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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

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PROBLEMS OF DIE DESIGN AND TECHNOLOGY OF SHEET METAL STAMPING IN DEVELOPING COUNTRIES[1/]

by

E. A. Popov
Moscow Baumann Higher Technical School
Union of Soviet Socialist Republics

1/ The views and opinions expressed in this paper are those of the author and do not necessarily reflect the views of the secretariat of UNIDO.

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Introduction

1. Stamping, or more specifically cold stamping, is presently one of the most intensively developing branches of the metalworking industry. This is indicated by the ever increasing number of press tools used in industry and by the change in the usage of metal-cutting and press equipment. The latter equipment is now favoured. The increase in the volume of stamping processes applied in industry is a result of the high quality of the processes (1, 2) and the perfected stage of development of the methods of stamping, dies and stamping equipment.

2. In comparison, stamping was previously believed to be advisable in large-scale and mass production as a means of preliminary processing with consequent and rather considerable machining of already stamped stocks. Presently such an attitude is, to a certain extent, considered obsolete.

3. Because of the development of metalworking processes and stamping equipment, stamping has become advantageous in small-scale production and sometimes even in the manufacture of single workpieces. This same perfection of metalworking processes, a result of higher quality and accuracy achieved during stamping, reduces the volume of machining; stamped workpieces require either no machining at all or only a few finishing operations of trimming, shaving etc.

4. The outstanding merits of stamping make it possible and desirable to apply this process in developing countries. The prospects of such application are determined by many circumstances, of which the most important are:

(a) Possibility of using comparatively few specifications for universal equipment suitable for handling large specifications of stamped parts with varied sizes and shapes;

(b) High labour output achieved by stamping and comparatively low cost of the articles produced by this process;

(c) Possibility of employing less highly skilled workers in stamping operations;

(d) Economical utilization of the metal in producing workpieces by stamping.

5. These and other qualities of stamping allow, with relatively small capital expenses, the production of workpieces with good qualities, low labour requirements, and low cost consistent with any other series production.

6. The economical efficiency, however, and the successful adoption of the stamping process in developing countries depend on many factors, including the proper type of technology and die design with respect to the character of series production and local conditions.

7. Several typical features of developing countries must be taken into consideration in planning the technology and die designs for stamping processes. These include:

(a) Predominance of small-scale production;

(b) Inadequacy of machine tools necessary for making dies;

(c) Scantiness of specifications for materials used in the manufacture of die units and die members;

(d) Difficult climate conditions generally necessitating greater safety precautions in the course of stamping operations.

8. Considering the above mentioned general and other local conditions, the procedure of stamping operations presents a rather complex problem that might or might not have a single, simple solution.

9. The success in solving this problem and the profitable use of stamping methods in developing countries require proper knowledge of all existing varieties of stamping processes and die designs adapted to small-scale production in order to choose the most suitable process from among the great variety of methods.

10. An abundance of scientific and technical literature dealing with the technological problems of stamping processes and die designs is available.

11. An attempt will be made in this paper to select and systematise the ideas and recommendations that may be useful while developing and applying various processes, sheet-stamping, in particular, in developing countries.

1 DEPENDENCE OF TECHNOLOGICAL PROCESSING ON SERIES PRODUCTION AND PRODUCTION CONDITIONS

12. The types of dies, their number and design are, to a great extent, determined by the series production of the workpieces to be stamped and by the intricate outlines of the workpieces.

13. With respect to the conditions of large-scale and mass production, there is generally a tendency to reduce the number of parts necessary for the desired article (an instrument, machine or unit). This results in more complicated designs of the parts to be stamped, which, in turn, leads to more complex technology and die design.

14. Despite their higher cost, dies of more complicated design prove to be economically advantageous in large-scale production in view of the higher efficiency of stamping and a reduction of expenses connected with the subsequent mechanical working and assembling. In this case, more complicated die designs are usually determined not only by the complex shapes of the parts to be stamped, but also by the desire to increase accuracy and to limit the number of the facilities employed. Compound and follow dies, producing a number of successive operations per die stroke, are rather widely used under such conditions.

15. The dies are equipped with good guide components. The working members (punches and dies) are occasionally made of expensive materials ensuring hardness, higher accuracy and better quality of the part to be stamped. In order to increase the amount of workpieces obtained from each press, die designs must provide for the possibility of mechanized stock feeding, both by means of universal mechanization devices connected with the press, and by specialized feeding devices built into the die (automatic dies).

16. The possibility of using complicated and expensive dies in small-scale production is considerably limited by the economical factor. The cost of the die divided by the small number of stamped pieces increases considerably the price of the product, and the possibilities offered by the die, assuming long lasting strength of the tool, are not fully exhausted. A reduction in

the cost of dies and the simplification of their manufacture and adjustment, are urgent problems in small-scale production. The successful solution of these problems depends on properly adopted technology, die designs, stamping methods, materials, and production processes.

17. This section will deal with the problems of planning technological processes in small-scale production, aiming at both a reduction in the expenses connected with die manufacture and adjustment and a simplification of die designs.

18. In planning such technological processes, three problems must be considered:

(a) Simplifying the design for stamped parts

(b) Stampless methods of sheet metalworking

(c) Reducing the adjustment needed

Each problem will be treated below in detail.

<u>Simplifying the design for stamped parts</u>

19. In designing any machine (a unit, device or an instrument), the designer distinguishes certain parts, the combination of which in assembly must ensure the desired quality of work and must easily permit the assembly, dismantlement, and repair of the machine, as well as the replacement of worn-out parts.

20. The parts must be designed to conform with both technology and the manufacturing conditions in the industry. As far as the parts obtained by stamping sheet metal are concerned, the choice made by the designer determines not only the degree of complexity of stamping technology and die design, but also the amount of metal utilized in manufacture. The latter consideration is of great importance in small-scale production, since the cost of the metal used in stamping metal parts is more than half the price of the parts themselves.

21. Parts stamped from sheet metal vary considerably in shape and design. A shape and size that ensures utmost simplicity and inexpensive production by stamping must, in every case, be adopted to conform with the purpose of

the parts to be stamped and the conditions of production. Experience in designing sheet-stamped parts [illegible] common practices and methods used in manufacturing [illegible], basic technology, and little [illegible] metal [illegible] in laying out the metal with respect to the part design [illegible] so that a minimum of metal scrap is produced.

22. In this instance, while taking into consideration the possible production process of the part being designed, it is necessary for the designer to determine the shape of the flat stock to be blanked, to calculate a possible arrangement of adjacent flat stocks so that sheet-metal scrap is at a minimum, and finally to find out what variations (within the limits of the qualities of stamped parts) may reduce the metal scrap in blanking.

23. The potentiality and advantage of such an approach in choosing the optimum part design may be illustrated with the following examples. The part designs were varied to improve the stamping processes that had already been applied in production.

24. Figure 1 shows variations in the design of one of the parts of a truck (3). The changes in the shape of the lateral surfaces have not affected the strength or other qualities of the part. At the same time, the blanking process is employed without scrap allowance, considerably reducing the metal scrap. The same change permitted, to some extent, the development of a simplified die.

25. Figure 2 shows variations in the design of the current-conducting contact spring (4). The intricate shape of the old part (figure 2a) produced 59 per cent metal scrap even with the most economical cross lay-out. Owing to variations in sizes and shapes of auxiliary (secondary) components, the new design (figure 2b) allowed a lay-out without scrap allowance. The qualities of the product were not changed, but the metal scrap was reduced up to 7.5 per cent as a result.

26. Applying at the same time double-step feeding, it was possible to obtain two parts per press stroke as in the case of cross lay-out. The new type of die design, however, proved to be more simple and, most important, the design

Figure 1

Variations in the design of a truck part

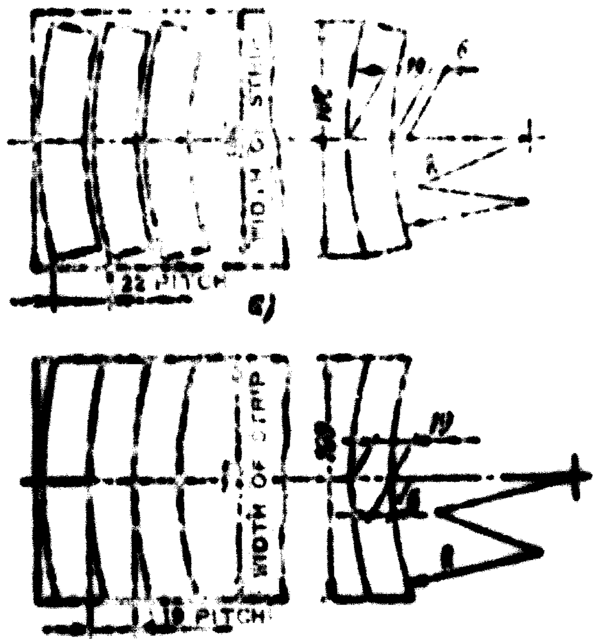
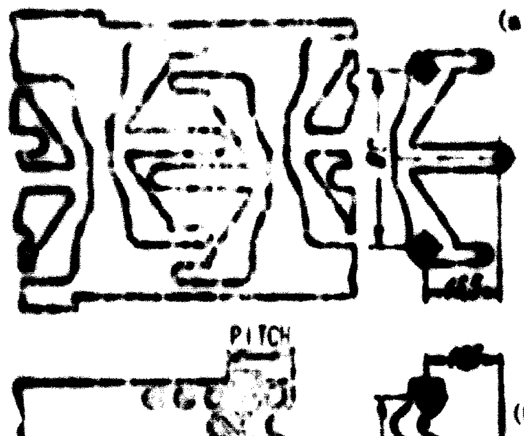


Figure 2

Variations in the design of a current-conducting contact spring

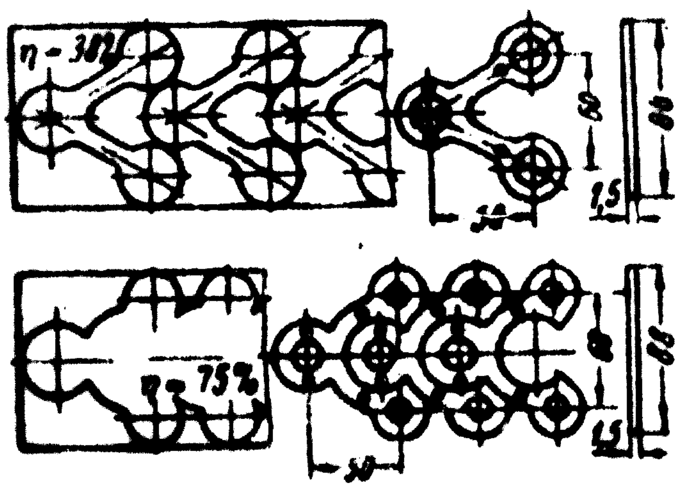


of the machine tool w[illegible] The labour necessary for production has [illegible] tool has been increased.

27. Figure [illegible] illustrates [illegible] alteration in the shape of a secondary component [illegible] (5). In this instance, changes in the part design reduced the waste from 62 per cent in the first case to 25 per cent in the second case.

Figure [illegible]

Variations in the design and lay-out of a part for full utilization of the metal

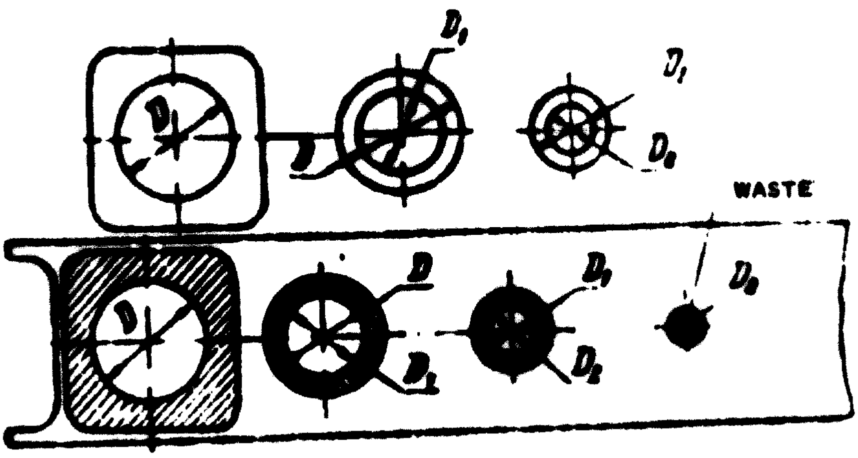


28. The above examples show that careful analyses of possibilities in varying the part design and its dimensions may secure more economical utilization of the metal owing to a much closer arrangement of complicated stock shapes to be blanked. This method of changing the shape and the design of the parts to be stamped is not the only effective way to reduce scrap. In a number of cases, it may prove useful to change the dimensions of the parts being stamped so that it is possible to blank still other parts on the scrap left after larger parts have been already blanked.

29. Figure 4 illustrates that if the dimensions of the part to be blanked are properly chosen, it is possible to stamp three different parts on one strip of metal, the two smaller parts being stamped out of the scrap left after stamping the larger piece (5).

Figure 4

Economical lay-out for blanking parts



30. A second method of improving part design and simplifying technological process is to vary the shapes and sizes of parts, reducing the number of stamping operations necessary for obtaining the given parts. It is known that the shape of the part primarily determines the type of operations necessary for its production.

