Western MACHINERY and STEEL WORLD

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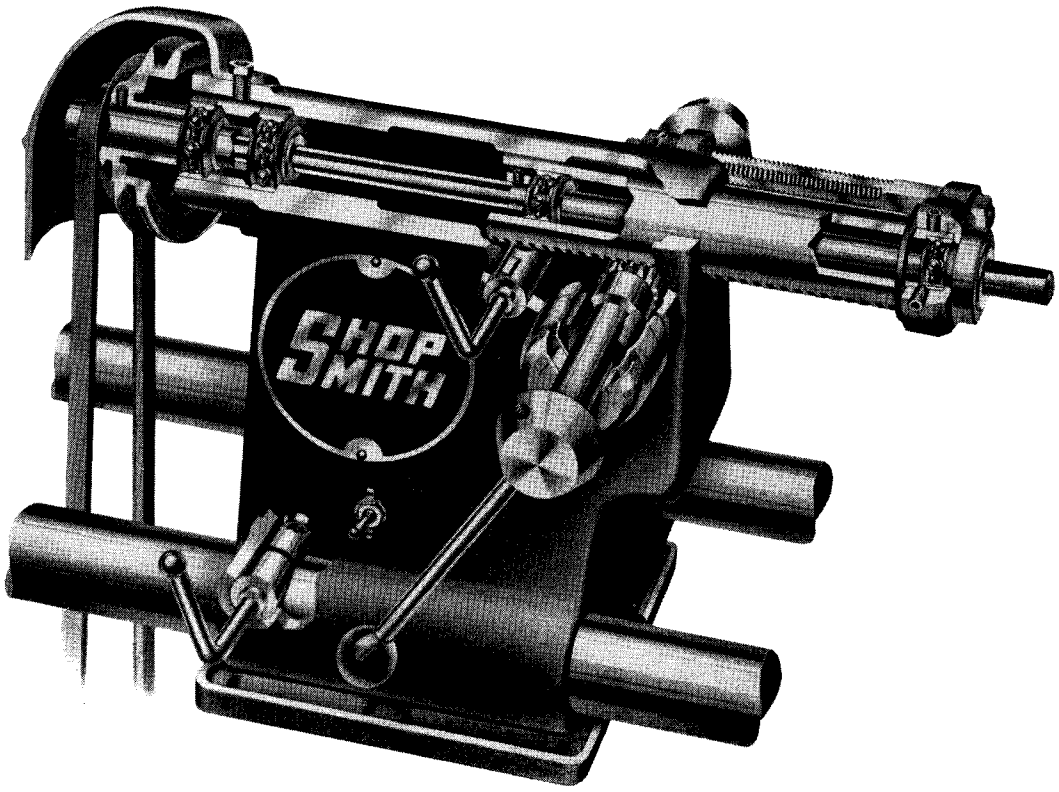
PRECISION

Makes the

SHOPSMITH



PRECISION
Makes the
SHOPSMITH

By Gordon B. Ashmead

If you haven't heard of Shopsmith, you have missed the sensation of the decade in home workshop power tools.

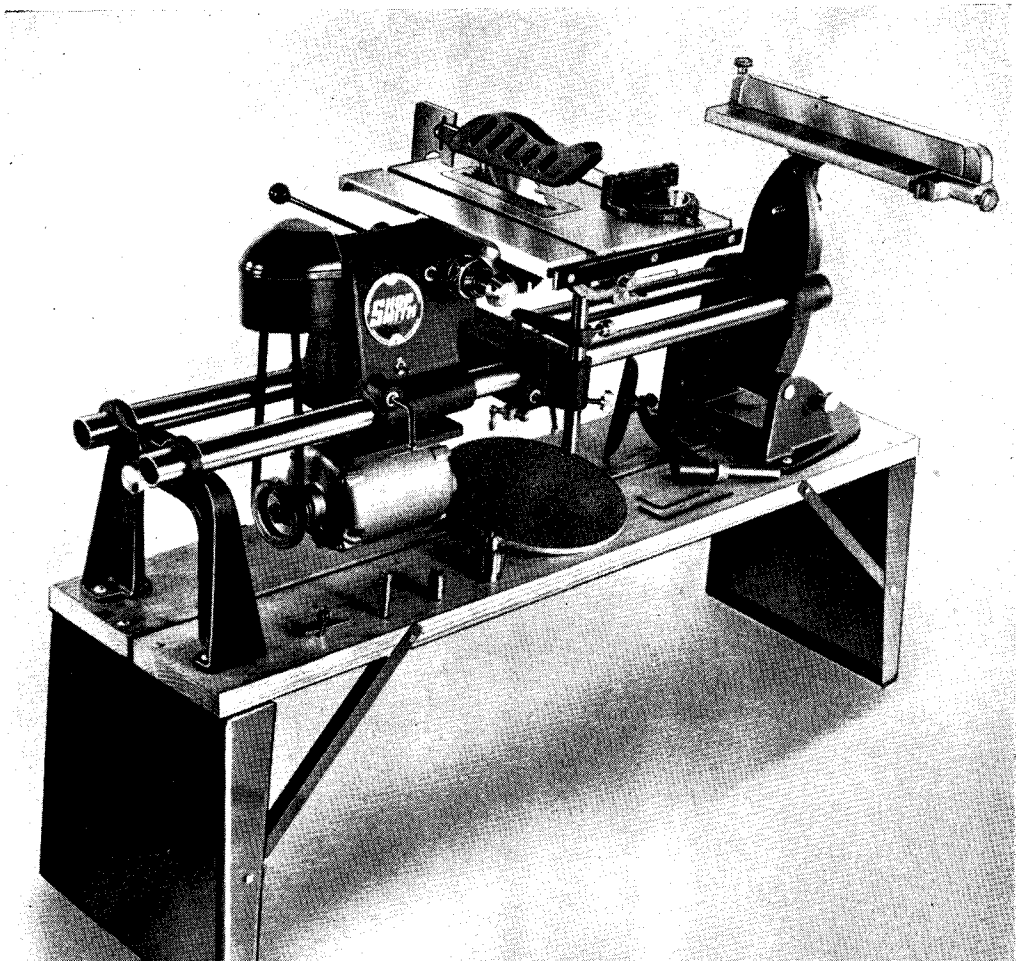
The postwar project of a German with a Ph.D. from the University of Berlin, who came to this country long before the last war started, Shopsmith is a product with an exclusive Western flavor. It grew first on paper, progressed in plastic and scrap metal to a half-scale model and emerged in the summer of 1947 as a full-scale, multi-purpose tool that, by the end of 1950, had sold more than 75,000 units over the counters of the most famous stores in the United States.

