

UNITED STATES DEPARTMENT OF LABOR

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## Women's Factory Employment in an Expanding Aircraft Production Program

One of a series of reports on women's present and possible employment in war industries, based on field surveys by Women's Bureau investigators since early spring of 1941 (issued first in mimeograph). A report on the actual employment of women in January and February 1942 will follow.



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Women's Sector Employment in an  
Expanding Arctic Production  
Front

One sees no better way to move a people or to open up new opportunities than to build a new infrastructure in the north. It is time to think about what needs to be done to support the growth of the economy in the north. We must work together to ensure that our communities are prepared for the challenges ahead.



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# Women's Factory Employment in an Expanding Aircraft Production Program<sup>1</sup>

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## INTRODUCTORY

The American factory was developed on the premise that women form its principal work force. While their proportion in manufacturing industries has decreased since agriculture claimed a smaller proportion of men, there has always been a seasoned, hard-drilled group of women workers in manufacturing industries. A sizable proportion have been employed regularly in the fabrication of metals, especially in the production of cutlery and edge tools, hardware, tinware, wire work, electrical machinery and apparatus, typewriters, sewing machines, clocks, watches, and time-recording devices, instruments, gas and electric fixtures, stamped ware, shell and shell parts, and other metal products. Through such production they have demonstrated their ability to operate satisfactorily punch presses, drilling machines, milling machines, lathes, grinders and polishers, as well as to achieve a high record in inspection, assembly of small parts, soldering, filing, and other bench work.

At the close of the first World War 23 percent of the employees in 40 airplane factories were women. In Germany and Great Britain present reports indicate that 40 to 50 percent of the employees are women. In the United States in 1941 women formed an infinitesimal proportion of aircraft factory workers.

The situation last mentioned is due chiefly to the great demand on the part of men for aircraft jobs. Large numbers of neither men nor women had been trained in aircraft manufacturing when expansion became necessary. Apprenticeship training was established for men and public and private vocational institutions catered to men.

However, a program of expansion and maximum production calls for the best person for each job, regardless of sex. With this in mind, the Women's Bureau visited seven aircraft plants assembling bomber, pursuit, observation, and training planes. In several plants where the monocoque type of construction prevailed, though one was producing the tubular steel welded fuselage, a careful analysis was made of jobs in relation to their suitability for women. In others, comparisons were made of differing plant set-ups and the possibilities of adding women to plant personnel were discussed with department heads. While approximately 100,000 workers were employed in the plants visited in 1941, in three there were no women and in the other four only a fraction of 1 percent were women. The few women employed were working chiefly in the sewing of covers for rudders, ailerons, wing tabs, and other control surfaces of the empennage, and a smaller number were making parts before painting and doing minor jobs on electrical assemblies, wrapping and identifying gas lines.

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<sup>1</sup> As of the early months of 1941.

## SUMMARY OF SUGGESTIONS AS TO WOMEN'S EFFECTIVE EMPLOYMENT IN AIRCRAFT FACTORIES

The World War I demonstrated that in an emergency some women make good on any job if adequately trained. However, this statement of the work women can do as satisfactorily if not more satisfactorily than men is based on the law of averages, that is, on what many women have done or are doing in other industries and can do in the aircraft industry after a limited amount of instruction.

In every department of the aircraft industry, as now organized, there are varying proportions of occupations in which women may be employed as the industry expands to an employment of 1,000,000 workers, the employment forecast for the end of 1941. In all departments there are jobs deemed not suitable for women, either because the work is beyond the average woman's physical strength ( $570/1000$  that of man) and resistance ( $679/1000$  that of man), or because the work requires lengthy experience and training which the emergency does not permit.

However, many of the jobs which women can do most effectively are to be found in production departments, such as machine shop, the press and forming, metal fabrication, bench and stainless steel assemblies, the assembly of the fuselage, wings, control surfaces, cowling, fairing, tank, final assembly, painting, covering, heat treating, anodizing, and welding departments. From a practical standpoint at the present time, departments concerned with the design, lay-out making and repairing of patterns, molds, templates, jigs, fixtures, tools, and experimental planes, and the service departments, require a high degree of mechanical skill and experience which few women have or could obtain in a short period. In the foundry, shipping, receiving, trucking, and maintenance, much of the work is intermittently heavy and concerned with cumbersome parts. The jobs involved in these departments, however, include not more than 15 percent of the total factory employment.

