Employment of Women in the Manufacture of Cannon and Small Arms in 1942

By

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WOMAN OPERATING JONES & LAMSON TURRET LATHE IN 20-MM. GUN PLANT. SIX-POSITION TURRET WITH A VARIETY OF CUTTING TOOLS.
Employment of Women in the Manufacture of Cannon and Small Arms in 1942

INTRODUCTORY

Earlier Survey in Canada.

A number of Canadian war plants making small arms and cannon were visited by representatives of the Women’s Bureau in January 1942 to observe the role women were playing in wartime production. Before the United States entered the war Canada recognized the imperativeness of bringing women into all phases of the war program as her men were drawn off into military service. As new cannon and small-arms plants were established, women were taken on as an integral part of the productive force, though most of them had had no industrial experience as Canada was not highly industrialized. Many were put through quick training courses prior to placement on the various types of factory operations. In one rifle plant two-thirds of the factory workers were women, and plans in general were to use 60 to 75 percent women in small-arms and cannon manufacturing.

Survey in the United States.

A comparative study of the work women are doing in the United States and of the occupations to which their employment can be extended was made in small-arms and cannon manufacturing during the summer of 1942. Four Government arsenals and four private firms were covered in the States of Massachusetts, Connecticut, New York, Michigan, Ohio, and Illinois.

The layman considers the term “guns” to cover everything from revolvers to huge coastal defense guns, but in a technical sense “guns” includes only large-caliber cannon, while the terms “small arms” and “firearms” include small-caliber weapons. “Small arms” (firearms) include hand and shoulder weapons such as rifles, pistols, revolvers, shotguns, machine guns, and other automatic arms having a bore of 0.60 inch (caliber .60) or under. All weapons of over .60 caliber are classed as “cannon” or “guns,” and these include howitzers, mortars, railway artillery, antiaircraft artillery, field artillery, naval guns, tank guns, and antitank guns. Under the metric system the division is “less than 20 mm.” and “20 mm. or over.” Though gun mounts, gun turrets, gun carriages, and so forth are included in the classification of “guns,” this study does not deal with the manufacture of such related equipment but is confined to the manufacture of the actual gun itself.


2 Hayes, Col. Thomas J., Elements of Ordnance, 1938, p. 624.
In the arsenals visited there was a considerable amount of experimental and repair work on castings, carriages, gun mounts, tanks, cannon, and small arms, in addition to actual production. Two of the plants made cannon ranging from the small 37-mm. guns to large-caliber cannon such as the 16-in., 14-in., 12-in., 155-mm., and 105-mm. Another did much experimental work on gun carriages, gun mounts, and tanks, but also manufactured and repaired machine guns. One firm produced chiefly small arms but also a few small-size (37-mm.) cannon. The four remaining establishments manufactured only small arms, including Garand rifles, Springfield rifles, Browning machine guns (.30- and .50-caliber), Thompson submachine guns, automatic pistols, and shotguns. The arsenals and two private firms were old-line small-arms and cannon manufacturers, but two of the private firms had converted from completely different lines of commercial production.

The establishments covered ranged in size from 4,000 to 15,000 employees, with a total employment in all 8 plants of about 75,000, 11,000 (15 percent) being women. There was great variety in the extent to which women were employed at time of survey, the percentage of women among total employees in the eight plants being respectively 3, 6, 11 (2 cases), 14, 19, 23, and 30. Those with the lowest proportions had only recently taken on women, a condition resulting from differences in male labor supply in the areas, differences in degree of stringency on the part of local draft boards in granting occupational deferments, and differences in outlook on the part of management as to the feasibility of using women.

The arsenals employed women on a limited number of factory operations at the time of World War I, but none were employed in peacetime, as arsenal production and activities diminished greatly. Very often women had not even been retained in the offices of the arsenals, but during the last months of 1941 and the first half of 1942 office managers again turned to the employment of women. The two regular private small-arms manufacturers had employed a few women in peacetime on filing, burring, polishing, and punch-press operations but the number was less than 1 percent. The expansion in women’s employment started in one plant in the middle of 1941 and in the other in the summer of 1942. The two firms converted from commercial production had always used many women in their regular line of manufacture and they placed women on factory work from the inception of wartime production, one in the fall of 1940, the other in the middle of 1941.

The analyses of occupations in small-arms and cannon manufacturing are replete with examples of the fallacy of considering war-industry occupations as traditionally men’s or women’s. In the transition period of hiring great numbers of women, men and women interchange on the same or comparable work on the same shift, or women do work on the day shift performed by men on the night shift. A certain type of work performed extensively by women in one plant may be done entirely by men in another plant. For instance, one arsenal had no women employed on even the simplest or lightest machine operations in making small-arms components, but had them driving electric trucks and car-loading machines, making large wooden packing boxes, operating band saws and nailing together the pack-
ing boxes. Other firms had no women on these operations but employed 60 percent women in certain machining departments.

In small-arms and cannon manufacturing women were operating a wider array of types and sizes of machine tools than in any other industry studied by the Women’s Bureau. This is significant because the standard machine-tool equipment that women have demonstrated they can operate has a wide application in other war industries. For this reason considerable detail is given in this report as to the specific machine makes and sizes as an indication of what women are doing and can do on machine tools.

Two plants were practically at peak employment and new persons hired were chiefly replacements. The other firms were in the process of expansion, having attained anywhere from 65 to 90 percent of their peak employment. At best, however, estimates of peak employment were mere approximations contingent on many indefinite factors. In all instances the plans were to use many more women in both factory and office work, there being opportunities for materially increasing the number of women in the office just as in the plant, as 40 to 82 percent of the office workers in the small-arms plants were men. The ultimate number of women that may be employed is dependent largely on the stringency of the male labor supply in each area, the extent to which draft boards may grant occupational deferments to the men, and the success of women on different types of work.

Due to the comparative lightness of the work it is possible to use many more women in small-arms manufacturing than in cannon manufacturing. It is estimated that up to 75 percent of the total employees may be women in small-arms manufacturing and up to 40 percent may be women in cannon manufacturing.

3 Studies have included machine-tool manufacturing, airframe assembly, small-arms ammunition and artillery ammunition manufacturing, and aircraft, optical and fire-control, and surgical and dental instrument manufacturing.
SMALL-ARMS MANUFACTURING AND THE EMPLOYMENT OF WOMEN

The small-arms firms visited make Garand rifles, Springfield rifles, Thompson submachine guns, .30-caliber and .50-caliber Browning machine guns (water cooled and air cooled), revolvers, automatic pistols, and shotguns. They assemble the arms and make most of the component parts, though there is some subcontracting which will be expanded as production quotas increase through new contracts. So much of the work involves use of standard machine-tool equipment that it is a logical field in which to develop subcontracting among the many machine shops.

Four of the plants manufactured solely small arms, a fifth manufactured mainly small arms but also some small cannon, and a sixth did much research and experimental work on gun mounts, gun carriages, mobile artillery, and tanks but manufactured some .30-caliber Browning machine guns. The percentage of women among the total employees in the six plants was respectively 3, 11, 23, 30, 19, and 11. The one with the largest proportion of women is a private establishment with many years of experience in employing great numbers of women in its regular line of commercial production, and in conversion to wartime production it carried over the policy of using women wherever possible. Those with the lowest percentages of women have been able to get liberal draft deferments for the men and a sufficient number of new male workers as the need arises; in the spring of 1942 male labor shortages began to develop and draft boards were not granting so many occupational deferments, which gave rise to an expansion in women’s employment.

Detailed employment reports from four small-arms plants covering 39,619 workers reveal that 70 percent of the employees were on factory production, including machine operators, assemblers, and inspectors; 22 percent were factory nonproductive workers, including tool-crib and stock-room attendants, tool-room workers, service and maintenance workers, laboratory technicians, tool and gage designers, production engineers, factory clerical workers, and so forth; and 8 percent were office workers in administrative, personnel, accounting, engineering, and purchasing and procurement departments. The proportion of women in each of these three main categories varied greatly in the four plants covered. Women averaged 20 percent of the factory productive workers, their percentage in the four plants being respectively but a fraction of 1, 19, 24, and 40. Women averaged 8 percent of the factory nonproductive workers, with respectively less than 1, 11, 10, and 4 percent; and they averaged 35 percent of the office workers, with respectively 18, 43, 60, and 19 percent. Seventy-five percent of all women employed were factory productive workers, 9 percent were factory nonproductive workers, and 16 percent were office workers. The varying departmental segregations of employees in different plants necessitates a consolidation of major groups as shown in the accompanying table.
### Departmental distribution of employees in four small-arms manufacturing plants