Shopsmith, only 55 inches long and 21 inches wide, is a circular saw, drill press, a lathe, a disc sander or a horizontal drill, as the occasion demands. And in all its functions the machine will perform its operations with efficiency equal to the best single-purpose tools of similar capacity.

In many cases Shopsmith will outperform single-purpose tools because of features which were necessary to permit multiple use. Among the features which are standard on some of the single-purpose tools Shopsmith replaces, but unique and highly useful in others, are the quill feed, tilting table, large effective table size, movable headstock, and independent carriage for table and tool rest. Many of the general quality characteristics of Shopsmith are far above the usual standards for most of the single-purpose tools it replaces because these characteristics had to be such as to satisfy the requirements of the most demanding of each of the single-purpose tools. This applied in particular to decisions with respect to strength, rigidity, materials, tolerances, and power.

Shopsmith is a home woodworking tool that, because it performs so efficiently, is now used in schools and small shops. And because of its versatility and high precision it can be

The Shopsmith.



On the Facing Page

(1) To assure perfect alignment, holes in the headstock for the tubular ways and quill assembly are bored simultaneously on six-spindle Ex-Cell-O Borematic boring machines. These machines, having exceptionally heavy boring bars, are used for no other purpose.

(2) Finish-boring in headstock castings is also an Ex-Cell-O six-spindle boring job. Operator checks every casting for size and concentricity with "go and no-go" gages.

(3) After each headstock goes through the subassembly line, it is run-in for 2 minutes on a specially constructed rig. This discloses any defective bearings, friction problems, etc., and insures that all working parts mate properly.

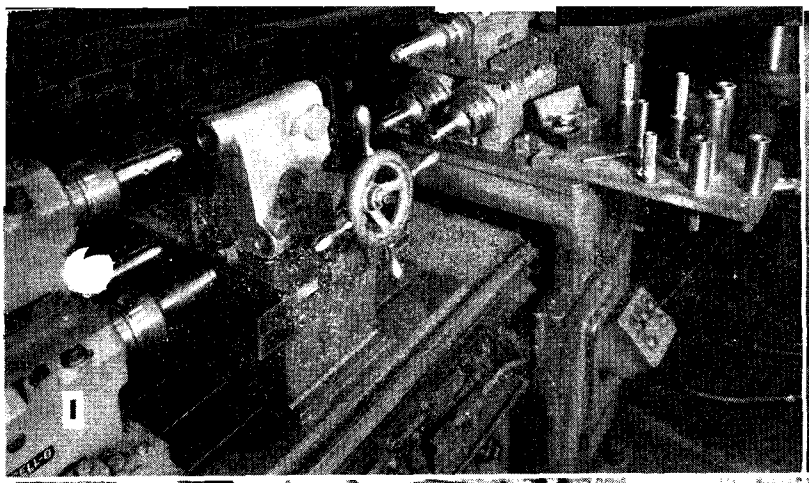
(4) Faces of 24 tool rests are ground simultaneously in a special jig on the Blanchard grinder.

(5) Two-spindle boring machine with quick-locking jig is used to bore holes in carriage for tubular ways. Every casting is checked with plug-type "go and no-go" gages.

(6) This Cincinnati milling machine cuts the miter gage slots in the table top and trims the edges of the table simultaneously. Because these cuts are made at the same time in a rigid jig, it is almost impossible to get anything but perfect alignment. Note the powerful air clamp which holds each table firmly against the bottom of the jig so that each slot will be exactly the right depth.

(7) Shopsmiths are used for production too. Each of those shown above is fitted with a jig and used continuously for drilling or tapping operations in iron and aluminum.

