MODEL CONSTRUCTION

Introduction (Speaker)

"The research facilities of the Langley Laboratory require models of varying sizes, shapes, materials, surface finishes and dimensional accuracy.

"In fabricating these models expeditiously to meet the requirements of research, a variety of methods and skills are utilized.

"In a few minutes you will be conducted through our Fabrication Shop, located in this building. This shop is equipped to fabricate, from both light and heavy sheet metal, various types of research equipment. We have also arranged for you to observe several other model-making methods normally performed in other model shops. These include the fabrication of plastic models, and the operation of several airfoil profiling devices which are examples of model-construction methods employed in our model shops.

"Time permits us to review only a few of the methods used in the construction of our research models. However, an exhibit set up in the Activities Building includes several models constructed by other methods used at this Laboratory.

"Mr. ________________ will now review several model-construction methods you will observe when you visit the shop."

Spinning Methods (Speaker)

"This is a typical pilotless aircraft model, which was constructed in our shops.

"The principal requirements of a model of this type are:

(1) Minimum weight;

(2) High strength;

(3) Dimensional accuracy; and

(4) Elimination of internal frames and stiffeners, so as to provide space for instrumentation.

"One method of meeting these requirements is to employ monocoque construction, utilizing spun shapes of one or more of the following materials: magnesium, aluminum alloy, steel, inconel, and titanium.

"The dimensional accuracy of such spinnings readily permits interchangeability of fitted parts, thus allowing for some standardization.

"The following movie will show the forming, welding, and spinning of a magnesium model nose section."

<u>Spinning Methods</u> (Movie - Speaker)

"Precut magnesium sheets are heated in a furnace to 650° F. Operators, wearing asbestos gloves, remove the hot sheet from the furnace and form it to a conical shape.

"The cone is clamped in an automatic welding jig.

"A vee groove is scraped at the joint line where a filler rod is laid in place.

"The inert gas shielded arc torch on the automatic welding machine is used to join the seam.

"The cone is then placed over a mandrel in a spinning lathe.

"To spin magnesium, it is necessary to heat it to approximately 400° F. This heat is applied by Bunsen burners attached to the lathe.

"While on the mandrel, the surface of the nose section is given its final finish, and cut to length to fit its mating part.

<u>Press-Forming Methods</u> (Speaker)

"This is a booster assembly, which is used to accelerate a pilotless aircraft model during the initial stage of its flight. After the booster's rocket force is expended, the booster falls away from the model.

"The booster assembly must be as light as practicable, yet sufficiently strong to withstand the severe loading resulting from its high speed in dense air. Only moderate accuracy is required for such construction.

"The construction of the booster fins is an example of taking advantage of the simplest methods of construction that will produce a finished product satisfactory for research needs, and thus speed up the supply of models.

"Commercially available material, consisting of a very light aluminum honeycomb sandwiched between two light-gage aluminum sheets, is used to produce these fins.

"The material is precut to planform shape, then placed in a press where the leading and trailing edges are pressed to shape. Cementing a metal fairing cap on the leading edge of the fin completes the part.

"Mr. ________________ will now tell you something about the use of reinforced molded plastics in model construction."

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Reinforced Molded Plastic Methods (Speaker)

"During the past several years, a number of problems in model construction have been solved at this laboratory by use of the reinforced molded plastic method of construction.

"An example of this type of construction is this dynamic spin tunnel model.

"This model must be to scale in regard to both size and weight. Space must be provided in the fuselage to house controls, instrumentation, and balancing weights. It must also be sufficiently rugged to minimize damage to the model in the tunnel.

"Reinforced plastic is better than wood for these models as it is considerably stronger, more dimensionally stable, and retains its surface finish indefinitely, thus eliminating practically all repair work to the model.

"The movie which you will now see shows the principal steps involved in this method of construction.