<table>
<thead>
<tr>
<th>Department</th>
<th>All workers</th>
<th>Men</th>
<th>Women</th>
<th>Percent of total</th>
<th>Percent of total workers</th>
<th>Percent of total women</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Grand total</strong></td>
<td>39,619</td>
<td>32,226</td>
<td>7,393</td>
<td>100.0</td>
<td>18.7</td>
<td>100.0</td>
</tr>
<tr>
<td><strong>Total factory—Productive</strong></td>
<td>27,653</td>
<td>22,089</td>
<td>5,564</td>
<td>69.8</td>
<td>22.8</td>
<td>75.3</td>
</tr>
<tr>
<td>General machining departments</td>
<td>12,796</td>
<td>9,884</td>
<td>2,912</td>
<td>32.3</td>
<td>22.8</td>
<td>39.4</td>
</tr>
<tr>
<td>(machines of all types)</td>
<td>2,047</td>
<td>1,789</td>
<td>258</td>
<td>5.2</td>
<td>12.6</td>
<td>8.5</td>
</tr>
<tr>
<td>Barrel manufacturing</td>
<td>2,126</td>
<td>1,212</td>
<td>74</td>
<td>3.2</td>
<td>5.8</td>
<td>1.0</td>
</tr>
<tr>
<td>Turret lathes, engine lathes,</td>
<td>1,074</td>
<td>980</td>
<td>94</td>
<td>2.7</td>
<td>8.8</td>
<td>1.3</td>
</tr>
<tr>
<td>automatic screw machines</td>
<td>441</td>
<td>343</td>
<td>98</td>
<td>1.1</td>
<td>22.2</td>
<td>1.3</td>
</tr>
<tr>
<td>Heavy grinders, hacksaws,</td>
<td>1,601</td>
<td>1,140</td>
<td>20</td>
<td>2.9</td>
<td>1.7</td>
<td>0.3</td>
</tr>
<tr>
<td>pressies, welding, forge</td>
<td>1,941</td>
<td>1,432</td>
<td>309</td>
<td>4.9</td>
<td>15.9</td>
<td>6.3</td>
</tr>
<tr>
<td>Woodworking machines</td>
<td>1,203</td>
<td>872</td>
<td>331</td>
<td>3.0</td>
<td>26.8</td>
<td>2.6</td>
</tr>
<tr>
<td>Heat treat, parkerize, sandblast,</td>
<td>1,580</td>
<td>1,102</td>
<td>102</td>
<td>3.3</td>
<td>8.4</td>
<td>0.8</td>
</tr>
<tr>
<td>barrel tumble, plate</td>
<td>339</td>
<td>248</td>
<td>91</td>
<td>0.9</td>
<td>29.6</td>
<td>2.9</td>
</tr>
<tr>
<td>Polishing and filing</td>
<td>250</td>
<td>182</td>
<td>68</td>
<td>0.7</td>
<td>27.7</td>
<td>2.6</td>
</tr>
<tr>
<td>Subassembly and final assembly</td>
<td>4,804</td>
<td>3,357</td>
<td>1,527</td>
<td>12.3</td>
<td>31.4</td>
<td>20.7</td>
</tr>
<tr>
<td>Assembly, packing, and repair</td>
<td>243</td>
<td>240</td>
<td>3</td>
<td>0.6</td>
<td>1.2</td>
<td>0.1</td>
</tr>
<tr>
<td>Inspection and proof firing</td>
<td>2,642</td>
<td>2,358</td>
<td>284</td>
<td>6.7</td>
<td>10.7</td>
<td>3.8</td>
</tr>
<tr>
<td>Trainees and apprentices</td>
<td>8,616</td>
<td>7,945</td>
<td>671</td>
<td>21.7</td>
<td>7.8</td>
<td>9.1</td>
</tr>
<tr>
<td><strong>Tool room (toolmaking)</strong></td>
<td>2,642</td>
<td>2,358</td>
<td>284</td>
<td>6.7</td>
<td>10.7</td>
<td>3.8</td>
</tr>
<tr>
<td>Tool cribs</td>
<td>215</td>
<td>199</td>
<td>16</td>
<td>0.5</td>
<td>0.7</td>
<td>0.2</td>
</tr>
<tr>
<td>Stock rooms</td>
<td>816</td>
<td>716</td>
<td>100</td>
<td>2.1</td>
<td>12.3</td>
<td>1.4</td>
</tr>
<tr>
<td>Shipping and receiving</td>
<td>212</td>
<td>192</td>
<td>20</td>
<td>0.5</td>
<td>9.4</td>
<td>0.3</td>
</tr>
<tr>
<td>Service and maintenance</td>
<td>3,219</td>
<td>3,169</td>
<td>50</td>
<td>8.1</td>
<td>1.7</td>
<td>0.1</td>
</tr>
<tr>
<td>Gage control and gage inspection:</td>
<td>292</td>
<td>248</td>
<td>44</td>
<td>0.7</td>
<td>15.1</td>
<td>0.6</td>
</tr>
<tr>
<td>tool and gage design Laboratory</td>
<td>106</td>
<td>87</td>
<td>19</td>
<td>0.3</td>
<td>17.9</td>
<td>0.3</td>
</tr>
<tr>
<td>Production control</td>
<td>227</td>
<td>190</td>
<td>37</td>
<td>0.4</td>
<td>16.3</td>
<td>0.3</td>
</tr>
<tr>
<td>Production engineering, safety,</td>
<td>157</td>
<td>133</td>
<td>24</td>
<td>0.2</td>
<td>15.3</td>
<td>0.3</td>
</tr>
<tr>
<td>efficiency, methods</td>
<td>730</td>
<td>653</td>
<td>77</td>
<td>1.8</td>
<td>10.5</td>
<td>1.0</td>
</tr>
<tr>
<td>Factory clerical not elsewhere</td>
<td>3,350</td>
<td>2,192</td>
<td>1,158</td>
<td>8.5</td>
<td>34.6</td>
<td>15.7</td>
</tr>
<tr>
<td>itemized</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total office</strong></td>
<td>3,350</td>
<td>2,192</td>
<td>1,158</td>
<td>8.5</td>
<td>34.6</td>
<td>15.7</td>
</tr>
<tr>
<td>Personnel, time study, cost,</td>
<td>558</td>
<td>365</td>
<td>193</td>
<td>1.4</td>
<td>34.6</td>
<td>2.6</td>
</tr>
<tr>
<td>pay roll</td>
<td>266</td>
<td>120</td>
<td>146</td>
<td>0.7</td>
<td>54.9</td>
<td>2.0</td>
</tr>
<tr>
<td>Accounting, finance, tabulating,</td>
<td>172</td>
<td>21</td>
<td>151</td>
<td>0.4</td>
<td>87.8</td>
<td>2.0</td>
</tr>
<tr>
<td>mail and record</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Procurement and purchasing</td>
<td>332</td>
<td>362</td>
<td>30</td>
<td>0.8</td>
<td>9.0</td>
<td>0.4</td>
</tr>
<tr>
<td>Engineering</td>
<td>62</td>
<td>51</td>
<td>11</td>
<td>0.2</td>
<td>82.3</td>
<td>1.7</td>
</tr>
<tr>
<td>Medical</td>
<td>1,960</td>
<td>1,373</td>
<td>587</td>
<td>4.9</td>
<td>29.9</td>
<td>7.9</td>
</tr>
<tr>
<td>Administrative offices not elsewhere</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1 Less than 0.05 percent.

### MACHINE-OPERATION PROCEDURES

Characteristic of small-arms manufacturing is the predominance of machine-tool operations, machine operators on production work composing 44½ percent of the total plant and office workers, or 64 percent of the factory productive workers. On each of the multiplicity of parts going into any weapon there is a gradual process of "worrying the metal away" by a series of machining operations bringing parts down to very fine tolerances. Most of the small arms and guns used in modern warfare must have "interchangeable" parts, making it possible for those worn and damaged to be replaced with spare parts when weapons are in actual use in the field. Interchangeability is imperative also when parts going into one weapon are manufactured by different subcontractors.

The .30-caliber Browning machine gun (air cooled) has 189 parts, with 1,800 separate machining operations—for example, 57 operations on the barrel extension, 66 on the bolt, and 38 on the barrel, these parts being some of the major components. An example of the large
amount of metal that must be removed by gradual machining is that the raw stock and forgings for one type of machine gun weigh 101 pounds and the finished steel parts weigh 18 pounds. Among the major components are the gun-body forging, weighing 45 pounds in contrast to the finished gun body's 5\(\frac{1}{2}\) pounds, the barrel forging weighing 10 pounds and the finished barrel 6 pounds, the slide-butt forging weighing 22 pounds and the finished slide butt 4 pounds.

**Plant Lay-out.**

The small-arms factories have been laid out on a straight line-production basis as much as possible, with some machines set up for one operation for the duration of the war, but others must be fitted with several tools to perform a series of operations. There are variations in plant lay-out, some having machines arranged by type with milling machines, drill presses, grinders, and so forth, in separate departments, all parts being routed to these departments for their respective milling, drilling, and grinding operations. Others have departmental segregations based largely on the parts manufactured, such as the barrel, barrel extension, trunnion block, bolt and receiver, with machine tools of all types necessary to make each part. There are also miscellaneous machining departments where parts of all sizes are made.

The usual practice is to have somewhat of an intermixture of the two methods, some departments composed of machines of one type and other departments composed of all machines necessary to make some major component as the barrel, trunnion block, or bolt, and other general machining departments making a whole array of parts.

**Types of Machines.**

The equipment varies somewhat from plant to plant because different types of machines can be adapted to perform the same operation, but most of them are standard machine tools. There is always a very marked predominance of milling machines due to their adaptability for doing a variety of work. Most of the small-arms factories have 40 to 50 percent milling machines, 10 to 20 percent drill presses, with profilers, grinders, barrel machines, lathes, and so forth following next in importance as shown below. A typical small-arms plant inventory shows the following distribution of principal machine-tool items:

<table>
<thead>
<tr>
<th>Type of machine</th>
<th>Number</th>
<th>Percent of total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>2,608</td>
<td>100.0</td>
</tr>
<tr>
<td>Milling machines</td>
<td>960</td>
<td>36.8</td>
</tr>
<tr>
<td>Drill presses</td>
<td>302</td>
<td>11.6</td>
</tr>
<tr>
<td>Profilers</td>
<td>291</td>
<td>11.2</td>
</tr>
<tr>
<td>Barrel machines (drills, reamers, etc.)</td>
<td>226</td>
<td>8.7</td>
</tr>
<tr>
<td>Grinders</td>
<td>214</td>
<td>8.2</td>
</tr>
<tr>
<td>Lathes (turret lathes and engine lathes)</td>
<td>201</td>
<td>7.7</td>
</tr>
<tr>
<td>Automatic screw machines</td>
<td>126</td>
<td>4.8</td>
</tr>
<tr>
<td>Woodworking machines</td>
<td>122</td>
<td>4.7</td>
</tr>
<tr>
<td>Thread grinders and thread millers</td>
<td>46</td>
<td>1.8</td>
</tr>
<tr>
<td>Punch presses</td>
<td>37</td>
<td>1.4</td>
</tr>
<tr>
<td>Shapers</td>
<td>34</td>
<td>1.3</td>
</tr>
<tr>
<td>Shavers (slotters)</td>
<td>32</td>
<td>1.2</td>
</tr>
<tr>
<td>Broaches</td>
<td>7</td>
<td>.3</td>
</tr>
<tr>
<td>Planers</td>
<td>3</td>
<td>.1</td>
</tr>
<tr>
<td>Miscellaneous (drop hammers, shears, etc.)</td>
<td>7</td>
<td>.3</td>
</tr>
</tbody>
</table>

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Machine Operators.

The distribution of machines by type does not give a wholly true occupational distribution of machine operators because of the common practice of having one person run more than one machine.

Either a series of operations is performed on one part using one machine at a time, or concomitant operations are performed keeping all machines going at once. In some plants a battery of six to eight machines is kept running by a single operator, the worker constantly moving from one machine to another loading and unloading parts. Where several machines are operated at one time, the speed is not so high and the machining cycle is longer, making multiple operation possible. Sometimes when the machining cycles are relatively long the operator runs fewer machines, perhaps only one, but files and burrs parts as well. Most operators make spot checks of parts, using micrometers, calipers, or fixed gages.

Examples of combinations of machines operated both by men and by women

- Cincinnati power mill No. 0-8, hand mill, and drill press.
- Brown & Sharpe mill No. 000, 3 machines operated by one person.
- Fellows Gear Shaper, 3 machines operated by one person.
- Cincinnati mill No. 1-12 and a drill press.
- Automatic profiler and a drill press.
- Natio drill (multiple spindle), Leland Gifford drill, and Cincinnati mill No. 0-8.
- Hand mill, bench profiler, and two Cincinnati mills No. 0-8.
- Pratt & Whitney profiler and 3 hand mills.
- Two hand mills and one Milwaukee mill Model H.

In two plants where detailed occupational figures are available there is the following breakdown of machine operators, who are classified according to type of machine on which they spend most of their time.

<table>
<thead>
<tr>
<th>Type of machine</th>
<th>Number of operators</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>4,710</td>
<td>100.0</td>
</tr>
<tr>
<td>Milling machine</td>
<td>2,182</td>
<td>46.3</td>
</tr>
<tr>
<td>Barrel machine</td>
<td>441</td>
<td>9.4</td>
</tr>
<tr>
<td>Profiling machine</td>
<td>420</td>
<td>8.9</td>
</tr>
<tr>
<td>Woodworking machine</td>
<td>400</td>
<td>8.5</td>
</tr>
<tr>
<td>Grinder</td>
<td>334</td>
<td>7.1</td>
</tr>
<tr>
<td>Lathe</td>
<td>268</td>
<td>5.7</td>
</tr>
<tr>
<td>Drill press</td>
<td>223</td>
<td>4.7</td>
</tr>
<tr>
<td>Punch press</td>
<td>156</td>
<td>3.3</td>
</tr>
<tr>
<td>Automatic screw machine</td>
<td>99</td>
<td>2.1</td>
</tr>
<tr>
<td>Broaching machine</td>
<td>55</td>
<td>1.2</td>
</tr>
<tr>
<td>Shaper or shaving machine</td>
<td>52</td>
<td>1.1</td>
</tr>
<tr>
<td>Thread mill, honing, or die-sinking machine</td>
<td>52</td>
<td>1.1</td>
</tr>
<tr>
<td>Hacksaw or power shear</td>
<td>28</td>
<td>.6</td>
</tr>
</tbody>
</table>

Machine Setters.

