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CYLINDRICAL SHAPE IN DESIGN

Abstract: *The paper presents the cylindrical shape detailed study, frequently used in industrial design.The geometrical cylindric shape is the ideal (perfect) shape which is given by mathematical equation. The functional shape is the ultimate (final) shape which is obtained using different technological proceedings and it is a part of designed device.*
Also, the paper presents geometrical shapes with variable geometry , shapes obtained wrapping small thickeness iron sheets, or products obtained arranging different cylindrical shapes.

Keywords: *Cylindrical shape, functional shape, technological shape, variable geometry*

1. INTRODUCTION

Most of the definitions for industrial design include in a way the notion of *shape***.**

Two of the definitions confirm the previous assertion:

"Design means organizing in harmonic equilibrium materials, processes and all elements which depend on a certain function. It integrates the technological, social and technological needs as well as the biological necessities or the material's psychological effects, *shape*, color, volume and space" – L. Moholy Nagy – Bauhaus School [1].

"Design is a creative activity which consists in setting out *the shape properties* of the industrially made objects. The object *shape properties* include not only exterior characteristics but also all the structural relations that make a coherent unity from an object or objects system, regarding the viewpoint of the producer or the anybody user too". (I.C.S.I.D. – The International Council of the Societies of Industrial Design) [1].

The cylindrical shape is the most frequently used shape in structure of industrial products (shafts, cylindrical bars and pipes, rivets, cylinder bores etc.)

The cylindrical shapes are manufactured by machine tools through lathing, drilling, boring or through wrapping from sheet, plastic materials etc. The rotation cylinder is the most technological shape, therefore it is more easily achieved than other shapes (conical shape, spherical shape, hyperboloid shape etc.).

2. GEOMETRICAL CYLINDRICAL SHAPE

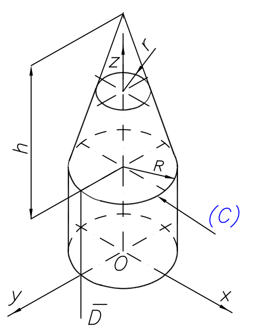

Fig. 1 Geometrical cylindrical and conical shapes.

The equation of the cone in figure 1 is:

$$x^2 + y^2 = R^2\left(1 - \frac{z}{h}\right)^2 \qquad (1)$$

If the vertex of the cone is at infinite, the ratio *z/h --> 0* and the cone becomes a cylinder with an equation given by (2). The equation of a cylinder with *z* as symmetry axis (fig. 1) is [3]:

$$\begin{cases} x^2 + y^2 = R^2 \\ \forall z \end{cases} \qquad (2)$$

The intersection of the cylindrical surface with a plane parallel to the horizontal plane *(xOy)* is the circle *(C),* constituting (establishing) the circular profile.

The intersection of the cylindrical surface with a plane containing the axis is a generatrix *D* which establishes the rectilinear profile.

Deviations from the ideal cylindrical shape are caused by:

-deviations of the circular profile (C) - circularity,
-deviations of the rectilinear profile D - straightness (the profile D is corrugated),
-deviations of the rectilinear profile *D* from the parallelism with the symmetry axis - cylindricity .

The shapes of industrial products are composed of simple (prism, cylinder, cone, sphere etc.) or complex geometric shapes (hyperboloid, helical shapes, etc.).

A lot of parts are simple, their real shape coincides with geometric shape.

Therefore, a cylindrical roller (fig. 2a), a bearing ball (fig. 2b), a flat key (fig. 2c) coincide with cylinder, sphere respectively prism.

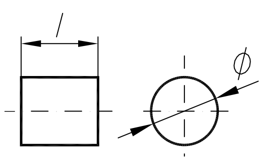

Fig. 2a Cylindrical roller.

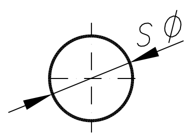

Fig. 2b Bearing ball.