(8) This is a special production set-up using the two Shopsmith headstocks on one set of tubular ways. This machine is used to ream holes for bracket pins in the table tie bar.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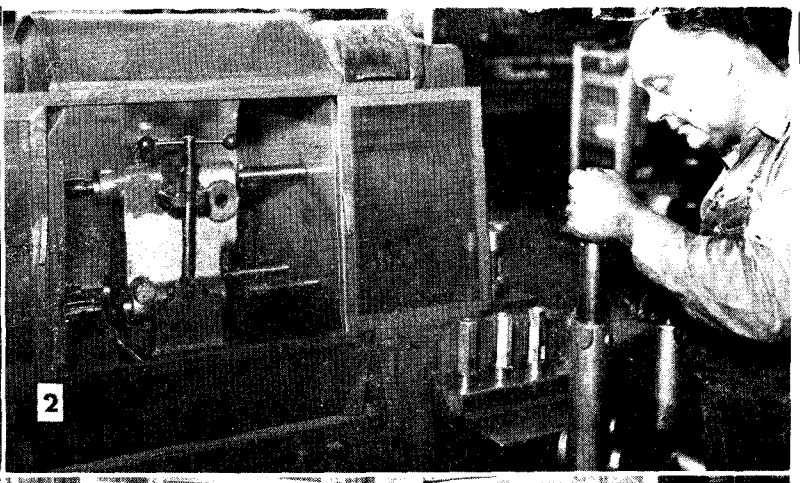
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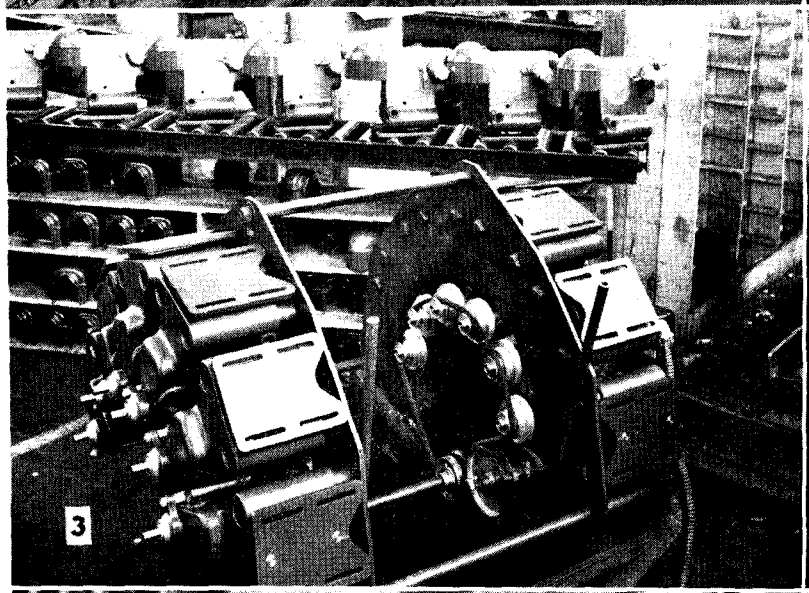
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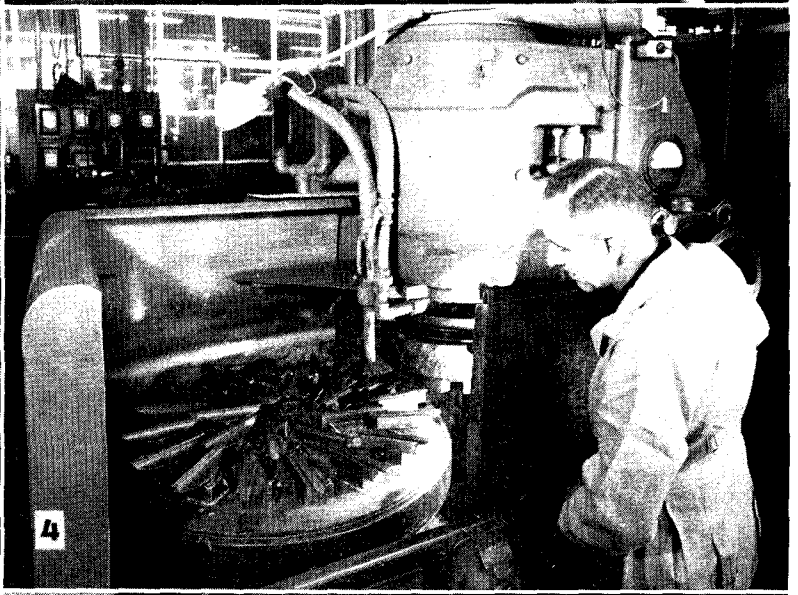
