II. Raw Materials - Cont'd.

These are purchased in the form of solid rods and bars in lengths convenient for handling. Smaller rods and bars of standard grades may be used for screws, pins and similar items. Both steel and brass in the form of tubes are utilized for tubular magazines while sheets of suitable thicknesses are used in the fabrication of box type magazines, butt plates and other flat and comparatively thin components.

Walnut wood for stocks and fore ends is procured in the form of rough cut blanks from the general area of Iowa. The blanks are especially cut to insure proper direction of the grain in the completed components and are carefully air dried and kiln dried for maximum stability in the same manner as the wood used in fine furniture.

Structural nylon is purchased in the form of pellets and is used together with special coloring materials to obtain suitable coloration when processed.

In addition to the typical raw materials mentioned above, some items may be purchased as semi-finished or finished components. These may include such diverse materials as aluminum castings, steel forgings, rubber recoil pads, leather sling straps, precision ground ball bearings, special purpose springs of various sizes, shapes and geometric forms, standard bolts, screws, pins and washers. Nearly all items in this category require specialized equipment and skills and are furnished by vendors catering to many manufacturers throughout the country.

III. Processing - A great variety of techniques are required in the fabrication, assembly and testing of components for firearms.

A. Metal - Broaching, milling, profiling, turning, drilling, reaming, honing, threading, forming, straightening, brazing, polishing and buffing are some of the operations performed on metal components. Among the most unique, interesting and difficult of these is the deep-hole drilling of the bore in gun barrels. Uniformity of wall thickness around the hole is mandatory, to avoid weak areas which might rupture under the stresses created by today's high pressure ammunition loads.

Starting with a round bar of tough ordnance grade steel, the hole is made with a drill of special design which passes through the length in one continuous thrust. The drilling tool may be approximately 48" to 60" long to permit attachment

III. Processing

A. Metal - Cont'd.

to the driving mechanism, passage through the barrel holding device plus the length of the barrel blank. Tool and blank alignment, clamping and tool thrust pressures, centrifugal force and other factors must be carefully and continuously controlled within degrees of accuracy measured in terms comparable to the diameter of a few human hairs over a total starting length ranging up to approximately seven (7) feet.

B. Wood - Sawing, jointing, planing, milling, profiling, inletting, routing, shaping and sanding are included in the operations employed in the manufacture of walnut stocks and fore ends. One of the most interesting machines to observe in the wood machining are is the "Profiler". Twelve (12) carefully matched cutters, guided both vertically and horizontally by formers, completely cut and shape the outside surfaces of twelve (12) stock blanks at the same time. This operation is typical of modern day manufacturing practices which make it possible to produce uniform and precision products at reasonable cost.

C. Structural Nylon - Continually striving for progress in the form of improved, more reliable and more attractive products at reasonable cost, Remington pioneered in the application of this especially rugged material in firearms. Age old traditions were broken when structural nylon replaced walnut in the Stock of the Nylon 66, tubular magazine, autoloading .22 caliber rifle, introduced January, 1959.

Injection molded under high pressure and heat, the stock includes the internal channels and slideways for the operating mechanism normally built into the receiver. Dimensional control of the critical surfaces is automatically built-in by the precision molding die which, together with the natural lubricating characteristics of the material, contributes to very smooth operation, dependability and phenomenal accuracy.

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III. Processing

D. Other Materials - As stated above, the search for improved, more reliable and more attractive products at economical cost is a continuous search at Remington. This effort includes not only the pioneering application of materials like nylon but the use of new techniques.

Conventional machining of metals has been described by some observers as a very wasteful way of building a product. And it is true that too often the bulk of the effort expended results, not in completed components, but in chips and waste. In fabricating a shotgun barrel from a solid steel bar, about 75% of the original material is machined away in drilling the bore and turning the outside contours. A receiver, the housing which contains the operating mechanism, contributes about 85% of its original blank weight to the chip bin before it reaches assembly. Likewise, smaller machined components contribute their proportionate share.

Components made from metal in powdered form, compressed in a die at tremendous pressures, then sintered to fuse the particles together is one answer to the waste problem used by Remington. Parts of uniform thickness, including those with holes passing through the part in the direction of the pressing pressures can be formed and are ready for assembly after sintering. Components with complicated geometric profiles, like gear wheels and front sights, can also be pressed to include the critical dimensions required in assembl leaving only a minimum of machining for completion.

Several smaller parts used in Remington products are now made by this method. Further exploration of this processing technique, which appears to possess enormous potential, is continuing.

