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POWDER METALLURGY IN THE MANUFACTURE OF HUNGARIAN MACHINE PARTS

Rudolf Welesz

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In response to the need for information on the part of engineers, technicians, and planners engaged in the various fields of metalworking and machine engineering, this article discusses the possibilities for the utilization of powder metallurgy in general and the manufacture of small-sized machine parts in particular, with primary emphasis on the manufacture of complicated iron and steel parts. Due to reduced porosity, the machine parts produced by means of powder metallurgy approximate, in quality, castings and rolled products.

Powder metallurgy also reduces the costs of labor and materials in the manufacture of machine parts, due to the complete or partial elimination of machining operations.

Engineers and technicians engaged in the various fields of machine engineering and metalworking have, in general, not yet become acquainted with the possibilities inherent in the utilization of powder metallurgy for the reduction of production costs.

The purpose of this article is to acquaint experts, especially on the planning level, with the essential features of powder metallurgy, its methods, and possibilities. A knowledge of powder metallurgy will be helpful in solving some problems of design and in selecting the most suitable process for the manufacture of machine parts.

Although the products now fabricated by means of powder metallurgy constitute only 0.1 percent of all metal products produced in the entire world, this percentage is increasing very rapidly. To illustrate the importance of

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this new branch of industry and the role it plays in modern machine manufacture, it will suffice to point out that in highly industrialized countries, a motor car now contains about 100, and a modern airplane more than 4,000 machine parts produced by means of powder metallurgy.

The large measure of acceptance of powder metallurgy, which is expected to increase in the future, may be attributed to two basic advantages:

1. By means of powder metallurgy, it is possible to produce materials that cannot be manufactured in any other manner. This process enables us to regulate the porosity of certain products. As a result, ferrous powders may be used to produce metals which possess the qualities of bronze and lead. We use this process, for instance, in the manufacture of self-lubricating axle bearings, filters, condensation rings, etc.

This method makes it possible to combine certain unalloyable metals, such as copper and lead, in so-called pseudoalloys. Similarly, metals with widely different melting points, such as tungsten and copper, can be combined to form integral compounds. Moreover, metals and semimetals or oxides and nitrides can be combined to produce compounds such as copper-graphite, titanium carbide, corundum, etc.

2. Parts can be molded into finished or semifinished dimensions (/Hungarian: tolerances/ H7, h7, etc.), thus entirely or partially eliminating machine operations, with consequent great savings in material and working time. In this manner, production costs of parts can be reduced in some cases by four fifths.

It is, therefore, of some interest to cite a few typical applications which illustrate the advantages afforded by powder metallurgy. The following have advantages:

Graphite-bronze brush materials used in the electric industry; friction washers made of copper, lead, zinc, graphite, and corrundum used in machine tools for the manufacture of automobiles and airplanes; and porous, self-lubricating axle bearings which overcome many difficulties in cases where systematic lubrication is impossible. Axle bearings with iron bases are of special interest, because they can be substituted for axle bearings made of other metals. Fuel filters of considerably reduced weight, obtained by controlled porosity, for automobile, marine, aircraft, and stationary diesel engines; noncorroding steel filters as substitutes for nonferrous metals; porous iron washers to replace lead washers in water pipes; and extremely hard contact materials of nonweldable metals for the electrotechnical industry, produced by embedding such metals as wolfram in nickel, copper, silver, etc.

The new process is employed primarily in the manufacture of small parts weighing 80 to 100 grams and used in the light-machine, vehicle, and household-appliance industries, including sewing-machine parts, office machine parts, sprockets for bicycles, bicycle brake hubs, gears for oil pumps, roller-bearing raceways, valve lifters, meat-grinder knives and disks, lock parts, keys, etc.

It may be pointed out, however, that this article is devoted mainly to the manufacture of iron and steel machine parts. Even within this restricted field, it is not proposed to deal with porous machine parts but only with machine parts of complicated construction and of slight porosity, designed to approximate the strength of solid metals. This branch of power metallurgy has just begun to come to the fore as a competitor of other metalworking processes.

For exploiting the possibilities of powder metallurgy with respect to the manufacture of machine parts, the designers must first become acquainted at

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least with the general outlines of its technology. To proceed further, they must become successively acquainted with its inherent limitations, the potentialities of its physical and mechanical properties, and its strong points.

Producing the Powder

The first step shown in Figure 1 illustrates the process for producing metal powder for machine parts. Different methods may be employed for this purpose, pending on the requirements of economy and future use.