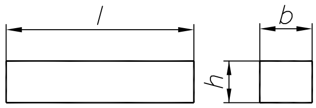

Fig. 2c Flat key.

3. FUNCTIONAL SHAPE IN DESIGN

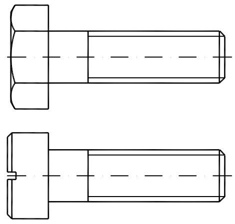

Fig. 3 The screws with different heads.

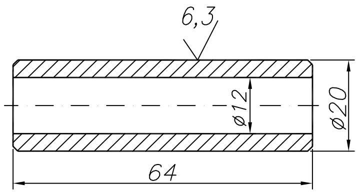

Fig. 4 Bush.

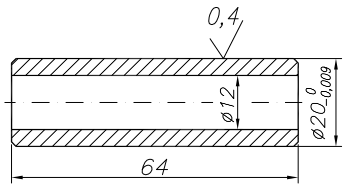

Fig. 5 Piston bolt.

The shapes variety composing industrial products is determined by their functional role.

The functional role determines (establishes) the functional or basic shape of a product.

Thus, the two screws in figure 3 have the same function (role): to assemble two pieces together. The thread is the *functional shape* (helical shape), although the heads have different forms.

The part in figure 4 can be a bush. In this case, the dimensions are more important than precision or roughness.

If the part in figure 5 is a piston bolt, the precision and the roughness have a great importance in the function. Although the two parts have the same shape, their functional roles are different. Different functional roles lead to different materials, different fabrication technologies and warm treatments.

4. CONSTRUCTIVE-TECHNOLOGICAL SHAPE IN INDUSTRIAL DESIGN

The constructive-technological shape is the final shape of a part and it is obtained as a result of different fabrication technologies.

In figure 6 are presented three constructive-technological shapes for a sliding bearing which assure the same functional role: turning shaft support.

If the metal is the cast iron and the parts number is great , the sliding bearing can be achieved through casting (fig. 6*a*).

If the parts number is small, the sliding bearing can be achieved through welding (fig.6*b*).

If the sliding bearing is unique (only one), it can be achieved through milling and drilling (fig.6*c*).

There are technological differences, different materials, different part number among the three constructive-technological shapes of the sliding bearing.

The cost price is different because of manual labour, tools, devices etc.

Finally, the designer chooses the best variant regarding the fabrication technology and the cost price too.

In figure 7 is presented a speed-reducing gear shaft.

The most important shapes of the shaft in figure 7 are functional shapes *1* and *2*. The two bearings are assembled on spindles *1* and the wheel hub is assembled on cylindrical shape *2*.

The shaft must centred and fixed between the two conical vertex both at lathing and at grinding for obtaining the deviations value.

Also, the spindles *1* and cylindrical shape *2* grinding must be made in the same fixing [5].

A concentricity deviation of cylindrical shape *2* greater than one prescribed leads to the gearing wrong function (cogs wheel wear, noise, even wheel sticking).

The concentricity deviation of the spindles *1* leads to bearings premature wear, noises and vibrations.

The dimensional deviations and the roughness for functional shapes *1* and *2* were chosen so that the bearing to be pressed on shaft (*k6*) and wheel hub to be easily pressed on shaft (the fit *H7/k6*).

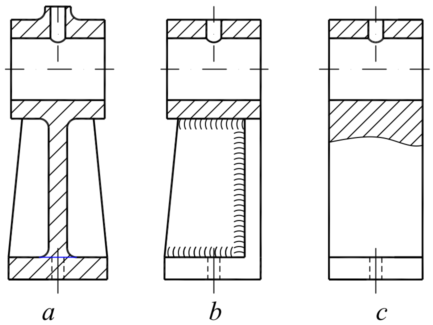

Fig. 6 Sliding bearing.