As a conservative estimate it seems reasonable that at least one-fourth to one-third of the jobs in the aircraft assembly plants might be filled satisfactorily by women.

As a summary suggestion the following is a list of the principal jobs on which women may be employed effectively:

### Machine Operating.

Drilling, reaming, countersinking on single, multiple drills, and pneumatic drills.

Small milling machines.

Small turret lathes.

Small and medium-sized punch presses.

Small angle bending machines and brakes.

Light grinders.

Riveting and dimpling machines.

Spot welding.

### Bench Work

Burring and filing of all kinds.

Soldering.

Hand forming over templates and blocks.

Tube cutting, bending, and assembly.

Electrical assemblies.

Wiring and bending.

Subassemblies in jigs and at benches.

### Hand and Machine Sewing of Covers and Fabric Accessories.

### Stretching of Covers on Plane Surfaces.

**Doping.**

Painting—Spraying of Small Parts, Stenciling, Applying Decalcomanias, Masking, Touch Up, etc.

Racking in Paint, Heat Treat, Anodizing, and Plating Departments.

Detail Inspection of Parts and Subassemblies.

Departmental Factory Clerks and Assistants in Planning, Parts Control, Blueprint Dispatching, and Drafting.

**Tool-Room Attendants.**

A fear seems to pervade the aircraft assembly plants' personnel managers of employing men and women side by side in the shops. As a beginning women might be tried out in the subassembly and bench-work departments where there is considerable light repetitive work, work on the control surfaces of the empennage, and on metal fabrication of small parts. Here large numbers of women could be used and men released for heavier work.

The predominating job throughout the assembly of an airplane is riveting, along with its concomitant processes of drilling, countersinking, dimpling, and bucking. Not all, but a large proportion, of the work of this kind might be done by women, and the training of girls as riveters appears to offer definite possibilities as a source of labor for an industry rapidly expanding its working force and for women seeking jobs.

## **DETAILED STATEMENT OF WOMEN'S EFFECTIVE EMPLOYMENT IN AIRCRAFT FACTORIES**

Departmental set-up and organization are not standardized, varying with size of plant and degree to which specialization and subdivision of operations are carried on. In general, however, the following are departments or divisions common to all plants.

### **PRESS AND METAL FORMING**

A press and metal-forming department of an aircraft factory which includes draw bench, drop hammer, and sheet metal departments generally comprises less than 10 percent of the total factory workers. It is estimated that 20 percent of the work could be done by women.

This department cuts and forms metal parts to specified sizes and shapes for the fuselage, control surfaces, wings, cowling, and so forth. After the rough cutting, blanking, or shaping of the parts they are either fabricated in this section or sent to a special fabrication department or one of the respective subassembly divisions. Different plants have varying amounts of bench work within the press and metal-forming department, depending on the particular plant organization. Many of the bench-work jobs, such as pneumatic drilling, burring, hand bumping of small parts over templates or wooden blocks, can be performed by women.

Punch presses are used to blank, form, and pierce webs, bulkheads, stringers, plates, ribs, gussets, reinforcements, and so forth, and in perforating slips and notching skins. Much of the work is on small and medium-sized punch presses which are light and simple to operate; this work can be done by women with very little training. Women can also do much of the drill-press work on gussets, ribs,

bulkheads, stringers, clips, skins, and so forth, most of the drilling being done with templates and jigs. Roll forming of lighter parts, angle bending on small brakes, cutting of metal with unishears, and cutting parts on nibbling machines are all functions which a woman can perform effectively.

Much of the other work in this department is very heavy and unsuitable for women because it involves the handling and cutting of large sheets of metal on power shears, and shaping and bending of metal parts with drop hammers, hydraulic presses, stretch and drawing presses, power brakes, and large power hand rollers. Large power hammers are used to shape and smooth metal contours, and hand bumping is used in forming large metal pieces over wooden blocks or metal dies; both these operations require a knowledge of shrinking and stretching properties of metal and skill in getting the metal to flow into its required shape without cracking or wrinkling.