The usual practice is to have machine setters who make all the machine set-ups so that the operators need only load and unload the machines and make spot checks of parts, using gages, micrometers, and calipers. Usually the plant lay-out, routing of work, and time allocation on each operation are premised on a system of set-up men for the majority of the machine operators, and the fact that women have been brought into the plants has not necessarily entailed the use of extra set-up men. As a means of making the maximum use of
skilled manpower it has proved advantageous to have men with 
machine-setting ability devote all their time to that, while unskilled 
workers are trained to carry on the more routine operation of 
machines.

In none of the plants visited were women employed as full-time 
machine setters, but it would be possible to train them for this work. 
Though machine setters generally are provided, some operators are 
required to make their own set-ups of short runs of certain parts. 
Men usually are employed on such work, but in some instances 
women set their own machines and more and more reliance is placed 
on their ability to do this, given the opportunity to learn.

Movemen and Material Handlers.

Material handlers or movemen are usually employed to move “tote 
boxes” an dtake materials and supeipls to and from the machine 
operators, thus enabling the operators to devote all their time to 
machine tending. The contention is sometimes made that extra 
movemen must be employed when women are hired, but this is 
hardly a legitimate reason for considering that women should not 
receive the same rate as men for the job. If the former male ma­
chine operators spent part of their time moving materials this was 
no economy, because such time would be paid at the machine opera­
tors' rate rather than that of a laborer. If extra movemen have been 
hired, the operators' efficiency and output may have increased suf­
ficiently to more than offset the laborers' wages, and in the last 
analysis the all-over labor cost per unit of output is the major con­
sideration.

MACHINE OPERATORS

As already pointed out, 44½ percent of the total employees were 
machine operators, about one-fifth of these being women. All but one 
of the small-arms firms had women on machine operations, the pro­
portion in some machining departments running as high as 60 per­
cent. Usually they were employed in general machining depart­
ments where smaller parts were made, but an increasing number 
were being placed on major components as well, such as the bolt, 
receiver, trunnion block, and so forth. The extent to which women 
can work on large parts is shown by the proportion of women em­
ployed in some of the machining departments of the plant most 
advanced in its use of women:

<table>
<thead>
<tr>
<th>Department</th>
<th>Total number</th>
<th>Percent women</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>of operators</td>
<td>in total</td>
</tr>
<tr>
<td>General machining</td>
<td>1,388</td>
<td>57.3</td>
</tr>
<tr>
<td>Barrel extension</td>
<td>287</td>
<td>32.1</td>
</tr>
<tr>
<td>Trunnion block</td>
<td>564</td>
<td>48.2</td>
</tr>
<tr>
<td>Bolt</td>
<td>390</td>
<td>34.9</td>
</tr>
<tr>
<td>Side plates and cover</td>
<td>226</td>
<td>48.7</td>
</tr>
</tbody>
</table>

Management's constant search for improved production techniques 
to lighten the machine operations made it possible for women to do 
a considerable share of the work on larger parts. New fixtures 
were designed to replace heavy arbors; benches or machines were 
raised or lowered to improve work lay-out and reduce lifting; con­
veyors were installed to slide parts from one machine to another; 
operations were broken down, separating the very heavy work from
the medium-heavy and light work; and the skill required in operating certain machines was reduced by installing automatic stops and adjusting machines for depth of cut.

The following analysis of specific machine operations performed by women is by type of machine rather than on a departmental basis because the machine is more significant than the department.

**Milling-Machine Operators.**

More women were operating milling machines than any other one type of machine; in one plant 35 percent of the women were milling-machine operators. Hand mills and small and medium-size power mills were the most numerous types of milling machines. Women generally operated hand mills, Brown & Sharpe mills Nos. 0.000, 12, and 2, Cincinnati mills Nos. 0–8, 1–12, and 1–18, Van Norman mill No. 118, and spline mills. The plant employing the largest proportion of women in factory work had no men on hand mills, small milling machines, and medium-size mills except for a very few operations on large parts too heavy for women to handle.

Typical milling machines operated by women (greatest numbers on those starred)

- Cincinnati power mill No. 0–8.
- Cincinnati power mill No. 1–12.
- Cincinnati power mill No. 1–18.
- Cincinnati power mill No. 2–18.
- Cincinnati power mill No. 2–24.
- Cincinnati power mill No. 2 (vertical).
- Cincinnati power mill Hydromatic No. 3–24.
- Brown & Sharpe power mill No. 0.000.
- Brown & Sharpe power mill No. 12.
- Brown & Sharpe power mill No. 2 (plain light type).
- Brown & Sharpe power mill No. 2 (vertical light type).
- Van Norman power mill No. 118.
- Milwaukee (Kearney & Trecker) power mill, Model H.
- Milwaukee (Kearney & Trecker) power mill, Simplex 12–24 and 18–24.
- Sundstrand Rigidmil.
- Pratt & Whitney power mill.
- Taylor & Fenn spline mill.
- Pratt & Whitney spline mill.
- U. S. Multi-miller.

Milling machines most frequently operated by men and not women were large Cincinnati Hydromatics (plain and duplex), large Cincinnati vertical millers, Milwaukee duplex millers (large), and large vertical boring mills. Very often the arbors and fixtures on these machines are heavy, the controls are harder to manipulate, and the parts machined are heavy in themselves.

In some of the Canadian small-arms firms visited in the earlier survey over 60 percent of the milling-machine operators were women and this proportion was to be increased. Thirty percent of the milling-machine operators were women in one of the firms covered in the United States survey. All plants had plans for hiring many more women for milling-machine operation.
Drill-Press Operators.

Women have long been employed as drill-press operators in various industries, so finding them in great numbers in the small-arms plants was no surprise. In one plant almost 80 percent of the drill-press operators were women. They did drilling, reaming, burring, tapping, and countersinking, and much of the work was jig drilling which is easily learned.

Typical drill presses operated by women (greatest numbers on those starred)

- Avey drills Nos. ½, 1, and 2 (single and multiple spindle).
- Allen drills (single and multiple spindle).
- Delta drills (single and multiple spindle).
- Buffalo bench drills.
- Sigourney bench drills.
- Leland Gifford drills Nos. 1, 2, and 3 (single and multiple spindle).
- Krueger drills.
- Kingsbury automatic drills.
- Natco multiple-spindle drills and tappers.
- U. S. drills.
- Fosdick drills.
- Bakewell precision tappers.

Though most of the women were on small and medium-size drills, a few operated the larger and more automatic types such as Kingsbury drills, which are automatic in operation, the worker standing in one place loading and unloading the machine as a series of drilling operations is performed on a number of parts revolving in the machine at one time. The larger drills such as the Fosdick, Natco, Krueger, and United States drills generally were operated by men, and in some plants only men were employed because the parts handled were so large. However, two plants in particular were beginning to put women on larger drills. No women operated such heavy-duty machines as American Tool Works radial drills, Cincinnati Bickford radial drills, and Ex-Cello horizontal boring machines.

The only limitation on using women for drill-press work is the combined weight of the jig and the part being drilled. However, if the jig merely has to be slid back and forth on the bed of the drill without being lifted or turned over, the weight can be quite great before exceeding the strain limit expected of an average woman. To reduce the effort required to push and pull a large jig it is possible to mount a small button under each bottom corner of the jig to reduce the sliding surface, thus eliminating the suction created by sliding a flat metal surface over the bed of the drill.

Profiling-Machine Operators.

A profiling machine is a special milling machine with a master form or template that has the desired irregular shape to be machined on another piece of metal. A guide pin follows the master form while the milling cutter reproduces the part. Profilers are used extensively in small-arms manufacturing because of their adaptability in making the many irregular shapes required on gun components. Ten percent of the machine operators were profiling-machine operators. Three of the five plants employing women on machines had
a few on actual profiling and a fourth firm had women on profilors but
doing milling rather than profiling.

In hand profiling on the master-follower type of machine the opera­
tor must have a sense of touch in holding the guide pin against the tem­
plate and exert some force in manipulating the two controls at the
same time. Because the work was considered more strenuous and
more skilled than some of the rest, women were not until recently
placed on profiling, but they have demonstrated a good sense of touch
and skill and are to be employed much more extensively. Pratt &
Whitney profilers No. 12–B were the most common kind operated by
women, but others were National Broach automatic profilors, Thomp­
son profilors, Newton profilors, and Wade bench profilors.

**Grinding-Machine Operators.**

In all cannon and small-arms manufacturing there is much grinding
to attain the close tolerances and the high finishes required. Two of
the firms employed women on all types of grinding, two had none on
grinding, and a fifth had women only on wet centerless grinding be­
cause of a State law prohibiting their employment on dry grinding.
Abrasive-wheel jobs are hazardous unless protective measures are
taken, but in the plants visited precautions to protect the health of
the workers usually were adequate. Local exhausts were installed
over the machines to draw off dust particles, wheels were covered
with hoods as a protection against flying particles, and goggles and
respirators were supplied to workers.

Women most frequently operated small tool and cutter grinders,
small and medium-size surface grinders, and plain grinders such as
Norton surface grinders 6” x 18” and 6” x 30”, Brown & Sharpe sur­
face grinders No. 2, Brown & Sharpe plain grinders Nos. 5 and 12,
Norton cylindrical grinders 6” x 18”, Landis grinders, and Henry
Prentice abrasive surface grinders No. 3–B. A few operated Cincin­
nati centerless grinders No. 2 and Blanchard grinders.

As a rule men were employed on the heavy-duty Blanchard grind­
ers, Hanchett surface grinders, and Mattison grinders, which gen­
erally were used for preliminary machining operations on forgings
and bar stock. Much of this work is heavy, but it is possible to segre­
gate the light work and that had been done in some places. Women
operated one of the more automatic types of Blanchard grinders, feed­
ing small parts onto a revolving dial.

Frequently hundreds of small parts were ground down at one time
on these heavy-duty grinders, and so much time was consumed in
laying out parts, loading and unloading the machines, and burring
and gaging parts that the operators spent relatively little of their
time on actual machine tending. Hence, some plants planned to have
women lay out the work, assist with the loading and unloading of the
machines and the burring and gaging of parts, thus releasing the op­
erators to devote their time to actual machine operating on several
machines instead of one.

**Turret-Lathe, Engine-Lathe, and Automatic-Screw-Machine
Operators.**

Women constituted 6 percent of the workers in the lathe and screw­
machine departments but not all were machine operators; some were
burring, filing, and gaging parts. Two plants employed women on automatic screw machines, including Brown & Sharpe automatic screw machines Nos. 00G, 0G, 00, 0, and 2-G and Brown & Sharpe Wire-Feed screw machine No. 2. They watched the functioning of the machines, gaged parts, and did some filing and burring. Men set up the machines and kept them loaded with bar stock. The other companies had plans for employing women on smaller automatics, one planning to have all such machines operated by women. No women operated the very large automatic screw machines such as the Gridley automatics, Cleveland automatic turret machines, Cincinnati Acme automatic screw machines, and National Acme automatic screw machines. The main task on these machines is the complicated and skilled set-up work, which sometimes takes four or five days, but once set up they operate automatically, needing only occasional attention.

