

## CURRENT TOPICS.

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**Developing a Gauging System.** E. OBERG. (*Machinery*, vol. 25, No. 2, p. 93, October, 1918.)—One of the most complete systems of gauging for the manufacture of ordnance is that developed by the Pratt & Whitney Company for the manufacture of modern rifles. A modern rifle has from 60 to 125 parts, according to its design, and requires about 700 machining operations for its completion. For that work not less than 1750 working gauges are required. An equal number of inspection gauges are used, and for every inspection gauge there is one reference gauge, so that altogether there are, in one set, 5250 gauges.

Gauging systems and interchangeable manufacturing are so closely related that it would be impossible to discuss one without dealing with the other. The main object in the introduction of interchangeable manufacturing was to reduce costs by standardizing the manufacturing operations and reducing the time required in the assembling of the mechanism. A secondary advantage is thereby gained, of interchangeability of parts. The latter advantage has become an object equally important with the reduction in the cost of assembling. As an example of the reduction of cost in assembling by the adoption of an adequate gauging system, it may be mentioned that the cost of assembling a certain rifle was \$2.50. By the adoption of a new tool and gauge equipment, which resulted in the scrapping of the former tool and gauge equipment, valued at \$80,000, the cost was reduced to 25 cents.

Interchangeability is sometimes carried too far, when the object sought is merely to facilitate assembling, any further refinement to insure absolute interchangeability involves useless expense. Very few mechanisms, in fact, are absolutely interchangeable. Even in rifle manufacture there are a few cases where matching of parts is permissible, this practice being known as "selective assembling." It is therefore necessary that proper judgment be used in determining upon the importance of interchangeability, and that the various factors be carefully weighed against each other.

It is generally assumed by those who have had no direct experience in devising gauging systems for interchangeable work that it is a comparatively simple matter to determine proper tolerances and limits. It has, however, been proved many times in ordnance and small arms work that without a most careful consideration of the many factors that enter into the production of a part, the cost of manufacture may be increased beyond all reasonable limits. The rule that the designer of the mechanism and the designer of tools and gauges must work constantly together cannot be too strongly emphasized. The most important subdivision of the whole subject

of establishing a gauging system is the determination of suitable tolerances. It should be emphasized that the original design should require as few fits as possible, and liberal clearances should be provided in every case where there is no actual fit.

The first principle that must be considered in the establishment of tolerances—and one that is the most often ignored—is that tolerances should not be determined with reference to what would be the minimum tolerances that could be obtained by modern machining methods; but they should be established with reference to what are the maximum tolerances permissible in the mechanism without interfering with its proper purpose and action. Great difficulty is experienced with designs that do not provide for initial clearance on the original drawings. The designer, while not considering tolerances, should decide upon the kinds of fit required, which, in turn, makes it possible with the maximum metal dimensions, thus providing for the initial clearance at the time the design is made.

In general, there is a misconception as to the tolerances ordinarily permissible in the building of machines and other mechanisms. It is generally believed that the tolerances on what are considered refined mechanisms are much smaller than they really are; and unless designers thoroughly study the subject, they are inclined to require tolerances that are by no means necessary. It is possible, by the application of expensive machinery operations, to obtain an accuracy of 0.001 of an inch, or even less, but when not essential, such accuracy is highly undesirable from the point of view of economy in manufacture. The rifle is a highly accurate mechanism, and, generally speaking, the tolerances might be considered as small as the tolerances in any other mechanism, yet the average tolerances on the important dimensions of a first-class rifle are about 0.004 of an inch.

The first and most vital principle to be observed in the development of a rational gauging system is to have the locating points in the jigs and fixtures for the machining operations agree with the points used for gauging the work. Unless the gauging is done from the same points as are used for locating the work in the jigs and fixture, it will be found impossible to obtain a product that will be interchangeable.

