MUNITION PLANTS
Within a few months, the United States must be ready to supply, without the aid of the factories of Great Britain or France, all the guns, all the shells, all the aeroplanes, all the clothing, all the food, all the other equipment, needed for army three thousand miles away, and larger several hundred fold than any army which the country has ever before maintained. Meanwhile, every day more men are sent across the seas, and more ammunition is needed for Pershing's growing force. Naturally, at the same time, fewer strong and efficient men are left to make war supplies. Every day makes clearer the signs of the increasing dependence of the country upon the work of women for the ultimate success of the war itself.

A factory in the East making shells now has a force of which one in nine is a woman. The plan is to increase the proportion of women to 50% or 60%, about one in two, within the next few months. A Government Arsenal in the West will open the doors of its machine shops to women tomorrow morning for the first time in its history. The Ordnance Department of the United States Army is about to employ women instead of men as inspectors of the quality of the munitions manufactured in plants throughout the country. These are merely chance illustrations. The changes have begun in many
The war program is such that no-one can doubt that these tendencies, manifest now on a small scale, will become the forerunners of a new order in industry. The new order already established in England shows how vital it is to guide and control these changes from the moment the first woman begins to operate a man's machine.

Wise guidance is essential not only for the sake of the woman herself, and the group of which she is one, but to insure the success of the Government's program of production. Three groups must share in the guidance,—the Government, the employers and the workers. The aim to be kept steadily in view is to increase production, not for individual profit, but for the triumph of the democratic ideals for which the United States entered the war.

Curiously enough, it was not a civilian agency, but a military organisation, the Ordnance Department of the United States Army, which was the first to organise a Women's Branch. The Women's Branch, which had its beginnings in January, 1918, is part of the Industrial Service Section, whose purpose is to represent the Ordnance Department in helping to establish conditions of labor which shall insure maximum production during the war. Doubtless it was the need to deal intelligently with strikes and threatened industrial disputes which brought home to the officers of the Ordnance Department the necessity for the creation of the Industrial
Service Section, but from its inception mediation has been only one of its functions. It has had a housing branch, to plan housing in communities where it is inadequate for munitions makers. Its employment management branch has aimed to establish in the plants employment management departments to organize efficiently the task of hiring workers, assigning them to the jobs for which they are fitted, and in other ways seeking to insure conditions making for a stable working force. An expert on safety and sanitation, working in co-operation with state departments of labor, is responsible for lessening the dangers to which munition workers are exposed. Nor are conditions outside the plants neglected, since a community organizer is bringing together voluntary groups, churches, clubs and similar organizations, and official agencies such as departments of health and school boards, to prepare for the problems brought by rapid increase in the population. Finally, the Women's Branch is charged with responsibility for conditions affecting women in the Government Arsenals and in plants working on contract for the Ordnance Department.

The Ordnance Department is the division of the War Department responsible for supplying the army with cannon, rifles, cartridges, shrapnel, high explosives, and many other forms of ammunition, and also with many other articles of equipment needed by the soldier in the field, including helmets, leather belts, and harness for horses in the artillery service. The production needed for the Ordnance Department is the largest
of any division in the War Department.

No-one can doubt that the women of the country are eager to do their full share to produce these supplies and all others needed by the army and navy. This is no time for selfish considerations. But it is also no time for the kind of self-sacrifice which can bring no good to the nation. The need now is to spend energies in the wisest possible way. If more goods can be made through a long period of time in nine hours a day than in ten, it is sheer folly to permit ten or eleven or twelve hours.

As it is the aim of the Ordnance Department to insure maximum production for the war, the Women's Branch interprets its task as that of setting free the best energies of women workers so that they may be able over a long period of time, if necessary, to do their full share in making the munitions needed for a growing army. Setting free the best energies of the workers means, first of all, finding out what are the obstacles to satisfactory production. England has already discovered some of them,—ten hours a day or longer, work seven days in the week, lack of nourishing food at lunch-time, crowded street cars, crowded homes, a sense of injustice among the workers, men and women, because of the introduction of women into men's places at lower rates of pay, and other difficulties long familiar to women who have been leaders in the labor movement. Experience in the United States shows already that there obstacles to production, not because of any
disposition to shirk, but because laws of fatigue set limits which cannot be disregarded.

These are facts which have not been widely recognized either among employers or workers. Requests have come to the Ordnance Department, from plants in which production must be increased, asking for exemption from state labor laws to make longer hours possible for women. On the other hand, some of our efforts to shorten hours, even though it was in the interest of production, have met with opposition from the workers who feared that it might mean lower wages for piece workers. Trade Unionists are familiar with this attitude. To the Women's Branch it shows the need for a demonstration to employers and to workers of the kind of shop practice, length of hours and other conditions which will actually produce the desired results.

The time is not long past,—before the war,—when this emphasis upon increasing production would have seemed almost an evidence of disloyalty to the interests of labor. This is because the making of more goods has so often resulted merely in the individual profit of a few, while the burdens of the many were increased rather than lessened. That danger is by no means at an end. But this war, which is a war of the whole people, fought in the faith that true democracy is possible for all nations, is a challenge to the United States to organize its industries as well as its army in united effort for one aim, and that aim the equipment of
the nation, both spiritually and materially, to play its part in the new international relationships. Voluntary limitation of output, on the one hand, and excessive profits on the other, must both be done away with because they are obstacles to united, national effort. Between the opposing interests of employers and workers, the Government, representing the whole people, must serve not only as mediator, or as an agency to enforce laws, but as a vital force to make industry serve the national good with the spirit and method of a democratic nation.

In the relation of Government to industry, incredibly radical changes have taken place since the United States joined its allies in the war. Governmental control and operation of industries has been greatly extended. To regulate the relations between employers and workers in private industries, an agreement drawn up by representatives of the organized workers, the organized employers, and the public has been officially requested and then sanctioned by the Federal Government. This report forms the basis for the work of the Industrial Service Section, including the Women's Branch. It affirms the right of workers and employers to organize and bargain collectively; declares that maximum production of all war industries should be maintained; and that "minimum rates of pay shall be established which will insure the subsistence of the worker and his family in health and reasonable comfort." Of women in industry, the report has
this to say:

"If it shall become necessary to employ women on work ordinarily performed by men, they must be allowed equal pay for equal work and must not be allotted tasks disproportionate to their strength."

It is this broad policy, expressed, also, in more detail in General Orders No. 13, issued by the Chief of Ordnance last November, which forms the platform for the Women's Branch. General Orders No. 13, which are not orders but suggestions to arsenal commanders and manufacturers, confirm the necessity for reasonable working hours, fair working conditions, and a proper wage scale as "essential to high production." They encourage provision for "joint negotiations between employers and groups of employees," and in the spirit of the report of the War Labor Board issued five months later, they declare that if women are introduced into the places of men "the standard of wages hitherto prevailing for men in the process should not be lowered where women render equivalent service."

These standards have no legal status. No federal laws regulating the conditions of women's work exist at present which can be invoked by the Women's Branch. Its authority is that of the Ordnance Department as a purchaser of goods, controlling through power to place contracts. But back of the formal legal status of the Industrial Service Section of the Ordnance Department and any other federal agency is the labor policy of the present administration.
Repeatedly, the President of the United States, the Secretary of War, and the Council of National Defense have declared that the war must not be made the occasion for breaking down any of the standards necessary to safeguard the health of women and children. Inspectors sent to munitions plants by the Women's Branch are expected to see that reasonable working conditions are maintained for women.

This demands detailed study in each plant, especially when conditions are changing so rapidly. Suppose, for example, that women are doing men's work under slightly different conditions. Suppose that four women operating machines need the services of a man to set up the machines. How should the rates of pay be determined in comparison with the wages of the men who formerly both operated and set up their own machines?

These and many questions like them are the details to be determined in applying the policy of equal pay for equal work. Similarly the best schedule of hours, the best seating arrangements, the best methods of training, the proper care of the health, are all subjects which need to be considered in relation to the particular processes in which the plant is engaged. It is this kind of industrial counselling which the Women's Branch purposes to give in the interest alike of the women workers and of the needs of the country at war.

The headquarters of the Women's Branch is in the Ordnance Department in the Army and Navy Buildings, 7th and B Streets, Washington, D.C. The Department has also district
offices in Philadelphia, New York, Bridgeport, Conn., Boston, Rochester, N.Y., Detroit, Mich., Chicago, Cleveland, Cincinnati, and Pittsburgh; and as soon as possible the Women's Branch will be represented in all of them. At present representatives of the Women's Branch are in three cities—Amy Hewes in Chicago (600 West Jackson Boulevard); Louise Cornell in Philadelphia (1710 Market Street); and Olga S. Halsey in Boston (19 Portland Street). These women are responsible for the plants in their districts. In special problems they will have the help of members of the Washington staff—Clara M. Teed on employment management, Dr. Kristine Mann on health, and a member, not yet appointed, on methods of training. In Frankford Arsenal, which is of course controlled by the Ordnance Department, another member of the Women's Branch, Nellie M. Reader, is stationed for an indefinite period to establish there the conditions which are desired in all private plants. This cannot be done in a moment, but step by step in order that there may not be even a temporary lessening of production urgently needed for the army.

