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MANUFACTURING OF A CASE-SHAPED PART IN CONDITIONS OF SHEET STAMPING

Abstract: A rational technology of manufacturing of a thin-walled case-shaped part by sheet stamping is presented in the article. Stages of deep drawing of a sheet billet in conditions of automated production were considered. Description and operating principle of technological equipment devices are given. An analysis of reject of a product at realization of the considered technological process of drawing was performed.

Key words: drawing, a sheet billet, a die, a part, a step.

Language: English

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Introduction

Researches of a deep drawing process of sheet billets by direct and reverse methods are presented in the works [1 – 13]. In these works, there were paid attention to the questions of wrinkling on a flange, plastic deformation of material and etc. from thickness of the sheet billet at drawing (one step). Thin-walled hollow parts of a complex shape are performed by multi-step drawing. This process of plastic deformation consists in gradual changing of the shape of the sheet billet before obtaining of a finished product. At such processing conditions, material is exposed to significant deformation, especially at bend. For reducing of material friction of the sheet billet about of forming tools surfaces of a drawing die, it is necessary to use lubricating fluids in a large volume. So as maximum plastic deformation of the sheet billet occurs at the first steps of drawing then it is rational to use the combined dies. Efficiency of multi-step plastic deformation of the (metal) sheet billets in conditions of automated production is provided at choosing of an optimal design of special devices (the dies) and observing of sheet stamping modes.

Technology

The technological process of multi-step drawing of the sheet billet was subjected to consideration. The

billets made of the cold-rolled sheet of normal rolling accuracy in thickness (the sheet with the high surface finish for complex drawing made of low-carbon quality steel) were exposed to plastic deformation. The sizes of a steel band were: thickness – 2.5 mm, the width – 1250 mm, and the length – 2500 mm in accordance with GOST 19904-90 [14].

The sheet billets are cut down on the operation 010 of the technological process of manufacturing of the part "Case". Cutting down of the sheet billet is carried out by means of the cutting die on the double column crank press. Required force of the press is 100 tf, a double-stroke number is 90. For implementation of the cutting down process of the sheet billets, it is necessary to use industrial oil I-20A (GOST 20799-88) and thread (yarn) waste (industry standard 1788-86). Work on the press is carried out in the mode of single strokes with foot switch. The sheet billets are folded in a plastic container. The sizes of the sheet billet are provided by the tool. Quality control of appearance of the sheet billet is performed visually. Nesting pattern of the steel band and the sizes of the sheet billet after cutting down on the press are presented in the Fig. 1. The sign * on the sketch of nesting pattern of the steel band is the linear size for reference. On the flange of the sheet billet after cutting down must not be chips and other mechanical damage.

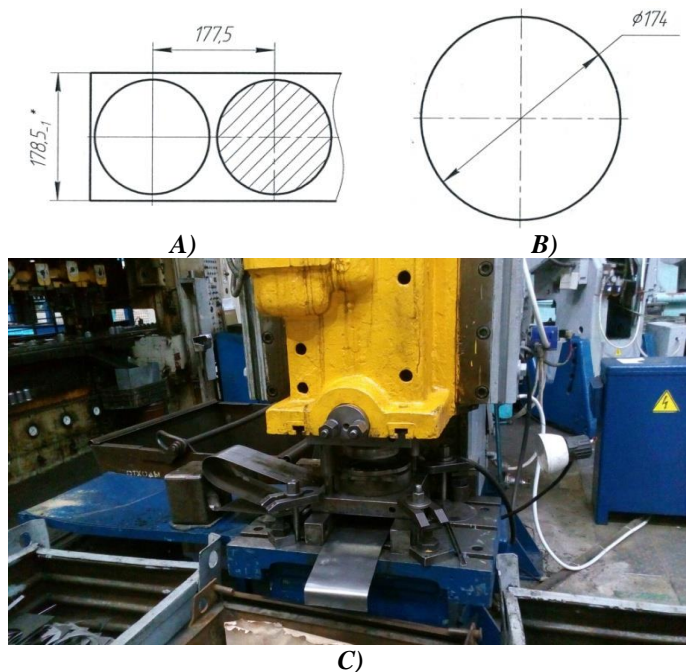


Figure 1 – Obtaining of the sheet billet for multi-step drawing: A – nesting pattern of the steel band, B – the shape and the size of the sheet billet, C – the double column crank press.


