleased that we were successful.

"There was considerable publicity about the initial difficulties the other commercial manufacturers had, and we recognized this. We studied this to the extent that it was possible to do, but we felt that we could resolve these problems.

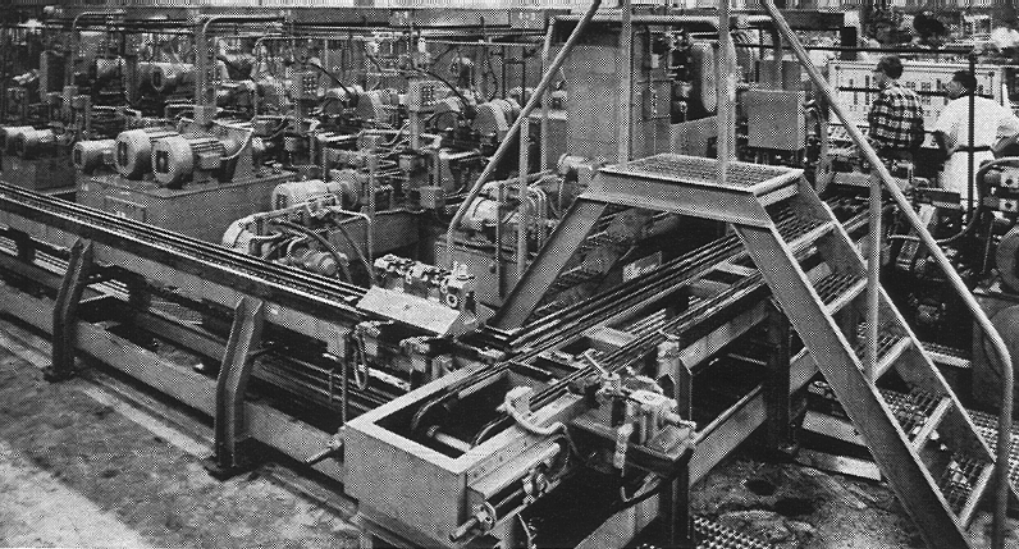
"We are not making money on the first order, and this was intentional. This was known and discussed at the time we made our quotation to the Army.

"We designed a manufacturing process and technique, and selected manufacturing machinery, to give us a low ultimate unit cost in production. This required a considerable amount of new machinery, which the Army was willing to put in, to achieve this low unit cost. We correctly analyzed the Army's requirements and desires and I think we matched them by this proposal.

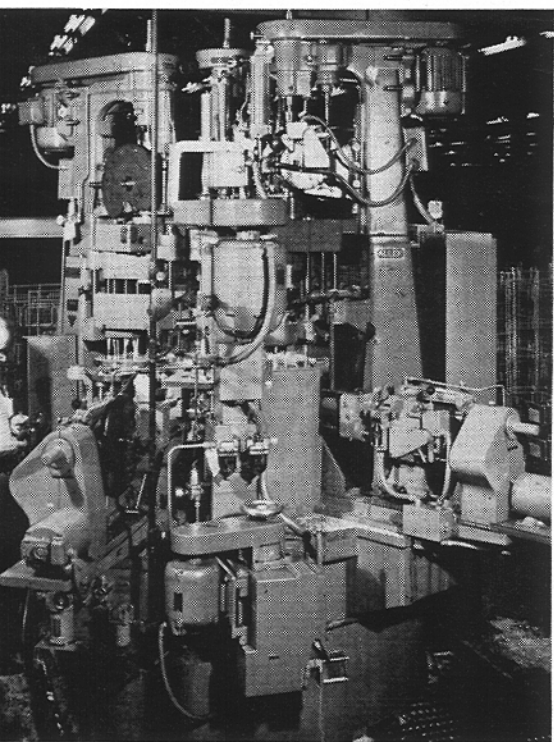
"We quoted originally on the basis of absorbing, on our shoulders, the start-up cost of this program. In other words, we quoted a unit price for the rifles which was, you might say, the unit price in full production without a 'learning curve' cost. We felt that this was our entrance fee into this business and we were very willing to make that investment in order to achieve an entrance. And so, because of this planned investment, which we have made and are making (though most of it is behind us now), we will lose money on the first contract, but we anticipate and hope that we will make money on the second contract which has already been awarded. We also anticipate continuing contracts.

"Now that we have resolved many of the problems and have begun producing rifles, I have been asked whether we have any second thoughts about it. Do we still want to be in the M14 business? The answer is that we are very proud and pleased with this program, and are looking forward to several years of production in it.