Preparing the Powder

The second step consists of the preparation of the powder, which involves the following processes: preliminary sieving, heat treatment, milling of the heat-treated powder, final sieving, and mixing.

Pressing Process

The third step consists of compressing the powder. The hydraulic or mechanical presses used for this purpose develop pressures of from 2 to 10 tons square centimeter. Compression is followed by sintering in a gaseous atmosphere in electric ovens at temperatures ranging from 800 to 1,300 degrees centigrade. If necessary, compression and sintering are repeated, sometimes followed by a copper bath and finally by calibration. The powder is routed along one of the four basic courses illustrated, depending on strength and other requirements. These four basic sequences, however, frequently undergo variations, which depart from the routings illustrated in variations 1, 2, 3, and 4.

Subsequent Operations, Finishing Processes

Any remaining operations that are necessary, such as machining, polishing, final heat treatment (hardening, tempering, casehardening), or oil impregnation (as in the case of axle bearings), are performed in the fourth step.

Details of Variations in Third Step

Variation 1. The pressure is varied between 2 and 8 tons per square centimeter, depending on the degree of porosity to be obtained. Lower pressure is used, for instance, in the case of machine parts which are to be impregnated with oil (axle bearings). Greater pressure is required for parts which will operate under greater stress.

Variation 2: In the manufacture of machine parts requiring greater strength, preliminary pressure ranges between 4 and 6 tons per square centimeter; preliminary sintering takes place at temperatures between 800 and 900 degrees centigrade; final compression is varied between 4 and 6 tons per square centimeter; and final sintering is done at temperatures between 1,100 and 1,300 degrees centigrade.

Variation 3: This variation is identical with the previous one, except that after final sintering, cold-calibrating compression is employed for precision.

Variation 4: This variation may be applied to parts which have been routed via variation 1, 2, or 3. In this case, however, the machine parts are copper-plated to increase strength and reduce porosity.

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Before proceeding to fill in the details of the above outline, it is first necessary to study the various pulverization processes commonly used to produce the powders necessary for powder metallurgy.

Pulverizing Processes

The iron or metal powder required for vacuum technology, for compressed iron powder cores for the communications industry, etc., is produced from gas phases by means of the carbonyl method. The product thus obtained has great purity. The granules are spherical and have a diameter of 0.1-5.0 microns. However, this method is very costly; the heavy investment required for it prohibits the extensive marketing of powder thus produced, except for special purposes.

Although the electrolytic method of powder production is somewhat more extensively used than the carbonyl method previously described, its more extensive use is profitable only at locations which have immediate access to cheap electric power. The fern-shaped granules thus obtained, having a dendritic construction, measure 5-50 microns; thus purity of this powder, as well as its excellent compressibility, also render it suitable for use in vacuum technology and for the manufacture of compressed iron powder cores and permanent magnets.

The so-called vortex-mill ("Hametag") process, a mechanical method of powder production, makes it possible to pulverize broken wires, plate scraps, granulated metals, and steel shavings. In this process, coarsely broken shavings, wires, or plate scraps are pulverized in a closed drum by two counter-rotating propellers. The powder thus obtained is widely used in the manufacture of machine parts and self-lubricating axle bearings.

The disadvantage of this process is the relatively small output of the equipment (10-20 kilograms per hour); furthermore, the so-called edge hardness of the resulting machine parts is not perfect. This deficiency is attributable to the disk shape of the granules, which does not assure satisfactory binding after compression.

The most widely used process consists of forcing molten metal through thin jets and pulverizing it by a high-pressure spray of water or air. Before the particles solidify, they fall on revolving shovels, which cut them into a fine powder. This process, which yields one to 2 tons of powder per hour, assures an adequate supply of powder metal for the large-scale production of machine parts. If the basic material is pig iron of high carbon content, cast iron, or steel, the concentrated oxide layer covering the individual granules will cause decarburization (refining) in the substance when air is the medium used in the powdering process. As a result, carbon monoxide is produced in the form of minute gas globules in the centers of the granules. After subsequent annealing, the powder thus obtained has excellent properties for compression.

The metal powders produced by the foregoing methods must then be prepared for the pressure-molding process in the technological sequence indicated (see Figure 1, Step 2). This preparation consists of sieving and grading, removing the oxygen absorbed during the pulverization process, milling the powder coalesced by the deoxidization process, alloying, and adding lubricants to facilitate compression, etc.