Profilers or routers are used in trimming metal, the parts being clamped into a block and manually fed against a rotating cutter. This work would be too heavy for women because of the strength needed in manipulating the profile block against the cutter. A variety of saws (band saws, circular saws, and so on) are used in cutting metal, and since the operation involves physical hazards there is question as to the advisability of having women operate any of these.

## PRODUCTION MACHINE SHOP

In the machine shop, parts from the press and raw stock departments are machined on the various kinds of lathes, milling machines, drill presses, broaching, boring, honing, profiling, and other machines. In this section the jobs in the production machine shop are considered and not the machining of tools, dies, and special parts which require skilled mechanics. In the production machine shop the majority of the workers are operators who are not required to have all-round mechanical skill and experience.

Not more, and usually less, than 10 percent of the employees in an aircraft assembly plant are in the machine shop.

At present most of the machines are set up and run by the operator, with the set-up being checked by a leadman. Many of the runs are of fairly short duration, requiring relatively frequent changes compared to most metal industries. On the lighter machines many of the set-ups are not exacting and can be done by the woman operator; on others, where the runs are of several hours' duration, the set-up of the machines can be assigned to special set-up men.

Women can be employed on a number of the machine-shop jobs and might constitute at least one-fifth or one-fourth of the operatives.

*Drill-press work* is significant in the industry. After a short training period women can carry on at least one-half and probably two-thirds or three-fourths of the drilling, reaming, spot facing, and countersinking of parts such as bearings, flanges, levers, nuts, clamps, and so forth. The set-ups for most of the jobs on a drill press are simple, with much of the work being done on jigs with prescribed standards for speeds and tooling.

*Milling-machine operation* is another possibility for women. Ailerons, stabilizers, tubes, fittings, and other small parts are machined on light milling machines where only minor decisions have to be

made in adjusting the machines and where the replacing of cutters and set-up of fixtures and chucks are not heavy, probably being done as well by a woman machine operator as a man.

*Light turret lathes and hand screw machines* shaping the cylindrical surfaces of bars or rods for small parts are other machines on which women can be employed. The set-ups are more exacting and diversified than drill presses or small milling machines but after some experience on simpler machines women have worked successfully on them.

There is a considerable amount of *grinding* which is of a repetitive nature and though tolerances on grinding are very fine and the setting of the work and grinder is exacting, women who had demonstrated their ability on other machines could do straddle and other grinding on parts such as pistons, small bars, cylinders, and others that are of light weight. Tapping and thread grinding is another definite possibility.

*Bench jobs* of cleaning parts by hand burring with files and scrapers and straightening bar stock in arbor presses would be the simpler jobs on which women can be introduced and given a chance to show their work propensities.

On the other hand, it does not seem that the operation of engine lathes, shapers, large automatic screw machines, broaching, large boring mills, radial drills, heavy grinders, and other more unusual machines is advisable for women. The set-ups are intricate, requiring experience and skill; and lifting of heavy parts makes the employment of men preferable.

### METAL FABRICATION, BENCH WORK, AND SUBASSEMBLIES

Most of the parts that come from the press and cutting departments require a certain amount of intermediary processing before they become a part of the fuselage, panel, or other assemblies. The amount and nature of the work done in segregated fabrication and bench detail assembly departments vary with the organizational set-up of each plant, but the tendency seems to be for an increasing break-down of operations with more subassemblies and bench work. Approximately 10 percent of the factory workers in the two eastern plants visited were in metal fabrication and bench assembly divisions.

Metal skins of all sizes are reworked; stringers, ribs, webs, and bulkheads are checked and lined up on the bench; and parts such as junction boxes and instrument panels are drilled and assembled. Armament parts, ammunition boxes, chutes, firewalls, and numerous other parts and fittings of stainless or cold-rolled steel are fabricated and assembled in separate bench divisions. Edges are trimmed and burred, holes are drilled or spot faced, and some parts are set up in jigs or fixtures with temporary clips and screws as a subassembly for later riveting or welding. Tack welding and spot welding are used for some of the subassemblies. Drilling and reaming with pneumatic hand drills and riveting of light parts are common operations.