"It is our goal to be the leading producer of M14 rifles for the Army."



A striking aspect of TRW production is the almost total absence of small machines. This Krueger lateral transfer machine performs 30 operations on two M14 bolts clamped to a pallet. This one-man operation replaces 15 machines used for single point machining. Bolts are precision bored, reamed, gun drilled, and hollow milled at rate of 190 per hour, including Sheffield Precisionaire gauging. Automatic gauging and inspection, with immediate exhibition of results on a control panel, detect any variation in setup as soon as it occurs



Allen multi-station drilling machine drills all the various small holes in the receiver during one complete index of the part. This special purpose machine by-passes many conventional machining operations

rifle, and was under no compulsion to adopt a new one immediately. Also there was no money for quantity production of a new rifle even if standardized. Most important, the American intention was not limited to correcting the 2 technical shortcomings of the M1 rifle. There was a wider purpose—to obtain greater firepower, a better individual rifle and automatic rifle, reduction in training time, simplification of maintenance, and simplification and reduction of logistics problems. These

ends were considered best attained by a *weapons system* in which one rifle-type weapon and one ground machine gun could replace the conventional rifle, carbine, sub-machine gun, automatic rifle, and machine gun.

Two rifles reached the stage of final consideration—the FN rifle under the designation T48, and the T44 which had been developed by Springfield Armory. These were given severe Service testing beginning in 1952, including testing in quantity in the Arctic and the tropics. The concept of a single rifle replacing former shoulder weapons was thoroughly checked with a special order of 3200 FN rifles. The extraordinary step was taken of manufacturing 500 of each model, by different contractors, to determine whether they would perform satisfactorily when made by mass production methods. Some serious difficulties were experienced with the T48, but these were corrected. The ultimate decision went to the T44.

On May 1, 1957, the Secretary of the Army announced the adoption of a new weapons system made up of the M60 general-purpose machine gun standardized a short time before, and the T44E4 adopted as the M14.

On Oct. 4, 1957, the Soviet Union launched the first man-made earth satellite. This focused public attention on the exotic weapons. First efforts to strengthen the U. S. position were directed toward these. It was eventually realized that military strength of the more conventional type is necessary also, and this led to the first appropriation of funds for quantity procurement of the M14 rifle.

Springfield Armory had carried out extensive production studies, and had the 'production package' of manufacturing drawings ready to furnish to contractors. These showed all speci-

cations for every part, including allowable tolerances. The Armory had been carrying on its own limited production of M14's under these standards.

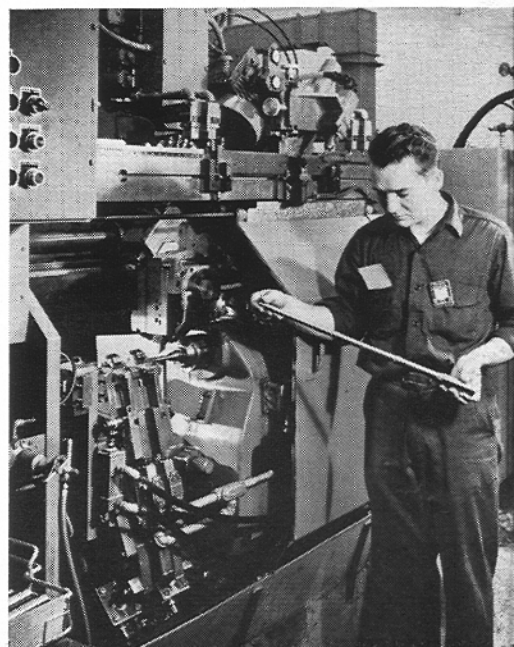
First contracts went in 1959 to Winchester-Western Division of Olin at New Haven, Conn., and Harrington & Richardson, Inc., Worcester, Mass. Winchester had manufactured more than 500,000 M1 rifles during World War II and Harrington & Richardson manufactured nearly 500,000 M1's during the Korean period.