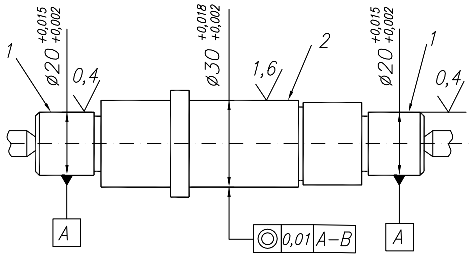

Fig. 7 Shaft.

The cylindrical shapes which have not a functional role are processed normal (normal lathing).

The small values for deviations and roughness lead to expensive product (performance machine-tools, high quality workers) therefore the designer has an important role.

5. CYLINDRICAL SHAPE WITH CHANGEABLE GEOMETRY

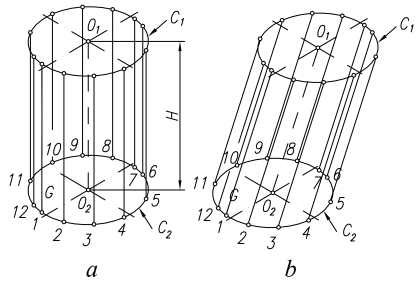

Fig. 8 Cylinder with extensible generatrix.

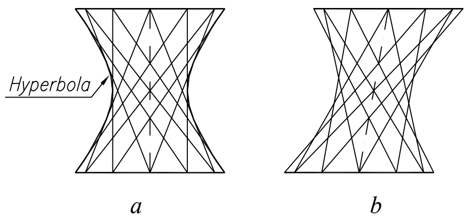

Fig. 9 Cylinder turned into hyperboloid.

The rotation cylinder in figure 8*a* has extensible generatrix. If the circle C_1 moves parallel with C_2 we obtain an oblique cylinder (fig. 8*b*). If the circle C_1 is turned round its own axis, we obtain a rotation hyperboloid (9*a*). An oblique hyperboloid is presented in figure 9*b*.

A device which turns the cylinder with extensible generatrix into a lot of other ruled surfaces is presented in figure 10 [4].

The component parts of the device are:

1 - base plate; 2 - guiding bar; 3 - cylindrical slides; 4 - disks supports; 5 - disks with holes; 6 - extensible threads.

-Oblique circular cylinder in figure is achieved by cylindrical slide 3 turning on guiding bar 2 and by superior disk 5 turning round its own axis, in order the generatrix to become parallel.

-Rotation cone in figure is achieved by superior disk 5 turning round its own axis with angle $\alpha=\pi$.

-Rotation hyperboloid in figure is achieved by superior disk 5 turning round its own axis with angle $\alpha<\pi$.

The changeable device can be used as teaching aid.

Also we can realise different ornamental items, for example a lamp-shade, which can be changed from a cylinder in many hyperboloid shapes [2].

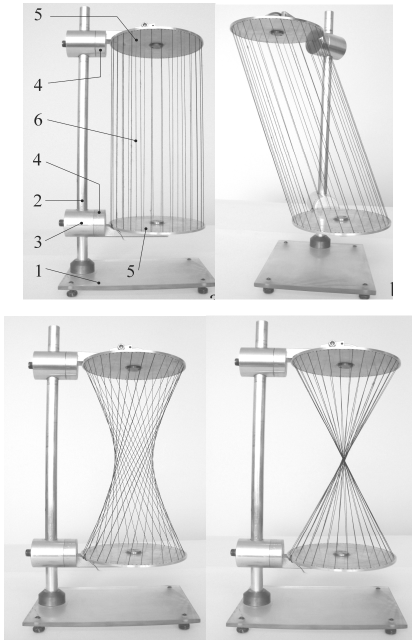

Fig. 10 The changeable device.

If the circles C_1 and C_2 in figure 8*a* are connected to the inextensible generatrix by spherical joints, than the rotation cylinder turns into a rotation hyperboloid (fig11). It can be can mentioned as practical applications the followings:

-clamping, pressing, grasping mechanisms when the hyperboloid generatrix are rigid bars attached to the C_1 and C_2 disks.

-wheels, rotors, adjustable abrasive or cutting tools based on property of the hyperboloid to change its profile to a cylinder.