Three plants employed women extensively on turret lathes, engine lathes, and bench lathes; two had no women on such work. Those selected for work on large turret lathes were tall, so that they could more readily reach the multiplicity of controls.

TYPES OF LATHES OPERATED BY WOMEN

Warner & Swasey turret lathes Nos. 2, 3, and 4.
Bardons & Oliver turret lathes.
Gisholt turret lathe Nos. 4 and 1-L (large).
South Bend bench lathe.
Rivett bench lathe.
Pratt & Whitney bench lathe.
Hardinge bench lathe.

Only a few women operated the large-size turret lathes, the work on these being without question more strenuous than on most other types of machines. The parts are heavier, the hand tools required are heavier, and the expanse of the machine itself makes it more strenuous to operate. Bullard vertical turret lathes, Warner & Swasey turret lathes Nos. 2–A, 4–A, and 3–A, Potter & Johnston turret lathes No. 6–A, Jones & Lamson lathes Nos. 7A5, 8B, 8C, 8A, and the largest Bardons & Oliver turret lathes and largest Gisholt turret lathes were all operated by men. These are used in machining the very heaviest parts and for rough machining forgings.

Barrel-Machine Operators.

Barrels are generally manufactured in separate departments with machines set up on a production-line basis. Variations were found in the extent to which women were engaged on barrel-machining operations, two firms employing no women, a third employing them on a very few operations, and a fourth having 21 percent women in its barrel departments. The last named had no women working on .50-caliber barrels but had them on practically every operation on .30-caliber barrels.

The general machining operations on any barrel are about the same, and to assist in the visualization of the types of work involved and the extent to which women were employed, a sequence of principal operations on a .30-caliber barrel is given on pages 13–14.
SMALL-ARMS MANUFACTURING

Operation

Squaring and countersinking both ends to working length, Davis & Thompson cut-off and centering machine.

Rough milling butt end, Brown & Sharpe mill No. 12. Rough milling muzzle end to working length, Brown & Sharpe mill No. 12.

Turning muzzle end for drilling-machine chucks, LeBlond engine lathe.

Spot grinding for steady rest, Norton cylindrical grinder 6" x 30". Rough turning and chamfering breech end, Jones & Lamson Fay automatic lathe 12" x 63".

Drilling bore from breech end, Pratt & Whitney 2-spindle horizontal barrel drill (operator runs 4 machines).

Rough reaming bore, Baush 12-spindle vertical barrel-reaming machine.

Recentering ends concentric with bore, Wm. Steel recentering machine.

Spot grinding for steady rest, Norton cylindrical grinder 10" x 36". Rough turning taper section at muzzle end and turning and forming breech end, Jones & Lamson Fay automatic lathe 8" x 33".

Turning upper section of taper and radius finish, Jones & Lamson Fay automatic lathe 8" x 33".

Turning and forming muzzle end and forming band bearing groove, Jones & Lamson Fay automatic lathe 8" x 33".

Recentering both ends concentric with bore, drill press, 2-spindle.

Semifinish grinding of breech end, Norton cylindrical grinder 10" x 36".

Threading breech end, Lees-Bradner thread mill or Hanson & Whitney hobbing machine.

Form milling top, Brown & Sharpe mill No. 12.

Millling rear band guard grooves, Cincinnati mill No. 0-8.

Finish grinding lower band bearing, Norton cylindrical grinder 6" x 30".

Finish grinding taper at rear of gas cylinder bearing, Norton cylindrical grinder 10" x 36".

Finish grinding gas cylinder bearing and gas cylinder lock diameters, Norton cylindrical grinder 10" x 36".

Reaming base, Wm. Steel 12-spindle vertical reaming machine.

Broaching lower band retaining pin slot, Colonial vertical hydraulic broach (small).

Millling 3 splines for gas cylinder, Brown & Sharpe mill No. 12.

Countersinking breech end to remove hardened stock, Fosdick drill.

Finish reaming bore, Pratt & Whitney 2-spindle horizontal reamer, each operator running 3 spindles (1½ machines); or on a Pratt & Whitney 6-spindle reamer.

Riffing, Pratt & Whitney 2-spindle rifling machine (operators run 3 or 4 machines).

Chambering (rough and finish), Pratt & Whitney 12-spindle chambering machine. Chambering is machining the seat for the cartridge.

Forming radius at intersection of ramp and chamber, Austin Hastings 2-spindle Fosdick drill.

Forming radius at mouth of ramp, Austin Hastings 2-spindle Fosdick drill.

Milling bullet nose clearance, Brown & Sharpe No. 000 mill or Nichols hand mill.

Countersinking and facing muzzle end to finish length and chambering, Pratt & Whitney 5-spindle chambering machine or Krueger 5-spindle chambering machine.

Chasing muzzle and thread, thread milling machine.

Honing chambers, Carlin honing machine.

Marking manufacturer's initials and date of manufacture, Schmidt hydraulic marking machine.
In this sequence of operations on .30-caliber barrels there were over 30 inspections, including visual, gage, and magnaflux inspection, Brinell hardness testing, and inspection of line straightening. Women participated in most of this, including magnaflux inspection, but were not on final inspection, line-straightening inspection, nor Brinell hardness testing.

Interspersed were numerous barrel-straightening operations of two types: Straightening of the outside surface and straightening of the bore. Outside straightening was done by both men and women, using presses on which are mounted dial indicators showing the accuracy of the barrel. The line straightening or shadow method of straightening, which was all done by men, involved sighting through a barrel onto a horizontal black line on a ground-glass window about 20 feet away. This line is reflected as two parallel lines in the barrel and any curvature indicates the necessity for straightening, skill being required to know where and how much pressure to apply with a straightening jack to properly align the barrel.

In this sequence of operations there were also various descaling, sandblasting, parkerizing, heat treating, oiling, and cleaning operations, all done by men.

Women performed a few operations on .50-caliber barrels for air-cooled Browning machine guns, these being considerably larger than the .30-caliber. They operated Pratt & Whitney barrel reamers, Builders’ Iron Foundry reamers, Pratt & Whitney barrel drills, and Pratt & Whitney chambering machines. Women were to be placed on additional operations on the .50-caliber barrels for air-cooled machine guns, but it was not deemed feasible to employ them on much work on .50-caliber barrels for water-cooled Browning machine guns because these are so much larger and heavier.

**Punch-Press Operators.**

In small-arms manufacturing there is not much punch-press work, punch-press operators composing only 3 or 4 percent of the total machine workers. Some of the work such as blanking and forming side plates is very heavy and only men were employed on this. Women blanked, formed, pierced, notched, and trimmed such machine-gun parts as the cam extractor, sear stop, bar pin lock, slide guide piece, and small washers. Small rifle parts, such as the latch clips, triggers, ferrules, butt plates, and swivel butts, were blanked and formed by women. Some of the presses were foot controlled and others were hand controlled with safety guards.

**Types of punch presses operated by women**

Niagara punch press No. 1½.
Consolidated punch press No. 6.
Toledo punch press No. 2.
Miscellaneous Machine Operators.

In small-arms manufacturing there is often required a type of metal shaving or slotting operation which is done on Pratt & Whitney shavers, Logan shavers, and Taylor & Fenn shavers. Women could do practically all this work and already they were doing a fair share. A few women were operating Hanson & Whitney thread millers, ExCello thread grinders, Fellows Gear Shapers, and Lapointe broaches. The broaches that they operated were small, all the large ones such as the Cincinnati duplex vertical broaches, large Colonial broaches, Lapointe broaches, and Footburt broaches being operated by men. The large ones require the operator to stand on a raised platform, and much of the work of loading and unloading parts is heavy.

In none of the plants did women operate cut-off saws or abrasive cut-off wheels, which are used for cutting bar stock to size. Most of this work is purely manual labor of moving bar stock and loading it into the machines, which are largely self-operating when once set up. Only a few persons were employed on this and they did both the light and the heavy work. If the volume of light work were sufficient to keep one or two people busy, women could do this.

Woodworking-Machine Operators.

Rifles have a number of wooden components, including the main gun stock, front hand guard, and rear hand guard, which are made of walnut. The manufacture of these parts requires high-speed woodworking machinery. Two of the firms visited had wood gun-stock departments. In one, women composed 28 percent of the work force, in the other no women were employed. The one employing women had not intended originally to employ them for this work, but with the great increase in volume of production, the introduction of a conveyor system, and the specialization in machine operations it was deemed feasible.

Men and women were often seen doing work that was the same or very similar.

Some of the major types of woodworking machines operated by both sexes

- Onsrud wood-turning lathe. (These machines shape the gun stock by following a master cam; each operator tends three machines.)
- Onsrud router (single spindle). (Many women on these machines.)
- Onsrud router (multiple spindle). (Only a few women on these.)
- Wood shaper (double spindle).
- Wood profiler.
- Pantograph machine.
- Milling machine (horizontal).
- Band saw.
- Drill press (Onsrud drills and Fosdick drills).
- Rotary sanding machine. (The sanding and finishing of wooden pieces formerly was done by hand, but now is done on sanding machines.)

BURRING, FILING, AND POLISHING

Machine operators quite frequently burred and filed parts that they had machined, but in addition there were many full-time filers, burrsers, precision filers, and polishers. Employees on this type of work composed about 5 percent of the total (see table, p. 5). With the
exception of machine operating and inspection, more women did this type of work than any other. About 16 percent of the burrers, filers, and polishers in the four plants with detailed information were women and in one instance the proportion ran as high as 30 percent.

Women generally filed and burred the smaller parts, using files, scrapers, portable burring machines, high-speed lathes, belt sanders, disk grinders, and emery cloth. Sometimes they straightened parts, using hand mallets and bench vises. In all the plants there still were great numbers of men doing small-parts filing, burring, and straightening similar to that done by women. One reason so many men had been retained is that filing of gun parts has been considered precision work requiring considerable skill, but women have now demonstrated their ability to pick up the techniques involved. Men did most of the precision filing, bringing parts to very precise tolerances, and the filing of larger parts such as the bolt, trunnion block, side plates, and receiver. But more and more women were being placed on precision filing and work on heavier parts such as the bolt.

One plant could not employ women on polishing because of a State law restricting this as an occupation for women. Elsewhere women were engaged on a certain amount of polishing, using rag wheels, emery wheels, and wire brushes; some were reaming and lapping parts on small bench lathes and lapping machines. The work of women on polishing was not a war innovation in these plants, a few having done this during peacetime, but the proportion had been greatly increased.

**ASSEMBLY**

Subassemblers and assemblers were not a major occupational group as in some industries, and they composed only 2 percent to 5 percent of the total workers in the small-arms plants. Women constituted 8 percent of the assemblers and the plant employing them on the widest array of assembly work had 17 percent. Most of the small-arms subassembly could be done by women and much of the final assembly, depending on the weight of the weapon.