31. At the same time, the sizes of separate components influence to a great deal not only the type of stamping operation, but also the number of necessary successive operations. The latter is mainly determined by the fact that there are certain rates of shape changes allowable for each forming operation of the machine tool. For instance, in drawing a flat stock without its being destroyed, a cup may be obtained with an approximate height of 0.8 of its diameter. If the design is such that the height of the cup is

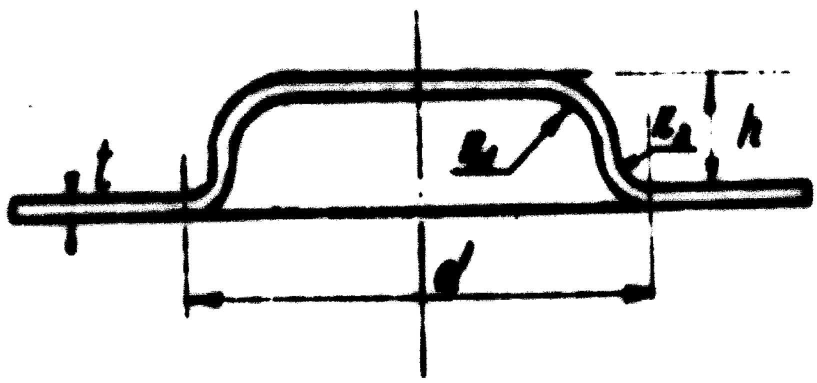
considerably more than its diameter, then such a part has to be produced in several drawing operations. The more stamping operations that are required for the production of the given part, the greater the number of dies that are required for its manufacture. At the same time, the technological process is more complicated and less economically efficient.

32. The following examples illustrate how the dimensions of separate part components affect technology.

33. In figure 5, a very common component of the spatial parts obtained by sheet-metal stamping is shown.

Figure 5

Component of the spatial parts obtained by sheet-metal stamping



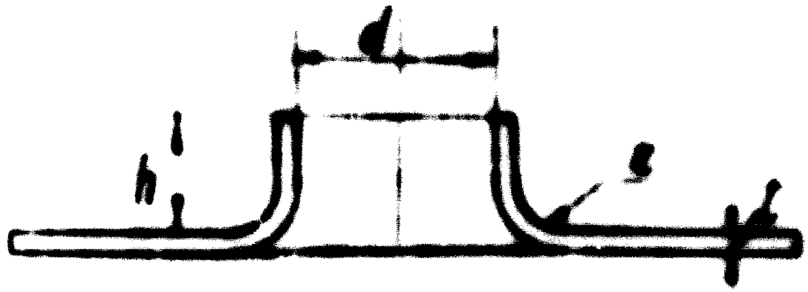
34. Subject to the dimensions of this component (characterised by the relationship: h/d; t/d; r_1/t; r_2/t), the complexity of stamping may vary considerably. The technological process is the most simple if the relative dimensions are such that the given component may be obtained per one forming operation. If the dimensions are such that the rate of shape change necessary for its production exceeds the rate of shape change permitted for each forming operation, either several forming operations or a combination of drawing and forming operations will be required to obtain this component.

35. In this case, the number of dies required for the production of the specified part is increased. As there are presently no reliable calculations of allowable shape change in the forming operation, some additional means are necessary for adjusting the process. As a result, the cost of production of the given part increases and the advisability of employing stamping diminishes, especially under the conditions of small-scale production.

36. The second example (figure 6) illustrates the influence of the dimensions of separate elements of parts on technology.

Figure 6

Influence of the dimensions of a throat to be stamped on the process selected



37. The technological process is the most simple when the dimensions of the throat to be stamped (t/d, h/d, r/t) are such that the throat may be produced only by piercing and burring. If the dimensions are such that the required extensions in diameter in burring exceeds the allowable rate, the throat cannot be obtained by the burring process without destroying the stock.

38. In this case, the throat is obtained by drawing followed by piercing and burring, or by forming operations with subsequent piercing and burring. The technology in either case is considerably more complex. The number of

dies to be employed [illegible] stamped parts as well.

39. The above exam[illegible] of the required stamped part[illegible] By varying certain dimensions, [illegible] and the number of required d[illegible] reduced.

40. Therefore, in designing parts to be stamped in small-scale production, it is absolutely necessary, within the allowable tolerances specified by the required quality of the part, to set dimensions that require the minimum shape change of the stock in the production of separate elements and completed parts. Only such conditions may afford production of the parts by means of the minimum number of simplified dies, at a minimum cost, while achieving maximum stamping efficiency.

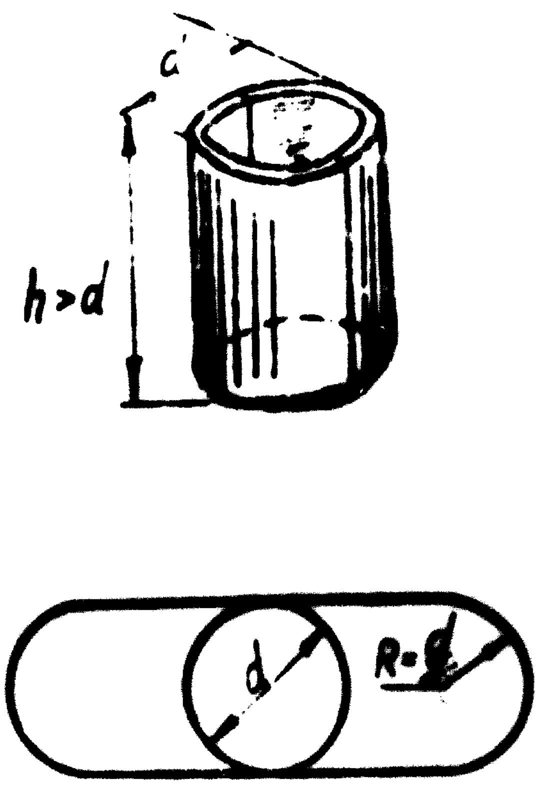
41. Not only alterations in dimensions may lead to an essentially less complicated process. Sometimes variations in the part design worsen the specifications but lead to simpler technology.

42. For instance, if a part in the shape of a barrel (with the relation of its height to its diameter being considerably more than one unit) does not have to be solid drawn, and if it is working under the conditions of its being loaded by outer compressive stresses, it may have longitudinal bayonets along the joint. In this case, the part may be drawn from a rectangular stock and not from a round one (figure 7). If such a part is drawn from a round stock, several drawing operations and drawing dies are required for its production. If a rectangular stock is used, the part may be obtained in one operation by drawing it through the lower die. The resulting part, instead of being solid drawn as is the case when it is drawn from a round stock, will have longitudinal bayonets.

43. A combination stamping and welding process is of special advantage in achieving the more simple stamping method This combination is most advisable in small-scale production because it allows the simplification of the stamping process. The cost of the stamped articles is also reduced as a result of less complicated equipment.

Figure 7

Process of drawing a barrel shaped part

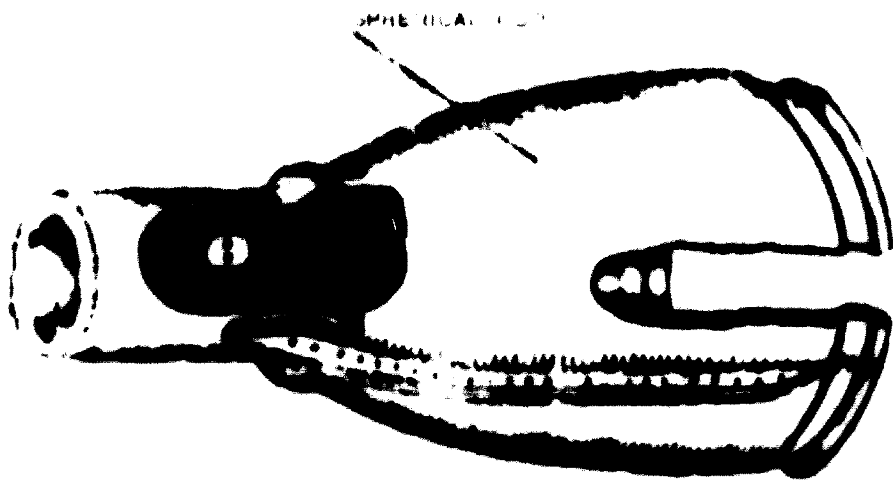


44. Stamped-and-welded parts consist of separate elements, which are obtained by stamping and then are welded to form the given part. Economical efficiency in using stamped-and-welded parts depends on the proper sub-division of elements. This sub-division results in the most simple stamping, but only on the condition that the subsequent welding does not require considerable expense and is not too complicated.

45. The stamped-and-welded part design is shown in figure 8 (6). The main element is a cup, i.e. a spherical body whose height exceeds its maximum diameter.

[illegible]

[illegible]



In order to produce such a part by drawing it out of a round stock, many drawing operations and numerous dies are required. In obtaining the same cup by welding two halves together, no difficulties arise. Only one drawing operation is required, followed by consequent trimming and cutting into two halves, as shown in figure 9. The simplification and the lower cost of the stamping process for the stamped-and-welded part reduce the cost of the completed part itself, despite the introduction of additional welding operations. This is particularly effective in small-scale production.

46. The adoption of part designs obtained by stamping and welding may not only make the process of stamping more simple and reduce its cost, but also, in a number of cases, may allow the substitution of cold stamping for hot stamping and the sharp reduction of the volume of metal-cutting processes.

47. This proposition may be illustrated by figure 10 (7): the outline of a lever obtained by sheet stamping followed by welding. The substitution of this technology for hot-stamping technology with consequent metal-cutting operations, has made the production process simpler and more inexpensive and, at the same time, has brought about a saving in metal.

Figure 9

Cutting and trimming lines for spherical cup

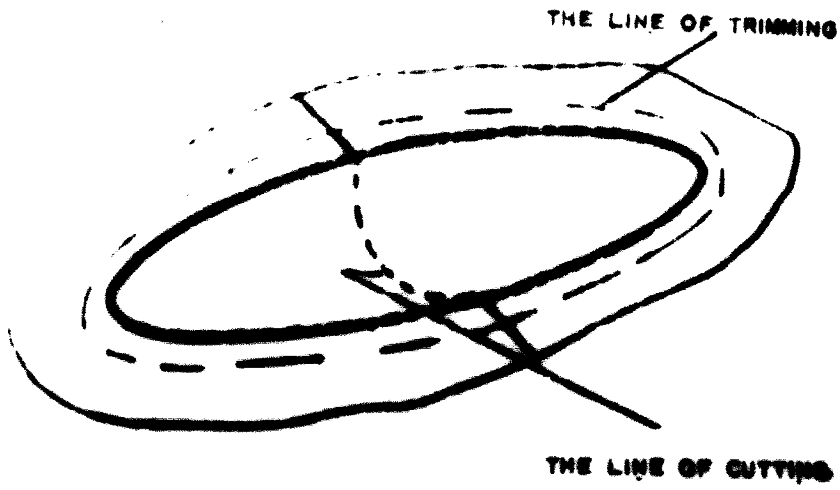
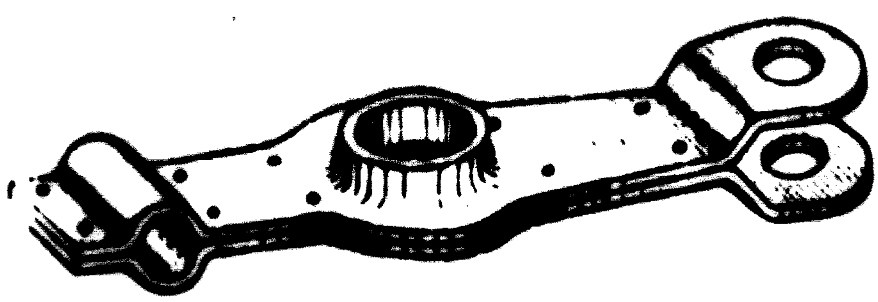


Figure 10

Lever to be sheet stamped and welded



48. Many examples of application for stamped-and-welded part designs are available in other publications (8).

49. In a number of cases, particularly with respect to non-ferrous metals, cold welding (7) may be applied and, moreover, welding may be substituted by soldering.

50. The above examples show that the development of expedient part designs makes the technological process rather simple and inexpensive. This offers, to a considerable degree, greater opportunities for the adoption of stamping in small-scale production.

Stampless methods of sheet metalworking

51. The second important problem to be considered in small-scale production is that of the application of stampless methods of sheet metalworking.

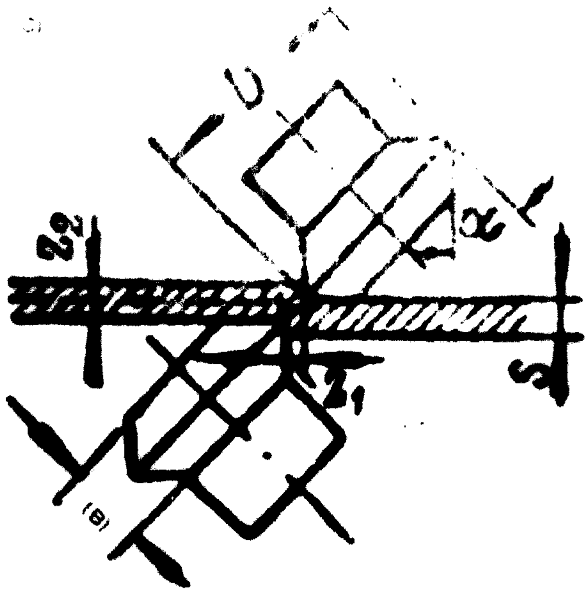
52. This refers to methods which make use of completely or partially universal machinery, i.e. machines suitable for the production of various parts.