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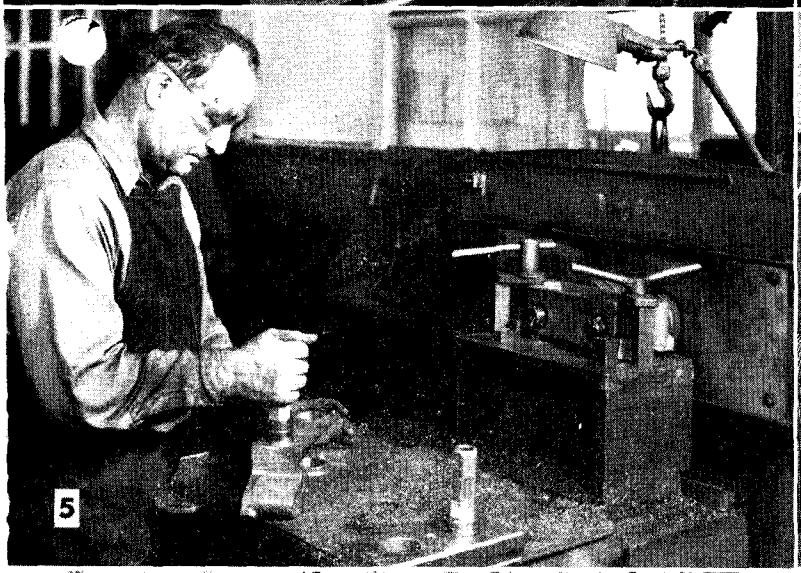
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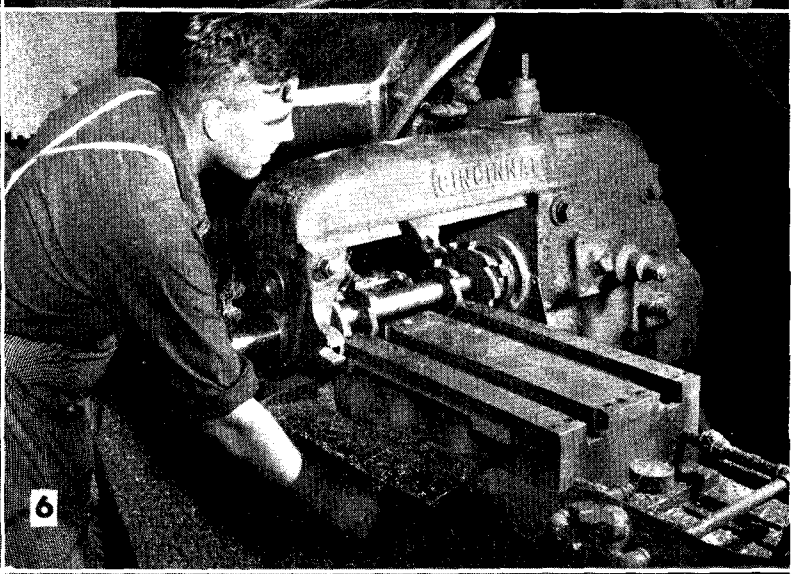
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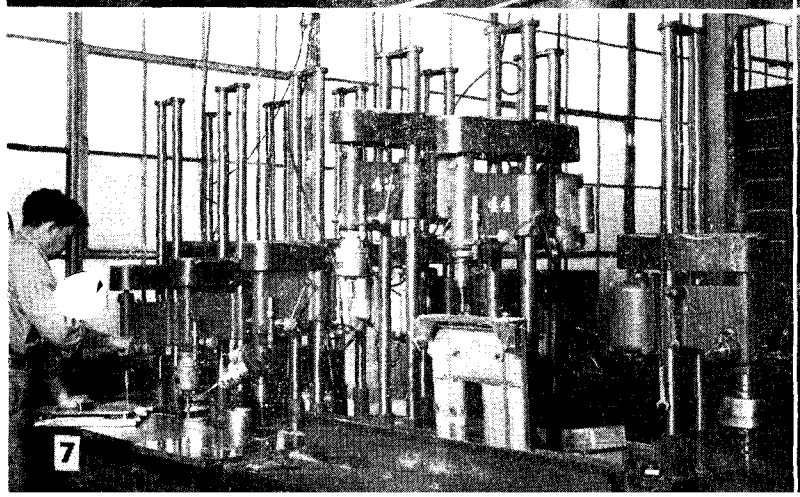
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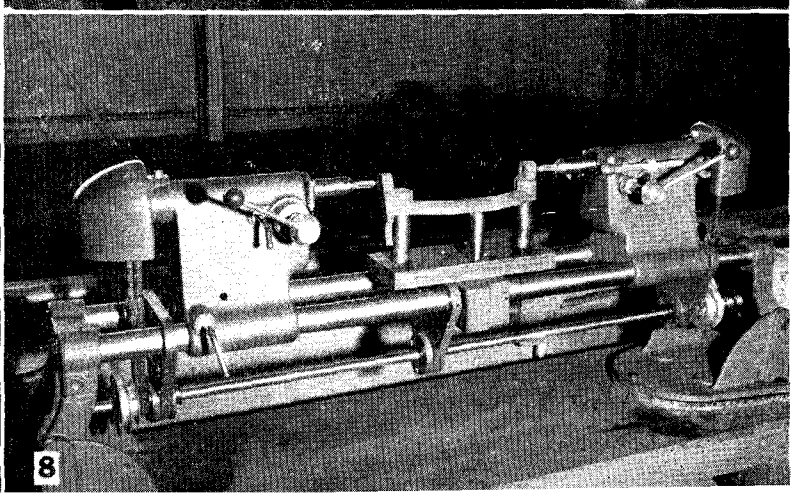
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adapted for metal working in the home with high speed drills and carbide-tipped tools.