It is the work of Mary Anderson which is of the greatest personal interest to readers of Life and Labor. Her appointment itself is an indication of the need for constant counselling by trade union women in the difficult problems brought by the war. She is our connecting link with the women's unions. To the men's unions she is an interpreter
of the Government's policy in dealing with the new conditions which the introduction of women into men's trades are bringing. The Women's Branch is seeking through her work to be prepared, and to have the unions prepared, so that the substitution of women for men, when it becomes necessary, shall not result in a disastrous lowering of standards, or in bitter industrial disputes.

It is, of course, the Department of Labor which is responsible for the administration of the national labor policy. The Industrial Service Sections of several departments responsible for production, including the Shipping Board, the Quartermaster's Department, the Signal Corps, and the Ordnance Department, are co-ordinating their work in the Department of Labor.

The plans for the reorganisation of the Labor Department provide for a division for women in industry. These plans were drawn up by an advisory council in which Agnes Nestor represented the women workers. Unfortunately, at this writing, this division has not yet been created. At present the Women's Branch in the Ordnance Department and the special work done by Marie Obenauer in the Signal Corps represent the only work for women in industry established in Federal departments. Much of the war work is outside the scope of either of them. By the time this issue of Life and Labor reaches its readers, it is hoped that the Department of Labor will have its women's division, and its work will of course be
more important than that of any industrial branch for women in any other department. Their work, it is hoped, will supplement and strengthen the Department of Labor.

The labor problems now confronting the United States cannot be solved by the government alone. Because of the important part which women must play in them, they are a challenge to the organized women of the country to be leaders in their solution. The Government can give voice to policies, and establish machinery for negotiation; but the success of the Government in a liberal program depends upon the wisdom and idealism of the workers in co-operating in the war program while maintaining the standards which must form the basis of industrial peace.

MARY VAN KLEBROCK.

In Charge of Women's Branch, Industrial Service Section, Ordnance Department.
WOMEN TO VOTE IN INDUSTRIAL ELECTION AT BRIDGEPORT.

Washington, September 6.—Eleven thousand women, workers in the munition factories at Bridgeport, Connecticut, where the law denies them a voice in the government of their community, state or nation, will nevertheless be among the 60,000 voters who are about to cast their ballots in a local election. It is not an ordinary election, to be sure. It is an industrial election, and almost community-wide—a thing unprecedented in this country. Its purpose is to choose representatives of the working people upon a board which will control the conditions under which those people work. And this is a case where working women, as well as working men, are considered people; therefore they vote.

The Bridgeport industrial election comes about as the method by which the munition workers of that city will put into operation the decision of the National War Labor Board in the dispute between the employees and employers in the 66 Bridgeport plants making arms and ammunition. These plants practically constitute the city of Bridgeport. Like all previous decisions of the Board, this one orders the institution of a system of collective bargaining. "We have passed from the day of the individual to the day of the group, and the will of the group shall have precedence over the will of the individual," is the language of the decision, which provides further that the local board referred to shall consist of six members, three to be chosen by the workers, three by the employers, and a chairman to be appointed by and to represent the Secretary of War.

The election at which the workers' representatives are to be chosen will be the culmination of a procedure no less democratic. The workers in each of the 66 plants concerned will elect shop committees to deal with the management of the respective plants. Members of these committees will be chosen as delegates to a convention which is to be representative of the workers in all the factories in Bridgeport, and this convention will nominate the candidates for election.

The function of the local board will be to adjust such future differences between employers and employees as can not be settled between themselves. If the local board finds itself unable to effect a settlement, the case will again come before the National War Labor Board.
MINISTRY OF MUNITIONS.

HEALTH OF MUNITION WORKERS COMMITTEE.

MEMORANDUM No. 20.
SUPPLEMENTARY TO MEMORANDUM No. 5.
(HOURS OF WORK.)

WEEKLY HOURS OF EMPLOYMENT.

Presented to Parliament by Command of His Majesty.

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[1917.
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HEALTH OF MUNITION WORKERS COMMITTEE.

The Committee were appointed by the Minister of Munitions, with the concurrence of the Home Secretary, "To consider and advise on questions of industrial fatigue, hours of labour, and other matters affecting the personal health and physical efficiency of workers in munitions factories and workshops."

The members of the Committee are:

Sir GEORGE NEWMAN, M.D. (Chairman).
Sir THOMAS BALLO, Bart., K.C.V.O., M.D., F.R.S.
G. BELLHOUSE, Factory Department, Home Office.
Professor A. E. BOYCOTT, M.D., F.R.S.
J. R. CLYNES, M.P.
E. L. COLLIS, M.B., Factory Department, Home Office
W. M. FLETCHER, M.D., F.R.S., Secretary of Medical Research Committee
LEONARD E. HILL, M.B., F.R.S.
S. BELLHOUSE, Factory Department, Home Office.
Miss R. E. SQUIRE, Factory Department, Home Office.
Mrs. H. J. TENNANT.

E. H. PELHAM (Secretary).

The following Memoranda have now been prepared by the Committee:

No. 1.—Sunday Labour.
No. 2.—Welfare Supervision.
No. 3.—Industrial Canteens.
No. 4.—Employment of Women.
No. 5.—Hours of Work.
No. 6.—Canteen Construction and Equipment. (Appendix to No. 3.)
No. 7.—Industrial Fatigue and its Causes.
No. 8.—Special Industrial Diseases.
No. 9.—Ventilation and Lighting of Munition Factories and Workshops.
No. 10.—Sickness and Injury.
No. 11.—Investigation of Workers’ Food and Suggestions as to Dietary.
   (Second Appendix to No. 3.)
No. 12.—Statistical Information concerning Output in relation to Hours of Work.
No. 13.—Juvenile Employment.
No. 14.—Washing Facilities and Baths.
No. 15.—The Effect of Industrial Conditions upon Eyesight.
No. 16.—Medical Certificates for Munition Workers.
No. 17.—Health and Welfare of Munition Workers outside the Factory.
No. 18.—Further Statistical Information concerning Output in relation to Hours of Work, with special reference to the Influence of Sunday Labour.
No. 19.—Investigation of Workers’ Food and Suggestions as to Dietary.
   (Second Appendix to No. 3. Revised edition.)
No. 20.—Weekly Hours of Employment (Supplementary to Memorandum No. 5).

INTERIM REPORT.—Industrial Efficiency and Fatigue. [Cd. 8511.]

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Health of Munition Workers Committee.

WEEKLY HOURS OF EMPLOYMENT.

To the

Right Honourable Winston S. Churchill, M.P.,

Minister of Munitions.

Sir,

1. The Committee have had under consideration the recommendations made in regard to the maximum weekly hours of employment of men, women and young persons, which were set out in their Memorandum No. 5 on "Hours of Work," (issued January, 1916). When the Committee commenced their labours, two years ago, they were faced with an almost complete absence of any scientific data as to the relation of hours of employment to output. They had accordingly to rely upon the general evidence of employers, workers and other persons of experience. As explained in Memorandum No. 1 on "Sunday Labour," this evidence was practically unanimous as to the need for a weekly period of rest. There was, however, revealed a marked divergence of opinion as to the limits within which weekly hours of employment should be kept. It was a matter of urgent importance that some guidance on this subject should be offered forthwith. On the other hand, it was clear that in the absence of exact and reliable data any recommendations put forward at that time must necessarily be tentative and provisional in character. Moreover, if they were to be of practical value and to secure any wide measure of acceptance it was necessary that they should satisfy two essential conditions. First, they had to be such as would be regarded as reasonable and moderate by the great mass of employers and workers, and in the second place, while taking account of the probable duration of the war they had to have regard to the immediate urgency of output at the time. Any recommendations which might involve even a temporary diminution of output would have been doomed to failure. It was evident, in fact, that any reduction of hours proposed must be gradual, and the Committee accordingly based their recommendations on what appeared to be immediately practicable rather than on what was ultimately desirable or might be defensible on a physiological basis. Further, they found it necessary to confine themselves to suggestions as to the maximum limits within which employment should be restricted, and they did not endeavour to set out the extent to which, in their opinion, it was necessary or desirable to reduce these limits to meet varying industrial conditions.

2. The Committee are of opinion that their cautious action and advice has been justified by events, and they are glad to take the present opportunity of recognising the sympathy with which their recommendations were received, as well as the active and continuous efforts which have been made by the Departments concerned to secure their general adoption. The limits of the weekly hours of employment then suggested were:

(a) For men, that the average weekly hours of employment should not exceed 63-67 (exclusive of meal times), i.e., a 13-14-hour working day.
(b) That boys under 18 should be allowed to work the same hours as men provided that—
   (i) The hours of boys under 16 should be limited to 60, so far as possible,
   (ii) Substantial relief at the week-ends should be insisted on,
   (iii) Night work should be limited, as far as possible, to boys over 16.
(c) That for women and girls employment should be restricted within the normal legal limit of 60, i.e., a 12-hour working day, though within these limits moderate daily overtime might be allowed, and that the employment of girls under 18 at night should be limited as far as possible.

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3. The Committee are of opinion that the time has now come when these recommendations may properly be reviewed in the light of the following facts: first, the experience gained and the new evidence collected during the past two years; secondly, the strain involved by three years of War conditions, a strain which is likely still to continue for a considerable period; and thirdly, the rapid increase in the number of women workers and in the variety of processes on which they are employed.