53. It should be noted that a die is usually a specialized tool designed to produce one or several operations required in the manufacture of one certain article. The possibility of using a universal die tool while applying stampless methods of working considerably reduces the cost of production. There is then no or little need for the manufacture of various dies. Apart from the reduction of expenses connected with the manufacture of dies, the time necessary for the preparation of production conditions is also reduced, and the mobility and manoeuvrability of equipment is increased.

54. Among the most commonly used and advantageous processes of stampless metalworking are shearing and spinning.

55. In shearing operations, disc or vibro-shears (2, 11, 10) are usually used. The lay-out of one of the most frequenly used designs of disc shears is given in figure 11.

56. Owing to the conical contours of the lateral working surfaces of the disc knives and the little contact area, it is easy to position the stock with respect to the knives and to partition along the curvature of the shear.
Attaching the stock in the centre of its rotation with respect to the knives,



it is possible to shear off round stocks; by varying the distance between the centre and the knives, the diameter of the stock to be sheared off can be altered.

57. The minimum radius of the circle of the stock being sheared is approximately equal to 0.7 of the knife's diameter. Consequently, in having a number of disc knife sets, it is possible to shear off round strips with a considerable variation in the range of diameters.

58. Shearing with disc shears eliminates the need to use blanking dies. It should be mentioned, however, that shearing with disc shears permits the obtaining of stocks (or flat parts) with curvilinear outlines and considerable radii of curvature. Sheared stock contours with less radii of curvature may be obtained by vibro-shears.

59. The stocks (parts) that are not of a round shape are sheared off according to marks or gauges. Thus, the use of disc or vibro-shears in small-scale production is rather advantageous.

60. In spite of a lower demand for labour, it is only natural in this case that the need for dies is decreased and the cost of the parts to be stamped is reduced.

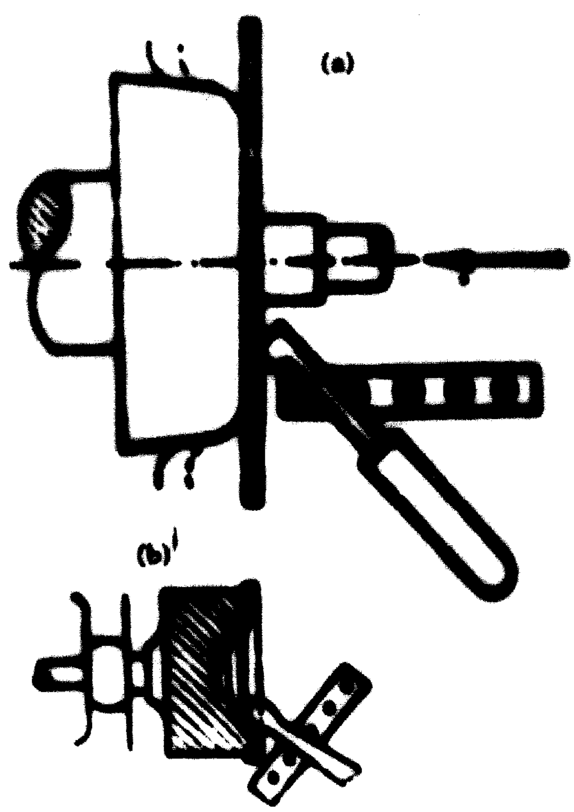
61. Shearing off, however, cannot totally exclude the requirement for manufacturing blanking dies, since through shearing operations, parts of medium sizes (diametrical dimensions usually more than 100 mm) with smooth curved outlines and comparatively large radii of curvature may be obtained.

62. It should be mentioned that the disc shears are produced by many manufacturers in different countries and their cost is not very high.

63. The second most expedient method of stampless working of sheet metal in small-scale production is the ancient process of spinning, which is still of importance in modern industry. Spinning not determined by a reduction of thickness offers the widest technological possibilities. The process is indicated in figure 12.

Figure 12

Sheet metal spinning process



64. The replaceable [illegible] attached to the face plate of the machine. The form [illegible] production may be made of a firm type of wood, is relatively cheap and requires [illegible] use of labour for its production. A [illegible] of [illegible] tool, provides for the production of [illegible] articles by means of varying the operations.

65. A great variety of parts may be obtained by spinning a flat circular stock. Under the conditions of stamping the same parts, such operations as drawing, necking, expanding, curling, and trimming are required. It is quite understandable that only cylindrical parts may be produced by spinning.

66. The drawback is that spinning requires higher qualifications and a considerable amount of muscular labour to carry out the operations. In manufacturing considerably simpler shaped parts, however, even in small-scale production, there may be elements of mechanization which considerably simplify and facilitate the work (12).

67. Recently one of the methods of spinning, i.e. spinning with ironing, has been found useful in industry. The parts whose underneath thicknesses differ from that of the body, or parts with alternating wall thicknesses along the construction joint, may be obtained by the process of spinning with ironing. This process requires more complicated and more expensive equipment, and its technical potentiality is limited. In developing countries, this process will probably find only a limited application.

68. The processes of thread rolling and ring pressing on empty cylindrical parts may be considered as variations of spinning without compulsory ironing (12).

69. It should be mentioned that metalworking, excluding the use of dies, may be applied in the handling of section metal and, in a number of cases, rather intricate parts may be obtained (13).

70. The same publication (13) illustrates how metalworking applying no dies is successfully used to improve surface qualities and to increase the strength (hardness). Some of the above mentioned processes employing no dies in the manufacturing of volumetric parts may be successfully used in small-scale production in developing countries.

71. In a number of [illegible], [illegible] countries with damp climates, the handling of [illegible] parts without the use of dies increases the resistance to corrosion. This is one of the advantages of the method.

Reducing necessary adjustments

72. In large-scale production, as compared with small-scale production, there are more facilities to carry out necessary adjustments while introducing the stamping processes in industry. In large-scale production, the expenses connected with the adjustment of the stamping process and with the unavoidable waste of metal are distributed among a great number of parts and leads, therefore, to only a slight increase in the price of individual parts.

73. In small-scale production, however, the same waste may considerably increase the cost of the stamped parts and reduce stamping efficiency. Under such conditions, therefore, special attention should be devoted to working out reliable processes that require as little adjustment for introduction into industry as possible.

74. The possibilities of minimizing the amount of adjustments depend on proper selection of the types of stamping operations, their number, and the choice of the working tool.

75. The designing of stamping processes is carried out in accordance with data and recommendations accumulated either in reference books or by stamping similar parts. Analytical relationships determining the value of any shape alteration allowed in different stamping operations with respect to fundamental factors and conditions of stamping are made use of, but only to an insignificant degree.

76. All data available in reference books, including those concerning the allowable variation value for different operations, stipulate a certain range of variations for the recommended values. This leads to some uncertainty in determining the number of operations necessary for the manufacture of the stipulated parts. Most often this results in the necessity to carry out some adjustments in order to correct the technology and die design after beginning stamping operations.

77. Considering these factors, the solution to the problem of curtailing adjustments may be found either in the adoption of such coefficients of allowable shape changing which are very close to the minimum ones recommended by reference books, or by wider application of scientifically grounded calculations, arriving at an estimate of the effect of main factors and conditions of stamping on the coefficient of the allowable shape changing in certain stamping operations.

78. The first method is expedient and may lead to restrictions in the amount of adjustment needed, but at the same time, it may cause an increase in the number of operations and dies compared with the manufacture of stipulated parts, especially those with intricate shapes.

79. In small-scale production, therefore, and particularly for the more intricate parts, more complex analytical methods of computing the processes should be considered. The time spent on designing the technological processes in this case is justified by the reduction of expenses necessary for adjustments in industry.

80. The use of practical data in the manufacture of similar parts is a good means of restricting the adjustment necessary. This requires collecting extensive material on stamping and die designs, with given sizes of machine tools. Such data have already been assimilated by the industry.

81. Making use of the available data, the processes producing parts with materials and sizes similar to the item being planned are selected for further study. In this case, however, it is necessary to take into consideration any differences in sizes between the part designed for production and the part that has already been introduced in industry.

82. In establishing stamping technology in developing countries, many difficulties are caused by a shortage in specifications of the material for the stamping operations, and by the lack of stability in the quality of material. The desire to reduce production costs frequently causes the use of inferior material. This necessitates the developing of processes in which the rate of shape changing in stamping operations is accepted with some positive allowance.

II TYPES OF [illegible]

83. The ordinary die unit used for sheet-metal stamping in large-scale production consists of a considerable number of parts.

84. All die parts may be divided into the following categories: the working member (punches or dies), accessories for attaching the working member, guiding devices for positioning the working members, associate parts for guiding and attaching the sheet (stock) in the direction of the feed, ejecting mechanisms forcing the stock out of the dies, associate parts for removing the workpieces from the die, and fixtures attaching the die to the press.

85. Because of the great number of parts, the accuracy necessary in assembling and operating the die unit, the amount of labour required for the handling of the die members, and the use of expensive materials for the production of die parts, this die unit design is very costly. The use of such expensive dies is economically expedient in series production where thousands of workpieces are pushed out through the die.

86. In small-scale production, it is more advisable to use simplified dies requiring less labour and lower cost. Extensive experience in the designing and application of simplified dies in small-scale production has been accumulated by industry, and a great variety of simplified dies has been established. This offers an opportunity to discuss systematically the main types of simplified dies.

87. The principle types of simple dies are classified as follows: dies with guide plates, plate dies, banding dies, universal dies, and sheet dies (tweezers), all of which have metallic punches and dies. The arrangement of the dies and their technical possibilities are defined and discussed below.

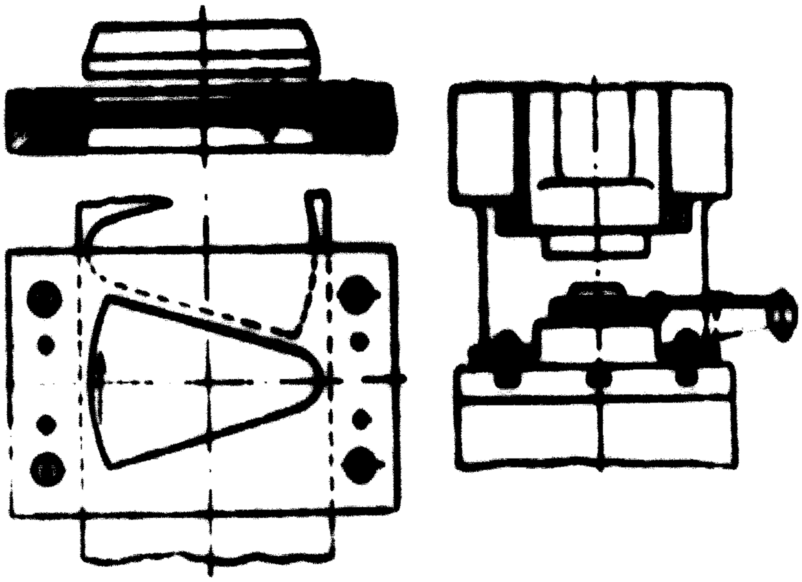
Dies with guide plates

88. Dies equipped with a guide plate are mainly used as blanking dies; the guide plate serves also as a stripper. The most usual design is constructed so that the upper die is not fitted tightly to the press slider. A lay-out of this die is given in figure 13 (14), where it is indicated that the press slider, when it is at its lowest point of the stroke, presses the punch that

is attached to the stripper plate and resting upon the flat stock. Because

<u>Figure 13</u>

<u>Die with guide plates</u>



of the action of the slider, the punch enters the stock. Blanking is accomplished with the cutting edges of the punch and the die. The die unit design is rather simple and its manufacture is not complicated. If the metal being blanked is comparatively soft, the punch and the die may be made without heat treatment operations.

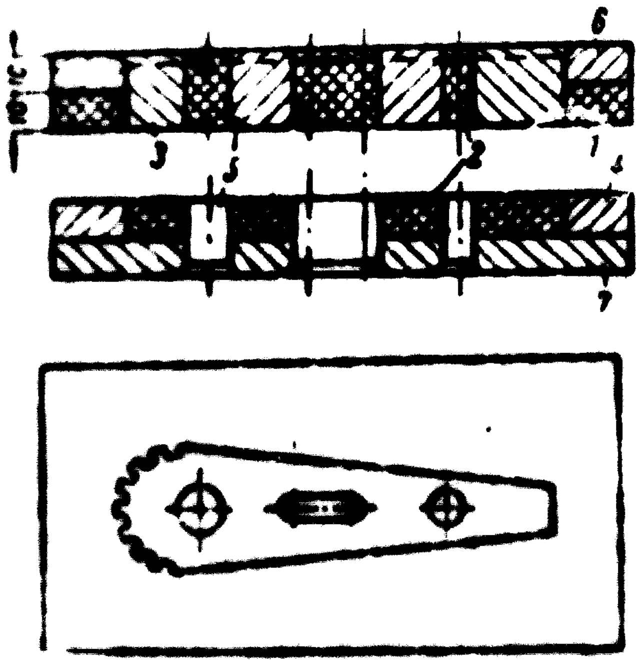
89. Despite certain drawbacks, similar dies may be successfully used in a number of instances in small-scale production. Two major drawbacks to the process are: (a) inaccuracy in positioning the punch with respect to the bottom die, resulting in inferior quality of the shears, and (b) inconveniences in handling the die caused by the difficulties in manipulating the punch.