**.30-Caliber Rifles.**

Most parts for .30-caliber rifles are light and women were doing both subassembly and final assembly, many operations being identical with those done by men. Women were doing about one-fourth of the assembly work and ultimately would do perhaps 60 percent.

Some of the principal assemblies performed by women and by some men

- Trigger assembly (trigger, sear, and sear pin).
- Trigger-guard assembly (trigger guard and stop hammer).
- Trigger housing assembly (clip ejector, hammer, trigger mechanism, safety and trigger guard).
- Rear hand-guard assembly (rear hand guard and rear hand-guard band).
- Front hand-guard assembly (front hand guard, front hand-guard ferrule, front hand-guard spacer).
- Butt-plate assembly.
- Bolt assembly (bolt, extractor, extractor spring, extractor-spring plunger, firing pin, cartridge-ejector spring).
- Gas-cylinder assembly (gas cylinder, gas-cylinder plug, gas-cylinder-plug screw, swivel stacking, and swivel-stacking screw).
- Barrel and receiver assembly (barrel and receiver assembled with rear sight, feeding mechanism, and hand guards).
Head bolt spacing (a hand-reaming operation on the bolt to get the proper clearance after the barrel and receiver are assembled).

Men assembled the major components such as the stock assembly, barrel, and receiver into the completed rifle.

**Revolver and Automatic Pistols.**

Women had normally not been used in the assembly of revolvers and automatic pistols. Not until the summer of 1942 were a few women placed on subassembly of automatic pistols, and they still did none of the assembly on revolvers. Only the most skilled gunsmiths were used to assemble revolvers because extreme precision and care are required, each revolver being assembled in its entirety by one man. A revolver is more or less custom made, with parts filed, polished, and lapped down to fit each other properly. Most of the men were old-time gunsmiths far beyond the draft age, so there was no danger of their being drawn off into the Army, and hence no need of thinking of replacing them with women. The making of automatic pistols is not quite so skilled and some women were filing, polishing, and fitting parts in subassembly.

**.50-Caliber Browning Machine Guns.**

In one plant women were doing most of the subassembly on .50-caliber Browning machine guns but nowhere were they on final assembly operations. Typical assemblies performed by women were the extractor, spring rod, retracting slide, bolt, rear sight, buffer body, buffer-body tube, back plate, and cover assembly. Most of this involved use of simple bench tools such as screw drivers, pliers, arbor presses, files, and so forth. They did some of the lighter riveting on the cover assembly, but the riveting on case assemblies was done by men, this being much heavier work.

Much of the final assembly on .50-caliber machine guns is quite heavy but some of the work could be broken down so that women could do the lighter tasks. The men employed for this had a knowledge of the proper functioning of the machine guns and were versatile enough to do practically any of the work.

**.30-Caliber Browning Machine Guns.**

Plants making .30-caliber machine guns had not gone so far in the employment of women on assembly work as those making the .50-caliber, though women could do a larger proportion of the work on those of smaller caliber because of their lighter weight. Some of the subassemblies performed by women on .30-caliber machine guns were the front-sight assembly, rear-sight assembly, trigger-frame assembly, trigger-mechanism assembly, and accelerator assembly. Women had just been started on this work and many more were to be employed.

**INSPECTION**

Inspectors are one of the major occupational groups in any small-arms manufacturing plant and with the exception of machine operators they compose the largest single group of workers. Twelve percent of the total employees were inspectors, 31 percent of the inspectors being women, with the proportion of women running as high as
62 percent in one plant. One-fifth of the women in the 4 plants reported were inspectors (see table, p. 5).

Some of the workers did only visual inspection but generally they combined this with the use of precision measuring instruments, these including dial indicators, thread gages, plug gages, ring gages, vernier height gages, vernier depth gages, scales, micrometers, and calipers. Some, but not all, were required to check parts against blueprints.

The women inspected primarily small parts, some in process of manufacture and some in final inspection. They did crib inspection, receiving inspection, heat-treat inspection, and inspection out on the floor among the machine operators. They sometimes combined inspection with burring, filing, and lapping of parts to fit fixed gages. In the heat-treat departments they were doing Rockwell hardness testing and Brinell hardness testing. In the .30-caliber-barrel department of one plant women did most of the inspection work, including visual, gage, and magnaflux inspection.

All proof firing was done by men, requiring a constant handling of the weapons and mounting and clamping the larger ones into stands prior to firing. Women should be able to do the proof firing of rifles, revolvers, automatic pistols, and small submachine guns because the weight is not excessive. They could assist with the proof firing of .30- and .50-caliber machine guns if men did the heavy lifting. At the Aberdeen Proving Grounds in Maryland women are assisting with the proof firing of everything from Garand rifles and tommy guns to huge railroad guns.

HEAT TREAT, PARKERIZE, BARREL TUMBLE, PLATE, SANDBLAST, WELD, FORGE

Men did all the heat treating, barrel tumbling, plating, sandblasting, electric cleaning, spray painting, and the great bulk of parkerizing. The numbers on these jobs were small, the men interchanged on different types of work, they had a general knowledge of different properties of metals, a knowledge of methods of hardening and treating metals, and they performed heavy as well as light tasks.

Women commonly did Rockwell hardness testing in heat-treating departments. In one plant a few were being taught parkerizing of cartridge clips, the operation of heat-treat furnaces, and the operation of degreasing machines, with men doing any heavy lifting. A few women had been employed for many years on a process known as "blueing," which is similar to parkerizing, giving a protective coating to revolver and pistol parts. The temperature and atmospheric conditions cause the parts to turn different shades and women matched up the shades so that all parts assembled into one firearm would be the same shade. Women could parkerize the smaller parts of firearms, clean parts, and do spray painting.

The forge and welding shops were not large and no women were used on any of the work, most of which was quite heavy. The welders were able to do almost any kind of welding, brazing, soldering, and sheet-metal work. Much of the welding was on jackets for water-cooled machine guns, which were heavy.
PACKING

After assembly and proof firing the firearms are disassembled, all parts thoroughly cleaned, reassembled, and then given final inspection. Most of the disassembly, reassembly, final inspection, and gun greasing was done by men. A few women reassembled bolts and buffer bodies for machine guns after the parts had been cleaned.

About 30 percent of the packers were women and most of them were counters, sorters, wrappers, and packers of spare parts. Parts greased or oiled were wrapped in heavy oil paper before packing into envelopes, cartons, or boxes. A few women were nailing metal strips around large packing boxes, this being one of the more unusual things they did. The only limitation on what women can do in packing departments is the weight of the work.

FACTORY NONPRODUCTIVE JOBS

In every manufacturing establishment there are large numbers of workers not directly engaged on production operations but essential in maintaining the flow of production. The table, page 5, shows that over one-fifth of the total factory and office employees were nonproductive factory workers, including tool-room workers, tool-crib and stock-room attendants, shipping and receiving clerks, service and maintenance men, production-control clerks, production engineers, gage inspectors, laboratory technicians, and general factory clerical workers. Only 8 percent of this group were women and this proportion could be materially increased.

Tool Room (Tool Making).

When the present war program started in this country women were rarely found in tool-room work, tool making being considered the province of highly skilled tool and die makers, jig and fixture makers, and first-class machinists. The mention of employing women in tool-room work was considered an absurdity by managers and foremen in plants visited by Women’s Bureau representatives early in 1941. But since the spring of 1941 a gradual transformation has taken place and women are making great inroads in tool-room work.

In one small-arms plant the largest single occupational group of women, aside from inspectors, were those in the tool room, where 40 percent were women. The proportion for all plants was 11 percent women. As a rule men set up the machines for the women, but some women were setting up their own and more were learning on the job to do this. The women were most frequently making cutters, reamers, end mills, gages, and draw bars. In addition to machine operating they did filing, burring, hand lapping, hand honing, polishing, and stamp marking of parts. In many cases the work done by women was the same as that done by men.

Most of the women operated bench-size lathes, small and medium-size milling machines, tool and cutter grinders, and surface grinders.

Some specific machines operated by women

Hardinge bench lathe.
Rivet lathe.
Hendy engine lathe 12" x 30" and 12" x 42".
Monarch engine lathe 18" and 10" x 20".
Bardons & Oliver turret lathe Nos. 2 and 3.
Southworth turret lathe.
Brown & Sharpe plain grinder Nos. 10, 12, and 5.
Brown & Sharpe surface grinder Nos. 2 and 5.
Brown & Sharpe tool and cutter grinder Nos. 10 and 13.
Landis grinder.
Carboloy tool and cutter grinder.
Hardinge hand miller.
Brown & Sharpe universal milling machine Nos. 2A and 3A.
Brown & Sharpe plain milling machine Nos. 2 and 2B.
Van Norman milling machine No. 22-L.
Milwaukee milling machine Model H.
Cincinnati milling machine Nos. 2 and 1-12.
Avey drill press.
Cincinnati shaper 20".
Hendy shaper 12".

Tool Cribs and Stock Rooms.

More women were employed as stock-room attendants than as tool-crib attendants. All plants still had many men on these types of work who could be replaced by women, and usually there were plans to augment the numbers of women. Twelve percent of the stock-room workers were women acting as stock-record clerks and storekeepers, filling cribs and boxes with parts and supplies and putting up orders to be routed into the plant. Seven percent of the tool-crib attendants were women who handled the smaller tools, jigs, and fixtures, checking them in and out and keeping records. This work requires a knowledge of different types of tools, jigs, and fixtures which women were acquiring gradually on the job.

Gage Control and Gage Inspection.

A development facilitated by the war was the service of women on gage inspection in two plants covered. This work requires great care and skill, a certain knowledge of mathematics, and use of a wide range of measuring instruments. In the gage-control and inspection departments all the various gages and dies used in production are checked for accuracy, the degree of accuracy of the parts manufactured being dependent on the correctness of the gages and dies.

Women were checking mainly thread gages, plug gages, ring gages, and fixed gages of smaller size but they would later be taught the inspection of small and medium-size fixtures and dies. Typical measuring devices and instruments used by women in this work were optical comparators, shadowgraphs, Carl Zeiss toolmakers' microscopes, Pratt & Whitney supermicrometers, vernier height gages and depth gages, calipers, micrometers, Rockwell hardness-testing machines, and Johansson gage blocks.

Laboratory.

So many men had been drafted in the laboratory of one arsenal that women were being hired as laboratory aides; at the time of the visit 30 percent of the laboratory workers were women and this proportion was to be increased. This was not an experimental laboratory but was for industrial control purposes, making tests of steel, oil, paint, and other materials purchased for use in manufacture.
Types of laboratory work done by women

Magnaflux inspection.
Jominy hardenability tests.
Calibration of thermocouples.
Repair and operation of industrial control instruments used on furnaces, boilers, etc.
Machine-tool operations: Lathes and shapers used to machine bars of steel to be subjected to tests in physical laboratory.
Chemical analysis of paints, oils, metal chips, etc.
Metallurgical laboratory work: Polishing steel specimen, analyzing steel specimen under laboratory microscopes, Rockwell hardness testing.

Service and Maintenance.

Service and maintenance workers, including watchmen, guards, elevator operators, chauffeurs, matrons, janitors, cleaners, truckers, laborers, yardmen, chipmen, oilers, millwrights, carpenters, electricians, masons, plumbers, and steamfitters, were always a large labor group, constituting 8 percent of the total plant and office workers and 37 percent of the factory nonproductive workers (see table, p. 5).