The machine is engineered for mass production. Not a single extra part or gadget encumbers it. Dismantle a dozen Shopsmiths, mix the parts and reassemble. The job will be done with such ease it will seem the original parts are being used. This is one of the secrets of the success of Magna Engineering Corporation, its manufacturer.

The machine is made of grey iron and aluminum castings, hardened steel, and centerless-ground tubular ways. These materials flow to the receiving department of the Berkeley plant where the Western Shopsmiths are made, and every bit of machining, forming or grinding is done under continuous surveillance by Magna inspectors.

Production is such that it is possible to assign mills, multiple drills, lathes, grinders, specially designed boring machines and other tools to single operational functions. And each of the tools so assigned is permanently fitted with a quick-locking jig or fixture to facilitate the particular operation. With such tool engineering it is comparatively easy to keep within the basic tolerance of .003". No steel mating parts have fits looser than this and tolerances are held to less than .0002" on the more critical surfaces.

This calls for machining of the highest order and rigid inspection to enforce adherence to these close tolerances. As a result there is scarcely a machine tool that isn't equipped with its own set of plug or other type of gages to make 100% inspection on each part. These are in-process inspection steps. They are augmented by traveling Magna inspectors whose only duty is to pull work from any machine in the plant, take it to the inspection laboratory and assess it with the most modern of inspection instruments.

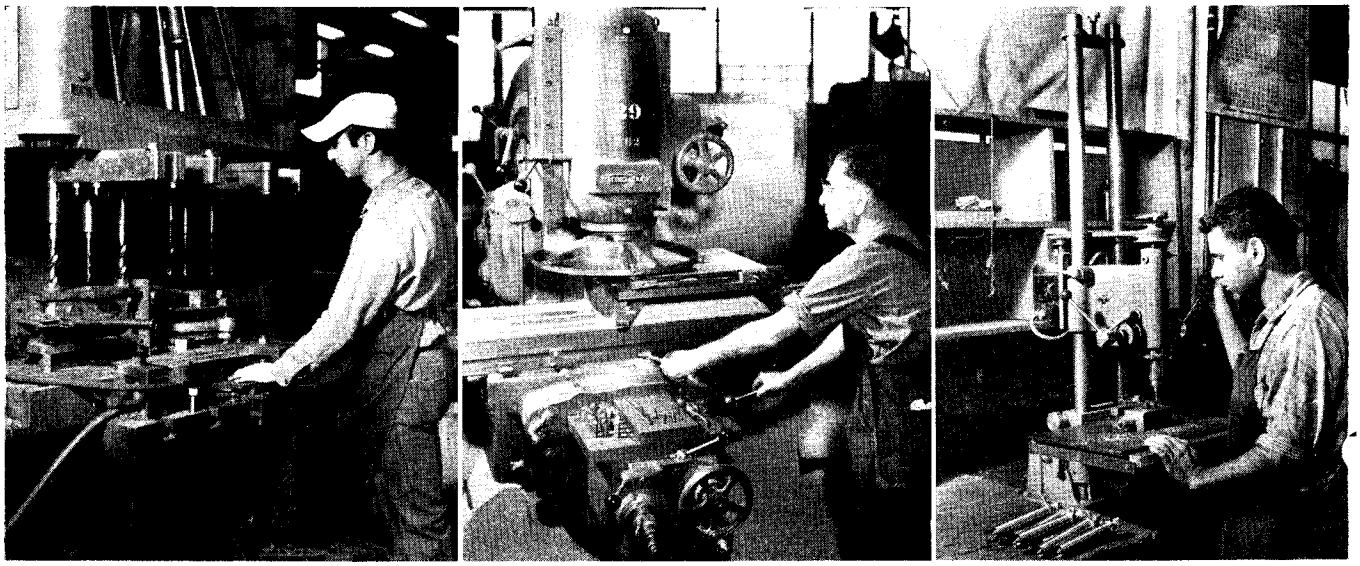
The inspectors have nothing to do with production. They report directly to Magna's plant manager. If the laboratory inspections reveal work that is below standard, the inspection gages at the machines are lifted and checked in the Shopsmith gage laboratory. Among the instruments used are Sheffield external comparators, indicating micrometers, gage blocks, and a light wave micrometer. The last was, until recently, the only one of its type in use on the West Coast. Errors have a short life at Magna because responsibility for any deviation from standard is quickly placed by the gage laboratory.

Few parts reach the subassembly lines without at least three inspections and many have double that number. And as each subassembly is completed it is individually run-in, checked and inspected before final assembly.

After it has been run-in for 20 minutes, each completely assembled headstock receives its final inspection under power. Here, in the permanent record book where the serial number of each Shopsmith is set down, inspection data are recorded. For instance, run-out of the spindle and quill assembly is accurately gaged under power. Incidentally, the maximum spindle run-out permitted is .0015". I watched this operation as a number of headstocks passed this station and was permitted to inspect the record book. While I watched, no spindle had a greater run-out than .0005", and going back in this record book for seven days the greatest run-out was .0010". The full significance of this is apparent when it is considered that the tolerances of a number of mating parts have a cumulative effect on run-out of the spindle.