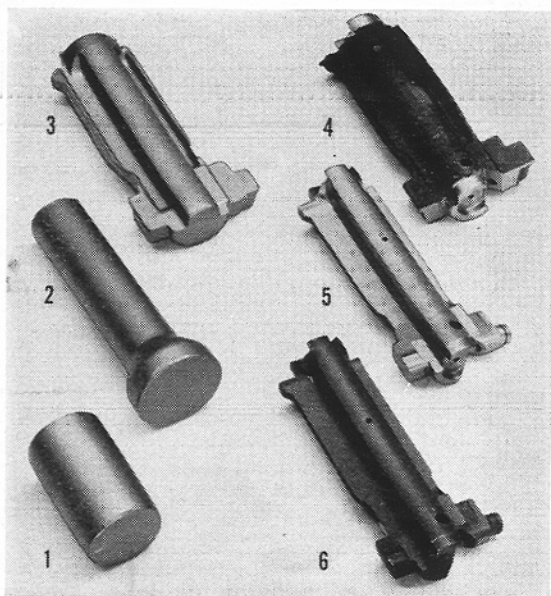
Harrington & Richardson had been designated as a storage site for M1 rifle production machinery. With the aid of this machinery, and also with extensive subcontracting, Harrington & Richardson got into production first. Both contractors, however, suffered difficulties and delays, to the extent that congressional and press criticism took the form that the rifle should never have been adopted, could not be made in production, and was not really different from the M1.

In July 1961 the Chief of Ordnance appointed Brig. Gen. Elmer J. Gibson as project manager for the M14 rifle. He brought the whole matter into proper perspective, initiated reforms, and urged that an additional contractor be brought into the picture. Incidentally, the project manager system is now in use for about 30 major development and manufacturing items in the Army.

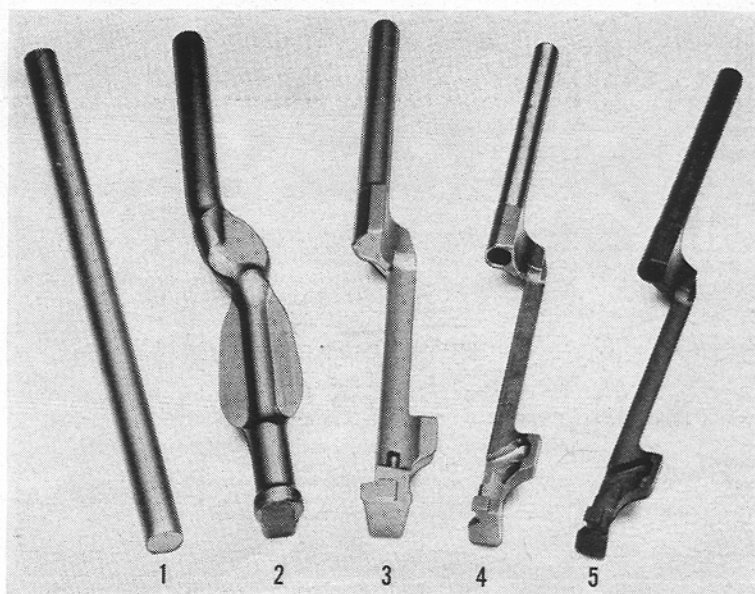
The National Rifle Association, with the full permission and assistance of the Army authorities, then sent a RIFLEMAN Staff team to Springfield Armory, H&R, and Winchester to see the actual operation at first hand. One of the first things this team discovered was that

Seneca Falls tracer lathe machining outside of the M14 barrel. It cuts the entire contoured form with one pass on rough machining and one pass on finish machining without removing the part. This tracer lathe replaces 6 conventional pieces of equipment