Women were employed as matrons and janitors, and one plant had just hired four as guards. An arsenal that had no women as machine operators on production employed them on some other rather unusual types of work in which more and more women undoubtedly will be employed as the war continues. For instance, women drove “shop mules” used for hauling wagons and carts around the grounds and shops, and Clark carloaders for transporting boxes, piling them, and loading freight cars. Women were also making wooden packing boxes, operating band saws and nailing together the boxes.

Factory Clerical.

Some factory clerical workers are included in the departmental segregations shown in the table, page 5, these being charged to the departments together with the regular production workers. It was not possible in all cases to subtract the factory clerical from the actual production workers because the numbers were not reported, but a surprisingly large number still were men because some plants had employed only men for this work up to the time of the war. Both men and women worked as shop checkers, timekeepers, blueprint file clerks, and general clerical workers.

In addition to these factory clerical workers there were others in offices attached more closely to the factory proper than to the general administrative offices. These included safety, efficiency, production-control, methods, and production-engineering departments. Eighty-eight percent of such employees were men, which indicates the extent to which women can still be brought in to replace men even for factory office work.
CANNON OR GUN MANUFACTURING AND THE EMPLOYMENT OF WOMEN

Two firms making cannon or guns, including heavy coast-defense guns, railway artillery, howitzers, mortars, antitank guns, and anti-aircraft guns, employed respectively 5 percent and 14 percent women; the third, manufacturing chiefly small arms but some small cannon (37-mm.), employed 18 percent women in the entire plant. Women naturally could do more of the work on small cannon than on large-caliber guns, and it was estimated that as high as 40 percent of the employees might be women in cannon manufacture as a whole.

The two plants with 14 and 18 percent women employed them on an extensive array of machine-tool operations on production work and in tool rooms, on filing, burring, polishing, and inspection. They worked on small minor components for large-caliber cannon and on major as well as minor components for 37-mm. cannon, the smallest manufactured. Men still were doing much of the same or similar work, and plans were to employ more women on jobs vacated by men and on new jobs in the general expansion program.

The plant with the lowest percentage of women was in the initial stages of employing them as factory workers. It had started a pre-employment training program for women and had surveyed the shops for prospective jobs with the intention of using women wherever possible. A preliminary report showed that this would include various machine-tool operations, filing, burring, piece marking, inspection, light subassembly, crane operating, tractor and truck driving, and stock-room and tool-crib work. They would do rough turning operations on some barrels with one man to every four or five women to do the heavy lifting. In the metallurgical laboratory where gun specimens are prepared for analysis, women will be used on hacksaws, lathes, centering machines, automatic thread grinders, thread millers, and cylindrical grinders.

MACHINE OPERATORS

Large-Caliber Guns.

The machining of large-caliber cannon or guns such as 16-in., 14-in., 12-in., 155-mm., and 105-mm. involves the use of some of the largest heavy-duty machine-tool equipment found in any line of manufacture. Many of the machines had beds over 200 feet long and the large component parts often weighed thousands of pounds, requiring extensive use of mechanical handling equipment. Even with mechanical handling devices there was so much inevitable heavy manual labor in connection with the use of large hand tools, clamping of parts into machines, and manipulating of controls that it would be difficult to employ women on much of this work under any conditions.
women were working on the heavy-duty machines in the big-gun shops and it was considered one of the last places where women could be employed.

The heavy-duty machines were used for turning, boring, reaming, grinding, and rifling such major components as the tubes, liners (inner tubes), hoops, jackets, breech rings, breech blocks, and rails. The built-up guns assembled by the “shrinkage method” must be finish-machined after they are cooled and this involves finish boring, rifling, chambering, and machining the breech end.

Typical heavy-duty machines in big-gun shops

- Bement-Pond special machines for turning, reaming, rifling, etc.
- Barnes horizontal drill.
- Sellers horizontal boring machine.
- LeBlond gun-boring machine.
- Bullard vertical boring mill.
- Giddings & Lewis boring mill.
- Newton vertical milling machine.
- Cincinnati vertical milling machine No. 4.
- Milwaukee milling machine (heavy duty).
- Sundstrand slab miller.
- Cincinnati-Bickford radial drill.
- Ingersoll planer.
- Lapointe broach (large).
- Mattison surface grinder.
- Blanchard grinder.
- Bryant internal grinder.
- Jones & Lamson turret lathe (heavy duty).
- Lodge & Shipley turret lathe (heavy duty).
- Warner & Swasey turret lathe (heavy duty).

37-mm. Cannon and Small Components for Large-Caliber Guns.

Though women did none of the machining of large major components for big cannon, they did some work on smaller parts such as in the breech mechanism and firing mechanism, and on the larger as well as small parts for 37-mm. cannon, the smallest gun manufactured. Men and women often worked on identical or very similar operations.

Typical machines operated by men and by women (greatest numbers of women on those starred)

- *Cincinnati milling machine Nos. 0–8 and 1–12.
- *Cincinnati vertical milling machine Nos. 2 and 3.
- *Brown & Sharpe vertical milling machine No. 2.
- *Brown & Sharpe milling machine Nos. 2, 10, and 12.
- *Milwaukee milling machine Model H.
- Sundstrand Rigidmill.
- Cincinnati Hydromatic milling machine No. 3–24.
- *Nichols hand mill.
- Taylor & Fenn spline mill.
- Pratt & Whitney profiler No. 12.
- Cincinnati automatic profiler (single and multiple spindle).
- Taylor & Fenn Colt shaving machine.
- Pratt & Whitney shaving machine.
- Henry Prentice surface grinder No. 3–B.
- Norton surface grinder 6" x 18" and 6" x 30".
- Brown & Sharpe plain grinder No. 3.
- Hanchett surface grinder.
Blanchard surface grinder.
*Gisholt turret lathe Nos. 3 and 4.
*Warner & Swasey turret lathe Nos. 2–A, 3, and 4.
Bardons & Oliver turret lathe No. 2.
*Hand screw machine (small).
*Monarch engine lathe 16” and 18”.
Lodge & Shipley engine lathe 18”.
Brown & Sharpe automatic screw machine Nos. 0G and 00G.
Brown & Sharpe Wire-Feed screw machine.
Lapointe screw type broach.
Fellows gear shaper.
Gould & Eberhardt shaper.
Smalley-General Co. thread hobber No. 20MB (large).

This array of machines covers practically every type used except a very few heavy-duty machines on which no women were employed. The machines most commonly operated by women were the small and medium-size milling machines, hand milling machines, hand screw machines, small and medium-size turret lathes and engine lathes, and drill presses. The women selected to work on the large turret lathes and profilers generally were the taller and more robust, so that they could reach the controls and exert the necessary force required in manipulating the levers, handwheels, and turnstiles. One plant manager spoke very highly of the success of women on profiling, saying they had a good sense of touch and allowed the machine to cut at a normal speed rather than forcing the cutter as men were sometimes inclined to do.

There was not the same volume of production of parts of one kind in cannon manufacturing as in small-arms manufacturing, so the machine operators had to be somewhat more versatile in shifting around on different work and making occasional machine set-ups. Women as well as men did this, including the setting up of machines, which more and more women were being trained on the job to do. The machine operators checked their own work with calipers, microscopes, and fixed gages; sometimes they did filing and burring of parts. The extent to which they did filing and burring depended on the length of the machining cycle and the number of machines operated. Very often one person operated three to six machines, either keeping them all running at once and constantly loading and unloading parts, or taking each part and performing a series of operations on one machine at a time.

Women did none of the barrel work on large-caliber guns, but they did reaming on 37-mm. barrels, operating LeBlond barrel-boring machines. Men loaded and unloaded the machines while women acted as operators, watching the controls and oil coolants and checking the proper functioning of the machines. With the aid of movement women could perform the majority of the machine operations on 37-mm. barrels.

Major operations on 37-mm barrels, some performed by women

Facing-off and centering ends.
Barrel drilling, Pratt & Whitney barrel drill.
Rough and finish reaming using wood packed bits.
Rifling by the disk method using a series of disks, each a bit larger than the preceding, the operator putting a new one on at the end of each stroke through the full length of the barrel.
Chambering the breech end for the cartridge.
Honing.
Turning breech end on a lathe.
Thread milling breech end.
Milling cartridge clearance slot on vertical power mill.
Grinding external portions of the barrel.
Milling wrench flats on vertical miller.
Barrel straightening on Farquhar straightening press.

There still was opportunity for employing many more women on machine work on small and medium-size parts, as men often were employed on the second and third shifts to do work performed by women on the first shift, or men and women on the same shifts were doing work that was similar. In a Canadian plant visited that made 40-mm. antiaircraft guns, 30 percent of the machine operators were women and many more were to be employed, which is somewhat indicative of the proportion of machine work women can do on smaller cannon.

Burrning, Filing, and Polishing

In cannon manufacturing as in small-arms making there is a great deal of filing, burring, and polishing of parts by means of files, scrapers, disk grinders, emery cloth, belt sanders, portable burring tools, emery wheels, and rag wheels. Much of the work done by women was the same as that done by some men, but men did a larger proportion of the heavy work and more precision filing. Women worked mainly on small parts but did some filing and burring on heavier parts such as the breech rings and breech blocks for 37-mm. cannon, the spline shafts and breech blocks for 75-mm. and 3-in. cannon, and the breech end threads on 90-mm. barrels. Most of this work was done at benches with the workers seated, but some was done in a standing position when the parts were so large that they had to be mounted on a stand.

Assembly

Large-Caliber Guns.

After the hoops, tubes, liners, rings, and jackets for large-caliber guns are machined to proper size they are assembled into a compound cylinder by a process known as “shrinkage,” the number of component cylinders depending on the design and caliber of the gun.

For example, the two-piece gun is assembled by shrinking the outer cylinder (jacket) onto the inner cylinder (tube). The inside diameter of the jacket is made slightly smaller than the outside diameter of the tube. The jacket is expanded by heat until it fits over the tube. Then, as it is cooled, the jacket shrinks into place, the process putting the tube into a state of compression, and increasing the elastic strength of the gun...

A summary of the assembly of the typical 16” howitzer follows:

The tube (B tube), filled with water, is placed in the shrinkage pit, breech end down, and supported in a vertical position. The expanded heated jacket is lowered over the tube until seated upon its shoulder. Cooling is effected by the use of encircling water sprays directed on the point where the first shrinkage gripping is desired, and then gradually moved upward. After the assembly has cooled to shop temperature it is removed from the shrinkage pit, the correct shrinkage verified by measurements, and the exterior surface finish machined for the next assembly operation. The successive preparation of the various hoops and rings, and their assembly, follows the same procedure outlined for the

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jacket and tube. The bore of the assembled gun is now finish bored and taper reamed to receive the liner.5

After the liner has been inserted into the compound cylinder the assembled gun must be allowed to cool, and this sometimes takes a week or more before it can be finish machined. The gun pits where this assembly takes place are huge depressions in the floor of the big-gun shops, with platforms built around the pit. Much mechanical handling equipment is used to move the tubes, hoops, rings, and so forth, and much of the work is heavy, hot, wet, and slippery. No women were employed in this phase of assembling built-up guns and it would not be feasible to employ them because of the manual tasks involved. However, on the breech mechanisms and firing mechanisms of heavy guns there are lighter subassembly operations that women could do.