4. From the commencement of their work the Committee have attached the highest importance to the collection of exact data affecting the problems at issue. The field to be covered is a very wide one, while the process of collection is slow and laborious. The Committee, however, consider that the data which have already been collected on their behalf by Dr. Vernon and others are of great practical value and merit the most serious attention. The results of these investigations are the more valuable in that they have been undertaken solely in a spirit of scientific investigation and with no preconceived opinions. The selection of factories for enquiry was based solely on the likelihood of reliable data being forthcoming. Further, in none of the operations studied was there any change in the nature of the operation or the type of machinery during the period under review. The data were so chosen as to eliminate any possible disturbance due to increasing skill. There is no reason to suppose that the data quoted below were vitiated by any artificial restriction of output.

5. The result of Dr. Vernon's investigations, which covered a period of over a year, are set out in Memorandum No. 18. Although that Memorandum has already been submitted to the Ministry and published, it appears desirable shortly to set out again the principal results of his investigations in so far as they concern the relation of weekly hours of employment to output. The following are the four sets of data which bear on this subject:

(a) Women Turning Aluminium Fuse Bodies.

<table>
<thead>
<tr>
<th></th>
<th>Average weekly hours.</th>
<th>Relative hourly output</th>
<th>Relative total output</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Nominal.</td>
<td>Actual.</td>
<td></td>
</tr>
<tr>
<td>First period</td>
<td>74.8</td>
<td>66.2</td>
<td>100</td>
</tr>
<tr>
<td>Second period</td>
<td>61.5</td>
<td>54.8</td>
<td>134</td>
</tr>
<tr>
<td>Third period</td>
<td>54.8</td>
<td>45.6</td>
<td>158</td>
</tr>
</tbody>
</table>

During the first period Sunday work (eight hours) was done on five out of six Sundays; during the second on three out of eight, the nominal weekly hours in these three weeks being 66.5 instead of 58.5, an average of 61.5. During the third period the time-keeping was bad, the normal weekly hours of work averaging about 55. Dr. Vernon accordingly suggests that with good time-keeping a nominal 50-hour week ought to yield the same actual hours of work (namely, 45.6), that is to say, that for women engaged in moderately heavy lathe work a 50-hour week yields as good an output as a 66-hour week, and a considerably better one than a 75-hour week.

(b) Women Milling a Screw Thread.

<table>
<thead>
<tr>
<th></th>
<th>Average weekly hours.</th>
<th>Relative hourly output</th>
<th>Relative total output</th>
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<tbody>
<tr>
<td></td>
<td>Nominal.</td>
<td>Actual.</td>
<td></td>
</tr>
<tr>
<td>First period</td>
<td>71.8</td>
<td>64.9</td>
<td>100</td>
</tr>
<tr>
<td>Second period</td>
<td>64.6</td>
<td>54.8</td>
<td>121</td>
</tr>
<tr>
<td>Third period</td>
<td>57.3</td>
<td>48.4</td>
<td>135</td>
</tr>
</tbody>
</table>

Dr. Vernon explains that the reason why a reduction of hours did not lead to an improvement of total output similar to that in the fuse-body turning operation is that for four-fifths of the total time required to mill the screw thread on the fuse body the operative had no opportunity of quickening her working speed since she had merely to
stand idly watching her machine, whereas the lathe worker had to apply seven different cutting and boring tools in succession to each fuze body, and could quicken up her speed of work at almost every stage.

(c) Men engaged in Heavy Work.

<table>
<thead>
<tr>
<th></th>
<th>Average weekly hours</th>
<th>Relative hourly output</th>
<th>Relative total output</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Nominal</td>
<td>Actual</td>
<td></td>
</tr>
<tr>
<td>First period</td>
<td>66:7</td>
<td>68:2</td>
<td>100</td>
</tr>
<tr>
<td>Second period</td>
<td>62:8</td>
<td>59:5</td>
<td>122</td>
</tr>
<tr>
<td>Third period</td>
<td>56:5</td>
<td>51:2</td>
<td>139</td>
</tr>
</tbody>
</table>

It should be noted that during the third period the nominal weekly hours were about 5-6 less than during the second period. Owing to the cessation of Sunday labour the time-keeping was so much improved that the actual hours of work were greater than during the previous period.

(b) Boys Boring Top Caps.

<table>
<thead>
<tr>
<th></th>
<th>Average weekly hours</th>
<th>Relative hourly output</th>
<th>Relative total output</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Nominal</td>
<td>Actual</td>
<td></td>
</tr>
<tr>
<td>First period</td>
<td>78:5</td>
<td>72:5</td>
<td>100</td>
</tr>
<tr>
<td>Second period</td>
<td>61:5</td>
<td>54:7</td>
<td>117</td>
</tr>
<tr>
<td>Third period</td>
<td>60:8</td>
<td>54:5</td>
<td>129</td>
</tr>
</tbody>
</table>

Increase of output in this process, which is largely automatic, could only be attained by a more continuous feeding of the machines throughout working hours.

6. The above data show that a reduction in the weekly hours of actual work, varying from 7 to 20, in no case resulted in more than an insignificant diminution of total output, while on the average it produced a substantial increase. As Dr. Vernon points out, the classification of the operations according to the possibility they offer for speeding up production demonstrates anew the self-evident fact that the alterations of hours may have very different effects in different operations. The exact measure of such alterations cannot be predicted; it can only be ascertained by observation and experiment. It appears evident, however, that for processes similar to those examined by Dr. Vernon, the weekly hours can advantageously be reduced to a total of from 30 to 55 hours, and he suggests that even lower limits might give an equally good output.

7. Two further points of importance emerge from consideration of these data. In the first place, the rate of production changed gradually, and frequently four months elapsed before an equilibrium value was reached. This gradual change appears to nullify the suggestion that the effect upon output of the change of hours was a mere consequence of the desire to earn the same weekly wages as before the hours were shortened. The explanation is rather to be traced to the worker finding unconsciously and gradually by experience that he can work more strenuously and quickly for a short-hour week than for a long-hour week. In the second place, the evidence suggests that a considerable increase in the average hourly output is possible, quite apart from any increased rapidity of working. Thus, as the result of special investigations, Dr. Vernon found that in the case of the first body of workers mentioned above, the time lost in commencing and stopping work during the first period averaged 37 minutes as compared with only 26 1/2 minutes during the third period.

8. Professor Loveday, in his Memorandum on the "Causes and Conditions of Lost Time," which is included in the Committee's Interim Report on "Industrial Efficiency and Fatigue," also supplies valuable data of a somewhat similar character. In the first place, he points out that the proportion of lost time that is due to sickness and other unavoidable causes is, as a rule, greatly underestimated in factory records, and the
proportion due to slackness consequently over-estimated. In the second place, he expresses the view that long hours, much overtime, and especially Sunday labour, exert a pernicious effect upon health, particularly of persons occupied in heavy trades. In paragraph 33 (5) of that Memorandum he gives two tables, the first dealing with a body of about 180 men, and the second with between three and four hundred men employed on heavy work, their normal hours being from 65 to 70. In both these cases, when comparison is made with the figures of lost time for June, 1915, and for a year later, the fact emerges that there was a material increase in the amount of lost time, and that by far the larger portion of the increase was due to recorded sickness. In both cases, throughout, recorded sickness represented a noticeably high proportion of the total amount of time lost.

9. Professor Loveday also devoted considerable space to the examination of figures concerning the amount of time lost before breakfast. He concludes—

(a) That if early hours be worked, the loss is likely to decrease if the start be later than 6 a.m.

(b) That when the total hours of the day-shift week are the same, there are likely to be more hours actually worked without than with work before breakfast, other conditions being similar.

(c) That a reduction of hours may be compensated for or even outweighed by the abolition of early hours, partly owing to reduced absences, partly owing to reduced waste of time, and partly to the greater vigour of work after taking food.

He quotes figures for a number of different factors which confirm these conclusions. The strongly presses the view that food should precede work. He points out the undesirability of hunger work, its bad effect upon health and the temptation to lose time in the short early spells.

10. There can be little doubt that there is an increasing recognition on the part of both employers and workers of the broad fact which emerges from the investigations of Dr. Vernon and Professor Loveday, namely, that substantial reduction of hours can be effected without any reduction of output. Whereas at the beginning of the War there was a general belief that longer hours necessarily produced larger output, it has now become widely recognised that a 13 or 14 hours' day for men and a 12 hours' day for women, excepting for quite brief periods, are not profitable from any point of view. Few, probably, would disagree with the statement contained in the Summary prepared by the Right Hon. G. N. Barnes, M.P., of the recent Reports of the Commissions on Industrial unrest that—

"There is a general consensus of opinion that Sunday and overtime labour should be reduced to a minimum, that holidays should not be curtailed, and that hours of work should not be such as to exclude opportunities for recreation and amusement."

It must be obvious that any reduction of hours which can be accomplished without loss of output is profitable not only to the employer, in that it reduces running expenses, but to the worker, since even if his or her daily measure of work involves the same amount of fatigue a longer period is left for recovery and for the enjoyment of adequate sleep and recreation.