Multi-step drawing of the case-shaped part is performed on the eight-position automatic press "Paust-320". The general view and the technical parameters of the automatic press "Paust-320" are presented in the table 1.

Maximum force of the press is 320 tf, the double-stroke number is 16-32.

Staged changing of the shape of the sheet billet during plastic deformation on the operation 015 of the technological process of manufacturing of the part "Case" is presented in the Fig. 2.

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Table 1. The general view and the technical parameters of the automatic press "Paust-320".

Parameter	Value
Maximum force of slider (at distance of 15 mm to end of stroke)	250 tf
Allowable force related in one position: - side slider - other positions	70 tf 80 tf
Maximum depth of drawing	140 mm
Stroke length of slider	420 mm
Number of strokes (stepless adjustment)	16-32
Number of positions	8
Distance between individual positions	400 mm
Adjustment of die holders	80 mm
Stroke of main slider	420 mm
Maximum distance between work table and die holders in the lowest position of slider (die holders at top)	750 mm
Sizes of clamped surface of die holder	390×400 mm
Thickness of die plate	80 mm
Level height of transportation above surface of work table	480 mm
Sizes of clamped surface of die plate	3300×1000 mm
Maximum width of steel band (thickness of steel band for feed of 2 mm)	500 mm
Maximum feed step of steel band in one stroke	400 mm
Maximum diameter of round workpiece	375 mm
Way of opening of each clamshell guide	80-120 mm
Maximum diameter of round workpiece at staggered arrangement	265 mm
Distance between work table and side slider at the lowest position of slider and the highest position of adjustment mechanism	980 mm
Maximum transverse displacement at staggered arrangement	240 mm
Distance between clamshell guides in closed state	320-400 mm
Power of main electric motor	63 kW
Feed rate of steel band	10 and 15 m per minute
Sizes of fitment bore in die holders and side slider	Ø80H8
	

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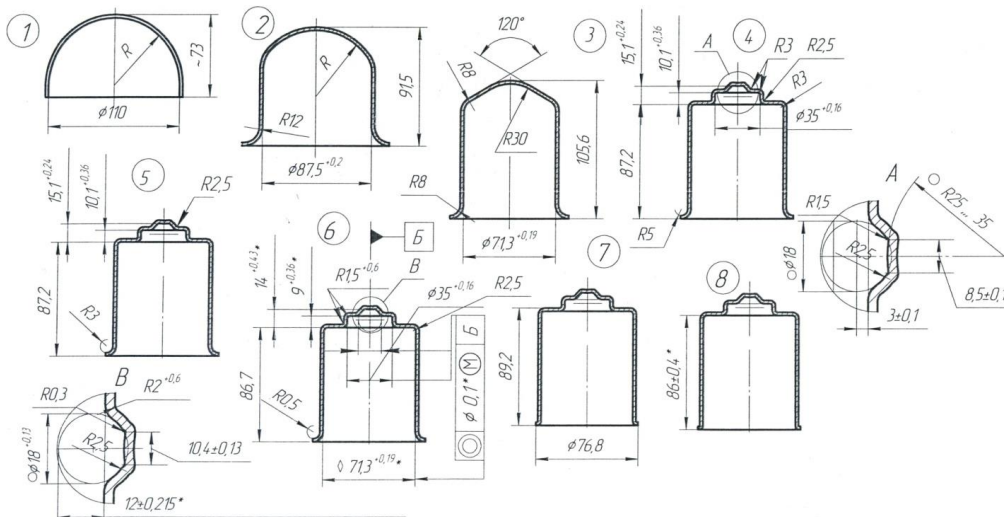


Figure 2 – The operation steps of drawing of the part "Case".

The sign * is the controlled size. The other sizes of the case-shaped part are provided by the forming tool. The size of 12 ± 0.215 mm is controlled by the steel ball 19-20 GOST 3722-81 after the sixth step of the sheet billet drawing.

During deep drawing of the sheet billet there are used technological lubricant "Rosoil-SHOCK" TS 0258-001-06377289-94 (or substitute material – "Lycopodium" GOST 22226-76) and thread (yarn) waste (industry standard 1788-86).