Reinforced Molded Plastic Methods (Movie - Speaker)

"Shown here is a wooden male pattern. The pattern is placed in a parting board, and the entire top of the assembly is then sprayed with a molten 50-50 bismuth-and-tin alloy, to a thickness of about 3/32 of an inch. This layer of metal will form the finished surface of the female mold, thus imparting a smooth, polished, accurate surface to the molded part, that requires no additional finishing.

"The metal coated assembly is now boxed and reinforced with wire mesh and plaster.

"The opposite half-mold will be processed in the same manner.

"The complete female mold is parted and the pattern is removed, leaving the desired opposite half-molds. The sprayed metal now forms the surface of the female molds.

"A special plastic is now melted and is put into a plaster mold of the half-fuselage. The resultant solid, rubber-like casting will be used to apply pressure to the lamination while curing.

"A finished half female mold is brushed with a parting agent to provide a release for the reinforced plastic molding.

"Six layers of .003" glass cloth are laid out on a table and saturated with a polyester resin. The lamination is then cut to lay in the mold. After the lamination is placed in the mold, the solid, rubber-like casting is pressed against the lamination to insure conformity to mold shape.

"After curing, the molded part is removed, and the parting agent is peeled off, and the flash, or excess is trimmed. The other half of the fuselage is formed in the same manner, and the two halves are cemented together to form the completed fuselage.

"To form the wing for this model, two layers of .004" glass cloth are sewn over a slightly oversize core of light-weight foam plastic material.

"This glass cloth is saturated with polyester resin. The lamination is placed in wing molds prepared by the same method as the fuselage mold. The mold compresses the entire wing structure into proper shape. The tail surfaces are made in a similar manner. The smooth surface finishes of the completed model parts, now seen, are as they came from the molding process.

(Speaker)

"This is a sample of the light-weight foam plastic material used for the wing core seen in the movie. Its moderate resistance to crushing holds the lamination against the mold.

"This is a wind tunnel model that was tested in the 8-Foot Transonic Tunnel, using this series of nosepieces. This model is difficult to construct because of the intricate internal ducting, and the difficulty of installing the orifices on external surfaces of the model and internal surfaces of the ducts. These pressure orifices are connected to a pressure-recording system with these tubes running through the afterbody.

"The use of the reinforced molded plastic method of model construction permits these nosepieces to be produced to a high degree of accuracy, and in a fraction of the time and cost that would be required by other known methods.

"In the previous movie, you saw two methods of forcing the reinforced plastic material to conform to the molds. One was the use of a solid, rubberlike casting, and the other method was the use of an oversize core of light weight foam plastic material.

"In this next movie, you will see a third and fourth method which were used in the construction of this nosepiece."

(Movie - Speaker)

"Here you see the third method used to apply pressure, in which liquid latex is sprayed on a pattern of an air inlet model. This latex cures in several hours to form an inflatable bag which is used to force the reinforced plastic against the female mold.

"The fourth method we employ consists of wrapping reinforced plastic material around a pattern. The covered pattern is then placed in a plastic bag which is deflated to a partial vacuum, thereby pressing the reinforced plastic to the shape of the pattern.

(Speaker)

"This inflatable bag is similar to the one shown in the movie. The desired number of laminations are wrapped around the bag, then positioned, and the mold is closed and clamped. Polyester resin is then forced into the mold and the bag is inflated, causing the lamination to conform to the mold, thus producing this exterior shape.

"The vacuum method shown in the film was used in the fabrication of these ducts. The ducts are then cemented in place, as shown.

<u>Telemetering Nose</u> (Speaker)

"Another example of utilizing molded plastic technique is the assembly of this telemetering nose for a pilotless aircraft model. Note that the plastic forms a rigid and unshielded support for this telemetering unit and at the same time forms the outer surface of the forward portion of the nosepiece.

"The next movie will show the procedure for constructing this nosepiece.

(Movie - Speaker)

"A telemetering nose for a pilotless aircraft model is made by first forming a spun magnesium shell. The sharp edge of the shell lip is removed to prevent any stress concentration in the plastic which could cause it to crack. The nosepiece molds are coated to release the potting compound, then assembled and clamped. The shell with gypsum positioning fixture is placed in the mold, the electronic insert positioned, and plastic is poured around the insert.