11. It must be recognised that the conditions are not the same now as they were in the early days of the War; not only have large numbers of the youngest and strongest workers been withdrawn for military service, but those who remain are suffering from the strain inseparable from a continuous period of long hours of employment. To this must be added the strain caused by family and other anxieties arising out of the War. While much has been done to improve conditions of employment they are still in many cases far from ideal, notably as regards housing and transit. Further, large numbers of women are now employed on heavy work and on skilled operations involving constant thought and attention, which were considered two years ago to be quite beyond their capacity. It may be true that no serious breakdown of health has as yet been observed among the great mass of the workers, but it cannot be assumed that this condition will continue indefinitely. The effects of the strain may even have been already more serious than appears on the surface, for while it is possible to judge roughly the general condition of those working in the factory to-day,
Little information is available concerning the large number of workers who for one reason or another, and often because they find the work too arduous, are continually giving up their job. This is an important point which is liable to be overlooked, since the supply of labour has hitherto been adequate to fill their places. The irritability and nervousness mentioned by the Commissions on Industrial Unrest are moreover well recognised symptoms of fatigue, while it must not be forgotten that the effects of fatigue are accumulative.

12. After careful consideration of all the circumstances, the Committee are convinced that the maximum limits of weekly employment provisionally suggested are too high except for quite short periods, or perhaps in cases where the work is light and the conditions of employment exceptionally good. In the great majority of cases, however, the hours of work should now be restricted within limits lower than those quoted in paragraph 2 above. It is impossible to lay down a single rule as to the best hours in all cases; the best scheme can only be determined after a careful consideration of a number of different factors, e.g.—

(a) The strain involved in the work, its character (heavy or light, continuous or intermittent) and the mental demand which it makes upon the worker.
(b) The extent to which the pace of the work is governed by the machine.
(c) The factory environment—temperature, ventilation, &c.
(d) The individual physical capacity of the workers, and their age, sex and experience.
(e) The organisation of the factory (including welfare supervision).
(f) The sufficiency and suitability of the workers’ food, canteen accommodation, &c.
(g) The arrangements of the hours of work (spells, breaks and pauses).
(h) Conditions outside the factory—e.g., housing and transit.

In arranging the hours of work for a factory, allowance should be made, as far as discipline and organisation permit, for the fact that the best hours of employment will not be the same for all processes, even in the same factory.

13. In conclusion the Committee desire to urge the view that the time is now ripe for a further substantial reduction in the hours of work. If this be effected with due regard to the varying conditions prevailing in different branches of industry, they are satisfied that reductions can be made with benefit to health and without injury to output.

Signed on behalf of the Committee,

GEORGE NEWMAN, M.D.,
Chairman.

E. H. PELHAM, Secretary.

October, 1917.

Printed under the authority of His Majesty’s Stationery Office

BY HARRISON AND SONS,
PRINTERS IN ORDINARY TO HIS MAJESTY,
ST. MARTIN’S LANE, LONDON, W.C. 2.
DILUTION OF LABOUR
BULLETIN

A Monthly Publication for Officers working in connection with
the D.A. Section (Dilution) of the
Labour Supply Department.

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ISSUED BY THE D.A. SECTION (TECHNICAL) OF THE
MINISTRY OF MUNITIONS
6 WHITEHALL GARDENS, LONDON, S.W. 1.

Vol. II.—No. 10.—AUGUST, 1918.—Copyright

[Owing to pressure of work on the printing establishments concerned no number has appeared for July.]

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Real repetition work is not even semi-skilled so far as the operators are concerned. The setting up of turret and automatic lathes requires skill, but the operating or minding of them, little or none, because most or all of the operator's or minder's work is controlled by the mechanism of the lathe. When repetition work, again, is done on an engine lathe, it is controlled by limit gauges; and these, again, though they leave the operator free to spoil the work if he chooses, enable him in the most difficult part of the operation to dispense with the really skilled use of callipers and replace it by the relatively mechanical control of the limit gauges, by the help of which he can venture into work of far greater accuracy than he would otherwise attempt.

Consider, for example, the sliding finishing cut along the outside of a shell. The operator has a double-ended limit gauge, or two gauges, one of which must go on, and the other must not. It is extremely doubtful if he could tell you what the difference between these two gauges is, or if he would understand exactly how much or how little it is. Let it be assumed that the operator started with gauges + and − 0·01 in. from the standard, and that new gauges were issued every day, the tolerance in each case decreasing by a ten-thousandth. It would be interesting, if the gauges were not marked with their size, to try and predict when the operator, or perhaps even the foreman or manager, would begin to detect that they were working to a much finer limit than they ever thought possible. It is known that watchmakers and instrument makers work to the highest degree of accuracy; but if asked to work to '001 in., they are quite likely to throw up their hands in horror, and say it is impossible, not realising that their every-day production is far within such a tolerance.

It may, in fact, be taken as demonstrated by experience during the War that working to fine limits does not necessarily involve any skill that with proper instruction cannot be acquired in a short time; and if the pages of this publication be gone through, many cases will be found of women working to '0005 in. and less, and doing it just as easily as others are working to '01 in., simply because their foremen and managers have taken the trouble to train them to it. But even then it will be said that this is on repetition work.

The question then arises as to whether a dilutee who can turn a piston rod of a certain diameter to a fine tolerance will be completely put out if asked to turn a valve spindle of the same diameter to the same tolerance. If this be the case, then duplicity would assist us by saying that they were both piston rods. Again, if a dilutee can turn a piece of metal two inches in diameter to limits of 0·0005 in., why not a piece 1·99 to the same limits, and if so, why not a piece 1 in. or even ½ in. diameter? If it should, however, turn out that the difference in size marked on the gauge in what shopkeepers call plain figures is sufficient to prevent him from being able to do the work, then let us have recourse to the hieroglyphics used by some retailers.

Similar remarks would apply with equal force to boring or any other machine work; and indeed the only real limitations of the accuracy to be obtained readily in machining is that the tool employed must be suitable to the limits, and the limits to the tool. It is absurd, for instance, to try and work to a limit when the machine has, say, an inherent lack of parallelism that is already greater than the limit imposed; and it is equally futile for draughtsmen to put very fine limits on parts where no limit was required at all, or even on limits which are impossible, such as the outside dimensions of angle and tee-iron framing, or on machine work to be executed in shops equipped with only very old machines. But with limits suitable to the machine and the work, it is impossible to believe, and the evidence which is being constantly received in the Ministry contradicts the impression, that the fineness required in engineering practice on machine work cannot as a rule be obtained with relatively short training, such an impression, indeed, can only be found in the minds of those who are afraid or cannot be troubled to make the trial for themselves.

This is the fair statement of the general truth; but it must be admitted that sometimes a certain sense of paralysis does occur on some classes of very accurate work. A case, for instance, was described on page 117 of the BULLETIN for May, in which this nervousness interfered with the manufacture of aero-engine cylinders. Sometimes such difficulties may be avoided quite simply. Thus, for example, a firm making large numbers of double-ended limit gauges decided to make these in two parts, joining them mechanically after finishing, because it was found that on the double-ended gauges men took so much longer to finish the second end, the first end having been finished, for fear of spoiling the whole piece. It is not, of course, always possible to find a solution so simple as that of the double-ended gauges; but apart from the fact that designers could probably do a good deal to avoid this cause of trouble, it must be recognised that such cases are the exception and not the rule, and that
there are thousands of parts now being made where the difficulty does not arise.

It must, in fact, be admitted that plain sliding cuts to gauge are repetition work, even when the diameter and the material or consecutive pieces vary. Whether the operator for herself can set up her own tools and grind them and adjust the speed of her machine, or whether these operations are done for her, she has only to obey the gauge that is given her, and not to use skill in taking up fine dimensions in calipers and applying them to the work. The same admission must be made in regard to plain boring and to surfacing in the lathe. The contrary suggestion is, indeed, not an advance on old practice but a retrograde view. Thirty years ago neither planing, shaping, slotting or drilling were considered to be skilled tradesmen's work, and if the operator can plane, shape and slot to markings in any one piece, it is very difficult to imagine that it is not possible to do so in other pieces. What may be difficult is to fix the work down; and where it is, it is well worth the management's while to face the difficulty systematically, instead of leaving it to be muddled through by the operator.

We are indeed rapidly approaching the stage when, instead of saying that all firms making a certain article should be able to dilute their labour to a certain percentage, the dilution should be prescribed for the operations, such as plain lathe work, screw-cutting, planing, slotting, drilling, &c., a small percentage of skilled labour being reserved for fixing of individual awkward pieces on the machine. In other words, we are getting beyond dilution by product, and arriving rapidly at dilution by process.

SPRING-MAKING.

A works in the Y. & E.M. Division is showing good dilution in the manufacture of spiral springs. They are making these in considerable variety, including nose clips for gas masks, hand grenade springs, locking springs for aero-engines, fuse springs for machine guns, running-out springs for field guns up to 60 pdr., mine springs and springs for railway and tramway work.

In the heavy spring shop women in addition to labouring and warehouse work are cutting off, tempering and driving a coiling machine, and constitute about one-fifth of the hands. In the light spring shop, where they form over four-fifths, they are cutting, coiling, annealing, grinding, working presses, setting, tempering, pressing, testing, finishing and doing miscellaneous work. Indeed, in light springs the skilled spring makers form only about one-tenth of the hands and are engaged on such work as is too heavy for women to handle, such as springs made of \( \frac{3}{8} \) in. to \( \frac{7}{8} \) in. diameter wire which is coiled cold on a mandril, and takes great strength in forming the spring and controlling the feed. On these springs the men carry through likewise the other operations, including tempering. It will be remembered that at another works in the N.W. Division women were being employed very successfully on making laminated and other flat springs. (See Bulletin, April, 1918, page 106.)