Drawing of the sheet billet consists of the combined steps: 1 step – to pull the sheet billet the first time, 2 step – to pull the sheet billet the second time, 3 step – to pull the sheet billet the third time, 4 step – to calibrate the sheet billet the first time, 5 step – to calibrate the sheet billet the second time, 6 step – to calibrate the sheet billet the third time, 7 step – to trim the flange, 8 step – to calibrate the sheet billet in the height size.

Control of the sizes is carried out by the following measuring tools: the inner diameter $71.3^{+0.19}$ mm (the plug gauge), the inner diameter $35^{+0.16}$ mm (the plug gauge 8133-0949 35H11), the size $9^{+0.36}$ mm (the special control device), the size $14^{+0.43}$ mm (the special device for control), a sphere (the special device), coaxiality of 0.1 (a control template), the size 86 ± 0.4 mm (the electronic depth gauge 200-0.01 GOST 162-90).

Multi-step drawing of the sheet billet is performed in the special dies. Durability of the each die is 850000 hits. The remaining technical requirements for manufacturing of the dies are performed in accordance with the proprietary standard 453 091-80.

The assembly drawing of the die for performing of the first step of drawing of the part "Case" is presented in the Fig. 3.

Formation of the part contour is carried out during vertical displacement of the die 1 concerning to the punch 4. The sheet billet is placed between the contact surfaces of the die and the punch. The punch is clamped to the holder 16 by means of four bolts 25. Clamping of the upper 10 and lower 13 plates of the die is carried out by the screws 24 and 26. The spherical surface is formed at contact of the takeout surface 7 with the sheet billet. Specified drawing force is provided by the spring 29 and the screw plug 30. The unstucker 6 prevents adhesion of the sheet billet surface to the takeout. Drawing force is set by the pusher 18, and stroke of the movable part of the press is set by the bolt 22 and the nuts 27, 28. Displacement of the processed sheet billet in a removal zone is performed by the puller 14 by means of the pusher 31. The die has the bush 5 for displacement direction of the takeout. The clamp 15 orients the cover 12 and the puller. Clamping of the clamp is carried out by the screw 23.

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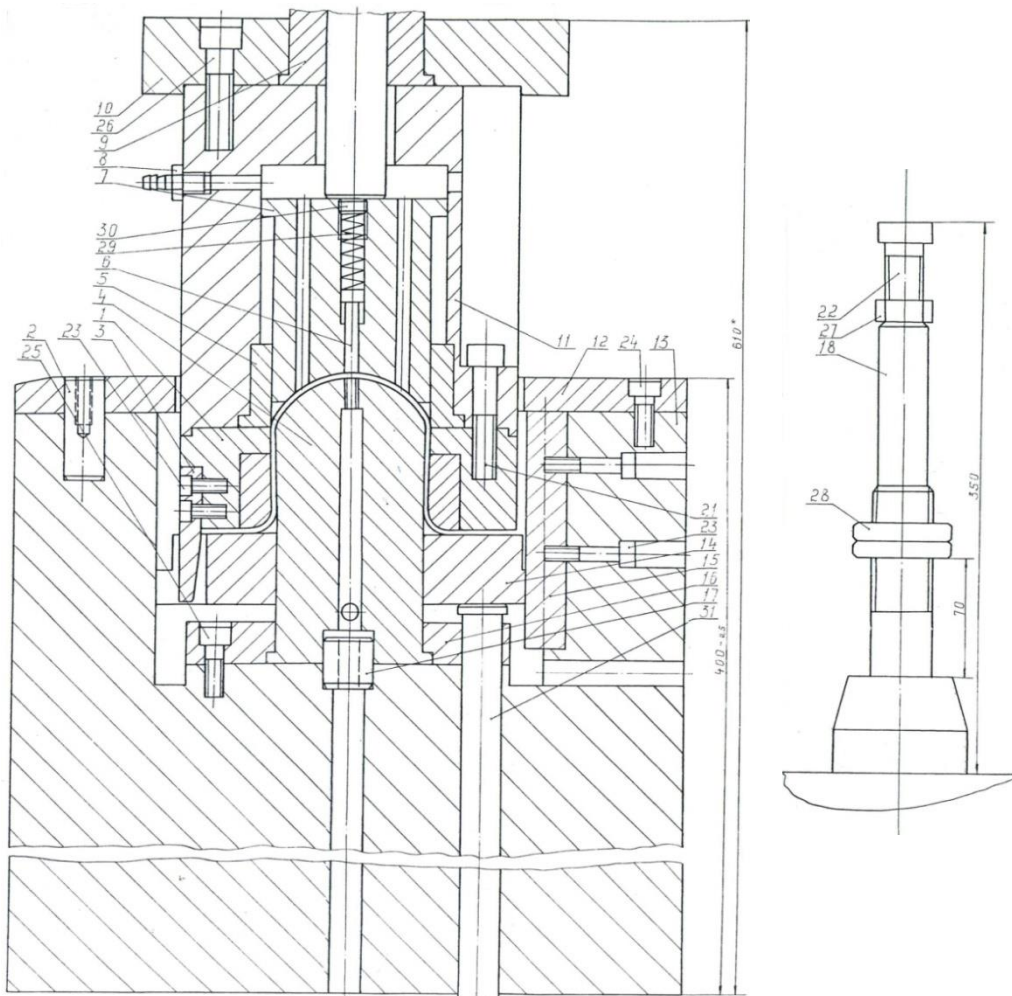