"When the plastic has hardened, the mold is parted and the positioning fixture broken away.

"After the plastic surface is machined and polished, the nosepiece is ready for assembly with the model.

"These telemetering noses are now being furnished us by contractors who use this method of construction.

"Mr. ____________ will now briefly discuss two types of airfoil profiling equipment, and a model-measuring method."

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Airfoil Machine (Speaker)

"One of the airfoil profiling devices that you will see during your tour of the shop is an airfoil cutting machine of 4-inch chord capacity. In addition to this 4-inch machine, we also have two 6-inch and two 14-inch airfoil cutting machines for handling the work load of this laboratory.

"The principle of operation of this machine is illustrated by this chart, and may be briefly stated as follows:

"It is a machine for milling from rectangular stock, two-or three-dimensional models of airfoils, compressor blades, propellers, and related work.

"The master template, which has a chord dimension 6 times that of the work to be cut, is rigidly attached to a rotatable barrel.

"The rectangular stock is fed longitudinally through the rotating barrel.

"The contour is milled on the stock by a milling cutter, which is located immediately adjacent to rigid jaws that support the rectangular stock.

"The motion of the cutter is controlled through a 6:1 ratio linkage, connected to a follower wheel through a torque tube.

"The follower wheel bears upon the master template, and is fed longitudinally along the template in proper ratio to the forward movement of the rectangular stock.

<u>Airfoil Profiling Fixture</u> (Speaker)

"Another type of airfoil profiling device that will be on display in the shop is shown schematically by another chart.

"As will be seen, it is a fixture for milling 3-dimensional straight-line element wings from a 2-dimensional root template. The motor-driven cutter is moved longitudinally down a bar which is supported at the wing apex, or origin, by a ball joint and by a roller on a 2-dimensional template at the root. The cutter cuts along straight-line surface elements of the wing. The cutter is kept normal to the airfoil cross-sectional contour by an out-rigger roller onthe bar which is in contact with a normalizing template.

Model-Measuring Method (Speaker)

"This concludes the review of our model-construction methods. We will now discuss model measuring.

"It is essential that our scientists know the dimensions of the completed research models precisely.

"Our most accurate method of measuring models is by the use of a standard jig borer, procured with a modified vertical measuring attachment which permits vertical measurements to be made as accurately and rapidly as those in the horizontal plane.

"This ability to measure the finished model with extreme accuracy, in many cases, eliminates the need for extreme precision in the manufacture of models. This permits the use of reasonable shop tolerances provided the surfaces are held to the specified fairness and smoothness. Considerable time and money is thereby saved.

"This chart shows a pictorial of the machine we use at this laboratory. This is a standard jig borer with a modified measuring head attached to the spindle and a special outboard table for mounting large, heavy models. This sensitive contact indicator, which is used with this machine, indicates surface contact with no measurable force and without damage to the surface to be measured. By the use of micrometers and electro-limit gages on the spindle, table, and carriage, models may be measured to accuracies of two ten-thousandths of an inch, vertically, longitudinally, and transversely. By this means model wing, tail, and fuselage coordinates, as well as their position relative to each other, may be determined to extreme accuracies."