THE MINISTRY'S EXHIBITIONS OF WOMEN'S WORK.

The Exhibition at the Whitechapel Art Gallery closed on 20th June. Over 26,000 visitors attended, including representatives from many works, and the presence of the Ministry's officers gave rise to the mutual exchange of information and to special inspections at the request of the firms.

A further exhibition was opened at the Art Gallery of Nottingham Castle on the 8th July by Mr. Kellaway, Parliamentary Secretary to the Ministry. The gallery was lent to the Ministry by the kindness of the Corporation. The exhibition remained open until the 27th of the month. It was open each week-day except Fridays from 10 o'clock to 8.30 without charge, and on Fridays from 10 to 6 o'clock by invitation or at a charge of 6d., and on Sundays from 3 to 5 o'clock.

A meeting was held on Sunday evening, the 21st July, at the Picture Hall under the chairmanship of Mr. Edwards, Vice-President of the Nottingham Chamber of Commerce, at which an address was given by Mr. Defries, of the D.A. (Technical) Section, explaining the function of the exhibition and the films, and the dependence of the country on the dilution that is now indispensably required. This was followed by a display of some of the Ministry's cinematograph pictures illustrating the manufacture of machine tools, aero-engines, aeroplanes, shells, fuse, and other munitions, as well as some view of their use in actual service at the Front. A second meeting was held on the 29th July, under the chairmanship of Alderman E. L. Manning, at which Mr. Field, C.D.O., of the N.W. Division, gave an address.

In addition to exhibits of work and photographs as at previous exhibitions, the number and variety of which was greater than before, trophies of special public interest were shown, such as specimens of the Madsen and Parabellum guns taken from the enemy. Women workers from the Training Section attended and worked at actual manufacture in the exhibition itself. This feature, which was quite new at these exhibitions, attracted considerable interest, and it is hoped that it may be practicable to repeat it at exhibitions in the future.
WOMEN IN FOUNDRIES.

Foundrymen include many of the most conservative among engineering workers, and it is not surprising that the objection to the employment of women has been strongly marked in a large number of foundries. Recent reports, however, indicate that in many of them this reluctance is being steadily overcome, especially in respect to the lighter work. Some recent examples may be of interest to manufacturers and dilution officers, as indicating that in many foundries the employment of women is no longer an experimental measure.

In the iron foundries of a large company in Scotland, employing some 1,400 hands, and making a considerable variety of light work from stoves and ranges to munitions, women were employed even before the war for some purposes, and formed about 10 per cent. of the staff; at present they are over 40 per cent. Apart from turners and machinists, of whom women form nearly 90 per cent., and fitters, nearly half of whom are women, they are doing almost all operations in purely foundry work.

Of the moulders, for instance, 45 are women; others do almost all the coremaking; in one foundry they do all the sand-mixing, emptying of boxes, knocking-off gates, and every other operation except metal pouring. Much use is being made of runways in one shop, together with a mechanical elevator and chute, whereby a great deal of heavy labouring is avoided, and the employment of women is much facilitated. The results on moulding have been on the whole satisfactory in respect of output. Two women, for example, mould 110 boxes a day of grenade base-plugs, including lifting boxes from the stool on which they are moulded and placing them on the floor. Three others, working on the floor, mould 35 boxes of fuse plugs per day. Others, moulding adaptor plugs and aerial bombs from plates, turn out 110 boxes, including placing on the floor and setting their own cores. Others make 80 boxes of stove parts a day in snap-flasks, including placing on floor. Others make 95 boxes of fuse plugs a day on Tabor machines and 80 boxes on hand machines.

At two fender and grate foundries in the Birmingham and West Midlands Division 56 out of 83 hands are women, including 7 out of 8 moulders, 18 out of 21 polishers, and 4 out of 6 fender fitters. Women riddle their own sand, put in the pattern plate, ram up the boxes, which are 30 in. by 18 in. and 24 in. by 18 in., draw the pattern plate and replace the top box; they also assist with the larger boxes (5 ft. by 19 in.). The fender fitters screw the end on the fronts, punch the holes in the bottom plates, and rivet up. At another works in the Yorkshire and East Midlands Division, making malleable iron castings, the core-making section employs only 8 skilled men with 91 women, 9 labourers and 2 apprentices, men doing only the heavy and complicated work. At a foundry in Scotland women are making all the cores, including very delicate cores for roller bearings, which previously had always been done by skilled labour. In a foundry in the North-Eastern Division 16 women are employed on hand-finishing moulds, and 2 on amending defective castings by electrical welding. At a works in the West Midlands Division a disused foundry has been organised in just over a month for making "Newton" bombs exclusively by women labour, with the exception of melting, carrying molten metal, and heavy labouring. Each bomb weighs 37 lbs., and is cast to a limit of 1 lb. Two women are at present so employed, and with the help of three core-making machines produce 750 bombs per week. The staff is to be increased on the same lines to produce 6,000 bombs per week.

In a large brass foundry in the North-Eastern Division some women are doing exceptionally good work core-making, some of the cores being 12 in. by 24 in. Other women entirely by themselves draw extruded metal and weigh up the heats for mixtures.

At a foundry in the Yorkshire and East Midlands Division 5 women are working in a section by themselves as floor moulders, using boxes 4 ft. long by 18 in. wide. They make intricate cored castings for marine work, such as baffle plates for oil-feed boilers, &c., weighing in some cases up to ½ cwt., and with several cores to fix into the different prints. They draw their own patterns, and the work is said to be remarkably clean and quite equal to men's. Each girl lays down 7 boxes a day. It is intended to increase the number of women moulders.

At a foundry in the West Midlands Division 13 women are employed by themselves on moulding machines, mixing their own sand and setting up their plates. Elsewhere in the works they are employed on core-making and settling, including grinding, for which they have shown particular aptitude. Two women are also making plaster patterns, and have acquired not only skill but a useful knowledge of the work. The tendency of foundries to drop into a conventional pace of production was illustrated strikingly in this firm's experience. The firm...
Fig. 84.—Women making Cores for Aero Engines.

Fig. 85.—Women making Cores for general Engineering Work.
has good relations with its employees, and on the outbreak of the war three-fourths of their hands joined the forces with the firm's encouragement. The principals then appealed to the staff that was left for increased output, and as a result an increase of 300 per cent. was obtained.

An operation on which there has been some difference of opinion as to the suitability of women is the driving of cranes carrying ladies with molten metal, and the employment of women for this purpose has therefore been left in each foundry to be settled by its own experience. The balance of evidence seems to show that, on the whole, women are fully equal to men in their ability and trustworthiness on this work.

In a large iron works, for example, in the Y. & E.M. Division a woman is driving an electrical travelling crane, handling hot metal. She has had no accident, and has the full confidence of the men.

In engine work a West Midlands firm is employing women on highly complicated cores, such as for the water jackets of two-cylinder Thornycroft motors (about 98 m/m.). They are made on machines similar to moulding machines. In the dressing shop women are also employed on dressing aluminium crank-cases, weighing up to 120 lbs. each, by means of horizontal bandsaws, the cases being raised from the ground by planks suspended from an over-head runway, which carries them to the band-saw table. Both in output and other respects the women's work is eminently satisfactory.

Another example of women employed on miscellaneous engineering work is seen in a brass foundry of a large engineering works in the W.M. Division, where women form nearly 30 per cent. of the total hands, and are moulding, core-making, grinding and otherwise fettling, sand-riddling, making chaplets, attending to magnetic separators, and doing other general operations. For all the lighter bearings they are making white-metal linings, preparing the brass for themselves, and carrying out the work alone. In the machine-moulding section two pneumatic moulding machines are being used by women for making thrust-block linings; each machine is in charge of a woman moulder, with two male labourers to prepare the sand, and four women to assist in carrying the boxes each weighing 1 cwt. The women pour their own metal in hand ladles, which with the metal and tongs weigh nearly 1½ cwt., and their output is the same as that of the men. Among the work for which they make cores are ignition boxes, pump discs, motor bearings, main bearings and eccentric straps. The women moulders are said to be thoroughly competent in the use of their tools, and the employment of women in the foundry is extending.

Fig. 84 shows a view of women making a variety of cores for aero engines in this foundry, including bearings, eccentric shafts, valves and bed-plates, and Fig. 86 shows them preparing bearings and running white-metal into them. Fig. 85 shows a group of core-makers in a foundry in the N.W. Division, engaged also on general work, the nature of which is seen clearly in the figure.

The net outcome of these notes is to show that there has been the same experience in foundries as in machine shops, that a woman will be practising in one shop satisfactorily an operation which for some reason she is not
foundry is brought home to all, the scope for the employment of women on this work will prove to be much larger than it has often been thought to be. In few branches of work, moreover, can judicious alterations of routine practice make more difference in the strain and fatigue involved. To substitute light for heavy boxes, for example, though often it is a long and costly business, may be profitable when the moulding operation is rapid. With even less trouble, again, hot foundries, where, for instance; metal is being poured all day in shanks, may be easier for women's work if pouring is done in alternate spells with moulding. In well authenticated experience, too, output may be increased considerably by compulsory rest for ten minutes or so once or twice in the morning and afternoon.

SCIENTIFIC GLASS MAKING.