While some of the work in the fabrication and bench assembly sections is technical and complicated, most of it is the kind that women can do very well. Bench jobs requiring finger dexterity, careful following of blueprint and work orders, checking with

micrometers, scales, and gages, and the use of simple tools such as screw drivers and files, arbor presses, and vises have been held by women for years in electrical appliance and other metal-working plants, and undoubtedly at least one-half of the bench work in the aircraft industry could be carried on expeditiously and efficiently with women operatives.

### TUBING

Thousands of feet of tubing for fuel, oil, coolants, oxygen, hydraulic and electrical conduit lines are a part of every plane. Tubes are cut, bent, and assembled into subassemblies for installation in wings and final assemblies. Only about 1 percent of the factory employees are in this department. While the work must be done with precision and care, most of it is light and simple and has served as one of the beginning jobs for men and can be done equally well by women. The training period in either a classroom or the shop is not more than a few weeks.

Tubes are cut to prescribed length and then bent either by hand or machines set up with controls for angle and direction of the bend. The ends of the tubes are flared, flattened, beaded, or otherwise finished to definite specifications by hand or machine. Washers are inserted and the ends sealed after testing and inspection. Tubes are numbered and sorted for final installation. All the jobs seemed of a kind that women could carry out.

### CABLE

The cable department is another of a bench-work type, and is of only minor significance in the numbers employed. Heavy-duty cable, bonds, and flexible conduits are cut, spliced, and soldered. Bushings and fittings are attached and the strength of the cable is tested. Since it is usually a small department the work is varied, with some of the work on heavy cables, requiring considerable strength and tending to cut the hands and fingers in handling. If the size of the department warrants specialized work on the lighter cables for conduits, bonding, and antennas, this work might be done by women, but it did not seem probable that the cable department might take many women.

### ASSEMBLY

The assembly of the plane sections is performed in a variety of major subassembly departments, and the extent to which the assembly functions are broken down into separate departments varies from plant to plant. However, the major plane sections to be assembled are the fuselage, wings, control surfaces, and cowling, and all these ultimately are brought together in the final assembly department.

#### Fuselage assembly.

In the fuselage department the bulkheads, ribs, stringers, longerons, brackets, firewall, skins (metal surfaces), windshield, cabin, and so forth, are brought together by assembly into progressively larger jigs until completion of the fuselage—the long center structure of the plane which holds the cockpit, cargo, and so on, and to which the wings and tail are attached. In addition to assembly of the fuselage

there is a good deal of metal fabrication, bench work, and small sub-assembly work which serve as a fuselage detail section supplying the larger jig assemblies.

Less than 10 percent of the factory workers are in the fuselage department. Approximately 20 percent to 25 percent of the jobs in this department can be performed by women, provided they are trained in riveting, which is the most common job throughout assembly.

The bulk of the work in fuselage detail is simple riveting and detail bench work, and women can be used on both of these. Operations included are drilling, reaming, countersinking, dimpling, hand and machine burring, putting in screws preparatory to riveting. Women can do the riveting of subassemblies in small jigs using all types of riveting equipment—gun, hand squeezer, and compression. The entire interior of the fuselage is air cleaned as a last step prior to sending it to the paint shop, and women can do this to advantage.

The bulkheads, stringers, longerons, and ribs are assembled in jigs to form the structural parts for the fuselage. This is very exacting work requiring all-round skilled assemblers who have a mechanical background and ability to work from blueprints. Much of this work and the actual fitting of the skin on the fuselage involves climbing, lifting of heavy parts, and working in strained positions, thus making it an undesirable section in which to employ women.

#### **Wing and control surface assembly.**

Wings are composed of the leading edge, interspar section, trailing edge, wing tip, and internal attachments, including ribs, beams, webs, and stringers. The various types of control surfaces (empennage movable surfaces) are ailerons, stabilizers, elevators, rudders, slots, fins, and flaps; the internal structure of these is practically the same as in a wing panel, but on a smaller scale.

Approximately one-fourth of the factory workers are in either the wing division or control-surface division, and in the two eastern plants visited it is estimated that women could do about 35 percent of the work on wings and almost twice that percentage of the work on control surfaces. The latter are so much smaller than the wings that there is opportunity for a far greater range of jobs for women, and possibly whole sections in the control-surface division could be filled by women working under the direction of leadmen.