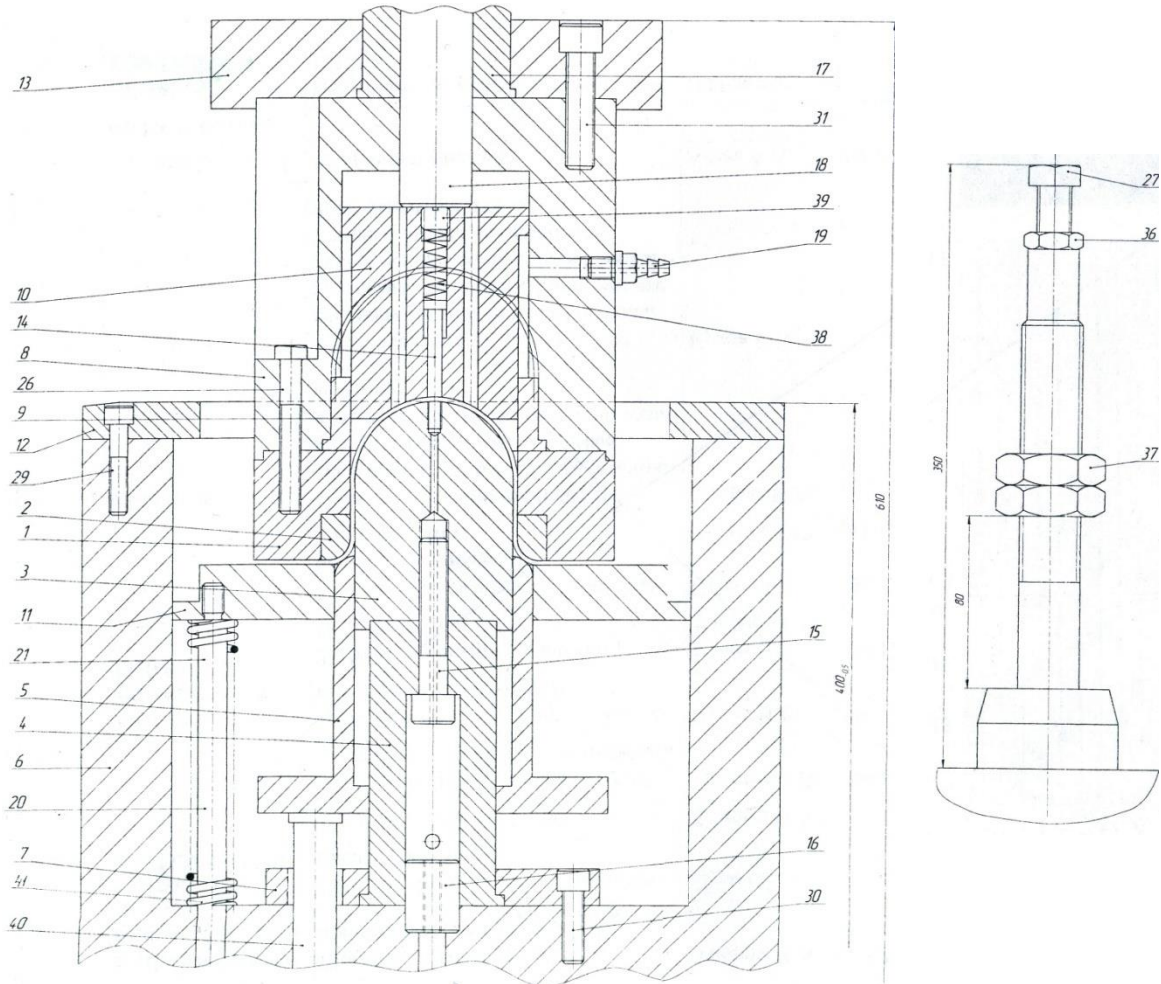
Figure 3 – The assembly drawing of the die for performing of the first step of the part drawing.