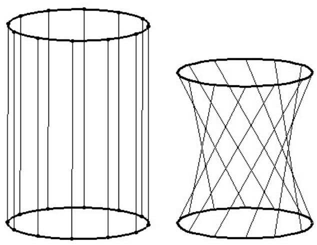

Fig. 11 Cylinder with inextensible generatrix.

In figure 12, the cylindrical helices are equally distributed to right and left and they can turned in intersection points so the cylinder height decreases or increases (fig.12).

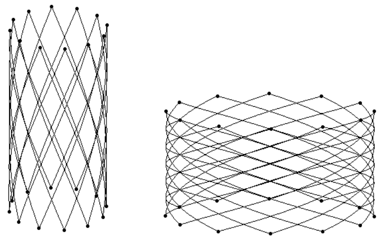

Fig. 12 Cylinder generated by cylindrical helices.

A lighting body can be achieved using this principle, reaching maximum luminosity when the angle between helices is 90^0.

6. OTHER CYLINDRICAL SHAPES

In figure 13 cylindrical pipe with great diameter are achieved by helical welding.

If sections S are cut from the pipe in figure 14, and are rotated successively at 180^0, the plane bend or an approximate torus segment it can be obtained.

In figure 15 is achieved a certain line from the pipe sections (for example banisters).

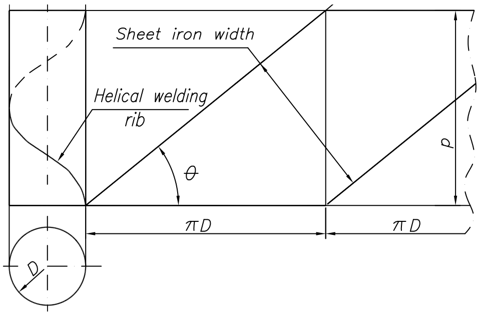

Fig. 13 Cylindrical pipe with great diameter.

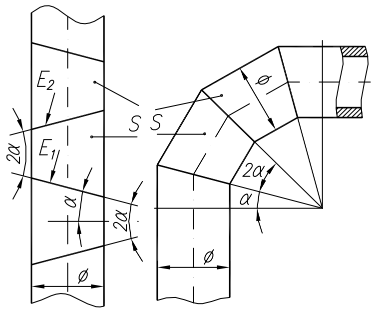

Fig. 14 Plane bend.

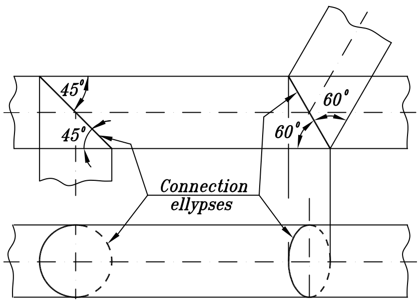

Fig. 15 The banister made of bars or pipes.

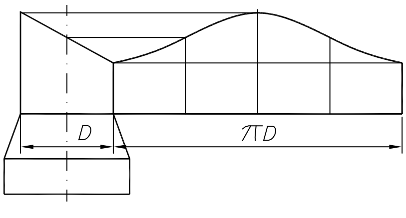

Fig. 16 Reducing socket.

The small thickness iron sheets (0.2 – 0.5 mm) cut out to a sinusoid and wrapt, can be used at pipes joining, piping, reducing sockets (fig. 16), etc.

7. CONCLUSIONS

The cylindric shape is the most technological and frequent used shape in industrial products design.

We can achieve a lot of cylindrical shapes by cutting (lathing, drilling, boring, etc),welding, developing and wrapping or joining different cylindrical surfaces.

The cylindric shapes with variable geometry are presented in this paper, so it can be turned into many other surfaces if its generatrix are extensible. A special device which turns the ruled cylindrical surface into other ruled surfaces is presented in the paper.

The cylindric shape is more easily achieved than other shapes; therefore it is an inexhaustible design creative resource.

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