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LAL 80175

Display for Presentation of Talks on Model Construction

NACA

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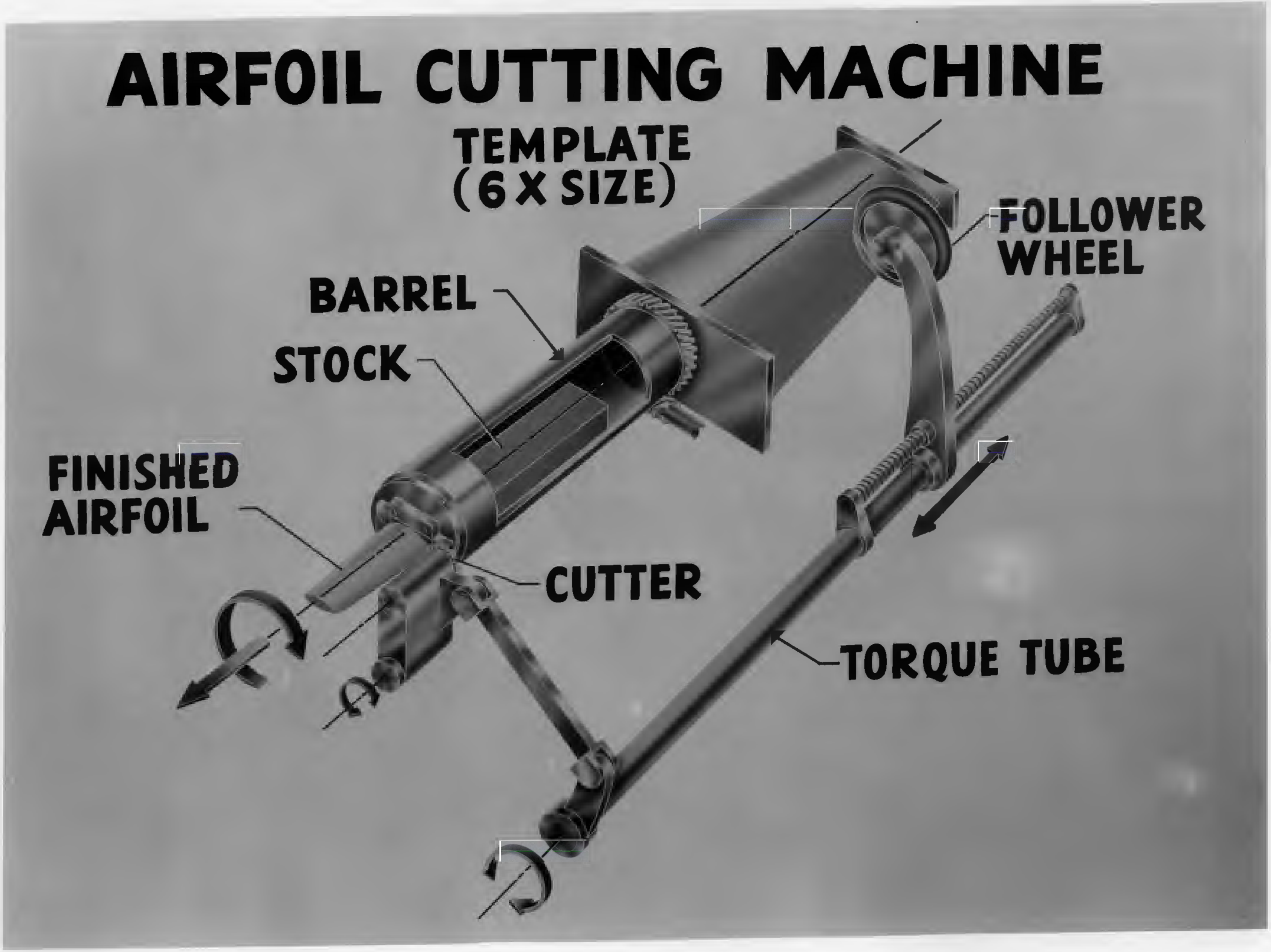