This wasn't a staged exhibition for me. These are the standard tolerances held in manufacturing Shopsmith. The spindle and quill assembly is the heart

Left: Three holes in carriage and three holes in tailstock are drilled simultaneously on the Natco multiple drill. Air-operated clamps and jigs with hardened bushings are used to hold castings. Plug gages similar to that near operator's left hand are used to check each hole. Center: Each table top acquires a mirror-smooth surface as it passes through this Cincinnati milling machine. Note extra heavy fly-cutter to insure a true surface on the table. Right: The second Shopsmith ever produced. After a short period of service as a demonstrator model, it was moved to the plant and has been used continuously as a production drill press ever since. The operator is here shown drilling holes for drive pins in the upper chuck assembly of the Shopsmith jigsaw.

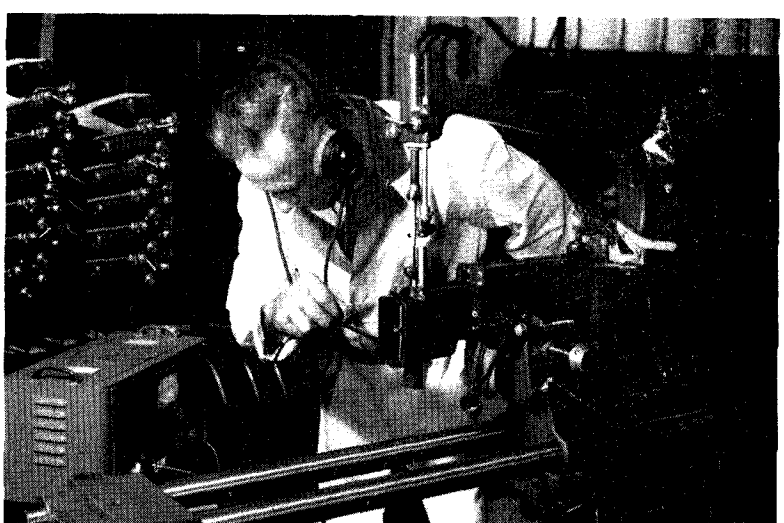


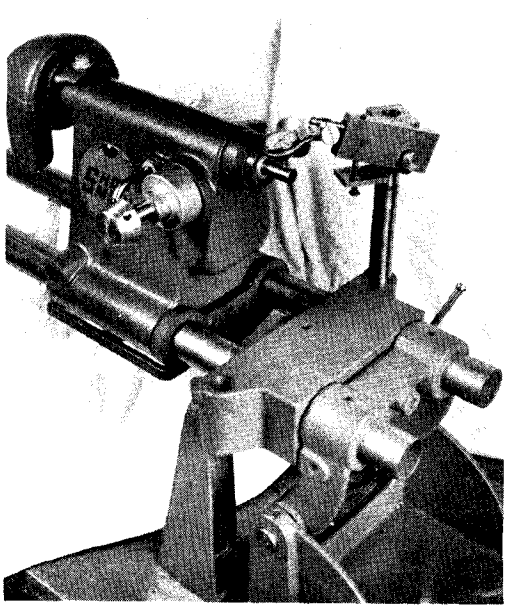
Left: At the left is an air-powered jig that inserts floating center in tailstock and assures alignment with drive center. Operator is assembling four tool rests with jig and air-powered screw driver. Right: Conveyor carries parts to be painted past spray booth with water curtain exhaust and infra-red drying lamps.

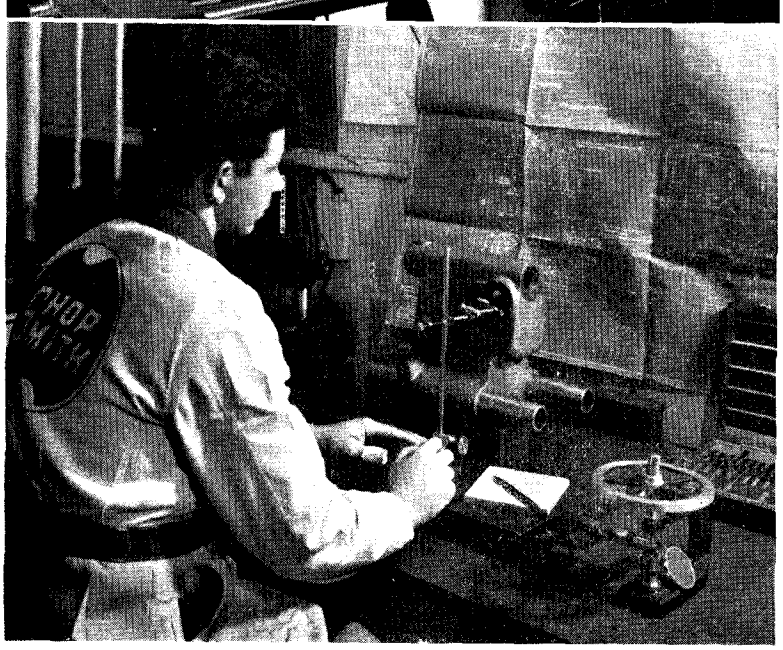
Center right: Shopsmith accessories are inspected as carefully as the basic machine. Here the inspector is using a Sono-Probe to check vibration and noise level.