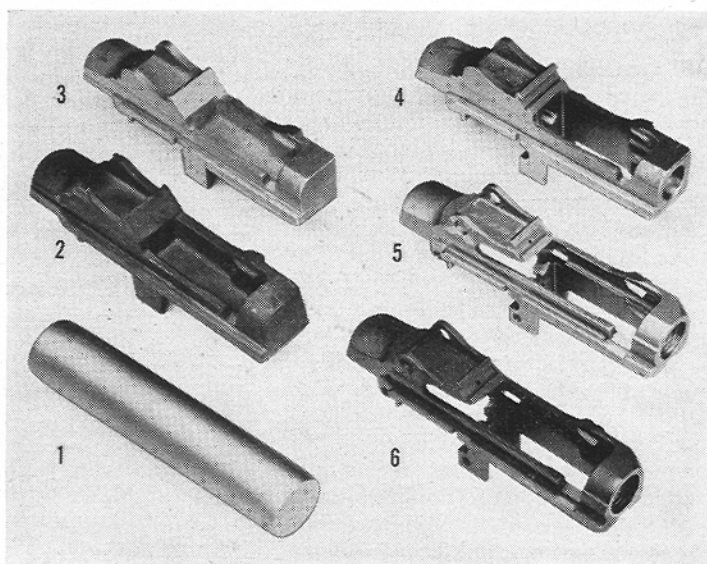




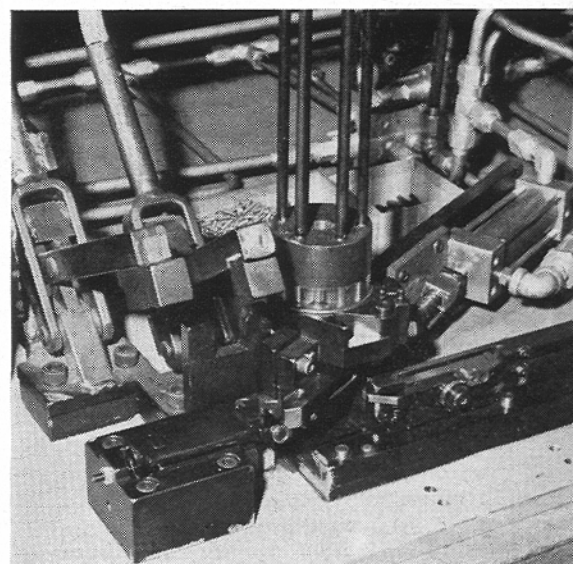
Principal stages in TRW manufacture of M14 rifle bolt. (1) Cut-off slug, (2) extrusion, (3) warm-coining, (4) after 30 milling and drilling operations on Krueger lateral transfer machine, (5) after 10 operations on two 5-station special milling machines, (6) finished bolt after coating



Principal stages in TRW manufacture of M14 operating rod. (1) cut-off slug, (2) bump up and roll, (3) warm sizing, (4) finish machined, (5) finished operating rod after coating



Principal stages in TRW manufacture of M14 rifle receiver. (1) slug cut off from bar stock, (2) forging after warm size, (3) after all chain broaching and a qualification broaching, (4) and (5) completion of machining through 3-dimensional mills and additional broaching, (6) finished receiver after coating



Partly semi-automatic, partly full-automatic fixture which assembles all parts of the rifle bolt except the roller. Machine has capability of out-producing hand assembly of the bolt by ratio of 20 to 1

the press reports had been written without a check of this kind.

The contractors readily admitted that some of their difficulties were purely internal. These were compounded by a government change order in metallurgical specifications for the bolt and receiver, including safeguards against a repetition of an error in the steel used in several days' production by one contractor, which was brought to light by discovery of cracks in some rifle receivers in the field. On accepting its contract Winchester had decided to take the time to install special machinery of late type for both wood and metal working, but some of this machinery took far longer than expected to get

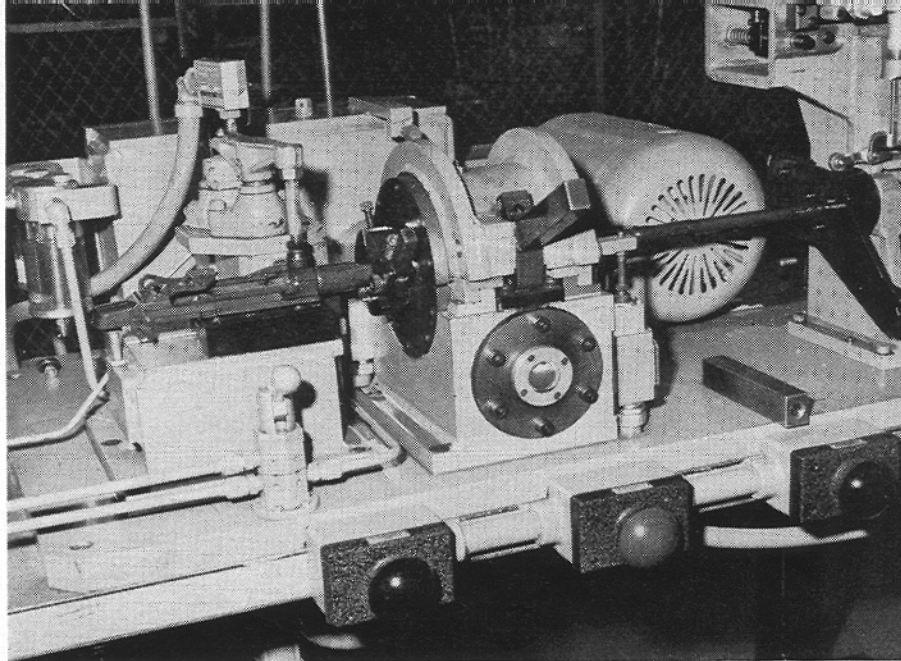
into operation and Winchester's production suffered correspondingly. Both contractors complained strongly of government delays in giving them assistance they requested, including decisions on detailed specification changes.