Pressing

The compacting of metal powders is performed under a pressure of 2-10 tons per square centimeter in a special hydraulic or mechanical press. In the

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following, surface will be taken to mean the greatest cross section of the part to be produced, perpendicular to the direction of the applied pressure. The density of the finished product depends on the magnitude of the pressure applied; consequently, it is possible to regulate porosity. Although low pressures (2-3 tons per square centimeter) are applied for the molding of self-lubricating axle bearings with a final porosity of about 30 percent, steel machine parts of great strength and minimum porosity are moulded under pressures of 6-10 tons per square centimeter. The application of higher pressures is not economical because of the excessive strain on the presses and tools.

When under pressure, the metal powders used for the manufacture of machine parts do not manifest the same behavior as do liquids. Friction is generated between the powder particles and along the surfaces of the tools, thus hindering the uniform transmission of the pressure.

When dealing with complicated machine parts, the entire pressing technique must be adjusted to compensate for the particular characteristics displayed by each type of metal powder. Consequently, a detailed discussion of this problem appears to be necessary.

If metal powder is to be compacted to form a solid cylinder, and the compacting pressure is exerted in only one direction (see Figure 2) the density of the compact powder decreases in direct proportion as the length of the cylinder exceeds its diameter. If the l/d ratio is greater than one, then the decrease in density will exceed 10 percent at the point farthest from the pressure punch. If the l/d ratio is greater than 2, the decrease will exceed 20 percent.

However, if pressure is exerted from two sides, as illustrated in Figure 3, densities are obtained which are suitable for purposes of machine production; in case the l/d ratio is equal to one, the decrease in density will be less than 5 percent. Figure 4 graphically illustrates this point. It also reveals that the friction generated by the interaction of the granules and by the movement of the granules against the surfaces of the forming tools can be decreased substantially by adding a lubricant, such as graphite or stearin, to the powder.

To offset the decrease in density resulting from the friction generated by the interaction of the granules, and to facilitate the even spread of the powder to the extremeties of the die, two different methods are employed. In the first method, illustrated in Figure 3, the die body designed to receive the powder remains stationary, while the upper and lower punches exert pressure from two directions. The second method is designed to reduce the effects of the friction generated by the movement of the granules against the side walls of the die (see Figures 5 and 6). It will be seen in Figure 5 that, in this case, the die body is moved by the powder under spring tension which is varied according to the powder used. Figure 6 illustrates a variation in which the motion of the die body corresponds to the motion of the punchs.

The properties of the metal powders described in the foregoing cause difficulties in the manufacture of irregularly shaped machine parts. Finished briquettes of irregular shapes will be of approximately uniform density only when the degree of compression is uniform throughout the piece.

When dealing with an irregularly shaped part (see Figures 7a, b, and c), the resulting variation in density can be tolerated. In the event, however, that a part requires steps which exceed one fourth of the total thickness, the product will be unfit for use because of uneven density. In such cases, the procedure illustrated in Figure 7a should be used, in which four punches, moving independently of one another, assure the uniform density of the finished briquette. On the other hand, it is not possible to assure uniform density when compressing similar parts with the punch depicted in Figure 7c.

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A comparison between Figures 7a and 8a reveals that punches 1 and 2 will have to compress sections of powder of the same height but to different degrees, which will positively cause unevenness.

To eliminate unevenness, the equipment illustrated in Figure 8b has been employed for filling in the powder.

The motion of the lower punch is synchronized with the motion of the upper punch, as shown in Figure 8b and 8c. Figure 8d, on the other hand, illustrates the manner in which the finished briquette is ejected from the die, while Figures 9a b, and c illustrate problems of tool construction.

With respect to the machine part illustrated in Figure 10a, uniform density can be obtained by the following method:

1. Preliminary pressing is done under relatively slight pressure to obtain the form as shown in Figure 10b.

2. This is followed by preliminary sintering at about 1,100 degrees centigrade.

3. Finally, finish pressing is accomplished under high pressure to obtain the form shown in Figure 10a, followed by final sintering.

The foregoing discussion justifies the conclusion that the various shapes of machine parts which can be produced by means of powder metallurgy are limited by the following principal considerations:

1. Powder does not behave in the same manner as do liquids or plastic substances, that is, powder does not fill out overcomplicated forms, does not flow around, does not fill out corners, and can be shaped only in the direction of the pressure.

2. Only such shapes can be obtained which will allow the punches to compact the powder in the direction of the pressure and permit the resulting briquette to be ejected from the die.