In a glass-bottle works in the Y. and E.M. Division, now engaged mainly on chemical glass, about one-sixth of the hands are women and discharged soldiers and about one-third are boys. Before the war boys and women amounted to about one-third of the staff, but no chemical glass was made. On lamp bulbs, flasks and scientific work, boys are marvelling, blowing, cutting-off and taking-off, changing about in these operations, and blow light bottles and similar work on machines, a man putting the vessels into the glory hole and forming the brims. Other lads also make feet for tubes and glass stoppers. Women are cutting off wide-mouth flasks, beakers and similar articles on carborundum wheels and with the flame, and are forming the brims of a variety of articles, such as round and taper flasks, measures and the like, putting in the lip when required; others do puntingy on various articles. Girls are also graduating measuring vessels with measured quantities of liquid, marking the graduations on tinfoil pasted in the tube, a woman having filled and marked the bottom graduation; women then fix the vessels in a graduating machine and put in the permanent marks. A women also graduates the specific-gravity bottles. Women and girls transfer, wash, apply tinfoil and badge vessels. In the laboratory a woman analyst is making small melts, analysing optical glass, determining refractive indices, critical constants and the like, and largely taking the place of two men who have been transferred to a new glass works.

In these works pots blown in moulds are being made by gangs of two men and a lad, the men covering, cutting-off, and pressing by hand, and the lad blowing to size with a pneumatic blower. At another Yorkshire works men and boys are blowing electric lamp bulbs, which in the works under notice are blown wholly by boys.

SHEET-METAL WORK.

Doubt is sometimes felt as to the operations in sheet-metal work that can properly be done by women. It is, however, generally known that their employment on press work and welding is in every way satisfactory, and the experience of a firm in the L. and S.E. Division illustrates the considerable advantage with which these processes can sometimes be substituted for older methods.

The firm is making aluminium bends, elbows, tees, and similar work, largely for aero-engines; and recently it has introduced the practice of making such articles in two halves, formed in the press and welded together, instead of working in the ordinary way. The work is made out of 20 gauge sheet with \( \frac{3}{8} \) in. rivets, and is done wholly by women, including assembling, pressing, welding (where necessary on jigs), filing-off, riveting and finishing. The welders, who had had experience of steel welding, learned to make first-class welds in aluminium in a fortnight; and the filers had three weeks' training, the riveters two days for hand-riveting and an hour for machine-riveting, and the press hands one day. In all, fourteen women are turning out weekly 1,600 Rolls-Royce induction tees, 50 Austin induction bends, 50 Sopwith induction tees, and 50 Rolls-Royce ignition tubes. It has been found in every way desirable as well as convenient for the women to weld in a shop by themselves.

The advantage of the new method is seen most strikingly in the Rolls-Royce induction bends, which used to be made by coppersmiths in six hours each, and by the present method are turned out at the rate of 4½ in an hour, without any further skilled assistance than the part-time supervision of one man. Similarly, tees that took coppersmiths 8 hours to do by hand are made out of press-formed halves in 2½ hours; the Austin induction bends, which took 7½ hours skilled work, take women an hour under the new method. Ignition tubes, formerly 12 hours' work for the coppersmiths, on the new method take about an hour and a-half.

Although it was not thought that the employment of women on this work was likely to be satisfactory in all respects, the trial has been completely successful; and as an incidental advantage it is said to have created a favourable feeling among the men towards dilution in general.
DILUTION OF LABOUR BULLETIN

WOMEN MAKING CHUCKS.

In the Bulletin for March, page 91, some particulars were given of the dilution effected in chuck making by a firm in the Y. and E.M. Division, amounting to over 62 per cent. of women in addition to 7 per cent. of boys and discharged soldiers, and including inspecting, fitting and assembling. Photographs of some of the work are seen in Figures 87 to 93. Fig. 87 shows a woman turning and finishing the front of a 16 in. chuck body casting and ringing it 1/4 in. pitch. Three tools take roughing cut, two on the face and one on the outer rim. The machine used is a Bullard vertical turret lathe. It is set up and the tools ground by the woman supervisor; the work is done to a tolerance of 0.002 in. The operator lifts the casting from the floor with quick lifting pulley blocks and removes it when finished without assistance. Fig. 88 shows a woman lifting a 2 cwt. body casting with pulley blocks to place on a jig for milling, on a plain horizontal milling machine, opening out jaw slots 1 3/4 in. deep by 1 13/64 in. wide. The machine is one of eight and worked by women in charge of a male supervisor, who sets up for them. Fig. 89 shows another woman on a vertical milling machine, milling jaw ways in body of scroll chucks. Fig. 91 shows a woman on a duplex boring machine, boring a chuck body which weighs 200 lbs. The machine, which drills or reamers two holes at a time, is set up and operated entirely by female labour. The operator lifts the casting with blocks in and out of the lathe for herself. In Fig. 90 the woman is grinding jaw ways in chuck jaws of independent chucks; the work being held by a magnetic chuck and done to a tolerance of 0.001 in. It is set up and the machine entirely manipulated by a woman. Fig. 92 shows a woman grinding scroll-chuck jaws internally and on face; the final operation on scroll chucks. In Fig. 93 the operator is working a broaching machine on chuck parts.

Women are also working grinders to limits of 0.0005; for instance, grinding and doing a variety of turning to 0.001 in., a male supervisor setting up the work.
The simple but important lifting gear which enables the operator to handle her work for herself will be noticed in some of the photographs, and it will be observed that where convenient she sits down to her work.

BRUSH MAKING.
A firm in the London and South-Eastern Division is employing twenty-five women on sand-papering the backs of brushes on a sanding drum, and others on boring brush backs on the multiple boring machine, and shaping them on a spindle-moulding machine, dressing bass and fibre, fixing bristles in varnish brushes in a clinching machine, examining and stacking boards, and trimming brushes. Three women act as forewomen, replacing foremen on brush work. In the tool shop women are doing non-repetition work on a centre lathe and a miller, some of it to 0.001". They already re-grind their own tools, and are about to learn to set up the work.

These operations include some that were performed exclusively by men in these factories before the war, and the work includes all kinds of brushes except those partly made of bone.
WOMEN IN POWER STATIONS.

At a Yorkshire electrical works less than one-tenth of the workers are skilled men, nearly one-third are women, and one-eighth are discharged soldiers. The women work as boiler cleaners, ash wheelers, light stokers and labourers, and the discharged soldiers as greasers, stokers and ash removers, and on other labouring that is too heavy for the women. They work three shifts. Among the operations done by women is stoking chain-grate mechanically-fired double boilers, on which 57 women are engaged under a skilled charge-hand for each shift, one woman to each double boiler; regulating the feed; raking the furnaces with 12 ft. rakes, made of hollow piping and solid iron; shovelling out the ashes from under the grates with shovels 18 ft. long, having iron or wooden handles, and handled by two women together; and throwing the riddled cinders back into the hopper, which is 6 ft. high. The cleaning occupies 27 other women, who attend to the station boiler-house, pump-room and fan-house, cleaning not only the floors but the tops of the boilers, engines, etc., and regulating the oil. As colliers 17 women unload coal into bunkers mostly from 10-ton wagons; in one day 12 women unloaded 55 wagons in 8½ hours, or between five and six tons per hour for each woman. Another woman works with pick and shovel as a railway-line worker, and keeps the lines clear.

WOOD-FORMING MACHINES.

Wood-forming machines depending on a controlling form or a shaped cutter are a means of economical production well-known to those who have sufficient work to occupy them, and at the present time their use wherever applicable is to be commended the more because they are eminently suitable to operation by discharged soldiers or women. Fig. 94, taken at a works in the S.W. Division, shows a woman operating a forming machine for propellers. The woman is able to do this work after three weeks' training without any male supervision; and other women polish and varnish the propellers and brass-tip their blades, also without any immediate male supervision. The women’s work is said to be thoroughly satisfactory.
HEAVY EDGE-TOOLS.

It is not always realised that a large scope for employment of women and discharged soldiers exists in the manufacture of heavy edge-tools. An illustration of the extent and variety of the work in this manufacture on which they are already employed may be given from a recent report on a works in the W. M. Division.

More than two-thirds of the staff of these works are women, discharged soldiers or boys, and more than half are women. In the shops where the women, 419 in number, are employed, there are five foremen and four forewomen.

Women do all the cold-pressing, heating and light smithing, most of the hot pressing, filing, dry grinding, viewing, drilling, riveting and wood turning, and a good part of the hardening and setting, labouring, storekeeping, clerking and other work.

For example, they file up hoes, assemble and rivet wire cutters, dry-grind and polish hoes, entrenching tools and ice-creepers, attend to shaking barrels, wheel heavy loads of horseshoes, hand-shape ashwood handles and fit them to shafts for shovels, and set horseshoes cold, frasing and piercing nail holes in the shoes on presses. In the stamping shop they attend to gas-fired furnaces as heaters, and forge 1 in. steel stock on power presses into entrenching tools, socket ends of spades, and the like. They also heat hoes and entrenching tools in gas-fired muffles, and dip them into baths for hardening and tempering; use power presses for hot shearing and setting horseshoes; polish hoes, entrenching tools and ice scrapers on double-ended spindles; dry-grind wire-cutter jaws, hoes and entrenching tools; set and grind wire cutters on belt machines; fit and rivet wire cutters, file up hoes, view horseshoes and hoes, and shape and finish by hand handles to shovel shafts. They also attend to shaking barrels for cleaning horseshoes, and with the help of boys black, paint, varnish, pack and despatch the works product. Grinding hoes, entrenching tools and the like involves considerable skill, as the articles are awkward to hold and manipulate, and a good surface has to be given without spoiling the temper or thinning the metal in a vital part. Up to two years ago all this work was done by men on wet grindstones, an old method used in other firms.
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DILUTION AND OUTPUT.