Plate dies

90. The plate die is the most recommended design for small-scale production. The working members are punches and female dies made of rolled-plate metal. Rubber pillows are successfully used as knock-outs and strippers. Figure 14 illustrates the plate-die working member designed for simultaneous blanking and piercing (1[illegible]). As it is seen from the figure, the punches and dies are are pressed into certain plates that serve as punch holders and die holders respectively.

Figure 14

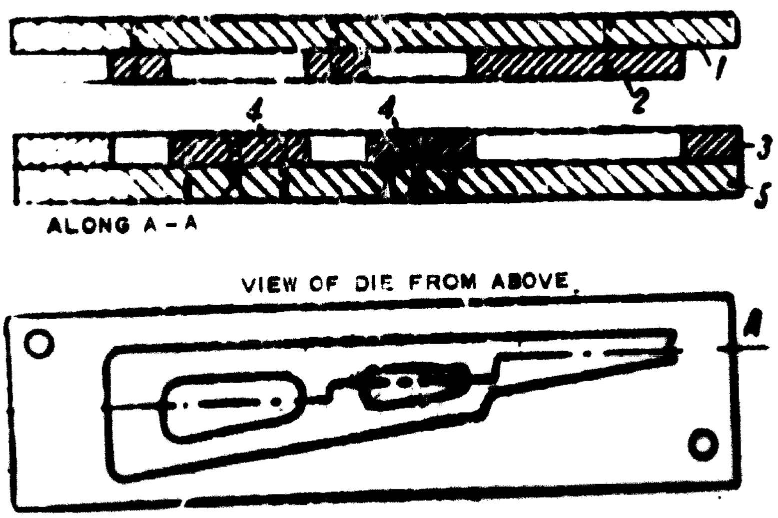
Plate die for simultaneous blanking and piercing



91. Another modification of the working member of the plate die is shown in figure 15 (rubber strippers and knock-outs are not shown). The punches and dies are riveted to the punch-holder and die-holder plates.

Figure 15

Plate die (view of die from above)



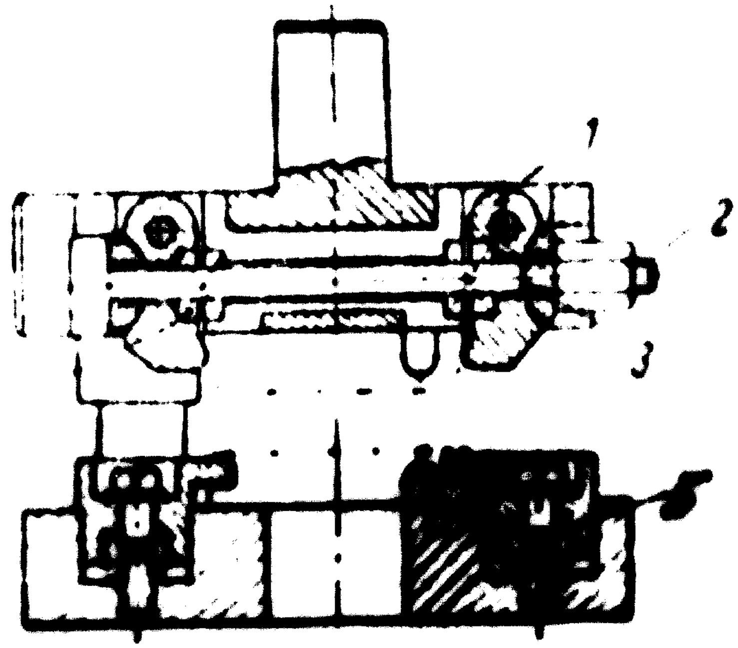
92. It is evident that the length of the punch in the second case is considerably less than in the first case. In stamping comparatively thin sheet material (t<2 mm), the thickness of the plates being used for the manufacture of punches and female dies and punch holders may be approximately 8-10 mm.

93. The working part of the plate die is attached to the base plates of the die block. The upper base plate is located with respect to the lower base plate by means of guide pins.

94. The diagram for attaching the working member of the plate die in the die block is given in figure 16. In the diagram, the upper punch-holder plate is attached to the upper base plate by cams 1 with the help of the inside screw and screw 2 and washer 3. When idle, the cams are drawn apart by means of spring 4. The lower die-holder plate is attached to the lower base plate by means of grippers 5. As the location of the punch and die holder plates can be determined by guide pins and they can be attached with respect to the base plates, it is possible to secure uniformity and a permanent amount of circumference clearance during stamping.

Figure [illegible]

Attaching the working members [illegible] block



95. This method provides for a sheared surface of high quality. In such types of plate dies, one and the same block may be used for the production of different parts, provided that the sizes of the punch and die holder plates required for stamping some particular parts do not exceed the distances between the fixtures on the base plates of the die. Stamping may be accomplished on a push-through job (the stamped part is pushed through the opening in the base plate). More often, however, the working parts are used as shown in figure 14 and 15. The lower base plate, in this case has no opening, and the stamped part, at the back thrust of the slider, falls into the stampings (waste) and is removed from the die in the direction of the feed by resetting the stock (strip). Dies of this type lack guide facilities and stop pins to limit feeding steps. This necessitates an increase in the amount of allowance and, consequently, leads to an increased amount of metal waste.

96. Blanking and piercing are most often carried out on the plate dies. It is possible, however, to use these dies for other operations, e.g. burring, shallow forming, drawing etc., in order to alter the shape. This requires a short working stroke.

97. The [illegible] to heat treatment and the [illegible].

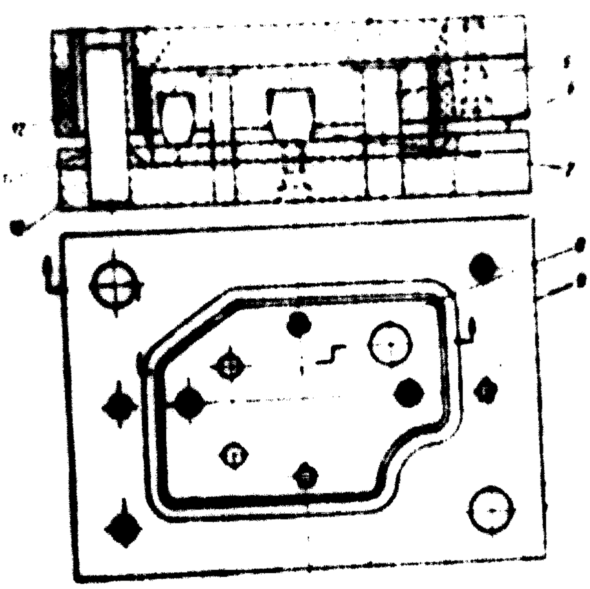
[illegible]

98. Great hardne[illegible] and [illegible] simplification of die manufacture are provided by banding dies. [illegible], the [illegible] of the punch and/or the [illegible]ed die are made out of a steel strip of 1-[illegible] mm thickness, tempered up to 45-55 HRC (Rockwell Hardness Test).

99. Figure 17 illustrates the band die (15). A knife-type female die is attached to plate 1 by means of metallic punch holder 3 and wooden (plywood) die holder 2. A blanking punch made out of steel strip is attached to base plate 10 and serves, at the same time, as piercing female die. The position of the upper member is secured by guide pins 11 and guide pin bushings 12. Stripping and knocking-out take place by means of rubber bushings 6 and 7.

Figure 17

Band die



100. On such dies, cutting is either by means of two edges (blanking on a push-through job, in which the blank passes into the die [illegible]), or by means of the cutting edge, against the solid surface. In the latter case, blanking takes place in the same way as in knife dies. The cutting part of the band is ground to an angle of approximately 30° and the cutting edge is 0.[illegible] of the stock thickness. Blanking on solid surfacing may take place on stocks of soft metals or on stocks of non-metallic materials. The drawback of the knife method of blanking (with one cutting edge) is low-punch hardness.

101. Banding stamps with double cutting lips provide high quality products and permit blanking on comparatively hard materials (alloy steels) having thicknesses up to 5 mm.

102. One of the difficulties of the banding dies is obtaining shaped contours with sharp bending of the tempered band. Therefore, it is necessary to apply these dies in blanking simple-shaped parts with great radii of curvature.

Universal dies

103. The universal dies are more complicated, but are, nevertheless, quite acceptable in small-scale production. These dies also consist of blocks, but the blocks of these dies are somewhat more complicated than the blocks of the plate dies. The complications are a result of the desire to increase safety and accuracy in attaching the working tools in the block of the die. With a view to providing more conveniences in handling the dies, the die blocks are designed for a certain number of parts to fulfil particular operations.

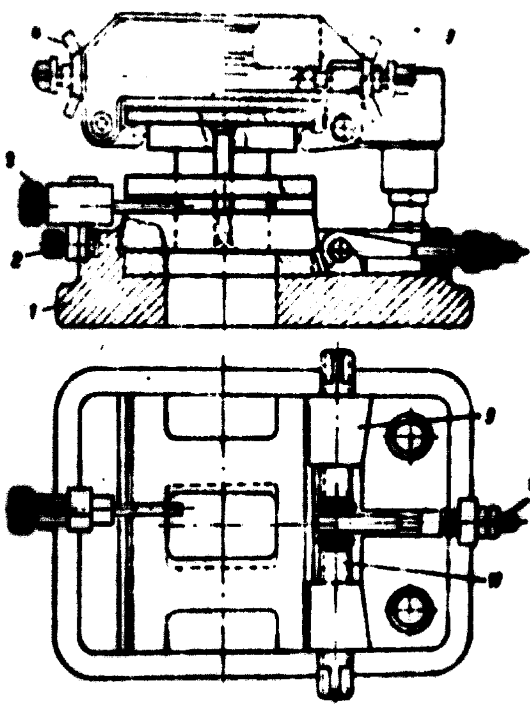
104. The working members and fixtures for the working members are removable and are designed so as to ensure easy replacement and reliable attachment.

105. In figure 18, a block of the gang die (group stamping dies) is illustrated (15). The upper part of the removable packet and the working tool are attached to plate 5 by means of grippers 7, screw 8, control rod 6 and counter-nut 4. The lower part of the packet is mounted on plate 1 with the aid of wedges 9 and left-and-right threaded screw 11. A springed control rod 10 holds the wedges against the solid surface. These dies can provide blanking, piercing, shape forming, and shallow drawing operations. The die may be used also

as a double-action follow die (piercing and blanking). In this case, besides the fixed-stop pin, a provisional-stop pin 3 controlled by nut 2 may be used. The block of the die is mounted on the press, and in proceeding to the handling of the other workpiece, only the replacement of the packet and the adjustment of the new packet on the block, which is fixed to the press, is required.

Figure 18

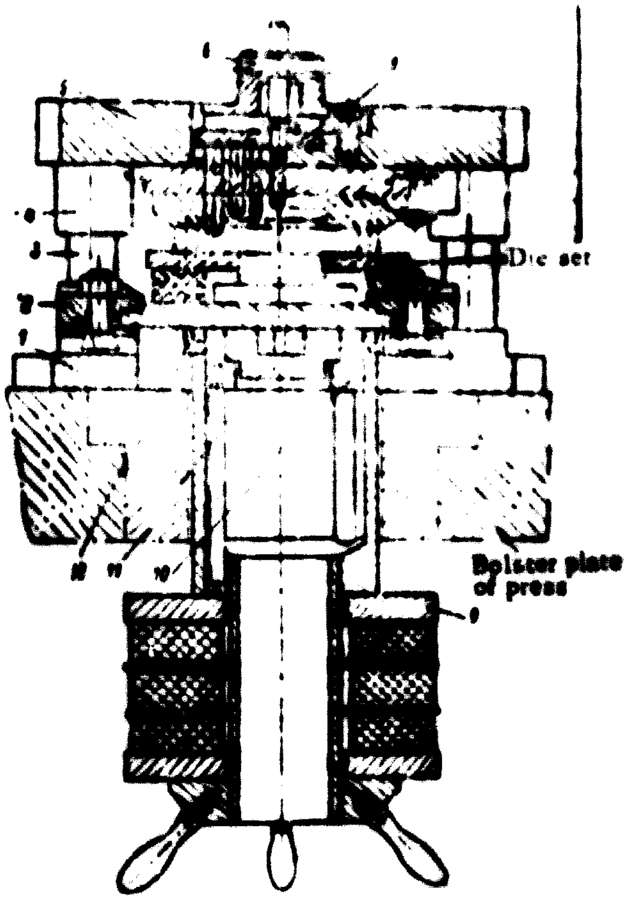
Block of the gang die (group stamping dies)



106. A somewhat more complicated design of dies for group stamping is given in figure 19 (15). A buffering arrangement 9, 10, 11, and 12 is provided in the die. As a result of this, the required force for holding the blank is induced in the die. In addition to this, in the upper part of the block, an arrangement is provided for knocking-out the part by means of dowel 7 and plate 8 through shank 6. Dies of this type permit not only blanking and piercing operations, but also drawing and pressing, and simultaneous blanking and drawing as in the compound-die operations.