**Small and Medium-Size Guns.**

On the assembly of small and medium-size guns such as the 37-mm., 75-mm., 3-in., and so forth there are filing, burring, fitting, and subassembly of small parts and attaching of parts to the breech mechanism and firing mechanism, all of which women could do. The men now doing this perform both light and heavy tasks, but the light operations could be segregated for women.

**INSPECTION**

In all the cannon plants women were scattered throughout the shops on detailed-parts inspection, and ultimately they were to do a much larger proportion of this work. Most of the inspectors used precision measuring instruments such as micrometers, calipers, gages, and scales; some were required to read blueprints. Frequently inspection was accompanied by a certain amount of filing, lapping, and fitting of parts to fixed gages. The women not only checked parts in process but did final inspection on parts prior to passing them on to the Government ordnance inspectors. In the heat-treat departments they did Rockwell hardness testing.

**PACKING**

Spare parts for replacement purposes are shipped with each gun, and women were greasing these small parts, wrapping them in oil paper, packing them into cartons and packages. Women assisted with the greasing and placing of protective paper coverings over the breech end of 75-mm. and 90-mm. barrels preparatory to shipping. Much of the cleaning, greasing, and packing of parts for cannon is heavy work and not suitable for women.

**PARKERIZE, HEAT TREAT, SANDBLAST, BARREL TUMBLE, AND PAINT**

No women were employed on parkerizing, heat treating, sandblasting, barrel tumbling, or painting of parts. Barrel tumbling for bur-

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5 Ibid., pp. 207–208.
ring small parts involves lifting big containers and is chiefly work of a manual nature. Sandblasting involves working in a standing position constantly holding and turning the parts by hand during the sandblasting process, which requires considerable strength. Much of the heat treating is very heavy work and requires a knowledge of methods of treating various metals, and the operation of different types of furnaces, temperature controls, and so forth. Women could do the parkerizing and spray painting of smaller parts.

FACTORY NONPRODUCTIVE JOBS

Tool Room (Tool Making).

As already pointed out, a significant trend in women’s employment is the extent to which they are being introduced to tool-room work, a field formerly dominated by men and one that was considered untenable for women at the inception of the present war program. In the plant making the largest cannon and employing the greatest proportion of women, 20 percent of the women employed as machine operators were working in tool rooms making end mills, broaches, reamers, milling cutters, and so forth. They were taken in on the same basis as men, being expected to learn to set up their own machines and develop enough versatility to shift around on different types of work. Where heavy lifting was involved movement were provided. At first there had been strong opposition to bringing women into the tool rooms, but the foreman found that women could do practically any type of work if given the time to develop necessary skills.

Typical machines operated by women were: Monarch engine lathe 14-in., 18-in., and 20-in.; LeBlond engine lathe 16-in.; Milwaukee milling machine No. 1–B; Brown & Sharpe universal mill No. 2; abrasive surface grinder No. 1½; Heald rotary grinder; Ott tool grinder; Oliver Instrument Co. tool grinder; Cincinnati tool and cutter grinder No. 2; Bryant internal grinder No. 16; Landis cylindrical grinder; Hendy shaper; and Cincinnati shaper. Women were not used on the heavy-duty milling machines, vertical boring mills, heavy-duty grinders, and planers.

Tool Crib and Stock Rooms.

In all the cannon plants women worked as tool-crib and stock-room attendants checking in parts, placing them in proper cribs or boxes or on shelves, checking out parts, and keeping records. In some of the tool cribs women did a certain amount of grinding of milling cutters and reamers.

Gage Inspection.

A somewhat new field of employment for women is gage inspection, which requires skill and a considerable knowledge of mathematics. Only college graduates had been employed for this work and they had been very carefully selected. The women were placed first on the simpler work of inspecting plug gages, thread gages, ring gages, and so forth, but were to be trained for checking dies, jigs, and fixtures. They used vernier height gages, vernier depth gages, vernier calipers, universal surface gages, dial indicators, Johansson gage blocks, and other precision measuring instruments.
Crane Operators.

Cranes and other mechanical handling equipment are used extensively in the big-gun shops because of the extreme weight of parts and materials. One of the plants had 20 women employed as crane operators, another was in the process of taking women on for this work, having employed them on cranes at the time of the earlier war. The women were reported as enthusiastic over this work and had demonstrated their ability to do it well, gaining the confidence of the men in the shops, which is highly important in crane operating.

Factory Clerical.

Women were doing both tracing and drafting in the engineering and tool-design departments and more were to be placed on such work. Men had formerly done most of the factory clerical work but some had been replaced by women coming in as shop clerks, production-control clerks, timekeepers, stock clerks, and so on. However, there still were many men in such positions who could be replaced by women.
RATES OF PAY, HOURS OF WORK, PERSONNEL PRACTICES, AND TRAINING

RATES OF PAY

Occupational Rates Rather Than Rates by Sex.

The basing of rates on occupation rather than on sex has been revived as a pressing issue, as it was at the time of World War I, when so many women were brought into all phases of the war program. Also in line with events of that war, the National War Labor Board has made an official pronouncement that—

Wage rates for women shall be set in accordance with the principle of equal pay for comparable quantity and quality of work on comparable operations.

Small-arms and cannon manufacturing establishments have been among those materially involved in this issue because so many women have been brought into plants formerly manned almost 100 percent by men, with little or no change in the physical characteristics of the jobs. As women have become more and more an integral part of the productive force, the wage-differential problem has become increasingly acute from the standpoint both of the women hired and of the men leaving for the armed services.

In considering the comparative similarity of work done by men and women, more than the physical characteristics of the job must be analyzed. Benches or machines may be raised or lowered to reduce weight lifting, operations may be broken down to segregate the light work from the heavy, automatic stops may be placed on machines to reduce the skill required, new fixtures or arbors may be designed to lighten the work, additional men may be hired to eliminate material handling by machine operators. These innovations may actually increase production and decrease unit costs, and do not serve as warrant for lower wage rates for participating workers. All-over production costs as well as the physical characteristics of the work as performed by women instead of men must be taken into consideration in contemplating rate changes. Only if there are substantial changes in job content and material increase in total labor costs is there a legitimate reason for proportionate wage adjustments, in the opinion of the National War Labor Board.

Three of the eight plants covered in the survey had adopted the principle of equal pay, the minimum entrance rates and the job classification rates being the same for men and women. In one, new workers were advanced in two or three months from a "mechanic-learner" classification to a job classification, with succeeding wage increases based on efficiency ratings. In the second plant, the majority of productive workers were on piece work, making increases in earnings dependent on individual output. The inspectors and non-

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productive workers were on time work and rate changes for them were largely on an individual basis. The third plant conforming to the equal-wage principle had salary reviews about every 6 months with a system of salary increases based on upgrading.

**Women's Rates Versus Men's Rates.**

The minimum entrance rate for women in the eight plants ranged from 39 cents to 60 cents, the range for men was from 39 cents to 75 cents, with 50 to 55 cents the most common minimum beginning rate for both. Three had the same entrance rates for men and women; in the others these rates were from 5 to 15 cents an hour less for women than men, as shown below:

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<thead>
<tr>
<th>Men (cents)</th>
<th>Women (cents)</th>
<th>Differential (cents)</th>
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<tr>
<td>53</td>
<td>43.4</td>
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</table>

One plant in the State of Michigan, where wage discrimination between the sexes is prohibited on work of "like value, workmanship, and production," classified all operations as either "male" or "female," and employed only men on "men's" jobs and women on "women's" jobs. According to standards established by management the specific operations performed by women were not the same as those done by men, though further analysis would be necessary to determine whether jobs were of "like value." There were varying occupational classifications and wage rates for work done by men, but all "women's" jobs fell into one wage classification of 60 to 76 cents an hour irrespective of the type of work performed, whether machine operating, assembly, or inspection.

A second plant with sex wage differentials had a flat rate of 43.4 to 47 cents for all women in the factory except inspectors, who had a higher rate. The women did all types of machine work, assembly, filing, and burring, much of which was identical with or comparable to that done by men, some of whom received 61.4 to 67.4 cents an hour and others of whom received 69.8 to 75.8 cents an hour.

Another plant had an elaborate breakdown of job classifications with lower rates for all "female" job designations though there was no question that the work done by women was comparable in quality and quantity to that done by men. In all cases the maximum rates for women were lower than the minimum rates for men on the same work, as is shown in examples of day rates on page 31.

These rates applied to day workers and not to those on piece work. Approximately 60 percent of the workers were under a piece-work system at the time of visit and more were to be added. On such jobs the wage differentials were eliminated because the same piece price applied to both men and women. To eliminate sex differentials among the day workers a job analysis was being made to ascertain if women were doing work comparable to that of men; then necessary wage adjustments were to be based on the job irrespective of the sex of the worker.
RATES, HOURS, PERSONNEL PRACTICES, TRAINING

<table>
<thead>
<tr>
<th>Occupation</th>
<th>Men</th>
<th>Women</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Minimum</td>
<td>Maximum</td>
</tr>
<tr>
<td>Assembler</td>
<td>$5.60</td>
<td>$6.24</td>
</tr>
<tr>
<td>Assembler—Helper</td>
<td>6.04</td>
<td>6.68</td>
</tr>
<tr>
<td>Barrel rifer</td>
<td>6.56</td>
<td>7.52</td>
</tr>
<tr>
<td>Benchwoman and benchman</td>
<td>5.60</td>
<td>6.24</td>
</tr>
<tr>
<td>Benchwoman and benchman—Helper</td>
<td>5.60</td>
<td>6.24</td>
</tr>
<tr>
<td>Material keeper</td>
<td>5.92</td>
<td>6.72</td>
</tr>
<tr>
<td>Mechanic-learner</td>
<td>4.00</td>
<td>(0)</td>
</tr>
<tr>
<td>Operator machine:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Automatic screw</td>
<td>6.72</td>
<td>7.68</td>
</tr>
<tr>
<td>Driller</td>
<td>5.92</td>
<td>6.72</td>
</tr>
<tr>
<td>Grinder</td>
<td>5.92</td>
<td>6.72</td>
</tr>
<tr>
<td>Miller</td>
<td>5.92</td>
<td>6.72</td>
</tr>
<tr>
<td>Profiler</td>
<td>5.92</td>
<td>6.72</td>
</tr>
<tr>
<td>Punch press</td>
<td>5.92</td>
<td>6.72</td>
</tr>
<tr>
<td>Shaver</td>
<td>5.92</td>
<td>6.72</td>
</tr>
<tr>
<td>Junior operator machine:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Driller</td>
<td>5.04</td>
<td>5.68</td>
</tr>
<tr>
<td>Grinder</td>
<td>5.04</td>
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</tr>
<tr>
<td>Miller</td>
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</tr>
<tr>
<td>Profiler</td>
<td>5.04</td>
<td>5.68</td>
</tr>
<tr>
<td>Shop inspector</td>
<td>5.60</td>
<td>6.24</td>
</tr>
</tbody>
</table>

1 Single rate.

Methods of Wage Payment.