As in fuselage assembly, there are subassemblies in progressively larger jigs until the wing or control surface is completed. The jigs are made with such accuracy that the parts must be properly placed in the fixture or they will not fit, thus making them almost foolproof and decreasing the number of all-round skilled assemblers needed. Most of the work on control surfaces is bench work and small sub-assembly involving drilling, reaming, countersinking, dimpling, burring of small parts, fitting of skins with clips and fasteners, inserting screws, placing rivets in holes for gang riveting, and riveting (gun, hand squeezer, compression, and gang riveting). Women could perform most of the work except the heavier and more complicated assemblies requiring an all-round assembler who can perform several tasks, read blueprints, make assemblies without the use of a jig, and also direct the work of some of the less experienced employees. Some of the control surfaces are fabric covered and the

framework of these is sent to other departments for covering, doping, and painting.

Most of the opportunities for women's work on wing panels will be found in the detail wing division where there is bench work and subassembly work similar to that on control surfaces. Additional work which women could do includes application of neoprene tape to gas-tank seams, bonding of movable parts, putting safety wiring on nuts and bolts, and putting in elastic stop nuts, all this being done on the smaller subassemblies. Women could do the final air cleaning of the wing before it is sent to the paint shop.

Assembly of the main wing panel involves moving and handling large and heavy wing sections, considerable climbing and stretching, and working in cramped positions, thus making it an unsuitable task for women. In this stage of assembly there is additional drilling, lining up of parts, riveting, and installation of aileron controls, gun-charging pulleys, bomb-control brackets, electrical-conduit boxes and lines, wing-panel lights, attaching of wing tips, and so forth.

#### Cowling and tank assembly.

Approximately 10 percent or less of the factory employees are engaged in the assembly of cowling, tanks, fairing, cabin hoods, and windshields, and about 20 percent of the work is of a type that could be performed by women.

In general, cowling includes metal covering for the engine, nose, landing gear, and speed ring, and it is not a structural part of the plane. The amount of metal forming and fabrication done in this department varies with the type of plant organization and the extent to which metal fabrication has been centralized. Any heavy-duty metal-forming and cutting machines such as power shears, large brakes, power hammers, profilers, and rollers, as in the press and forming department, would be out for women. The fitting and assembly of large metal pieces, and the final assembly of the cowling to the engines, landing gears, and so on, also would be unsuitable.

In any cowling division there is some detail bench and subassembly work that women can do, most of the assemblies being made in jigs and fixtures. This would include the usual drilling, countersinking, buffing, burring, polishing, simple grinding, light hand bumping, some roll forming of light parts, inserting of temporary screws and fasteners for riveting, and riveting.

Women can also do some of the lighter bench work on windshields and cabin hoods, installing Plexiglas and laminated glass, occasionally putting rubber tubing around the hood edges, and putting rubber compound around seams and grooves.

Tanks are made for gas, oil, Prestone, water, and so forth, including their necessary fittings and baffles. Most of the metal-forming jobs involving the use of hand brakes, saws, rollers, shears, and sand bag forming are definitely heavy work and out for women. Any hand hammer riveting and dimpling that might be done also would be too heavy, as would tank testing in large baths. The occupations in which women could best be used include soldering of screens, oil coolers, filters, and so on, light riveting, rolling beads on baffles and light metal pieces, punching and drilling holes, assembling small parts and fittings, lock wiring fittings, burring and grinding small parts, and rubber cementing of certain tank seams.

### Final assembly.

The fuselage, wings, control surfaces, cowling, engine, instruments, and so forth, are brought together on the final assembly line. The wings are mounted on the fuselage, the control surfaces are attached, the engine is installed, the controls, tubing, conduit and junction boxes, instrument panels, control boards, charts, guns, ammunition, and everything else, are installed. There is an increasing tendency for as many assemblies as possible to be made before final assembly, and for much of the equipment, the wiring and tubing, to be installed in the major sections of the plane before reaching final assembly.

Less than 10 percent of the factory employees are in the final assembly department and not more than 15 percent of the work could be done by women.