To the question of mass producibility, all 3 producers gave a positive answer. Springfield Armory pointed out that this was checked by a trial production before the rifle was standardized, and that the Armory had carried on its own production at the full rate allowed to it. H&R and Winchester, while strongly defending their reasons for the initial delays, were enthusiastic over the rifle, and both expressed a strong desire to be allowed to produce it in much greater

quantities. All 3 producers pointed out that they were mass producing.

THE RIFLEMAN team went on to interview Gen. Gibson, Commanding General of the Ordnance Weapons Command and project manager for the M14 rifle. While pointing out the legal and other requirements involved in acting on the deviations requested by the contractors, he said that too much time had been taken to act on some requests and he had taken special measures to correct this.

He stated that the government intended to select a third commercial contractor for production of the M14. Some firms had offered production processes entirely new in gun manufacture.



Mating of M14 barrel and receiver in TRW manufacture. Barrel and receiver are held in exact alignment and screwed together by power with correct force, requiring only a few seconds. Machine is generally similar to that in use by other M14 rifle producers but with some differences in design based on experience

While the government would not disclose the total eventual production planned, Gen. Gibson explained that part of the reason for introducing an additional contractor was to secure competition. The government would be guided by considerations of performance and cost.

Events up to this point were reported fully by THE AMERICAN RIFLEMAN in its article "The M14 Rifle" of October 1961. This report attracted a tremendous amount of favorable attention. News items and opinions as to non-manufacturability of the M14 rifle ceased at once.

Demand made it necessary to reprint this article, together with an earlier one, "New Service Rifle", from the June 1957 RIFLEMAN, which gave the development history of the rifle. Copies of these reprints are available on request, without charge.

THE AMERICAN RIFLEMAN continued to follow the progress of M14 rifle production, including the choosing of a third commercial contractor which was anticipated. This actually took place shortly after appearance of the RIFLEMAN account of events up to October 1961. Thompson Ramo Wooldridge Inc., the manufacturer chosen, was given until November 1962 to begin deliveries in quantity. At that time, THE AMERICAN RIFLEMAN requested permission of Gen. Gibson, project manager for the M14 rifle, to visit the plant of this manufacturer and witness the production. The permission was given without hesitation. The visit was made with help of the Army's Cleveland Procurement District. With the wholehearted cooperation of Thompson Ramo Wooldridge, the M14 production was seen in closest detail. The following, then, is the picture in its essentials.

M14 RIFLE PRODUCTION

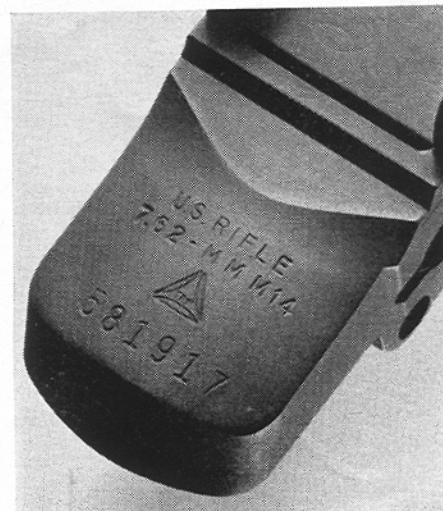
Following are the production contracts (orders in the case of Springfield Armory) which have been issued on the M14 rifle.

Fiscal Yr.	Springfield	H&R	Winchester	TRW	Total
1958	15,600	-----	-----	-----	-----
1959	-----	35,000	35,000	-----	-----
1960	32,000	70,082	81,500	-----	-----
1961	70,500	133,000	-----	-----	-----
1962	49,000	224,500	90,000	100,000	-----
1963	-----*	75,000	150,001	219,691	-----
	167,100	537,582	356,501	319,691	1,380,874

* In accordance with the mission of the Springfield Armory, which is that of research, development, and pilot production but not competition with American industry in quantity production, the manufacture of M14 rifles at the Armory is scheduled to be phased out by September 1963.

While total deliveries have not been announced, it may be estimated that these amounted to not less than 800,000 by the end of January 1963.