Three of the seven plants reporting had a straight time-work system of wage payment throughout the plant. The others had various types of piece work, incentive, and bonus systems: Group bonus with guaranteed base rate, individual bonus with guaranteed base rate, and straight piece work with no guaranteed base rate. These incentive and piece-work systems applied to productive workers and not to non-productive workers nor inspectors; in some cases they did not apply to all productive workers. Under an incentive system where a standard time is set for performing a certain operation, pay is received for the time allowed even if the work be completed in a shorter time; for example, 10 hours' pay could be received for 8 hours' work. But the hours earned are applied to the worker's base rate, so this system does not eliminate any existing wage differentials between men and women.

HOURS OF WORK

As a means of augmenting wartime production, most plants were kept operating 24 hours a day, 7 days a week. This gave rise to much fluctuation in hours and shifts in an effort to keep the output of various departments timed properly, to allow maintenance men to service and repair machinery, to make the fullest use of supervisory staff and skilled workmen, and to keep the working hours of women within the statutory requirements of the respective States. In one plant there were 18 different working schedules, which gives some idea of the complicated arrangements necessary in both office and factory hours.

Work schedules were not always based on a 7-day week, but might be on an 8-day or a 6-day week, with allowances for 2 days off after 6 days of work, 1 day off after 5 days of work, 1 day off after 20 days of work, and so forth, thus complicating greatly the computation of hours worked in a 7-day week. There were often differences in work schedules among the men, those more highly skilled working longer.
hours because of shortage of such workers as tool and die makers, jig and fixture makers, and machinists. Swing shifts were common, with days off varying each week over an 8- or a 6-week cycle. Sometimes it was necessary to have shorter work schedules for women due to State laws restricting their hours, but usually the States would grant special emergency permits relaxing slightly the hour and night-work provisions.

The work schedules for women in the 8 plants visited were not uniform; three plants had an 8-hour day and a 48-hour week; one had a 47-hour week, 7 1/2 hours on 5 days and 9 1/2 hours on 1 day; one had a 7 1/2-hour day and a 45-hour week; one had a 48-hour week for 5 weeks and a 40-hour week for 1 week. One plant had some women on a straight 54-hour week (10 hours on 5 days and 4 on 1 day), and other women on a 50-hour week (10 hours on 5 days) for 6 weeks and a 60-hour week (10 hours on 6) for 2 weeks; the eighth plant had some women working an 8-hour day (56 hours a week), with 1 day off in 21, and others working a 9-hour day and a 54-hour week.

Most plants started with women on the day shift and the majority of women still were on that shift. The number employed on the night shifts was gradually increasing with the expansion in women’s employment.

Four of the plants had a 30-minute lunch period for which no pay was received, three allowed 10 to 20 minutes for lunch for which there was no pay deduction, and the eighth plant allowed either 30 minutes without pay or 20 minutes with pay. Frequently those with only 10 or 20 minutes were expected to eat at their jobs if the nature of their work was such that this was possible.

In only one of the plants was there a formal rest period for women of 10 minutes in the morning and 10 minutes in the afternoon; in the others women usually were allowed 5 to 10 minutes or a reasonable time away from their work twice in each workday. This was not an officially proclaimed rest period but merely something allowed by management as long as women did not abuse the privilege.

PERSONNEL REQUIREMENTS, POLICIES, AND PRACTICES

Women in Personnel Work.

Most of the plants visited had one or more women handling personnel relations among the factory women and looking after their general welfare. Some worked in conjunction with the employment office, interviewing women applying for factory work, spending time in the plant seeing that the women dressed properly and observed shop rules and regulations, checking wash rooms and locker rooms, and giving counsel on complaints and questions. Others did only interviewing of the applicants, instructing them as to factory procedures, work clothing, safety rules, and assigning the work to which they seemed best fitted, while a matron or forelady stayed in the factory, watching the locker rooms, checking the clothing of the women, and so forth. Those called “foreladies” usually had nothing to do with the selection and hiring of the women, but checked quite closely on their efficiency and progress on the job, watched their conduct in
the plant, and saw that safety-clothing measures were observed. Usually those with some background in factory work were selected as "foreladies," as having a better understanding of the problems that arise.

It was considered advisable to have women acting in these capacities because the factory women found it easier to bring their problems to a woman than to a man. Then, too, a woman would understand better than a man the extent to which shop morale and harmony can be bolstered by small service-facility appointments and working conditions on the job that may mean a great deal to a woman getting an introduction to plant life, possibly for the first time.

Age.

A minimum age limit of 18 years was most common, with no maximum except in the case of two plants where maximums were set at 45 and 55 years. One arsenal had an 18-year minimum for women on "classified labor" but would take those of 16 years for work as "shop girl" or "machine operator trainee" providing the employment of 16-year-old girls was not in conflict with law.

Marital Status.

Marital status of the women was reported as immaterial in all but one of the plants, and this plant was intending to rescind its ban on married women. It was just as common to hire married women as those single. In one plant 70 percent were married; in another 50 percent to 60 percent.

Medical Examinations and Medical Facilities.

Most modern industrial establishments in this country have taken pride in developing model medical facilities for caring for their workers, and more and more emphasis is being given to the importance of preemployment physical examinations in selecting workers. All plants covered in this survey had medical departments for first-aid treatment and preemployment physical examinations. Most of the examinations were quite rigid, one firm even requiring that new employees be vaccinated against smallpox. The more elaborate of medical departments had a surgery for emergency operations, examination rooms, treatment rooms for various types of injuries and treatment, X-ray and dark-room equipment, laboratories, and wards for patients who could not be moved for a matter of hours or a day or two. The arsenals had post hospitals with a staff of Army doctors and nurses, and first-aid stations out in the factory buildings.

Education and Experience.

The Government arsenals had to select their workers from Federal Civil Service registers, and a "mechanic-learner" register usually was set up for women seeking factory employment. Two arsenals required a mechanical-aptitude test but had no education or experience requirements for mechanic learners, and one did not require a mechanical-aptitude test but asked for 8 years of grammar school or 3 months of any kind of manual work. In the fourth arsenal three different registers were set up for women: One for "shop girls," requiring elementary schooling and 3 months of manual work or 2 years of vocational or high school with no written examination; a second for
“classified laborer” requiring four grades of schooling and 6 months of manual work with no written examination; and a third for “machine-operator trainee” requiring 250 hours in a VEND\(^7\) course or some vocational school but no written examination.

There were no specific education requirements for employment in the four private plants covered, but it was an advantage to have as good an educational background as possible. Three did not require experience but preference generally was given to those with shop experience because they were accustomed to factory environment and shop practices. The fourth plant required factory experience in related types of work or completion of a defense training course in machine shop or inspection.

**Uniforms.**

Only two of the plants required a standard work uniform, the first a two-piece blue uniform with a visor cap to match that could be purchased at a local store for $3.50, and the other a white smock uniform provided by the company. A third plant was planning to require the women to wear a standard uniform. The remaining plants generally required low-heeled closed-toe shoes, slacks or coveralls of the worker's choice, and a head covering of hair net, cap, or bandanna. Slacks were not always specified, but instead any clothing that was not loose around the sleeves or waist. Goggles, eye-shields, and respirators usually were provided where needed.

A problem almost always raised was the great difficulty in getting women to wear a head covering, or to get them to wear the head covering properly instead of on the back of the head with the front hair exposed or in a loose-fitting fashion with hair hanging out all around. Even in plants where there had been serious accidents due to women getting their hair caught in high-speed machinery, the women had not taken heed and were careless in their hair dress. The only solution to such a condition is a rigid enforcement of rules regarding hair dress in the interest of plant safety, even to the point of discharging those not conforming.

**Food Service.**

Providing adequate food-service facilities for a multitude of workers in a large factory, perhaps composed of several buildings, has become a pressing problem. With lunch periods limited to 10, 20, or 30 minutes the cafeterias or lunch wagons must be so located that the workers can wash and be served in very few minutes, but this is often difficult. Even where there is a cafeteria for serving hot food many workers prefer bringing their own lunches to going some distance to the cafeteria and then having to stand in line. Lunch stands or cafeterias should be so located as to be fairly convenient to all workers, or more time should be allowed for lunch.

Six of the eight plants had cafeterias, and one of them had in addition sixteen food trucks serving those not having time to go to the cafeteria. The trucks served a few hot dishes such as soup, beans, and spaghetti, as well as sandwiches, ice cream, and candy. Two of the six plants had vending machines for cold drinks, candy, fruit, and so forth. One of the remaining plants made no provision for serv-

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\(^7\) Vocational Education for National Defence.
ing hot food but sent mobile canteens through the shops at noon selling milk, sandwiches, small pies, candy, nuts. The workers were allowed 10 to 20 minutes for lunch but were supposed to eat at the job if possible. The eighth plant had neither cafeteria nor canteen service, but plans had just been approved for constructing food stands in various shops where sandwiches, coffee, and some hot food would be available.

**TRAINING**

**Training Within the Plant.**

With the sudden increase in small-arms and cannon manufacture necessitating the hiring of great numbers of unskilled workers with little or no experience, the most workable procedure has been to give them on-the-job training. Time has not allowed training people as “all-round workers,” nor has that been necessary where the volume of production has increased so that workers can be confined to a single type or a few types of work. A new employee usually was placed under the guidance and instruction of an experienced worker, leadman, or foreman to observe an operation and gradually try to do the work. In this way, on the majority of operations a fair degree of proficiency could be attained in from half a day to two weeks. If the use of calipers, micrometers, and gages and the reading of blueprints were required these were taught right on the job. Most plants visited followed this informal on-the-job method of training, with no formal classroom instruction.

Two plants had formal programs of training for women within the plant. One used the facilities of the men’s apprenticeship training school for an initial orientation program to acquaint the women with shop atmosphere and teach them the fundamentals of machine operating. The time spent in this school varied with the individual’s aptitude and the demand for new workers in the various shops. The trainees were paid for the time spent in school. The other plant required women to take preemployment training in a National defense training school, and after finishing this 2-to-3 months’ course they were brought to the men’s apprenticeship training school in the plant and taught the specific task they were to do in the factory.

Supplementary or part-time training in the plant for women already employed was uncommon, there being only one plant that had classes in blueprint reading and use of precision measuring instruments for the men and women working as inspectors.

**Preemployment and Supplementary Training Outside the Plant.**

In most of the areas where plants were visited preemployment training courses in machine-shop practice and inspection were available for women in National defense training schools or regular vocational schools. The training programs usually were set up to meet the needs of all plants in the area rather than the specific needs of any one plant. Only one plant required women to have preemployment training, but two others frequently used training schools as a source of women workers. One estimated that 50 percent of the women it employed had had three months’ preliminary training.
The one plant requiring preemployment training for women applied this only to machine operators and not to assemblers, inspectors, tool-crib attendants, and so forth. Very few women were actually employed at the time of the visit, but over 100 were in training and hundreds more were to be trained. Length of training was somewhat contingent on individual progress but the usual period was two to three months. Two hours a day was spent in classroom work and 6 hours on shop work, learning the operation and machine setting on drill presses, milling machines, engine lathes, turret lathes, grinders, shapers, and planers. The students were taught shop mathematics, blueprint reading, use of micrometers, calipers, and gages, filing, burring, heat treating, and the sharpening and grinding of tools.

Very little supplementary part-time training in schools outside the plant was given to persons already employed, and any such training was primarily for foremen, leadmen, and supervisors. One plant was intending to arrange for supplementary training classes for women in nearby defense training schools.