There generally are some relatively small feeder shops off the final assembly line for the assembly of such things as accessories, controls, or electrical devices, and practically all the more suitable jobs for women are found in these feeder shops rather than on the final assembly floor. For instance, women would be especially adaptable for most of the work on electrical assemblies such as cutting wire, putting identification tags on wiring, soldering terminals, light sockets, and fittings, assembling a variety of instrument boards, switch boxes, or panel boxes. Other bench work for women might include lock wiring, bonding, and putting fittings on engine accessories, including oil coolers, oil drains, carburetors, fuel pumps, temperature regulators, and assembling engine control rods, control cables, chutes, racks, pulley housing.

Much of the work on the final assembly line involves crawling in and out of narrow passages, working in strained positions, climbing around the outside of the ship, and working from quite high platforms, thus making this an undesirable place in which to employ women. Also, as yet there is not a high degree of specialization in jobs and instead each assembler must work interchangeably on several tasks. Often there is a segregation of work so that one group works on power plant assembly, another on control surfaces, another on engine controls, another on fuel and oil system, and so on, but even so, each person does a variety of things that require some general mechanical knowledge. However, as production increases and more of a division of labor is used it would be possible for women to do some of the lighter tasks and those requiring the least amount of climbing. For the present the final assembly line is one of the more untenable places in which to employ women.

## WELDING

### Torch welding.

When most planes were fabric covered, with a skeleton of welded steel tubes to carry the construction strain, the relative need for welders was greater than under the present monocoque type of construction. Engine mounts, however, still are steel torch-welded assemblies, and aluminum tanks, boxes of various kinds, stacks, and other fittings of alloys are assembled and made tight with acetylene, oxygen, or hydrogen welding. Altogether, however, torch welders make up less than 2 percent of all productive workers. Welding of this kind has always been considered a skilled job requiring training

and years of experience to become adept, and most of the welders in the aircraft industry are men with work histories of 5 and more years at their trade. The Army and Navy standards require all welders on stressed parts to pass an exacting test of their ability to lay smooth penetrating welds without burning the metal and these tests are repeated at periodic intervals. Though women were successful welders during the first World War and are occasionally found in metal plants at the present time, the probability of any appreciable number qualifying without years of experience and long periods of training seems slight, and since only a small proportion of the force are welders the needs and possibilities for women as torch welders are negligible.

### Spot welding.

New engineering developments are increasing the use of spot welding as a substitute for riveting in fitting the skins on parts such as the wings and control surfaces. Spot welding makes a smooth surface, is faster and cheaper than riveting, and its applications probably will increase, so the demand for spot welders should be an expanding one.

The spot-welding operation is relatively simple. Voltage and amperage standards have been specifically worked out for the various metal thicknesses and weights and these can be quickly set up or checked by a leadman. The physical effort required to operate a spot-welding machine is light and when the skin parts were cumbersome in size in one plant visited they were suspended by hooks and pulleys from overhead supports. As a part of the spot welding of skin parts, there are simple preliminary wire brushing operations to clean the surface and reduce resistance. After the weld has been made, the part is rolled on a special machine to remove slight gaps and stresses and is given a final buffing as a finishing process. On large pieces these last operations might be unwieldy for women but it is not heavy work. It seems that women could become adept at spot welding, and though the present proportion employed on this job is small, the possibilities for future expansion would warrant the consideration of women's training as spot welders.

## COVERING DEPARTMENT

The few women who are found in the productive division of aircraft manufacture are chiefly in the covering department, and in this department their jobs usually are limited to hand- and machine-sewing operations. The structural skeletons of ailerons, rudders, elevators, and wing tabs are the only surfaces being covered with fabric to any extent. Women sew the control surface covers on regular single- and double-needle sewing machines and also sew covers for motors, tool kits, head rests, and upholstery parts. Men usually are employed to stretch the fabric to the proper tension and tautness and to do the rib lacing or rib staying which holds the cover securely in place. In one plant where a special order for dive bombers with fabric-covered fuselage and wings was being filled, women were doing most of the taping of the structural parts—a preliminary operation before covering—and were helping with the stretching of the fabric. Stretching fabric covers on plane parts was considered

a strenuous job by some of the men interviewed but the women in this plant were doing it with apparent ease and dispatch. The ends of the covering were finished by hand sewing, using the baseball stitch. The covering and sewing room is a small department but practically all the jobs could be done successfully by women.