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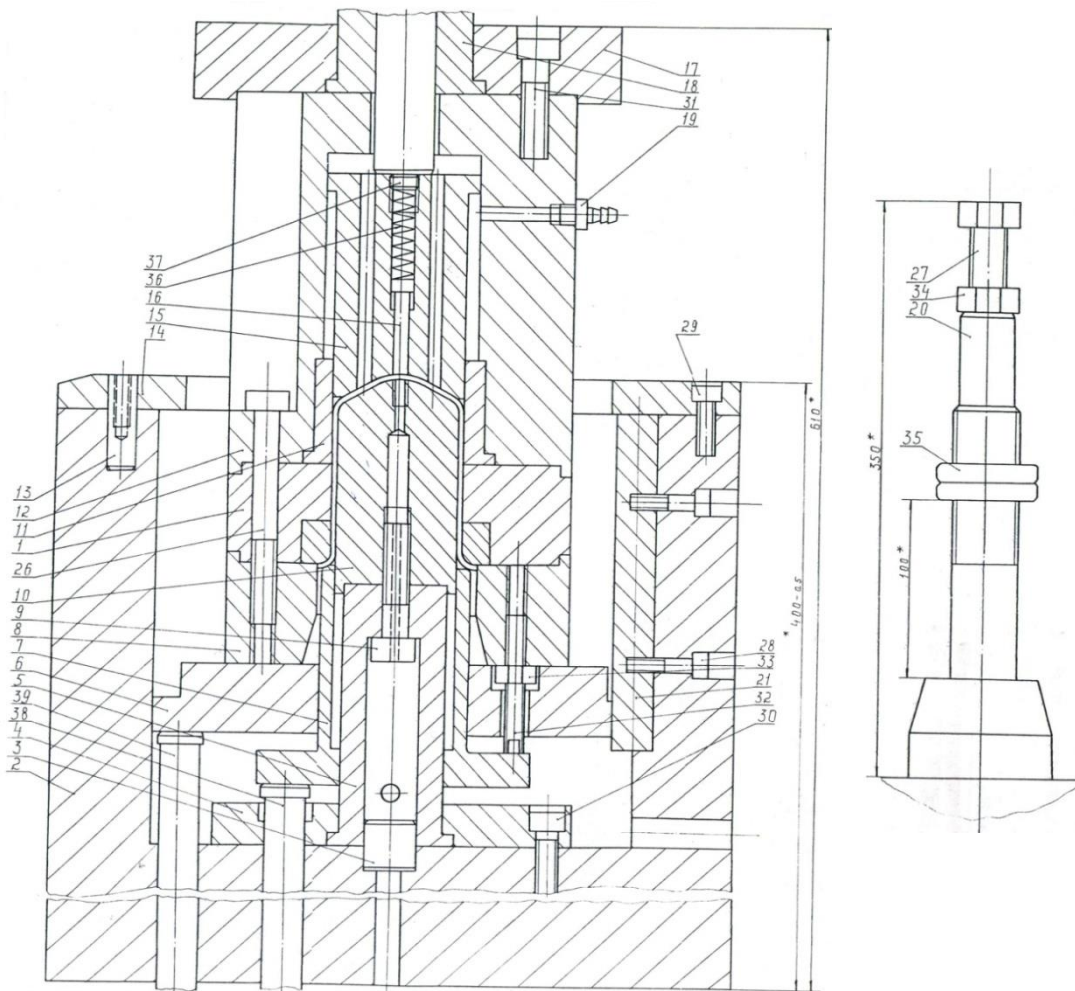
1 – die (1 piece),
 2 – insert (1 piece),
 3 – punch (1 piece),
 4 – block (1 piece),
 5 – blank holder (1 piece),
 6 – lower plate (1 piece),
 7 – holder (1 piece),
 8 – retainer (1 piece),
 9 – bush (1 piece),
 10 – takeout (1 piece),
 11 – puller (1 piece),
 12 – cover (1 piece),
 13 – upper plate (1 piece),
 14 – unstucker (1 piece),
 15 – screw (1 piece),
 16 – clamp (1 piece),