The following are secondary limitations:

1. An unfavorable distribution of density will be obtained in the case of solid cylindrical parts when the ratio of the length to the diameter exceeds 3:1 for bronze and copper and 2:1 for iron. If these ratios are exceeded, deformation will follow after sintering.

2. There can be no undercut projections in the side of the die, such as those which are usually found in certain types of conventional dies, for the purpose of facilitating chip clearance in the course of subsequent turning and grinding of the casting (see Figure 11a). However, there is no need for such a procedure in powder metallurgy, because the machining or polishing operation is entirely eliminated, since the parts are usually made to final dimensions.

3. In shaping the die, any shoulder-forming angle must be chamfered as illustrated in Figure 11b. Since the compressing of a perfectly sharp shoulder is impractical, a minimum radius of 0.2 millimeter must be applied in such cases.

4. The chamfer required at the ends of the castings must form the smallest possible angle with the horizontal, since acute chamfers are easily broken (see Figure 12).

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5. Only holes with axes parallel to the axis of pressure can be cored in the powder-metal die. Holes with axes running athwart the axis of pressure must be machined subsequently.

6. Feather edges, very narrow or deep notches, thin bosses, and gears are difficult to compress under a modulus of 1.5. Such machine parts will easily break when they are ejected from the die. Abrupt changes in cross-section thickness cause considerable cracking along the junctures on shrinkage of the metal after the sintering process.

Taking these considerations into account, machine parts are frequently designed to make a few machining operations necessary after the powder-metallurgical process has been completed.

The foregoing is represented by Figures 13a and 13b, in which the part shown is a feed attachment for a sewing machine. Figure 13a represents the part when the powder-metallurgical process has been completed; at this stage the teeth are still missing. The teeth are cut in a subsequent machining operation. Figure 13b shows the part in its final, finished form, produced by conventional machining operations.

Figures 14a and 14b illustrate bobbin parts of a sewing machine made according to two different technologies.

Where parts were previously manufactured of tempered alloys, they are now being made from steel powder containing 0.6 percent of carbon, pressed twice (6 tons per square centimeter, plus 6 tons per square centimeter), and calibrated.

Figures 15a and 15b illustrate the manufacture of the brake drum of a bicycle, which entails a steep breakoff amounting to 20 degrees and subsequent undercutting to a diameter of 19.7 millimeters. The part previously produced from A 34 11 polished rods [see Figure 15a] is now manufactured by powder metallurgy from steel containing 0.8 percent of carbon, pressed twice (6 tons per square centimeter each time), followed by calibration.

Figures 16a and 16b represent the upper eccentric of a sewing machine. The hole having its axis parallel to the direction of pressure must be machined subsequently, since its relatively small diameter involves danger of die breakage in this special case.

Sintering

The powders, when pressed into proper shape and removed from the die, have a strength similar to chalk; they must be handled carefully lest the edges break off or become marred. (So-called peripheral stress is one of the characteristic features of various metal powders). To endow machine parts with the durability required for practical purposes, the pressing process must be followed by sintering. This process should take place in reducing or neutral atmosphere to prevent intermediate oxidation. Usually, an electric furnace with molybdenum resistance elements is employed for sintering. The temperature varies from 800 to 1,300 degrees centigrade, and sintering lasts from 2 to 60 hours.

Sintering assists in forming the durability and mechanical properties of the finished part; in this respect, sintering is of even greater importance than the pressing process. The temperature and duration of sintering determine the porosity of the substance and also the cohesion between the individual metal particles. The diffusion that takes place at various temperatures during sintering is explained by research engineers as follows:

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The amplitude of atomic oscillations increases at the sintering temperature to such an extent that the magnetic fields of force of the atoms along the edges of the crystals become diffused and the atomic chains of the two crystal particles become connected. Once this connection has been established, it persists even after the cooling process has been completed. This increase in amplitude and atomic oscillation are also present within the crystal, but here, a state of equilibrium exists. The possibility of oscillation is much greater along the surface of the crystals, since only a unilateral stress exists and the space for movement is larger. The surface of the crystals is sharply articulated. There appear peaks and deep indentations, with the atoms representing the peaks taking up positions in the indentation of another crystal.

These phenomena have been substantiated by experiments performed in connection with sintering, in which a vacuum was used instead of a protective hydrogen atmosphere. Since the gas charge hindering surface diffusion (the surface being defective, or its hollow portions having been occupied by foreign particles) was eliminated, better results were obtained in this case than when a protective hydrogen atmosphere was used. (The use of the vacuum has not been generally adopted because of the technical difficulties involved).