E. Other Processes - Various specialized processing techniques, other than the machining described above, include forging, welding, brazing, hardening, tempering, metal coloring and wood finishing with both varnish and lacquer. Special equipment and know-how is required for successful application of each of these processes.

III. Processing - Cont'd.

F. Assembly - Most completed products of a complicated nature are made up of several individual mechanisms or groups of related parts, each of which may be identified as a sub-assembly. A typical shotgun barrel assembly includes the barrel, the front sight and the guide ring for attachment to the receiver. A center fire rifle bolt assembly is made up of the bolt body, bolt handle, bolt head, firing pin, firing pin spring, the extractor and the extractor rivet which holds it in place.

At Remington, assembly of the barrel and related components is accomplished in the machining area to permit further adjustment and machining to close tolerances prior to finish polishing and uniform coloring of the completed unit. On the other hand, the bolt body and bolt handle of the bolt assembly described above are brazed together in the machining area to permit uniform surface finishing of this unit, but the additional components are added to complete the sub-assembly where most convenient just prior to final assembly.

Final assembly, then, essentially consists of bringing together sub-assemblies, the balance of the individual components and the fastenings required to complete the product.

IV. Inspection and Testing - The very nature of the products produced by the Remington Ilion Plant - firearms - mandates careful control of quality throughout the entire process. These controls start with incoming materials and purchased parts, continue through the machining and finishing operations, hardening and color and through assembly to packaging.

Incoming raw materials, including not only those used in the product, but also those used in processing such as coolants, lubricants, cleaners, etc., are subjected to Remington chemical and metallurgical tests as required. Two (2) laboratories are maintained to accomplish these controls.

Incoming purchased parts are also subject to metallurgical tests to insure use of the correct materials by the vendor. In addition, of course, the parts are subjected to dimensional inspection to assure that only satisfactory parts will be incorporated in the final product.

Control of dimensional quality during machining of parts produced by Remington starts with the equipment before release for production. Each machine is set up and run under normal operating conditions on a pilot-lot basis. A quantity of the

IV. Inspection and Testing - Cont'd.

parts produced are measured and the data analyzed statistically to determine the ability of the machine to consistently produce parts within the limits required. Corrective adjustments are made if indicated and effectiveness verified before release for regular production. Statistical studies are also made at intervals after the machines are in production to verify the original controllability data and to detect wear or other factors in the equipment which could affect quality. Facilities are provided for prompt repair and maintenance as required. These include a modern tool room, machine shop, electrical shop, carpenter shop and sheet metal shop.

A wide variety of modern precision measuring equipment is provided for setting up machines and controlling dimensions during manufacture. Dial indicators and air gages are commonly used together with more conventional types of gages. Since modern firearms are made up of close fitting parts, most of which must be interchangeable, variation from piece to piece must be controlled within very small tolerances. The difference between the largest and smallest acceptable piece may frequently be equivalent to the thickness of a sheet of paper. The cost and quality of the gages provided for control, therefore, may be likened to the same elements in fine time pieces and similar items.

A system of periodic gaging for control by the operators, based on statistical methods, is used supplemented by an auditing system to measure the effectiveness of the controls. A similar approach is used at the finishing and color operations, after Gallery testing described below and after packaging.

The quality of sub-assemblies and final assemblies is controlled by the assemblers using gages, dummy cartridges and other suitable testing methods. In addition, the completed firearms are subjected to rigid shooting tests. All shotguns and high-power center fire rifles are first proof-tested with special extra powerful ammunition to insure proper strength characteristics. The guns, including .22 caliber rim fire models, are also tested for function using standard live ammunition. The function test is comprehensive and includes shooting of the several different shells and cartridges available for different purposes for each gun type, gage or caliber. For example, both shorts and long rifle ammunition in both standard velocity and high speed are used in .22 caliber rifles. In the center fire calibers, cartridges with both pointed and round nose bullets in light and heavy powder loads are used.

Following Gallery testing, all guns are routed to a final inspection. Critical dimensions in the operating mechanism are

IV. Inspection and Testing - Cont'd.

verified and the overall finish is reinspected to make sure that shooting and handling through Gallery testing has not impaired the appearance. The completed guns are then ready for packing.

V. Packaging - Each container, carton, box, wrapper, cushioning item, tape or method of closure is carefully designed by Remington to support and protect the finished product during shipment and storage. Only materials and container designs which have successfully withstood the rigors of actual shipments to the field are specified. Large photographs of actual packages are used to show the details and placement of each item in the container for reference by production packaging personnel and to insure consistent adherence to specifications.

Each firearm is packed in an individual box as moved to the Warehouse and may be shipped as a single unit. Shipments may also be made in larger containers designed to hold five (5) unit packs.

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