Workshop technology

Part 2

SI UNITS

Dr W. A. J. CHAPMAN

MSc(Eng), FIMechE, Hon FIProdE

CBS

CBS Publishers & Distributors Pvt. Ltd.

New Delhi • Bengaluru • Chennai • Kochi • Kolkata • Mumbai
Hyderabad • Nagpur • Patna • Pune • Vijayawada

most holes produced under quantity production conditions are machined with some form of reamer or fixed diameter cutter, whilst shafts are turned using tool boxes with easily adjusted tools. If the shaft basis system were employed very little benefit would be given to the production of shafts, but hole production would be much more complicated because for every type of fit, in each size, a different reamer would be necessary. By employing the hole basis one size reamer suffices for all the holes to any particular diameter. In a few circumstances it may be desirable to employ a shaft basis. A case in point is where a single shaft may have to accommodate a variety of accessories such as bearings, couplings, collars, etc. and it is desirable to maintain a constant diameter for the permanent shaft, and vary the fittings to suit. Some provision is made for shaft basis in the ISO limit system below.

Limit systems

The design of a limit system is not as simple as might be supposed. Consideration has to be given to the allowances suitable for the various classes of fit included, and to ensure that the desired fit will still be obtained under all possible variations of hole and shaft within the limits set out. The allowance for any fit will vary according to the diameter, and conditions for medium or low-class work will not be suitable for high-class products. If the limits are too close (small tolerance) a better control of the fit is possible, but production will be expensive. Wide limits (large tolerance) will cheapen production, at the same time introducing the risk that mating components which may happen to be on opposite extremes of size will not provide a satisfactory fit. To summarise, the limits and allowance will depend on the following:

(*a*) Nominal size (e.g. whether 25 mm, 100 mm, etc.).
(*b*) Class of fit required.
(*c*) Quality of product.

The limit system generally employed in this country is the British Standar. System.

The ISO system. This system, set out in BS 4500: 1969, allows for 27 types of fit and 18 grades of tolerance, covering a size range of zero to 3150 mm. At first sight the provision of 27 fits with 18 grades of accuracy seems to offer a much wider selection than should ever be required but the provisions allow for everything from fine gauge and instrument work to the roughest form of production. Average workshop the best and most common example of a 'ready made' limit system in this country for general work. Engineering firms may prefer to create and use limits and fits which they consider more suitable for their particular work. In any case, no system gives any guidance on the determination of a tolerance for purposes outside the fit of one component in another. Limits and tolerances on such elements as angles, tapers, hole centres, contours, etc., must be determined from experience and other considerations. The adoption and careful adherence to a reliable system of limits and fits is an essential part of any modern system of interchangeable production. It ensures that components made in one factory may be assembled with mating parts made in another and, by eliminating the necessity for the preliminary trial of a fit, parts may be made and held in stock until they are required. The application of a system of limits and fits is not confined to circular holes and shafts but may be applied to any set of conditions where a particular type of fit is required. It will be seen, therefore, that it may be used for keys and keyways, square and flat fitting combinations and similar applications.

Selective assembly

The principle we have just described is that of full interchangeability in which any component assembles with any other component. Often special cases of accuracy or uniformity arise which might not be satisfied by certain of the fits given under a fully interchangeable system and resort is made to a scheme of selective assembly.

If particular accuracy is required it is cheaper to work to a reasonable tolerance, and sort the articles into size groups during inspection, than to impose such close working limits that the conditions are achieved during manufacture. An interesting example of this is given in the mating of aluminium pistons in motor-car cylinder bores. On a bore of 63 mm the best skirt clearance for a certain type of piston is 0·12 mm on the diameter. If we assume that there is a tolerance of 0·02 mm on the bore diameter $\left(63{\cdot}00\begin{smallmatrix}+0{\cdot}02\\+0{\cdot}00\end{smallmatrix}\text{ mm}\right)$ and the same on the skirt of the piston $\left(62{\cdot}88\begin{smallmatrix}+0{\cdot}02\\+0{\cdot}00\end{smallmatrix}\text{ mm}\right)$, the smallest piston in the largest bore would be $63{\cdot}02-62{\cdot}88=0{\cdot}14$ mm clearance, and the largest piston in the smallest bore would be $63{\cdot}00-62{\cdot}90=0{\cdot}10$ mm clearance. By grading and marking the bores and the pistons as shown they may be selectively assembled to give the conditions required.