Experiments have been conducted to prove that in the fusion of two metals in their solid state, the first step consists of the migration of electrons from one atomic orbit to the other. A current of 3.5 amperes was passed through pressed iron-powder rods, resulting in an increase of temperature amounting to 2-3 degrees centigrade. Despite the rise in temperature, considerable additional stability was found in the pressed parts, which was attributed to the electronic flow.

The higher the temperature at which diffusion takes place, the greater the rate of diffusion. Its magnitude depends on the duration of the sintering process, on the number of atoms participating in it, and on how closely individual crystals have approached one another during the pressing process. The porosity remaining after the crystals have cohered decreases slightly during the increase in granulation occurring in the recrystallization which takes place during sintering.

Figure 17 illustrates the extent of diffusion and the increase in stability values as influenced by the duration of the sintering process. Figure 18 illustrates the effect of the temperature of the sintering process on stability.

Figure 19 shows the electric resistance of metal powder prior and subsequent to the sintering. From these indications, certain conclusions may be drawn with regard to the extent of granular bonding. This figure also illustrates the considerable difference which exist in the resistance values before and after sintering.

The resistance of metal powders decreases by about one half when the pressure increases from 2 tons to 6-8 tons per square centimeter; there is little or no change if the pressure is further increased. Therefore, an increase in pressure beyond 8 tons per square centimeter is not economical.

Figure 20 illustrates the effects of repeated compression and sintering on density and stability values. It is not economical to increase the number of operations beyond two or three at the most. An increase in compression pressure especially is not economical, since the density of the piece subjected to sintering will not increase essentially even if greater pressure promises such an increase (see curve, 6 tons per square centimeter).

Sintering not only establishes the proper relationship between granules of pure iron or other pure metal powders brought into close proximity by the

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pressing process, but also has the function creating diffusion (alloying) between the initial substance and the alloying substances admixed with the initial substance in different ratios. For example, a mass compressed from a mixture of soft and cast-iron powder and annealed at a temperature of about 1,200 degrees centigrade for 3-4 hours will yield a uniform, temperable perlite-ferrite material of crystalline structure.

The carburization of parts manufactured of pure iron powder can take place either in a salt bath or in a gas. Due to the object's porosity, the carbon absorption occurring during the carburization starts on the surface and than penetrates the interior. Diffusion taking place between the iron particles and the carbon during subsequent sintering results in a metal of uniform carbon content.

A process similar to that observed during the sintering of ferrocarbon alloys occurs when iron powder is mixed with powders of manganese, chrome, etc.

Sintering of the above material does not always take place in the protective hydrogen atmosphere usually employed for this purpose. In view of the intense removal of carbon taking place in such cases, it is preferable to conduct the sintering in graphite tubes under a graphite-powder cover; a suitable neutral atmosphere for such treatment is a mixture of CO and CO_2 or hydrogen and CO.

Physical Properties Articles Produced by Powder Metallurgy

Figure 21 illustrates the physical and mechanical properties which can be obtained by using various methods in powder metallurgy.

In addition to tensile stress — strain curves for standard alloys and carbon steels, the figure shows the same curves for various powder-metallurgical products. A comparison of the curves reveals that when great durability is required, powder metallurgy is endeavoring by four different methods to achieve -- through elimination of porosity -- the physical properties of dense, standard metals.

The first method is to increase compression. While the tensile strength of a part produced at lower pressure (4 tons per square centimeter) and pressed once amounts to approximately 50 percent of that of standard steel, pressure of 6 tons per square centimeter increases the tensile strength to 60-70 percent of that of standard steel. However, as has been pointed out, this method is uneconomical due to the size of the required presses and the high cost of tools.

Another method involves repeated pressing and sintering. If a pressure of 6 tons per square centimeter is applied twice and followed by several sinterings, 80 percent of the tensil strength of standard steel has been obtained. This process cannot be carried beyond the limits pointed out in connection with Figure 20.

By repressing the compact while it is still warm, it has been possible to obtain a density approximating 100 percent that of standard steel and a corresponding tensile-strength value. Preliminary pressing at 6 tons per square centimeter was followed by preliminary sintering at a temperature of 800 degrees centigrade. The compact is then repressed at 700 degrees centigrade and receives a final sintering at 1,200 degrees centigrade. However, this method has certain limitations. Some tolerances can be maintained only within approximate limits, and only parts of relatively simple contour can be produced.