On Oct. 2, 1961, award of a contract was announced to Thompson Ramo Wooldridge Inc., as the third commercial producer of the M14 rifle. The contract was for 100,000 rifles and some new tooling at a cost of \$8,554,070, with delivery to begin in November the following year. These rifles would thus have a direct cost of about \$85.54 each. There was at the same time a contract for rehabilitation of existing facilities and purchase of production equipment,



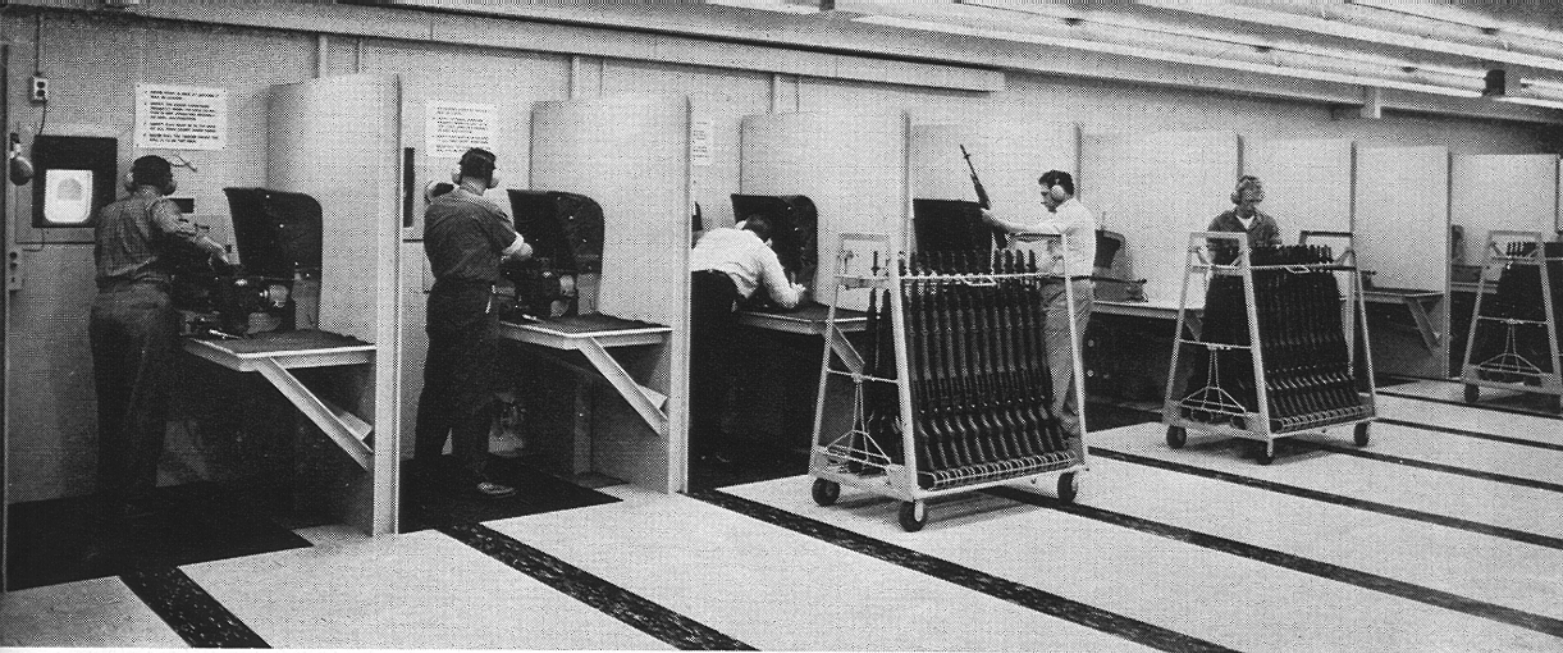
Receiver marking of M14 rifle as manufactured by Thompson Ramo Wooldridge

generally similar to the facilities contracts to the other contractors at beginning of their operations, in amount of \$6,522,164.

On Sept. 28, 1962, Winchester was awarded a contract for an additional 150,001 M14 rifles at a cost of \$15,675,000, or about \$104.50 per rifle. Shortly afterward a supplemental contract was awarded to H&R for an additional 75,000 rifles for approximately \$7,320,000, or about \$97.70 each.

On Oct. 9, 1962, a contract was signed with Thompson Ramo Wooldridge for an additional 219,691 rifles for \$17,465,000, or \$79.45 per rifle. Thompson Ramo Wooldridge thus became a major contractor for M14 rifles.