An instance recently reported illustrates what excellent times can be obtained by the use of diluted labour, when it is used under suitable conditions.

A firm in the Y. & E. M. Division, who used to make wood-making, cloth-cutting and similar machines, took on during the war the manufacture of tools for a variety of other work, and by the end of 1916 were employing a fair proportion of women. They are now engaged altogether on aero-engine and motor-lorry parts, and employ about 150 hands, of whom nearly 40 per cent. are women, distributed over all parts of the shops including the tool room.

Among the articles of which the manufacture has been entrusted to the women is an ordinary flat-headed aero-engine mushroom valve, approximately $2\frac{1}{4}$ in. diameter over the head with a $1\frac{1}{4}$ in. diameter stalk about $2\frac{1}{2}$ in. long, machined all over from a drop stamping. It is being made on ordinary lathes, fitted with stops such as would be used ordinarily in bulk manufacture, and the workers are paid piece-work. The time taken over the job is eight minutes.

This time is certainly a good deal less than what many shops would accept as sufficient; and it is perhaps, therefore, a reminder that the previous practice of a shop is not necessarily a guide to the time that should be allowed for making a particular job, especially when large quantities are in question. Dilution of labour is undoubtedly necessary in existing circumstances for the mere purpose of economising skill and man-power when without economy there is not enough of either to go round. An equally essential part of its purpose is to maintain or increase output and to economize plant; and a careful consideration of the instance quoted will show how necessary it is to neglect no means of assuring the fullest output from diluent as well as from skilled labour. The past experience of a shop or a number of shops indicates very usefully rates that have been already attained, and may set a lower limit for output, below which a management should not be content. But it does not necessarily indicate the best that could be done.

A works that has adopted systematic methods of analysing its jobs is probably able to judge whether the speeds already attained are really as great as might be, without waiting till an accidental performance by a new worker, or a sudden emergency shows that better speeds are possible. Even, however, when the system of systematic time studies does not exist in the works, and is considered too circumstantial to be introduced in present circumstances, it should usually not be difficult to take out an overall calculation, showing how the recorded time stands to the calculated time on the cutting speeds and feeds that are known to be best. Some such analysis is always an assistance to a works manager or foreman in judging whether work is being done with a reasonable approach to what is possible, and the absence of such knowledge may lead, without the wish or even the knowledge of either workers or employers, to a serious loss of output.

WOMEN TECHNICAL ASSISTANTS.

Ten women are now employed in the Criticism of Construction Section of the Design Branch in the Ministry's Aircraft Production Department, which also contains seven full-time men, under the head of the office. The women are distributed in two of the three sub-sections, one of which has a woman in charge. They share in all the regular work of the office, and are also employed occasionally to represent the section outside, especially at the strength tests carried out at the Royal Aircraft Establishment.

The work consists in the first place of strength calculations, based on the drawings and specifications for all new designs submitted to the Department by the Aeroplane firms. Reports are prepared stating whether or not the various structural members are up to strength; these are signed by the man or woman responsible for the calculations, and sent out to the firms concerned. The types of machine vary greatly, and, as the size of machines increases, grow steadily more complicated, as do the methods of calculation employed; so that there is no mere routine work.

In the second place, there are questions continually submitted to the Branch concerning alterations of machines in use, substitution of materials, and investigations arising out of accidents, which require special calculations.

A third section of the work deals with the general theory of aeroplane construction, leading to greater knowledge of stresses and improved
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methods of calculation; these results, if of sufficient importance, are issued confidentially for the information of designers.

The experiment of allowing women to attempt this work was begun towards the end of 1916, when three Cambridge women joined the Design Branch of the Admiralty Air Department. They are now distributed in different branches of the Aircraft Production Department. In August, 1917, three more women joined the staff, and the number has been gradually increased as suitable applicants were found. The standard qualification required has been an honours degree in pure and applied mathematics.

The success of this experiment is due almost entirely to the time and trouble which the men of the section gave freely to the training of the women, especially those who joined first, and to the consideration which has been shown to them all along. A very important point is the short hours (10 to 5); this has been found the best way of getting the maximum output of good work. The women have always been encouraged to ask questions, and the heads of sub-sections make it their business to answer them fully, or to refer them to the head of the section if necessary. They are naturally handicapped at the start by their ignorance of engineering, and of the engineer's way of thinking and speaking of applied mathematics; they have never seen nor handled the parts of an aeroplane, and are not used to slide-rules and blue prints. There is very little in books about the stressing of aeroplanes to help them, and they get their training entirely by contact with more experienced people. It is reckoned that after about two months they get to feel at home in the work.

There is every reason to suppose that women could do similar work for private firms, provided that adequate initial qualifications were required, and that a competent engineer were prepared to devote the necessary energy to their training during their first few weeks. For work as various and as complex as is required in the Criticism of Construction Section the requirement of mathematical knowledge equivalent to that possessed by those who have taken an honours degree in pure and applied mathematics, and preferably evidenced by such a degree, does not appear to be too stringent. The extent that is necessary for other purposes will vary with the work. The qualification of the engineer-in-charge is particularly important to the success of the work. The purpose of employing women is to dilute and not to replace the skill of the responsible officer. The women who are employed on technical work are well aware of this; and an officer who is to secure their best services must be qualified to assure them that he is completely master of the work of which he requires them to do a part. Where possible it is an advantage that he should have at least as good a general education as the women who work under him; but this is clearly of less consequence than that he should be, and be evidently, master of their work as well as of his own.

NOTES ON THE EMPLOYMENT OF WOMEN.

Coke-Oven Plant Work.—Of the staff of a firm in the Y. & E.M. Division making coke-oven plant 40 per cent. are women, engaged on assisting bricklayers and as general labourers.

Foundry.—In a foundry in the Y. & E.M. Division, engaged on castings for machine tools, all the plate moulding is being done quite successfully by women, and some of the machine moulding. In this foundry working was said to be transformed from an unsatisfactory to a highly successful position by the introduction of piece-work.

General Engineering.—In a shop in the W.M. Division making crabs and winches, 19 fitters are women, and so are some machinists and labourers. In a general machine-shop in the same establishment, a woman has been doing non-repetition work for the last twelve months on a Landis grinder 12 in. by 42 in., working without supervision to 0'0005 in., and setting up for herself.

In a works in the Y. & E.M. Division, 58 women and 24 men are turning steel road-wheels on 36 in. chucking lathes to a limit of 0'002 in., doing all the slitting, most of the drilling, half the viewing and gauging and all the crane driving, a little of the supervision, and in the foundry all the core-making.

In a works in the Y. & E.M. Division, 8 women are doing non-repetition centre-lathe work, turning pulleys and couplings of various sizes and types.

Machine Tools.—In a works in the Y. & E.M. Division, making principally wood-working machinery, one-third of the fitters are women, in addition to varying proportions of the turners.
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and machine hands. Considerable scope exists for further dilution, which is likely to be introduced.

Ordinance Breech Mechanism.—In a works in the Y. and E.M. Division, engaged on ordnance breech-mechanism, more than half the 720 hands employed are women, including over half the tool-room hands, and just over one-fourth are skilled men, including less than 20 per cent. of the tool-room hands. Nearly two-thirds of the machinists are women, and about 30 per cent. of the miscellaneous labour. The work is done mostly to limits of 002 in., and on one job on the shaping machine a woman works with a mirror and has no direct view of what she is doing. The sizes made run from 12-pdr. 105 in., 65-pdr.

Internal Combustion Engines and Tool Room Work.—In a works in the N.E. Division employing 864 hands on Diesel engines for battleships and other engines for tanks, over 35 per cent. of the staff are women, discharged soldiers and boys; for example, 20 out of 82 fitters, 4 out of 11 planers on heavy machine work, and 6 out of 14 machinists in the tool room are women. Further dilution is in progress.

Motor Vehicles.—A firm in the S.W. Division, engaged mainly on engines and vehicles for motor transport and aero-engines, employ women in most departments, their staff including 37% per cent. of women, discharged soldiers and boys, and their skilled men being under 30 per cent. The more skilled jobs are mainly done by men upgraded in the works. Women among other jobs build up entirely the frames of motor lorries, drilling and bolting up the spring brackets and other details; the frame is then taken over by a gang of three men, one skilled and two unskilled, who complete the exterior of the chassis. Men are often upgraded from chassis erection to engine erection.

Gauges, Jigs and Small Tools.—In a works in the L. & S.E. Division making exclusively gauges, jigs and small tools, about 40 per cent. of the staff are women. They do all kinds of tool turning and machining, some to close limits, as well as backing-off cutters and tool fitting.

Ball Bearings.—In a large firm in the Y. & E.M. division dilution on the manufacture of ball bearings has progressed until now over half the hands are discharged soldiers or women, less than two-fifths are men, and only about one-sixth are skilled men. Of the charge-hands nine-tenths were trained in the works from labourers; and it is expected that when the works to which extensions are now being completed are got fully going, dilution will be over 90 per cent. in all departments, excepting the tool-room, where nevertheless substantial dilution may be looked for.