Figure 19

Dies for group stamping

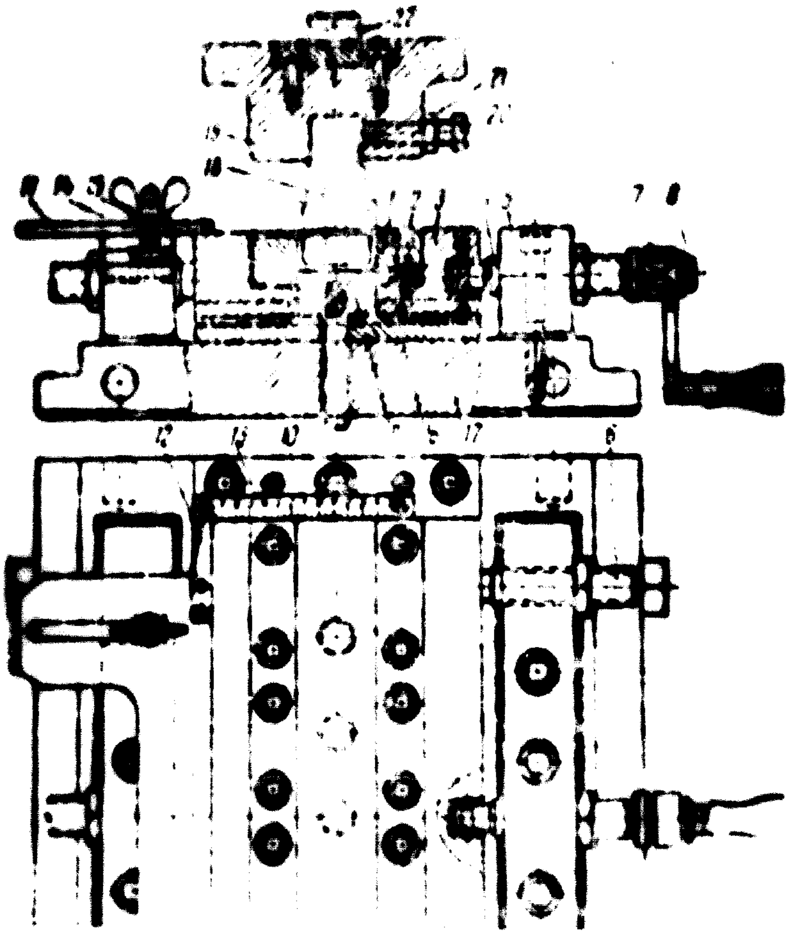


107. The universal dies, in which the only removable part is the working tool, offer great opportunities not only in cutting but also in shape-forming operations (16, 19).

108. Figure 20 presents the universal bending die developed for obtaining π-shaped parts by double-angular bending operations. The removable parts are punch 18 and stripper plate 9. The space between the dies is adjusted by screws 6, attached by screws 14 and inside screws 15, and aligned by ruler 13.

[illegible]

[illegible]



109. The universal dies vary considerably in their design. Comprehensive material on designs of universal dies and various applications has been included in other studies (16).

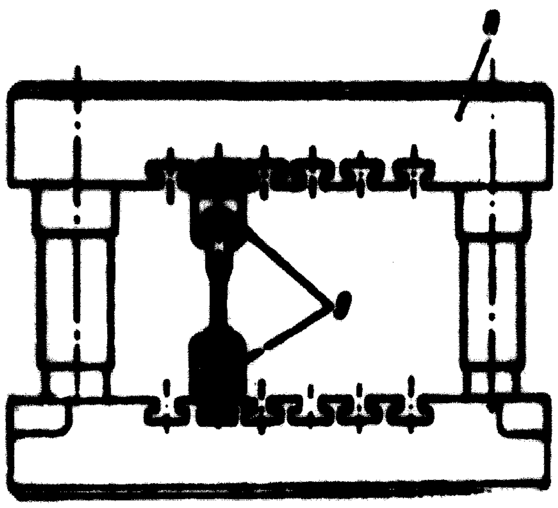
110. An additional use of universal dies in small-scale production should be mentioned. This method deals with the manufacture of medium-sized parts that require piercing a number of holes or creating several hollows or throats.

111. The block plates of these universal dies are constructed so that punches and dies may be easily mounted on them at any point. Punches and dies 9 in figure 21 are attached by means of grooves ground in the plates 8 (17) or by

means of grippers. Plates with built-in electromagnets blocks (16) can be used as well. The lay-out of the die equipped with electromagnets is given

Figure 21

Block plate with punches and dies attached by means of ground-in grooves

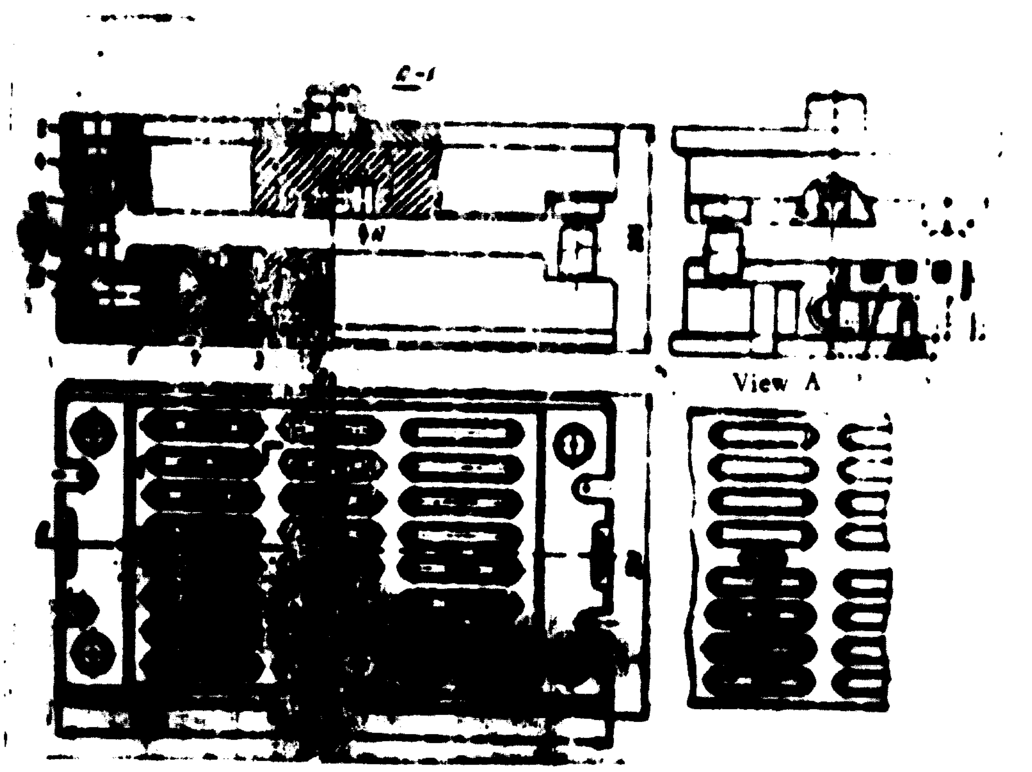


(d)

in figure 22. It should be mentioned that dies whose working tools are fixed by means of electromagnets are more convenient in stamping non-magnetic materials.

Figure 22

Die equipped with electromagnets



Sheet dies

112. The last types of simplified die designs to be discussed in this short review are sheet dies. These are rather simple, inexpensive dies made of sheet material with a thickness slightly more than that of the sheet stock to be stamped. Sheet dies make it possible to obtain workpieces accurate in their dimensions up to 2,000 x 1,000 mm, with thicknesses ranging from 0.3 mm up to 10 mm. The workpieces have either plain or intricate outlines (18).

113. Some of the available schemes of sheet-blanking dies are given in figure 23 (18).

Figure 22

Variations in sheet-blanking dies

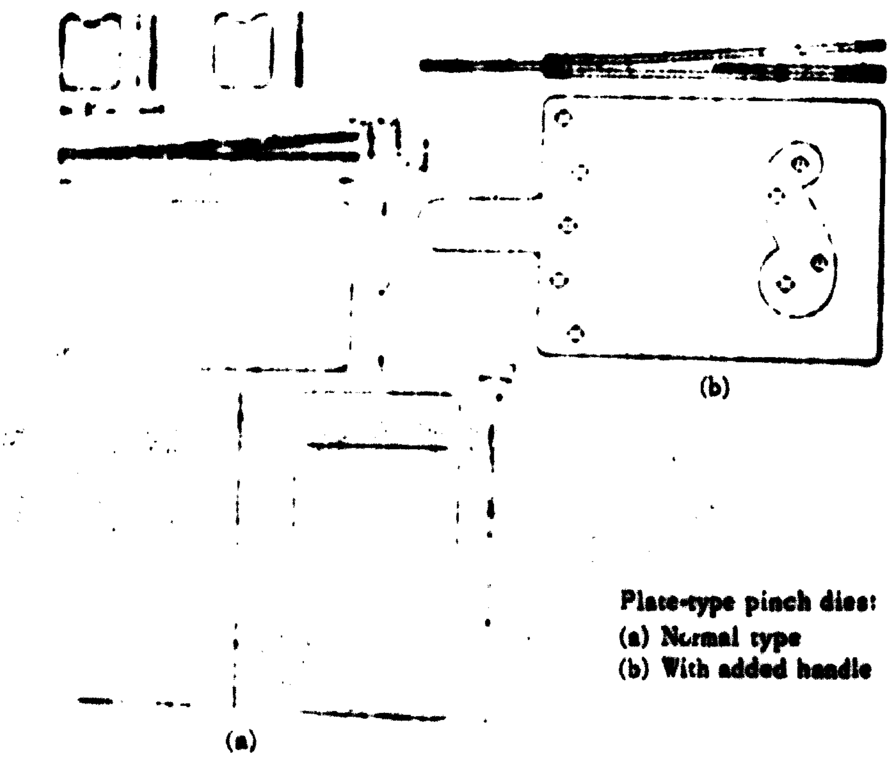


Plate-type pinch dies:
(a) Normal type
(b) With added handle

114. The die consists of two plates welded (a) or riveted (b) together. One of the plates (with an opening) is a die. The other plate 2 is welded or attached to still another plate 3 which is its punch. The close fitness of plate 1 and plate 2 provides the movement of the punch with respect to the die. To facilitate stripping the scrap from the punch, rubber strippers 5 are sometimes provided in the dies. In considering the conveniences in handling the die and in the hopes of improving conditions for securing a certain amount of permanent clearance during stamping, a handle 4 is sometimes provided in the dies.

115. The plates are made of either low-carbon steel or of chisel tool steel (carbon or alloy steel). In stamping soft sheet metal, the plates are not necessarily subjected to heat treatment. With a view to improving the hardness of the tool and in stamping parts on hard materials, the plates must be

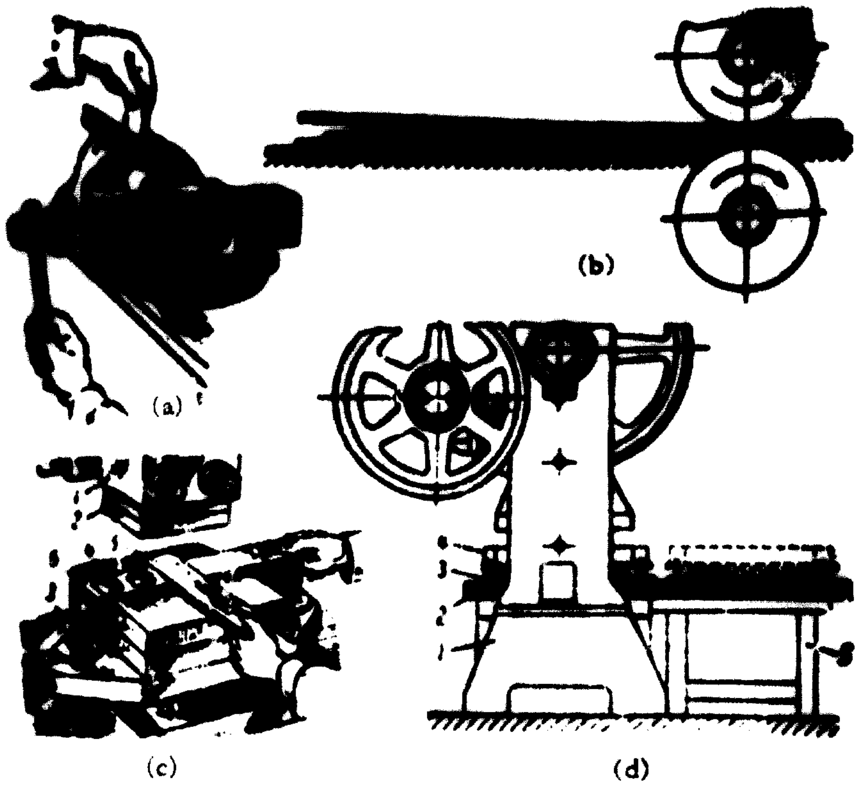
heat treated. Plates of low-carbon steel are case-hardened and then tempered.