Bottom right: A corner of the gage laboratory and a small part of its equipment. The inspector is checking a headstock casting selected at random from the production line. The instrument at the lower right is a light wave micrometer used to check accuracy of other gages.

Below: Every completed headstock is checked for spindle run-out and the data are permanently recorded with the serial number of the machine. Those with a run-out exceeding .0015" are rejected.







of the machine. It transmits all movement to all of the tools—drill chucks, saw arbors, sanding discs, lathe centers, etc. The assembly must be right, and it is right or the final inspector will not buy it and back it goes for rework. Incidentally, the amount of rework in this closely-controlled shop is only a fraction of one per cent of the total production.

Further to emphasize the sturdiness and precision of Shopsmith, I found about 20 Shopsmiths set up with jigs as production drill presses, either drilling or tapping parts for the unit.

Shopsmith is not the first multi-purpose tool made for the hobbyist but it is the first one made to such high standards. One of the first requirements recognized by the designer was the need for a vibration-free, solid foundation. That was followed by the need for keying the components to provide perfect alignment and torsional rigidity. Centerless-ground tubular ways in parallel were chosen to form the bed of the machine because of greater utility and lower production costs. In the Shopsmith design one tubular way is fitted to very close tolerances and serves as a guide. The other serves to maintain radial alignment, supply a locking surface and provide additional rigidity.

High-grade grey iron castings provide the rigidity and mass desired to damp normal operating vibration in the base assemblies and the headstock. The saw table, which becomes also the bed of the drill press, is made of cast aluminum, primarily because it is a part that must be removed from the machine by hand to convert to a lathe.

The Shopsmith headstock is one of the most precise, frictionless and efficient transmitters of power in general use today. To perform as a multi-purpose tool it was essential that the spindle and bearing system be capable of withstanding axial as well as radial thrust, be quill-mounted to provide axial displacement for drilling and related operations and be capable of mounting the various cutting and polishing tools used on the machine. Axial and radial thrust are accommodated by high-precision ground steel ball bearings mounted individually in the quill. Radial drive loads developed by the drive belt are not transmitted to the spindle but are carried by a second pair of bearings which mount and support the drive sleeve.

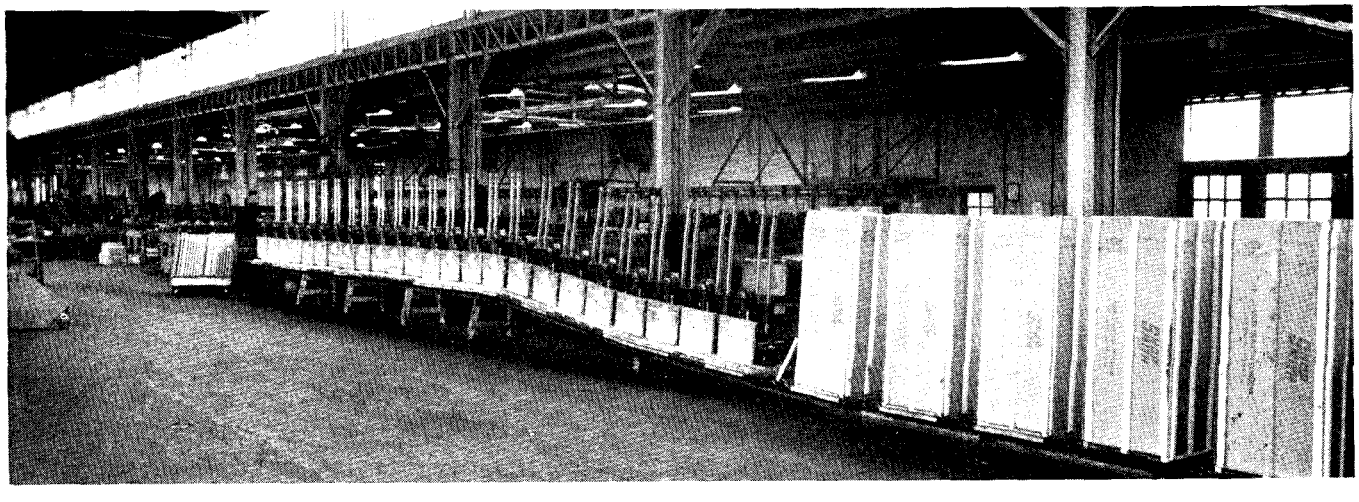
To accommodate frequent changes of cutting tools, an entirely new method of securing tools and attaching parts to the spindle was developed. It is based on a reverse-tapered flat which is machined into the cylindrical ground spindle near its induction-hardened tip. Arbors and accessories are attached by means of wrench-locking Allen screws which engage the tapered flat. Concentricity is controlled by fits which provide a maximum tolerance of .0005" between the spindle tip and parts that mate with it.