Aero Engine Valves; Aircraft Metal Parts.—At a works in Wales the manufacture of aero-engine valves and aeroplane forked ends, eye-bolts and nuts is done entirely by 27 women with the help of one grinder and 2 charge hands; 9 of the women are engaged on hand-tapping.

Stampings and Aeroplane Components.—A firm in the Birmingham and West Midlands Division which employs women on several kinds of press and machine work, put one on to swaging tappet-valve rods in a press, but found that the work was too much for her wrist. They were able to replace her by a one-eyed disabled soldier, who is said to be doing the work quite satisfactorily.

Aircraft.—A works in the West Midlands Division employs 65 women out of a total of 81 woodworkers engaged on aircraft, and all the men are either ineligible for the Army or have been discharged from it. At another works in the same Division nearly 40 per cent. of the total staff are women, and over 10 per cent. are discharged soldiers or boys. The women are engaged on nacelles, plane assembling and various other operations.

Saw Mills.—In a saw mills in the N.E. Division nearly half the staff are women, 52 of whom are pulling off boards from the saw, assisting the sawyer to lift the logs into the machine, and doing other labouring work. In addition about 35 per cent. of the staff are boys.

Door and Window Frames.—A firm in the Y. and E.M. Division, making among other things door and window frames, is using women to a considerable extent. With the assistance of youths they assemble machine-made parts of doors, an operation that takes a little skill in getting the joints close up; in the cutting and planing department they feed and "take-off" machined timber, and bundle or tie it up when planed and moulded. This work requires both care and nerve, and the women do it with remarkable confidence. On the saw benches women are cross-cutting with 12–18 in. circular saws, on which they attain the fullest possible skill. Eleven women also assist the carpenters and do the priming.

Electrical Attendants.—In a works in the W.M. Division women trim, adjust and re-carbon the arc lamps throughout the works, and also clean, oil and inspect electrical motors and report faults.

Scrap-Metal Sorting.—In a yard on the Clyde employing 30 hands, 8 women are sorting metals, operating derrick cranes and loading up for them. They are stated to be "ideal" workers, and require little or no supervision, except in distinguishing steel from iron.

Nickel Refining.—At a Welsh nickel works women empty filter presses and are employed on other process work, on weighing and testing, and on various kinds of labouring.
DILUTION AND AGE.

In a recent report on a firm employing about 100 hands it was observed that only 4 women were employed. After considering how far this represented what was practicable it was discovered towards the end of the report that the average age of all the hands in the firm was 58, the firm having released every fit unmarried man at the beginning of the war.

The age of the staff is, of course, not conclusive as to the propriety with which an apparent excess of males can be used. One of the two primary objects of dilution is economy of skill, and the elder men may include a needlessly high proportion of skilled workers, who might be transferred; but without being conclusive, the fact that the excess of men consists of those who are beyond military age and have long been settled in their homes is undoubtedly material to judging whether their removal is expedient, and it is therefore of much assistance for full information as to age to be given wherever it is conveniently possible. It will be remembered that the transfer of men is not always the only remedy for excess of skilled male power; sometimes it may be possible to alter the type of work sent to the establishment, so as to make a better use of its skilled labour, and so avoid the necessity for distributing it.

HACK SAWS.

Probably the lightness of the work has made the manufacture of hack saw blades always an industry in which women have done a conspicuous part. The proportion of women employed on it has, however, now become greater than ever before. A good case is that of a small shop in the Y. & E.M. Division, making hack saw blades from 12 in. to 24 in., both for machine and hand. Here, before the war, ten women were employed with three boys and four men. There are still four men, the only skilled one of whom is the hardener, no boys and 39 women. Of these women one is a forewoman, another is an assistant, and the others work on hardening, cleaning, milling, including milling cutter grinders, punching, shearing, marking, setting, flattening and tempering the ends. Dilution is even better than it looks, for one of the two male labourers is 51 and the other is a medical reject. It is hoped that by putting on an extra hardener and two discharged soldiers, two day shifts of eight hours each may be worked in place of the present shift of nine hours; another 30 women being taken on for the purpose.

DILUTION ON REPAIRS.

In a works in the W.M. Division making electric lifts, constructional work, heavy machine tools, marine engine parts, mine sinkers and mine firing mechanism and similar work, in addition to some bombs and shells, the general tool-room is run by twelve hands, three of whom are skilled men and four are women. One woman working on a lathe true up reamers, blanks for milling cutters and a variety of other work, setting up her own work, adjusting for taper and carrying the job through. A girl on a milling machine, again, makes all the milling cutters, sets up her own work and operates all the necessary settings for angle, depth, number of teeth, and other details. A girl also grinds all the tools used in the general shop on machine work. In spite of the variety of sizes of angles she is found to grind them correctly and for the most part by hand, only employing the grinding rest very occasionally. She is found to judge quite accurately the cutting angles for turning, planing, shaping, slotting, etc. The instance is notable partly as showing the fallacy of the impression that women can only be employed to do single jobs, but partly also because a shop that had shown the competence which is evidenced by this enlightened employment of women labour might have been expected to have defined the cutting angles of tools for various work and not to have left them to be put in by eye.

TOOL-ROOM WORK.

In a works in the Y. & E.M. Division a case is recorded of practically complete dilution on both the repair and the manufacture of cartridge cylinders. Old sheet metal cartridge cylinders are sent down for repair, together with heaps of apparent rubbish, such as hoops, ends, nozzles and old screws, &c. The cylinders are hammered into shape, repaired, riveted up, soldered and painted, and any details that are required for making good are taken out of the heap of rubbish, no new metal or details being used; when finished the cylinders are said to be equal to new. In the same works new cartridge cylinders and cones for mines are also made. The new work is done by 60 women under the supervision of two discharged soldiers, and the repairs by 39 women with the assistance of a semi-skilled metal worker of 56 and a labourer of 53, under a charge-hand who is a discharged soldier. A further number of women are to be taken on shortly for the repair work. Two women inspectors pass the whole of the work.
OUTPUT AND DILUTION REPORTS.

Dilution is not always successful without good management, and in any change of arrangements a temporary fall off in output may often be unavoidable. Subject, however, to good management, experience shows that judicious dilution may at the worst make no more than a temporary reduction of output. It cannot be realised too clearly that for the large majority of mechanical operations the characteristic of a skilled man which distinguishes him from a diluent worker is not the ability to work a particular machine or to perform a particular operation. Suitable labour previously untrained can be taught this much in a far shorter time than was ever thought possible before the lessons of the war had been learned. What cannot be taught in a short time is the ability to work not a machine but any machine; the knowledge and judgment as well as manual skill, which is the result of experience, and distinguishes a tradesman from a trained machine hand or other upgraded specialist operator.

It is natural that those who have not made a practical trial of dilution, or who have done so without making the simple but sometimes troublesome arrangements necessary for starting it in suitable conditions, may have the fear that dilution will be followed by a permanent drop in output. For example, in a works in which output in the last resort is limited by plant, and the object of a manager pressed for delivery is to get the most out of his plant that it can yield, the management, and even the Government authority for whom it is working, may well fear that if dilution is introduced the necessary supplies will not be forthcoming. There are only two ways of combating this fear. Either the works must make practical trial and find from experience that its fears are groundless, or the experience of other works must be at its disposal to enable it to see how dilution on similar work has affected output elsewhere.

The value of a dilution report is therefore considerably increased when it contains data of this kind; where practicable, it is of course desirable that figures should be given for the work before and after the introduction of the diluent labour; and seeing that the change is often accompanied by changes of manipulation or arrangements which themselves tend to improve output, any alteration in methods should be clearly stated. Nevertheless where records have not been kept so as to enable both sets of figures to be given, a clear description of the work and a statement of the actual times in which it is performed by the diluted labour may often give valuable information that will be quite sufficient for the purposes of an engineer. In a recent report, for example, of a works in the Y. and E.M. Division making rolling stock and permanent way for light railways, women are described as boring wheels 12 inches diameter on duplex boring machines and rough- and finish-turning the axles for them on centre-lathes. The dimension worked to is that of the bore of the wheel, and the women take this in callipers and turn the axle to a limit of .001 inch. Working on piece-work, the average output of wheels per woman per shift of 8 to 10 hours is 50 to 60 wheels, and of axles 20. For a fortnight before it was recorded, this work had been handed over to each woman to do individually right through on piece-work instead of being split up between the group of women on each shift, and the times evidently are not such as to deter the employment of women. Circumstantial information such as this can only be obtained by dilution officers through the records and goodwill of manufacturers. It is earnestly hoped that such data will be noted by the works and given to dilution officers as fast as they are obtained. In no way can a works which is already diluting give more valuable assistance to the Ministry in promoting the dilution of other works.

WORKS TRAINING.

A firm in the W.M. Division has been so impressed with the operation of M.M. 130 (Revised) that in view of future eventualities it has decided to start girls in its shops with a view to giving them a good all-round training, similar to that given to indentured apprentices. Training so described may vary widely in value according to the establishment, and that which is given to indentured apprentices in some establishments may not necessarily train them into good workmen. If, on the other hand, the training is really careful and judicious, as in the instance in question there is no reason to doubt that it will be, and the girls are taught good mechanical habits from the outset instead of being left to discover them for themselves by a process of trial and error, good results should be possible within a reasonable time.