116. Detailed recommendations regarding the technology of making sheet dies are given in other publications (19).

117. The procedure for the operation of stamping with sheet dies is presented in figure 24.

Figure 24

Steps in the process of stamping with sheet dies



118. As it is seen from the figure, smaller, thinner parts may be stamped by gripping them in a vice without the use of machinery (a). In stamping small and average-sized workpieces, the work is stamped on an eccentric press (6) between the plates mounted on the table and attached to the press slider (b).

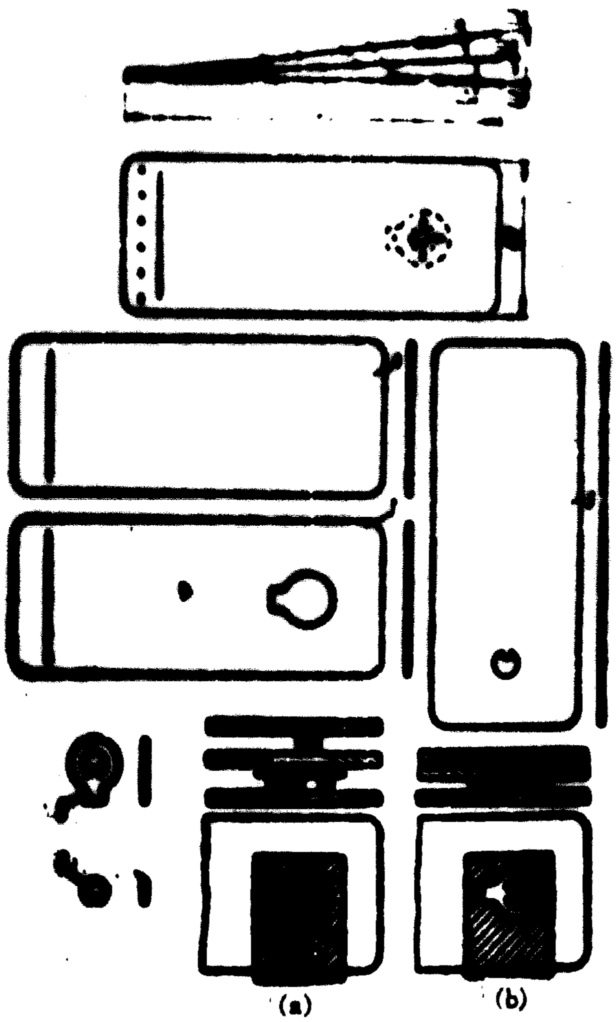
119. When stamping large workpieces (also when the required presses are lacking), tandem rolls can be utilized (c). The rotating rolls pull in the sheet die and blanking takes place as the punch and die pass between the rolls. As a result of this, the force required for blanking is considerably reduced.

120. In stamping large workpieces with greater thicknesses, sheet dies of a somewhat different design but similar to that of the plate die may be used. The stamping process, as it is in this case, may be carried out on bigger crank presses (d). In stamping with sheet dies, friction-screw presses and hydraulic presses may be used as well.

121. If the design is somewhat complicated, sheet dies with compound action may be built. Blanking and piercing are handled simultaneously. An example of such a die is given in figure 25 (18). In this case, the die consists of three plates. The intermediate plate 3 is a female die. Blanking punch 2 is attached to the bottom plate 5. The punch serves also as a female die in piercing. The piercing punch is attached to upper plate 4. The procedure for blanking and piercing operations is given in the same figure.

Figure 25

Sheet dies with compound action for simultaneous blanking and piercing

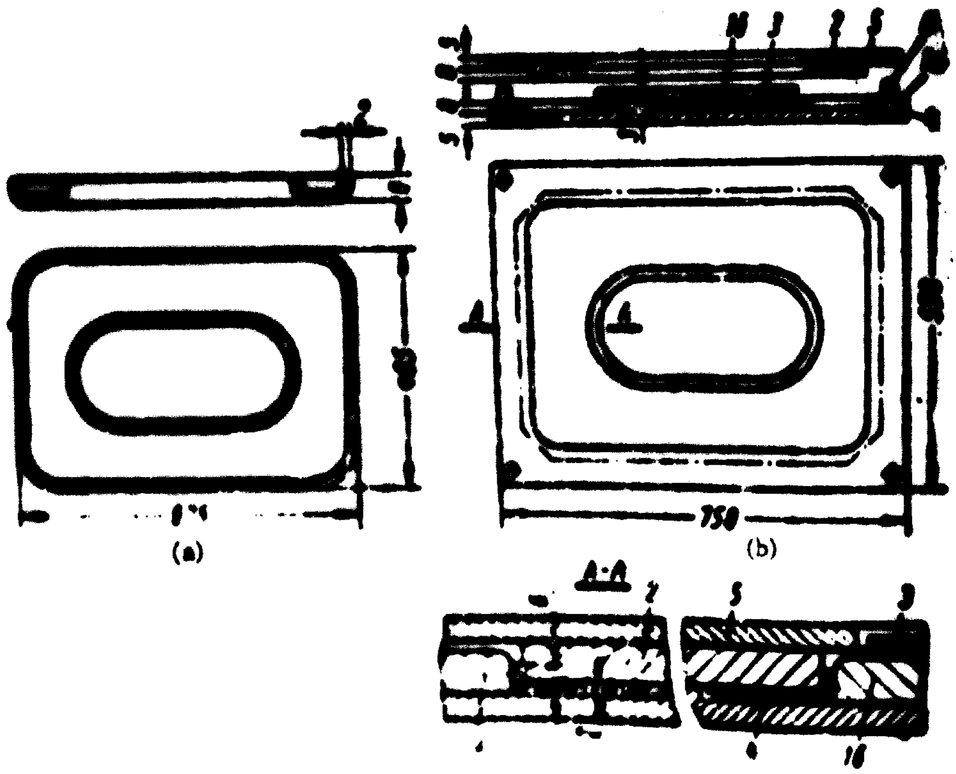


122. Sheet dies may be used not only for cutting operations, but also for bending, forming, burring, and shallow drawing.

123. A lay-out of such a sheet die is given in figure 26. The die is designed for burring and drawing. The original stock is in the shape of a washer and is placed in the lower part of the die. To provide better alignment between the upper and lower parts, guide pins 6, which enter the holes cut in the upper plate, are provided. Circular stock is attached to its inner contour by means of pilot 3.

Figure 26

Simplified plate die for internal and external flanging



124. The above-mentioned [illegible] illustrates the vast opportunities for [illegible] to fit small-scale production.

125. The use of simplified [illegible] cost of the process, shortens the time required for preliminary [illegible], makes easier the actual process of manufacturing dies, and decreases [illegible] complicated and expensive metal-cutting equipment. The use of these dies of simple design is most advantageous in developing countries.

126. It is necessary to mention another trend towards simplifying the manufacturing processes of dies and reducing costs. This is a substitution of the materials that are customarily used in die manufacture. The new material should cost less, it must be easier to handle, and it should stand up under repeated use. Cast dies or dies with plastic parts are often selected to meet these requirements. In cast steel dies, the working members (punches and dies) are cast of specialized, easily-melted alloys (4). In stamping soft materials, zinc-base and aluminium-base alloys are often used as casting alloys.

127. The developed alloys have good fluidity, allow for a small amount of shrinkage, and their hardness is sufficient for small-scale production.

128. Manufacturing the working die members by casting not only reduces metal expenses (the worn-out metal is remelted), but also simplifies the technical processes for the production of the tool. Indeed, the cast punch or die stock requires but little surface handling, a feature which considerably reduces the volume of expensive machining operations in manufacture of the working tool of the die.

129. The application of plastic materials for the manufacture of dies (21) proved to be rather useful. Substitution of plastic for metal in the dies lessens the weight of the die, simplifying the production of die parts and facilitating their assembly. The cost is also reduced (if sufficiently inexpensive plastic materials and polymerides are available).

130. The use of [illegible] average and large-sized parts. At the same time [illegible] dies may be advisable regardless of the dimensions of [illegible] stamped.

131. The use of [illegible] and [illegible] requires additional facilities, a factor which [illegible] the application of these materials in small-scale [illegible] advisable.

III SPECIAL METHODS OF STAMPING IN SMALL-SCALE PRODUCTION

132. The simplified dies discussed in the previous chapter were characterized by the fact that they employed metallic punches and dies; each punch and the die associated with it (except for some of the types of universal dies) were used for the production of one particular part. Under such conditions, it is necessary not only to use a proper tool to manufacture each particular part, but also the punch and the die must be fitted to each other so that the proper punch movement can be provided. This naturally makes preliminary production operations more expensive. At the same time the processes of manufacturing dies and utilising tools become more complicated.

133. Specifications for stamped parts in small-scale production are usually rather comprehensive. These particular circumstances gave rise to the peculiar methods of stamping which more or less eliminate the above-mentioned difficulties connected with the application of specialised dies with metallic punches and dies.

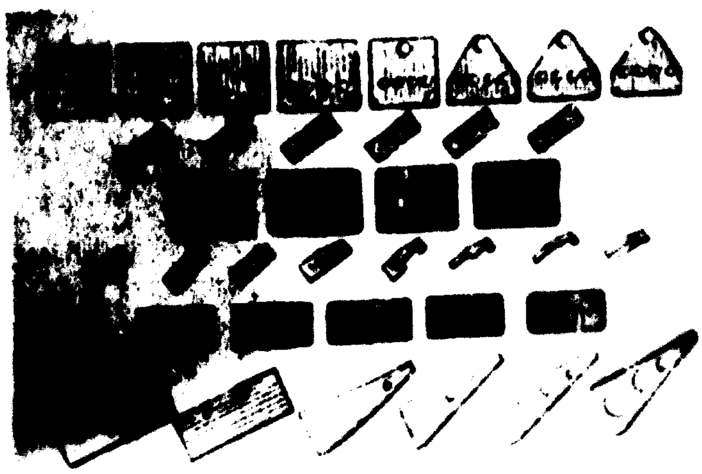
134. In this section, two methods will be discussed. Both have already been successfully used in industry and are considered by some to be the most advantageous in small-scale production. The two methods involve stamping by elements and stamping by one specialised machine tool.

Stamping by elements

135. Stamping by elements was originated and introduced into industry by V. M. Bogdanov. A number of universal dies are employed for the manufacture of stipulated parts. Each of the dies shapes only one of the elements of the whole part to be stamped. Successive operations which produce some of the parts in stamping by elements are presented in figure 27 (22).

Figure 27

Steps in stamping by elements



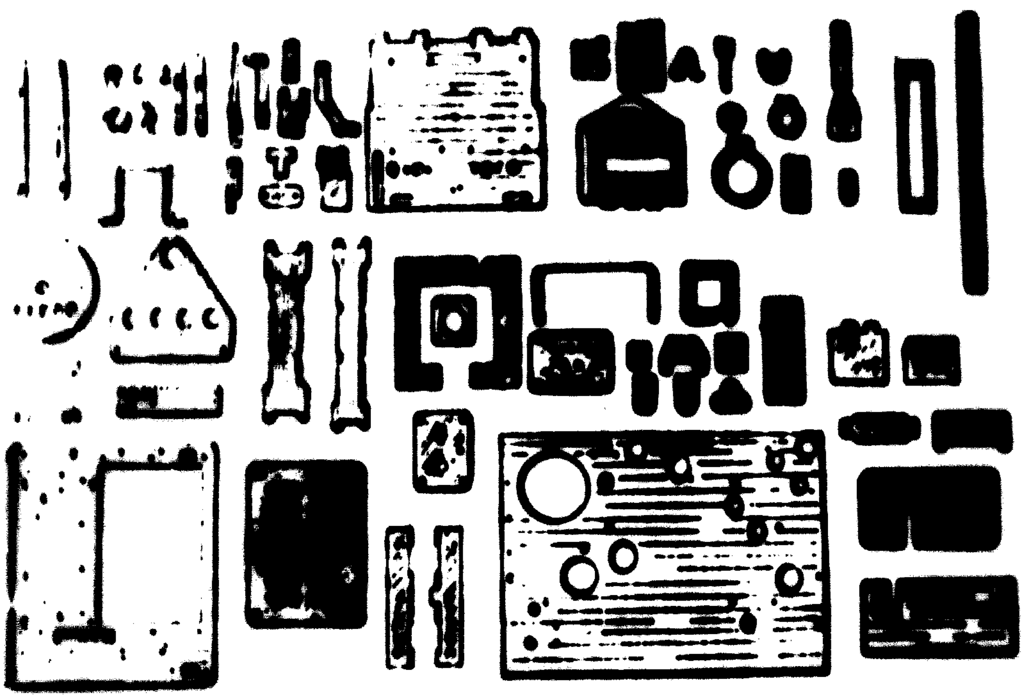
136. As it is seen from the given examples, in stamping by elements, the exterior outlines of the part to be shaped are not cut on a blanking die with one stroke only, but instead the excessive metal is gradually cut off the stock with several strokes. At first, during a number of operations, rectilinear elements of the outlines are cut. Then in the same way, in the course of several operations, curvilinear elements of the outlines are cut. The interior outlines of the part may also be cut by elements, or holes may be pierced in turn.