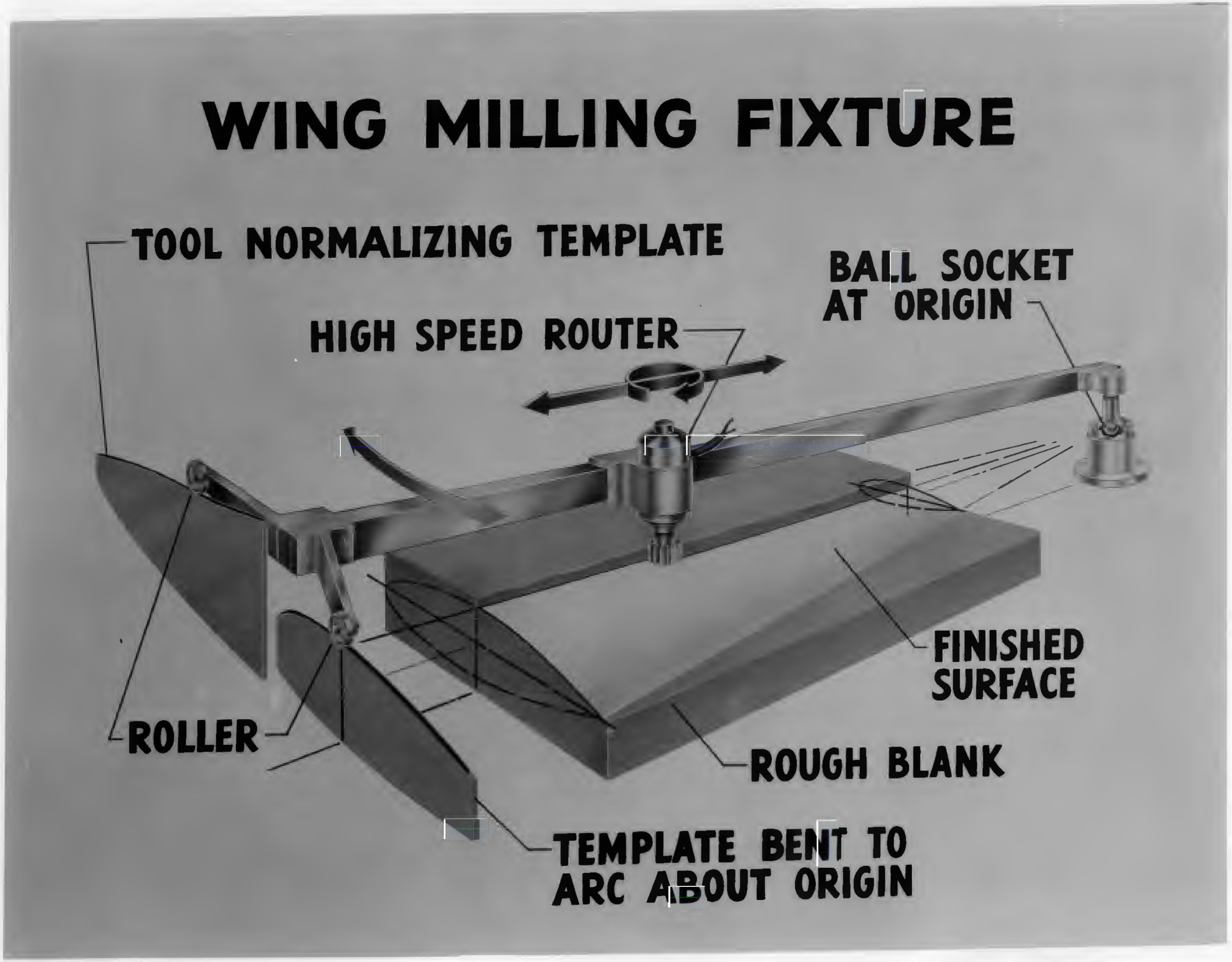
WING MILLING FIXTURE
TOOL NORMALIZING TEMPLATE
BALL SOCKET AT ORIGIN
HIGH SPEED ROUTER
FINISHED SURFACE
ROLLER
ROUGH BLANK
TEMPLATE BENT TO ARC ABOUT ORIGIN