### DOPING, PAINTING, AND ANODIZING

After the control surfaces have been covered, several coats of dope—liquid acetate paint—are applied to the fabric surfaces to make them taut and waterproof. Finishing tape for extra reinforcement over the ribs is attached before the final doping coats are applied. All doping was being done by men but might be done by women.

In the case of many of the parts, they are sent before assembling to the paint department for anodizing, to build up resistance against corrosion. Anodizing is an electro-chemical process, and in the suspension of the parts in large tanks on overhead hoists or racks is similar to plating. Some parts are cadmium plated. In the plating and anodizing processes only a few persons are employed and about the only work that could be done by women would be wiring small parts and hanging them on racks, and unracking after the operation has been completed.

In the paint shop large assembled parts are sprayed in paint booths by skilled men painters, who usually wear transparent shields. The working conditions in the paint shop are disagreeable—fumes and spattering paint covering and stiffening clothing and shoes. Some small parts are painted in table booths and others are dipped. Surfaces and parts not to be painted are masked with paper and various kinds of masking tape. Decalcomania transfers and stencils are used in the painting of insignia, numbers, letters, and other special designations and inscriptions on the plane.

Women occasionally do masking in the paint shop and might be employed for practically all this work. They could also do spray painting of small parts, rack parts for dipping, and serve as general helpers. On the whole, however, the work of the paint shop does not affect large proportions; though women can do the work, it is not one of the most desirable places in which women might be placed.

### HEAT TREATMENT

Many metal parts are heat treated to normalize the strains, to give tensile strength, or to change the physical properties of the metal while in process. Sizes of the pieces handled vary from very small to very large. Some metals are heat treated in electric ovens and others in chemical baths, with various methods of cooling naturally or by immersion in or spraying with liquids. Small parts are wired together for heat treatment. Bolts, nuts, screws, and similar parts are given insulating coatings of substances such as asbestos cement, and the application of this coating is light work. The numbers involved in the department are small, only a fraction of 1 percent, and about the only job women might do would be to serve as helpers on light wiring of parts, cleaning, and applying oil coatings on steel before heat treatment. Heat and fumes from the ovens and tanks

make this a disagreeable working place and, like the paint department, it is not a section where many women could be used satisfactorily.

About 10 percent of the jobs in aircraft are in the tools, parts, and production control and inspection divisions, which are not directly productive.

## INSPECTION

Every part and every job has specific standards in aircraft which must be met. Inspectors check parts and operations at almost every step and constitute 5 percent and more of the total factory force. In most instances inspectors work on the factory floor alongside of the operatives and must be thoroughly familiar with the construction and technique of aircraft production. Women are not experienced enough in the industry to serve as floor inspectors on complicated assemblies. However, in the departments which have special sections inspecting incoming parts and small subassemblies, women could be used advantageously. Testing on hardness-testing machines such as the Rockwell, inspection with gages, micrometers, and checking to simple blueprint specifications could be done as well by women as men, and such inspection jobs are now held by women in the aircraft engine and instrument plants and many other metal-working plants. At least one-fourth of the inspection could be done by women and in case of a dearth of male workers considerably more.

## TOOL ROOM

Tool grinders and repair men are skilled all-round mechanics working to high degrees of precision with close tolerances and it is not probable that women could qualify for such work. In the tool crib, however, where tools, dies, and small parts are issued, women might well be used. Tools must be kept in their proper boxes or bins, and check-out tickets and receipts are issued. Tool-room employees must be familiar with types, sizes, and properties of the tools.

A knowledge of decimal equivalents and ability to read micrometers, scales, and other gages is needed. The work of checking out tools and keeping records is of a storekeeping nature. Similar work in the receiving and stores division could be done by women.

## PRODUCTION PLANNING AND ROUTING

In the planning department the jobs are largely those of factory clerks. The keeping, routing, and dispatching of blueprints could be carried on by women, and also clerical work in the charting, issuing of orders, and checking the progress of component parts and assemblies. Production schedules are set up for each part and usually for each worker. Maintaining these standards is part of the supervisory duties of the foremen, but clerks from the planning department often have to follow up parts and reroute work on the floor for additional processing, which requires a knowledge of plant methods and lay-out. As their experience in the industry accumulates women should be able to fill these jobs as well as those that are more strictly clerical.