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The most suitable method for eliminating porosity is to impregnate the prepressed and presintered parts with copper (see Figure 21). The pressed and sintered part is placed in copper powder or chips, after which it is heated until the melting point of copper is reached. The molten copper is absorbed by the part through capillary action, and fills up the pores. Since at its own melting point, copper dissolves iron to some extent (8 percent at 1,100 degrees centigrade), some alloying occurs between the iron and copper. This alloying increases the tensile strength of the product, possibly even surpassing that of standard steels. Results even better than the values shown in Figure 21 have been obtained by employing special heat-treatment processes. Parts processed by this method offer excellent resistance against corrosion.

Close examination of the curves in Figure 21 reveals that while the tensile strength for the various processes approximate fairly closely the values for standard steels, elongation values, on the other hand, remain very much behind the elongation values of standard steels.

When a part made by powder metallurgy is to replace a standard-metal part, its low elongation value, compared to carbon steel, need not be prejudicial to its use if the tensile strength is adequate and other factors of economy are in its favor. While the fatigue limit of standard steels amounts to approximately 50 percent of their tensile strength, the fatigue limit of materials produced by powder metallurgy is much higher, amounting to approximately 70 percent of their tensile strength. Powder-metallurgical parts, although possessing relatively lower elongation, often can be bent better than standard-metal parts which have a higher elongation value.

So far, low-carbon steel is the basic raw material for parts produced by powder metallurgy, but rapid progress is being made toward the manufacture of alloy steel parts.

Today, stainless chrome-nickel steel parts and nickel tempered steel parts with durability values higher than those of carbon-steel parts are being manufactured. For instance, the indexes for a sprocket wheel manufactured of case-hardened tempered steel are as follows: R_c, 58-61; tensile strength, 50 kilograms per square millimeter; elongation, 10 percent. Experiments which have been conducted with nickel-alloyed materials impregnated with copper and subjected to special heat treatments show a tensile strength of 130 kilograms per square millimeter, with an elongation of 4 percent.

It is possible to machine parts produced by powder metallurgy without special difficulty, although the edges of the cutting tools are exposed to greater stress due to the porosity of the material. By using built-up hard-alloy tips, however, they can be machined economically.

Permissible Variations in Size

Generally speaking, a tolerance of ± 0.01 millimeter can be maintained per 25 millimeters of length in a direction perpendicular to the pressing, and a tolerance of ± 0.1 millimeter can be maintained per 25 millimeter parallel to the direction of pressing. These tolerances can be reduced in case of smaller products by changing tools more frequently or by subsequent calibration.

In the case of products of cylindrical shape, eccentricity of ± 0.02-0.06 millimeter can be maintained. Teeth on spur gears can be held to a tolerance of ± 0.02 millimeter.

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Economy of Powder Metallurgy

Production costs of smaller machine parts can be reduced by powder metallurgy. The following brief summary represents a condensation of detailed calculations performed by the author with the cooperation of leading experts in the field of powder metallurgy.

The manufacturing cost of a complicated 50-gram part made by conventional machining technology is approximately 450 forints per 100. This figure was arrived at by checking the manufacturing costs of about 200 different parts of this type.

Selecting from the above parts those suitable for manufacture by powder metallurgy, the manufacturing cost was cut to approximately 100 forints per 100 parts. If the cost for subsequent machining operations is added, the total is 200 forints per 100 parts. However, such economy can be expected only in mass production, due to the high cost of dies.

In view of the fact that a complex die costs about 6,000 forints, the smallest series should be 10,000 units. The manufacture of even smaller series is justified only when it would be inexpedient to employ other methods.

The manufacture of self-lubricating axle bearings represents a specialized chapter of the technology of powder metallurgy. The same is true of objects exposed to light stress or of special physical properties.

BIBLIOGRAPHY

M. J. Balshin, Poroshkovoye metallovedyeniye

M. J. Balshin, Poroshkovya metallurgiya

Kieffer and Hotop, Sintereisen und Sinterstahl

H. Silbereisen, "Das pulvermetallurgische Fertigungsverfahren," Werkstattstechnik und Maschinenbau, Vol 40, No 6

C. G. Goetzel, Treatise on Powder Metallurgy

Powder Metallurgy Bulletin. 1 September 1948 (lectures delivered at First International Congress for Powder Metallurgy at Graz, 1948)

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Sanitized Copy Approved for Release 2011/10/06 : CIA-RDP80-00809A000700060354-1