Thompson Ramo Wooldridge is a highly diversified and decentralized corporation of modern type. It came into existence in 1958 through the merger of Thompson Products, Inc., of Cleveland, Ohio, an old established manufacturer of automotive and airplane engine parts; and the Ramo-Wooldridge Corp. of Los Angeles, which had been founded in 1953 by Dr. Simon Ramo and Dr. Dean E. Wooldridge, two leading physical scientists, with financial support of Thompson Products. Its major groups are Automotive, Electro-Mechanical, Electronics, the Space



TRW test range for acceptance firing of M14 rifles. Rifles are taken to test range and from there to packaging area by automatically controlled tractor trucks, running without operators. High grade closed-circuit television system, manufactured by TRW's Dage Division, shows target directly to each firer. Targets are changed by push-button controls from the firing point. At end of 100-meter range, bullets are deflected into a water trap. A Kirk Keylock system prevents entering the area ahead of the firing point until all necessary safety precautions have been completed. Patent is being sought on the concepts of this modern range

Technology Laboratories, and TRW International. These carry on research, development, and production of components and complete assemblies with missile, space, aircraft, automotive, electronic, nuclear, ordnance, and industrial applications.

The contract for third-producer manufacture of M14 rifles was bid on by 42 major firms. Competition was severe. The proposals had to be detailed and thorough, showing exactly how the bidder would proceed and demonstrating that he had the competence to manufacture and deliver on schedule. The Ordnance Weapons Command stated that it was decided to bring in a company experienced in mass production of precision products, regardless of arms experience. Thompson Ramo Wooldridge submitted the next-to-lowest bid, and on the basis of competence received the award.

To prepare its proposal, the corporation formed a special group from engineers and manufacturing personnel of the Electro-Mechanical Group to study the rifle, decide on the manufacturing method for each part, and compute costs and rates of production that would be involved. Preparation of the proposal required the labor of 6 months and expenditure of \$200,000.

It is notable that none of the top people of this project are from a gun manufacturing background. Thompson Ramo Wooldridge, like all the bidders, was given full information on past experience in manufacturing the M14, but this was not shown to the project crew until after they had decided on their own methods. The management made a point of not being influenced by processes used in small arms manufacture

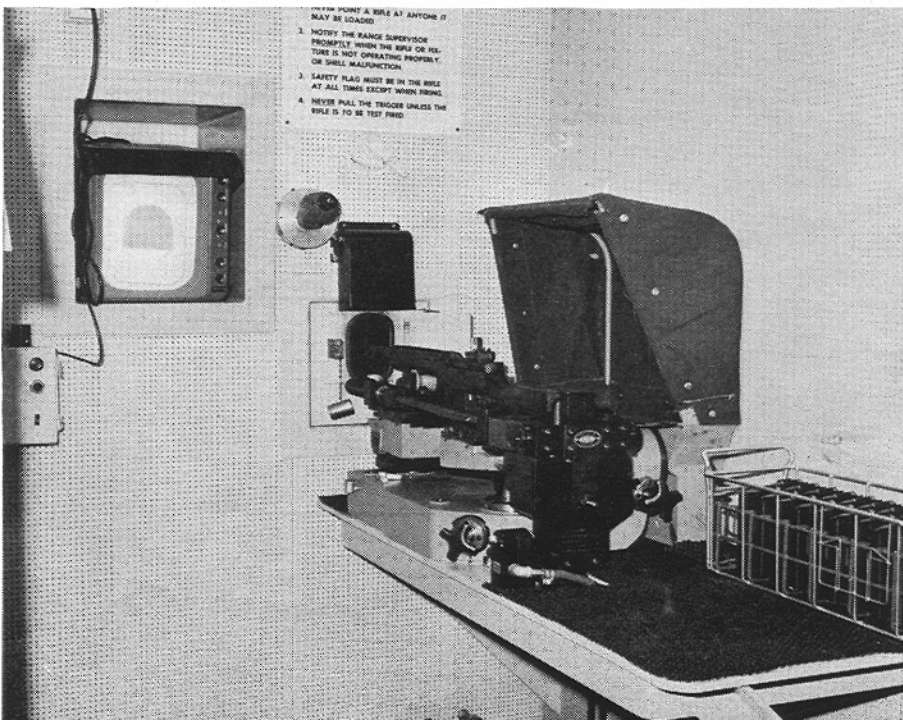
in the past. The rifle was regarded simply as a precision device made of modern materials, and therefore to be produced by the most suitable among the special manufacturing methods continually coming into existence.