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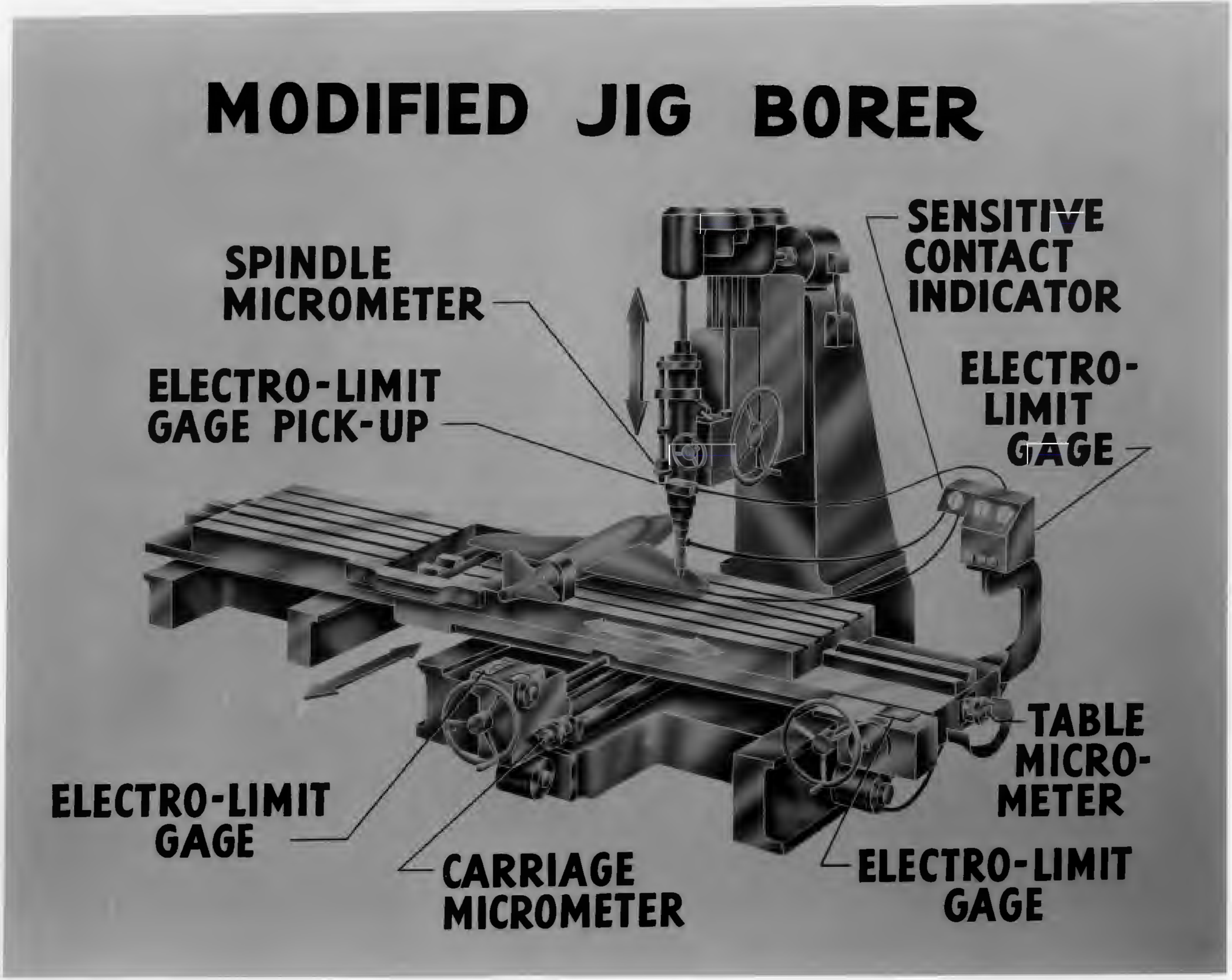
MODIFIED JIG BORER
SPINDLE MICROMETER
SENSITIVE CONTACT INDICATOR
ELECTRO-LIMIT GAGE PICK-UP
ELECTRO-LIMIT GAGE
TABLE MICRO-METER
ELECTRO-LIMIT GAGE
CARRIAGE MICROMETER
ELECTRO-LIMIT GAGE