137. Not only flat parts but also spatial parts (the parts requiring bending operations) may be obtained in stamping by elements.

138. Figure 28 shows some sketches of the parts obtained through stamping by elements (22), but do not entirely comprise the variety of possible shapes of the parts obtained by this method.

Figure 28

Examples of parts obtained through stamping by elements



139. However, even these examples show that stamping by elements may provide a great variety of rather intricate parts. The expediency in using stamping by elements in small-scale production, however, depends on a number of factors among which the most important are: the rating of the elements of the stamped parts and the advantages of universal die designs being applied in this case.

140. A reasonable solution to the problem of rating the stamped part elements creates prerequisites for decreasing the number of universal dies required for the parts of given specifications. At the same time, both the precision and the quality of stamped parts depend on die design and on the capacity of the universal die, which, in turn, influences the number of dies required.

141. These two factors affect the amount of required dies and, consequently, the economical efficiency of stamping by elements. The less the number of

dies required for the manufacture of given parts is, the greater is the variety of the parts obtained by the available dies and the higher is the economical efficiency achieved.

142. The problem of rating elements is rather complicated and many factors have to be considered. Not all the parts stipulated for production must be obtained in stamping by elements. It is necessary to select parts of plain configuration: flat parts, obtained by blanking and piercing, and the parts that may require only bending operations in addition to cutting operations.

143. If there is quite a number of such parts, stamping by elements may be considered as economically advisable. It is then necessary to find out the possibilities of unifying the elements of separate part designs without spoiling their working specifications. Among the most important elements being subjected to unification are radii of curvature of the outer and inner contours, the diameter of the holes to be pierced, the angles between the flat sections of the part obtained by bending and the radii of curvature in the bent sections.

144. The contours of any stamped part may be formed by a combination of straight lines and circular arcs. Four universal dies may be required for obtaining such flat parts in stamping by elements: a die for rectilinear sections of the exterior outline, a die for curvilinear sections of the exterior outline, a die for curvilinear sections of the interior outline, and a die for rectilinear sections of the interior outline (dies are mentioned in the order of technical process).

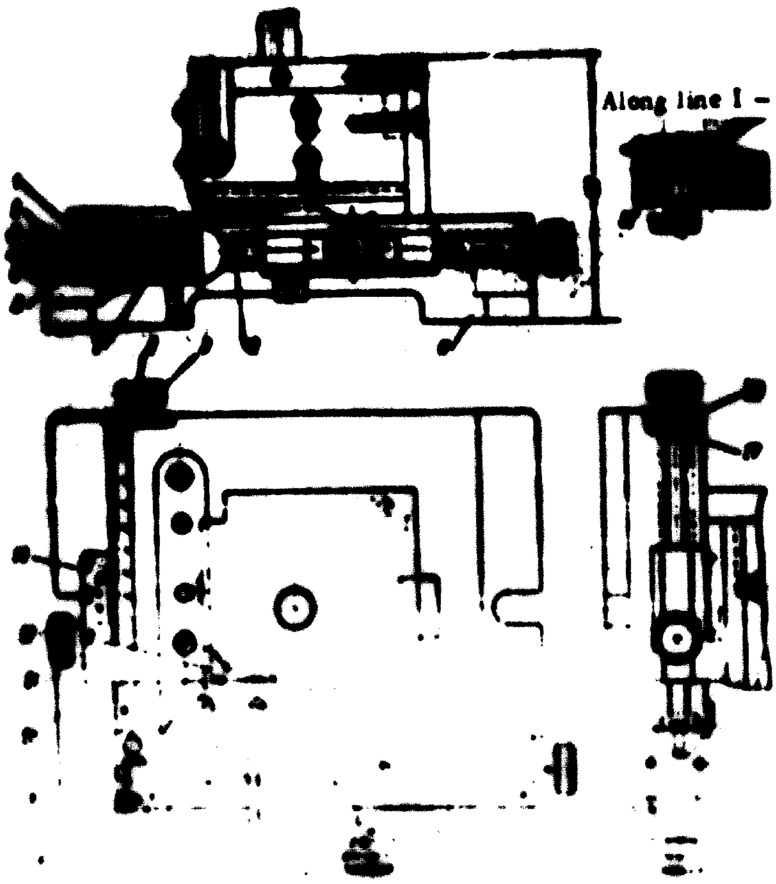
145. The degree of complication in the design and cost of required universal dies depends upon the ability of the designer to meet universal requirements.

146. Therefore, in establishing part designs with respect to stamping by elements, it is desirable that the required gradation of the dimensions of separate elements should be at a mimimum. First of all, this concerns the radii of curvature of contoured sections. As has already been mentioned, the number of required universal dies depends also on the degree of perfection of a specific die design.

147. Figure 29 illustrates the die designed for cutting rectilinear sections in the external outline of the part (22).

Figure 29

Die for cutting rectilinear sections in the external outline of a part



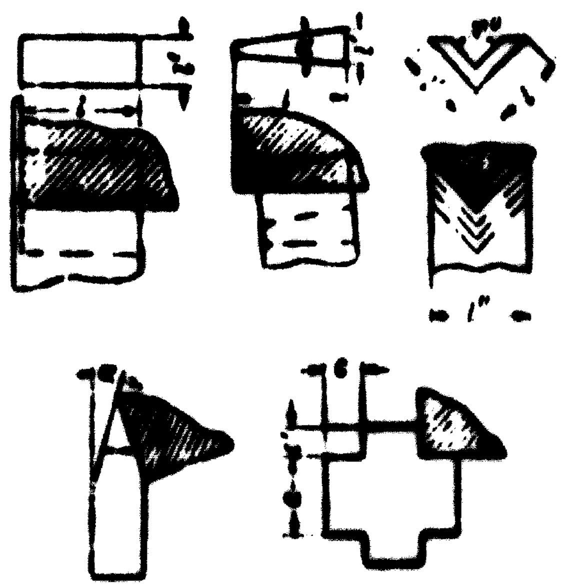
148. The die is equipped with a female die, consisting of two sections 17 and 21, which are installed in a shaped base plate 1 and attached to it by means of screws 18. In the base plate there is an opening through which the sections being cut off are pushed. The dimensions of the female die are such that the size of the part to be cut is not more than 100 mm. The parts to be

out are attached by plank 16 and 20 and adjusted by screws 27 and 10, and the sizes are controlled by means of rulers 12, 13, 22, 23 within 0.05 mm. The device for turning plank 16 varies the angle between adjacent rectilinear sections.

149. The stamping process for obtaining the rectilinear sections of the outline with this die is presented in figure 30. The range of variations in the dimensions of separate parts being stamped and the gradation that may be achieved on this die by means of adjusting rulers is also given.

Figure 30

Methods of manufacturing parts whose outline is made up of straight lines (dimensions in mm)



From 0 to 55 with an excess of 0.05

From 0 to 105 with an excess of 0.05

Not more than 90, with an excess of 0.1

From 5 to 180°

Up to 55, with an excess of 0.05

From 0 to 105 with an excess of 0.05

From 0 to 55 with an excess of 0.05

150. As is seen from the figure a great variety of rectilinear-shaped parts (both protuberant and concave) can be manufactured by means of one and the same die. It should be pointed out that stocks for the parts are cut from the sheet as in stamping without allowance.

151. Certain rectilinear elements of the outline can be shaped without resetting the die unit.

152. Before shaping the next rectilinear elements, the die must be reset. Readjustment generally means attaching rulers 10 and 20 in a new position by adjusting the screws provided in the die. Because accuracy in controlling the plates on the die is rather important (micrometric screws) and the adjustment dimensions are indicated by ruler gradation, additional readjustment of the dies after test stamping has been completed is not required. Hence, the dies for forming external outlines made up of straight lines are rather universal. Their possibilities are limited only with respect to the sizes of the opening of the base plate which determines maximum sizes of the section to be cut off.

153. If the scrap is dispatched into the female die and the original stock is cut off a metal strip or a sheet by means of shears, the parts whose dimensions are much larger than those of the base plate holes may also be made by means of similar dies.

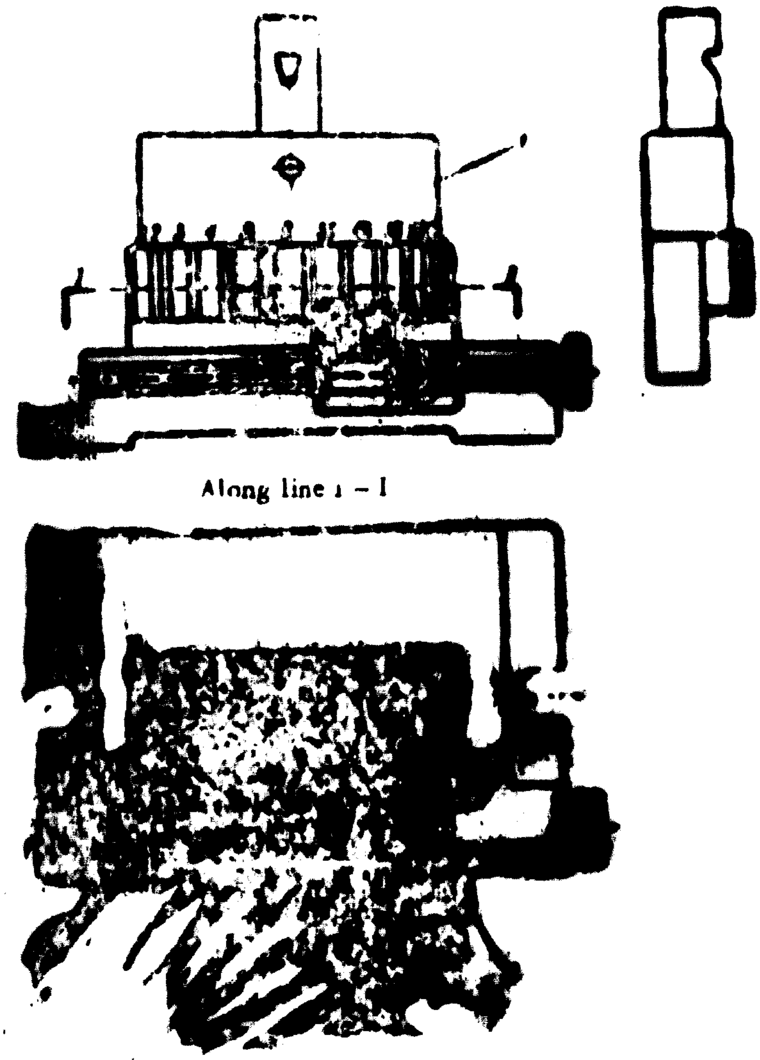
154. The available die designs for obtaining non-rectilinear outlines are discussed below.

155. Figure 31 illustrates the die designed for radial shearing (22). This die provides for making up to eleven different radii of curvature on the outer contour of the part to be stamped. The die is designed to couple the parallel straight lines of the outline with the circular arc. The dimensions of part A are attached by moving frame 2 so that its marking coincides with the gauge marks of ruler 6 plotted with respect to the given radius.

156. Replacing punch 1 and die 8, and using inclined position of ruler 3 relative to the bisector of the cutting angle (two inclined rulers are more suitable), it is possible to adjust the similar die so as to slit angular sections of the part when the arc of a certain radius connects with the straight lines of the outline, the amount of the angle between which is not equal to zero.

Figure 31

Die for radial shearing

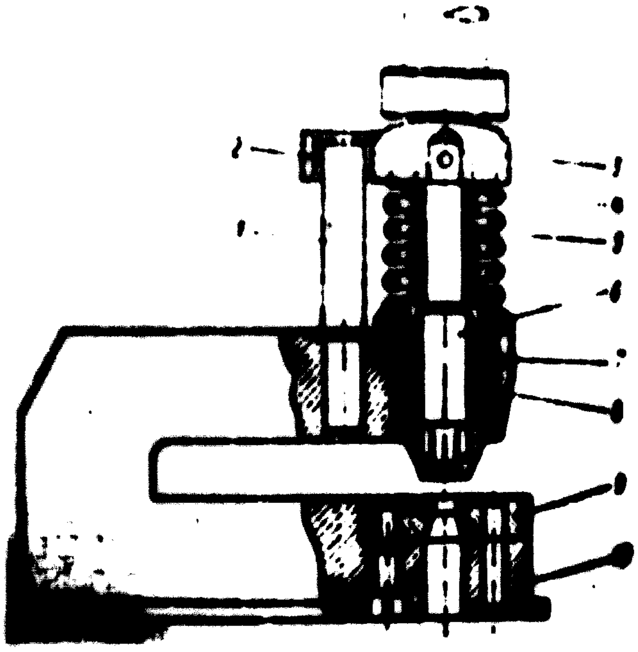


157. Figure 32 portrays the universal die designed for piercing holes and slitting splines of various shapes. Removable dies 9, punches 6, and bushing 7 provided in the machine permit piercing holes and slitting splines of various dimensions. The die is not fixed to the press, and the back stroke of the punch as well as stripping the stock by means of bushing 7 is provided by springs 4 and 5. The punch is placed with respect to the die by means of

bushing 7, and guide pin 1 is positioned according to bushing 2. The quick replacement of the die may be speeded up by using ball attachment (4).