Processes in which the Electro-Mechanical Group considers that it possesses a special competence are the techniques of precision forging, in which pieces are forged in dies much closer to final dimensions than is the ordinary practice; and chain broaching, in which steel parts can be cut to final

dimensions with high accuracy and at the same time great speed. Competence rests most of all, however, on the knowledge, experience, and ability of the personnel who can be called together for the job.

The rifle is being manufactured in Cleveland, Ohio, in the Ordnance Works organized by the Electro-Mechanical Group within its Jet Division. The Ordnance Works was manned with personnel drawn from the Jet Division and other divisions to obtain the desired qualifications.

One of firing points in TRW test range, with M14 rifle in standard accuracy firing cradle. Range design and construction minimize operator fatigue. Fired cartridge cases drop through chute to conveyor on lower level. Keylock system includes feature which prevents going in front of firing points while any rifle remains at a firing position. Each rifle is fired one high-pressure proof round, then 40 rounds at semi- and full-automatic for functioning. Then rifle is fired 3 settling rounds and 5 rounds for accuracy with Service ammunition, and must deliver these 5 rounds into 6.1" group at 100 meters. Largest group obtained to date has been 5.5"; average has been 2.5" to 3"





Conveyerized packaging line provides well-organized packaging. Approximately 200 cartons, each containing 2 rifles, can be packaged per hour. Packed rifles have plastic guards over projecting points at muzzle and breech, and are kept from deterioration by vapor corrosion inhibitor in the sealed carton without use of grease, so rifles are ready for use when unpacked. Rifles are shipped in bulk to the field in large steel shipping container (arrow) which has been standardized for Army and Air Force shipments of various items

Eleven major parts of the M14 rifle, totaling slightly less than 65% of the rifle's dollar value, are manufactured by Thompson Ramo Wooldridge in its Ordnance Works. These parts were chosen on the basis of their suitability for manufacture by processes in which the corporation excels. The other parts, which were considered readily producible by conventional means, are left to subcontractors. Thompson Ramo Wooldridge as the prime contractor is responsible for assembly, test, and delivery of the completed weapon.

The first M14 rifle was assembled and tested in August 1962. First block delivery was made in October, obtaining a bonus for the manufacturer since this was a month before the required date. If delivery had been delayed past the required date the manufacturer would have been assessed a penalty.

At the time of the RIFLEMAN team's visit in November 1962, production was about 100 per day. There had been no rejections at all up to that time. It was then the manufacturer's intention to increase this to well above 1000 per day in the spring of 1963, and to an average rate in midsummer of 24,000 per month. With the plant operation which the RIFLEMAN team saw, it was readily appreciated why the attainment of this rate was expected in a 2-shift operation.

The photographs show characteristic features of the Thompson Ramo Wooldridge manufacture of the M14 rifle, as witnessed by the RIFLEMAN team.

What Next, and When?

ALTHOUGH the M14 rifle is now being manufactured in quantity and in a short time a million of them will be in use, there have always been some who believed that a light, comparatively short-range shoulder arm would best suit U. S. needs.

The Armalite AR-15 cal. .223 rifle has been most advocated among those available. Extensive Army tests showed this rifle, which weighs approximately 2 lbs. less than the M14 and uses lighter ammunition, to have many good features as well as serious limitations.

BALLISTIC PERFORMANCE

M14 (cal. 7.62 mm. NATO), AR-15, and cal. .30 carbine

	Bullet Wt., grs.	Velocity (f.p.s.) and Striking Energy (ft.-lbs.)					
		At Muzzle		300 yds.		500 yds.	
		V	E	V	E	V	E
M14	150	2750	2521	2127	1508	1772	1047
AR-15	55	3185	1239	2138	558	1595	310
Carbine	111	1974	961	1062	278	865	184

The U. S. Air Force desires the AR-15 for its use as a replacement for the cal. .30 carbine, and has obtained approval for procurement of a limited quantity. A number have been under test in Viet Nam, where (together with the standard cal. .30 carbine) they offer the advantage of special suitability to use by troops of small stature.

The above, with much detail on development and test history of the AR-15, was reported in *THE AMERICAN RIFLEMAN* in May 1962.

It was noted in that review that the "Salvo" program, a study in depth instituted by the Army to obtain a major improvement in hit probability no matter how new and radical the means, had been completed and approved. A satisfactory solution to the hitting problem has never been even approached by any existing weapon, including the M14 and AR-15. It is understood that action to put the system into effect has been begun. The U. S. small arms industry is cooperating fully in this effort. ■