17 – shank (1 piece),
 18 – pusher (1 piece),
 19 – connection (1 piece),
 20 – column (4 pieces),
 26 – bolt M12×80 (4 pieces),
 27 – bolt M20×100 (1 piece),
 29 – screw M10×30 (4 pieces),
 30 – screw M12×35 (4 pieces),
 31 – screw M16×50 (4 pieces),
 36 – nut M20 (1 piece),
 37 – nut M36 (2 pieces),
 38 – spring (1 piece),
 39 – plug M16×1.5 (1 piece),
 40 – pusher Ø24 (4 pieces),
 41 – spring (4 pieces).

Figure 4 – The assembly drawing of the die for performing of the second step of the part drawing.

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|--------------------------------|---|
| 1 – die (1 piece), | 19 – connection (1 piece), |
| 2 – lower plate (1 piece), | 20 – pusher (1 piece), |
| 3 – clamp (1 piece), | 21 – clamp (1 piece), |
| 4 – holder (1 piece), | 26 – bolt M12×115 GOST 7805-70 (4 pieces), |
| 5 – block (1 piece), | 27 – bolt M20×100 GOST 7805-70 (1 piece), |
| 6 – puller (1 piece), | 28 – screw M8×20 GOST 11738-80 (2 pieces), |
| 7 – blank holder (1 piece), | 29, 30, 31 – screws M10×30, M12×35, M16×55 GOST 11738-80 (4 pieces), |
| 8 – throwout collar (1 piece), | 32 – screw M12×70 GOST 8878-84 (3 pieces), |
| 9 – screw (1 piece), | 33, 34 – nuts M12 (3 pieces), M20 (1 piece) GOST 5929-70, |
| 10 – punch (1 piece), | 35 – nut M36 GOST 11871-88 (2 pieces), |
| 11 – bush (1 piece), | 36 – spring 1086-0795 GOST 18793-80 (1 piece, Ø1×12×60), |
| 12 – retainer (1 piece), | 37 – plug 7009-0231 GOST 12202-66 (1 piece, M16×1.5), |
| 13 – pin (2 pieces), | 38, 39 – pusher Ø24 Proprietary Standard 453.423-82 (4 pieces, L = 260 _{-0.5} , L = 360 _{-0.5}). |
| 14 – cover (1 piece), | |
| 15 – takeout (1 piece), | |
| 16 – unstucker (1 piece), | |
| 17 – upper plate (1 piece), | |
| 18 – shank (1 piece), | |