Shopsmith can be equipped with accessories that make it a jigsaw, shaper, jointer, router, mortiser or drum sander and its uses are increased almost daily by the ingenuity of Shopsmith owners, many of whom correspond avidly with Magna. All suggestions which appear to have merit are checked by the Engineering Department. Then, if the value of a suggestion is substantiated by tests, it is included in one of the bulletins that are sent periodically to all owners.

Magna Engineering Corporation is really three down-to-earth young men who work with facts and, working with them, have made Shopsmith the shining success story it is today. The oldest, and he is just entering his forties, is Hans Goldschmidt, the vice president and inventor. It was while he was working with the Henry Kaiser organization building ships that he met Robert Chambers, a Utah boy and Harvard Business School graduate. When the war ended both these young men cast about for some method of earning a living that would be pleasant as well as profitable.

When Goldschmidt had developed his machine to the model stage he called Robert Chambers into the picture. Robert Chambers thought so much of the possibilities he summoned his slightly older brother, Frank, an ex-Lt. Colonel in the Army Service Forces, from the East, and before their second meeting was completed the Chambers brothers had agreed to undertake administrative and

Shopsmiths are assembled on wooden frames that travel on the assembly line. The remainder of the crate is added as a pre-assembled unit when each Shopsmith leaves final assembly.



financial responsibility for Shopsmith production and marketing.

It should be noted that the combined financial resources of the three were far from adequate for the job that had to be done. They gambled everything they owned on their ability to achieve mass production and mass distribution in a few short months. Although it has no place here, this is a success story in the best American tradition.

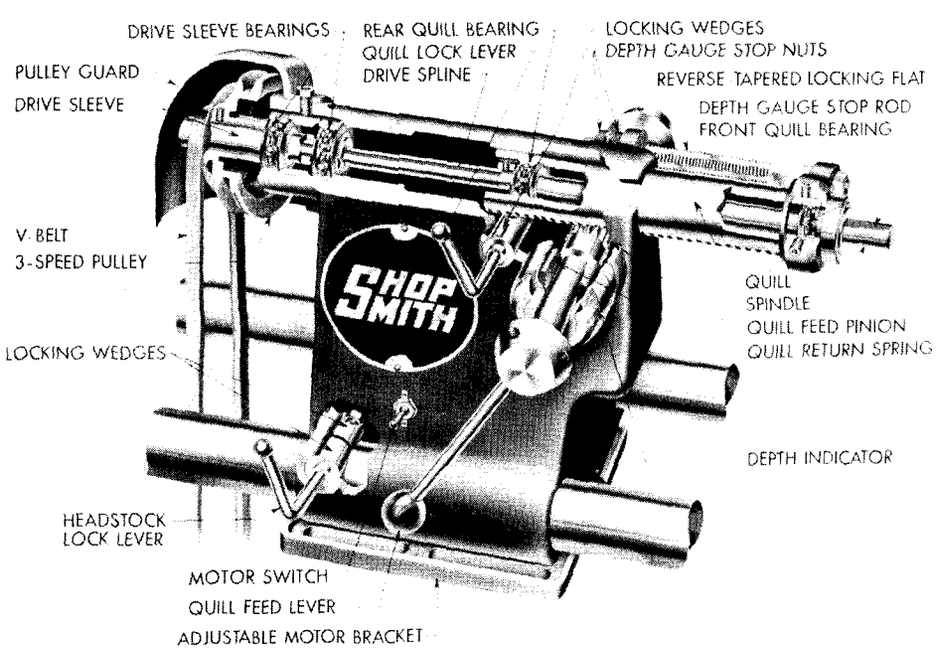
Shopsmith is made in Berkeley in the plant of Production Engineering Company. Magna owns all of the specific tooling and a large share of the machine tools that have been added since Shopsmith came to the plant. Shopsmith operations now comprise a *major portion of the total production* from this Berkeley plant.

Although Magna started in the West and maintains its headquarters in San Francisco, shipping costs made it desirable to produce Shopsmiths in the East for eastern consumption. Arrangements were soon made, therefore, to produce Shopsmith to the same requirements in the shops of National Acme Company in Cleveland. National Acme is one of the largest producers of automatic machine tools in the world.

Robert Chambers, president of Magna, proud as he is of Shopsmith and the job that has been done, says that his company will continue to develop new products and improve the old. Furthermore, headquarters will remain in the West because of the faith the entire organization has in its future development. The versatility and vigor of the Magna organization is evident in the record for 1950. New accessories for Shopsmith include *retractable casters with continuous cam* action for easy movement from place to place and a new-principle dado head, the Magna Precision Dado. Several improvements have been made in Shopsmith itself. The Engineering Department of Magna is constantly working on new developments, some completely unrelated to Shopsmith. It all adds up to a comparatively new organization that will carry on and enhance the reputation of products from the West.

Loading by power conveyor for transport to dealers throughout the world.

Excellent design of headstock shows six-spline spindle and drive sleeve and four *grease-sealed steel ball bearings.*



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Magna Engineering Corporation
417 Montgomery Street
San Francisco, California