Figure 32

Universal die for piercing holes and slitting splines of various shapes



158. Sufficiently comprehensive recommendations and advice for rating the elements of the stamped parts and the universal die designs for stamping by elements are available in certain studies (22). Even the die designs and principles of using stamping by elements discussed above illustrate that this method of stamping may prove to be efficient in small-scale production. This efficiency is achieved (in spite of some decrease in labour productivity) by saving metal required for die manufacture and by reducing the expenses connected with die design and manufacture.

159. In introducing stamping by elements into industry, it is advisable to organise a shop equipped with presses so that each press performs a certain

operation according [illegible] the manufacture of parts. In this case, the time and [illegible] required for replacing dies are saved, a fact which improves labour productivity.

160. Stamping by elements is most advisable for manufacturing small and medium-sized parts which may be made on small eccentric presses. In some cases, stamping can take place with hand-driven devices.

Stamping with one specialized tool

161. This method of stamping employs only one working member for obtaining each part, while some resilient medium (rubber, liquid, plastics) is used in place of the second tool.

162. The fact that the second co-ordinated tool is dispensed with makes manufacture and alignment of the die considerably easier. There is then no need to manufacture one of the two members (a punch or a die). Alignment is unimportant and, consequently, the accurate placing of one member relative to the other during the stamping process is not necessary.

163. These processes of stamping include stamping with rubber, stamping with liquid, and high-energy methods of stamping (explosive, electro-pulse, and magnetic stamping).

164. Comprehensive, scientific and technical literature dealing with these methods of stamping is available at present (23, 24, 25, 26, 27, 28, 29).

165. The principle methods of stamping with one specialized tool is discussed below from the point of view of technology and adaptation to the conditions of small-scale production in developing countries.

166. Stamping with rubber, as compared to all the other methods of stamping with one specialized tool is perhaps the most universal and simple method. It provides not only shaping but cutting operations as well (28).

167. In blanking and piercing operations, the working tool is a plate cut from sheet metal of 5-10 mm thickness. Its inner and outer contours correspond to those of the part being stamped. The working member design is

extremely simple. No devices for fixing the plate and guiding the stock are required. The preliminary adjustments required for the production of the stipulated parts are inexpensive and easy. Blanking and piercing with rubber, however, are limited to a certain extent.

168. The thickness of the part being stamped usually does not exceed 2 mm. The harder the metal is, the less thick the stock is. In blanking with rubber, it is difficult to obtain narrow slots in the outlines of the part with small radii of curvature at the points of connexion.

169. The minimum diametrical dimensions of the blanked holes are considerably larger than those that are obtained through piercing with a metallic punch or a die.

170. The quality of the sheared surface is usually not as high in blanking or piercing with rubber than in blanking with a metallic punch and die. It should be added also that the force required in blanking and piercing with rubber is considerably greater than in stamping on a metallic die and depends on the area of the rubber plate. (The pressure is usually 150-200 kg/cm^2.)

171. Blanking and piercing take place under a certain specific pressure. The amount of pressure depends on the thickness of the metal-stock, mechanical qualities of the metal to be stamped, thickness of the working plate (gauge), and the conditions for jamming rims in blanking. Various specific forces are created as a result of different amounts of compression of the rubber plate at the bottom of the working stroke. Hence, in stamping with rubber, it is preferable to employ machines with a loose movement, such as a hydraulic press, friction-screw press or hammer. In principle, it is possible to stamp with rubber on a crank press, but the adjustment of the process in this case might be somewhat more complicated.

172. Specialized hydraulic presses were developed for stamping large-sized parts typical in the aircraft industry. On these presses, the rubber plate is held against the press slide, or stamping takes place with the help of liquid pressure exerted upon the rubber plate. The use of such specialized presses designed for stamping with rubber is limited in developing countries. In

stamping [illegible], [illegible] universal hydraulic [illegible] container attached to the [illegible].

173. Stamping with [illegible] punching, such operations as [illegible], [illegible], [illegible] straight and curved lines, and [illegible]. [illegible] are limited [illegible] drawing [illegible] blank holder.

174. By equipping the press with auxiliary [illegible] provide for variable pressure of the blank holder to conform with the movement of the [illegible] deep [illegible] with [illegible] rate of shape change than is allowed in stamping with metallic tools (25).

175. Using a spatial stock and the dies of specialized and somewhat more complicated configuration, it is possible to stamp rather intricate parts, such as syphon corrugated tubes (25).

176. Stamping with liquid is mainly applied when shape-change operations are desired. The dies for stamping with liquid may be rather simple in their design (25).

177. In some cases, stamping with liquid through a rubber membrane (diaphragm) is successfully applied for drawing such parts as barrels, e.g. the Marform process (30).

178. Hydraulic drawing, however, requires special equipment that is primarily used in drawing large parts. If usual equipment is used, the process may be rather complicated to adjust and may result in lower quality parts.

179. It is more advisable to apply hydraulic stamping, particularly for forming operations, especially in obtaining various impressions on hollow or tubular stocks.

180. High-speed or high-energy stamping processes are being widely employed in industry. The most important among them are explosive stamping, electro-pulse (electro-hydraulic) stamping and electromagnetic stamping.

181. Explosive stamping is most advisable for obtaining large and comparatively thick parts. Electro-hydraulic stamping is best for stamping average-sized parts of less thickness.

182. Magnetic stamping is expedient for manufacturing parts out of ferromagnetic materials of relatively small thickness, for obtaining small-sized parts and for assembling operations by stamping.

183. Explosive stamping usually requires building a special reservoir for water and observing strict safety rules of engineering. At the same time, explosives are cheap and are used in small quantities.

184. Electro-hydraulic and magnetic stamping require special installations with condensers and dischargers, and they consume a large amount of electrical energy. Thus, high-power methods of stamping have limited technical potential, their application involves great capital expenses, they are fraught with many injuries, and require highly-skilled operators.

185. The adoption and adjustment of stamping processes usually require a great deal of time, highly qualified personnel, and are accompanied by a great waste of metal. All this makes one believe that the wide application of these high-energy methods of stamping in developing countries is not expedient at present.

186. It would seem, however, that the application of stamping with rubber, plastic, and liquid is definitely advantageous for developing countries. These processes reduce considerably the expenses and save the time required for preliminary production arrangements. At the same time, these processes provide stamping a great variety of different sized and shaped parts.

187. It should be borne in mind, however, that these methods of stamping cannot, in a number of cases, provide high accuracy for the parts being stamped. It is therefore advisable to use stamping with rubber and liquid along with the usual methods of stamping with metallic tools. In a number of cases, it is rather advantageous to combine the use of elastic and metallic instruments in processes designed for the manufacture of stipulated parts.

5. 4. 74

01245

1.0
2.8
2.5
3.2
2.2
3.6
4.0
2.0
1.1
1.8
1.25
1.4
1.6

[illegible]

188. The [illegible] material spent on their [illegible] in their manufacture. [illegible] and die, uniformity, [illegible] punch and the die are [illegible] can arise in these factors [illegible]

189. In ordinary dies, [illegible] tightly fitted to die plates without any [illegible], and [illegible] the punch with respect to the die is provided by means of [illegible] which are also fixed in the die plates.

190. Therefore, the accuracy in placing the punch in relation to the die and the clearance depends mostly on the accurate location of plate cavities with respect to pins, bushings and other fixing facilities. In well organized large-scale production, where a great number of dies is available, or in plants specializing in making dies, there are great possibilities for the adoption and application of most developing technology in making dies. This all aims at perfect and precise metal-cutting equipment, e.g. copy milling machine, reciprocating boring ma[illegible] and so on.

191. In small-scale production and in production with a comparatively small total volume of output, the application of technological processes and equipment for die manufacture is often at a disadvantage owing to the high cost of such equipment and a less than full capacity operation. Therefore, an attempt is made to use as simple die designs as possible in small-scale production.

192. However, the simplification of dies causes, in most cases, less accurate positioning of the punch with respect to the die, an increase in the waste of stamped metal, and an inferior quality of the stamped parts.

193. One of the most important problems in small-scale production, therefore, is procuring a means for simplifying the technology of die production, while maintaining accuracy and high quality.

194. The present study cannot discuss in detail the numerous methods for simplifying the technology of die production. Further information can be

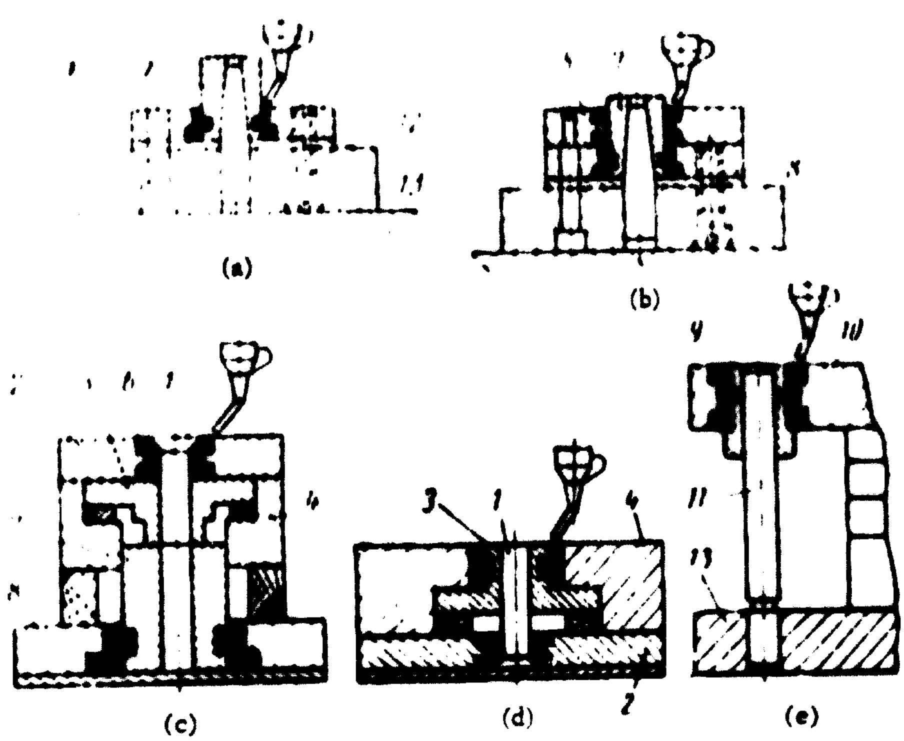
found in other publications (31, 32). Certain measures that might be of interest for small-scale production are explained below.

195. The need for highly accurate dimensions and spacing of cavities in plates, punch holders, and die holders etc. and in fitting considerably increases the demand for labour in the manufacture of dies.

196. One of the best methods to decrease the required accuracy of the given dimensions in fixing certain die elements is the application of a quickly solidifying plastic such as styrocril. In this case, considerable clearance must be provided between the stock to be attached and the hole that is filled with plastic while being assembled. Plastic, which is in a liquid state while being poured, becomes sufficiently strong after polymerization and holds the connected parts tightly. Figure 33 illustrates the methods of attaching coupled parts with the help of plastic and the ways of handling the fused parts in order to increase the strength in attaching (21).

Figure 33

Methods of attaching coupled parts with plastic



197. As it [illegible] between the coupled parts [illegible], and can fully compensate for [illegible] d[illegible] but also in locating [illegible]. All [illegible] simplify the manufacture [illegible] equipment [illegible] pr[illegible].

198. In order to [illegible] with [illegible] clearance, fusible alloys (similar to [illegible]) [illegible] be used instead of plastic.

199. In making dies, it is very difficult to provide the required amounts of clearance between the punch and the die. It is particularly difficult in manufacturing tools designed for blanking and piercing thin sheet metal, because the clearance between the punch and the die amounts to tenths and even hundredths of a millimetre. If the shape of the part being blanked or the hole to be pierced is rather intricate, the making of the tool becomes still more difficult.

200. In such cases, a rather peculiar design of machine tool may be applied in small-scale production. The female die is made and tempered acquiring final dimensions and hardness. At the same time, the punch is partially finished with dimensions exceeding those of the die cavity (with inferior accuracy, as compared to the female die, and, if required, with some simplified outlines). On fixing the female die and the punch in the die unit, the punch is passed through the die [illegible] the latter shear [illegible] the allowance from the punch, after which, by filing the lateral surfaces of the punch, the required clearance between the punch and the die is achieved.

[illegible] In blanking soft materials, [illegible] quantity is required, [illegible] need not be tempered. [illegible] case, when the edges of the punch [illegible] and then [illegible] the die cavity.

[illegible] great number of [illegible] simplification of die [illegible] technology. [illegible] show that [illegible] applying such methods [illegible] cost.

This paper [illegible] technology [illegible] die designs [illegible] wider and more advantageous [illegible]. The study was not [illegible] problem of the expedient use of [illegible].

However, the expediency [illegible] adopting such methods of technology and die designs which are discussed in the paper must be analyzed in conformity with the particular conditions of industry in developing countries. The tendencies mentioned for technology [illegible] small-scale production present only the initial data for such analyses.

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