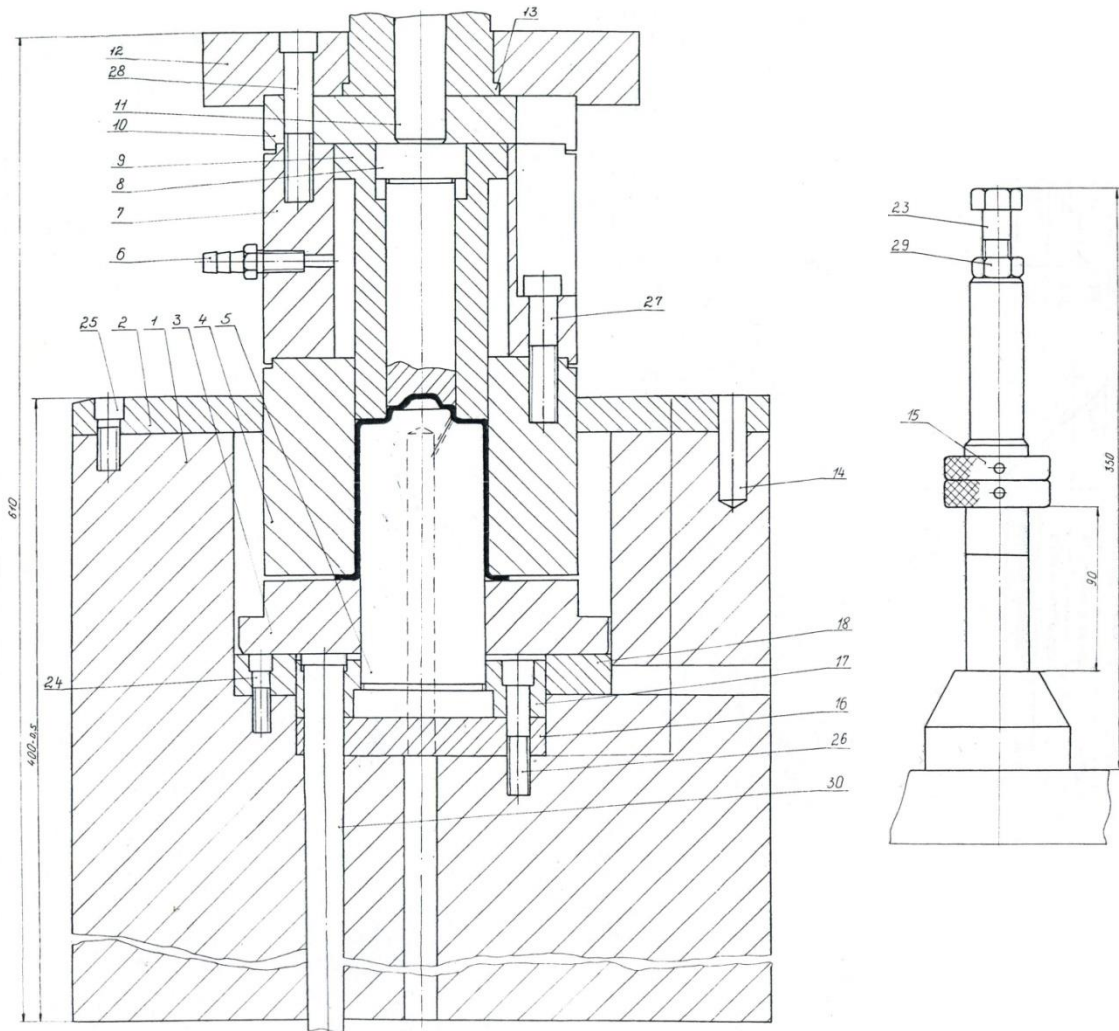
Figure 5 – The assembly drawing of the die for performing of the third step of the part drawing.

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1 – lower plate (1 piece),
 2 – cover (1 piece),
 3 – puller (1 piece),
 4 – die (1 piece),
 5 – punch (1 piece),
 6 – connection (1 piece),
 7 – frame (1 piece),
 8 – takeout (1 piece),
 9 – takeout (1 piece),
 10 – liner (1 piece),
 11 – pusher (1 piece),
 12 – upper plate (1 piece),
 13 – shank (1 piece),
 14 – pin (2 pieces),

15 – nut (2 pieces),
 16 – plate (1 piece),
 17 – holder (1 piece),
 18 – ring (1 piece),
 23 – bolt M20×75 GOST 7805-70 (1 piece),
 24 – screw M10×30 GOST 11738-84 (2 pieces),
 25 – screw M12×30 GOST 11738-84 (4 pieces),
 26 – screw M12×60 GOST 11738-84 (4 pieces),
 27 – screw M16×70 GOST 11738-84 (3 pieces),
 28 – screw M16×80 GOST 11738-84 (3 pieces),
 29 – nut M20 GOST 11871-88 (1 piece),
 30 – pusher 1041-1201 GOST 18780-80 (4 pieces, before processing L = 360).

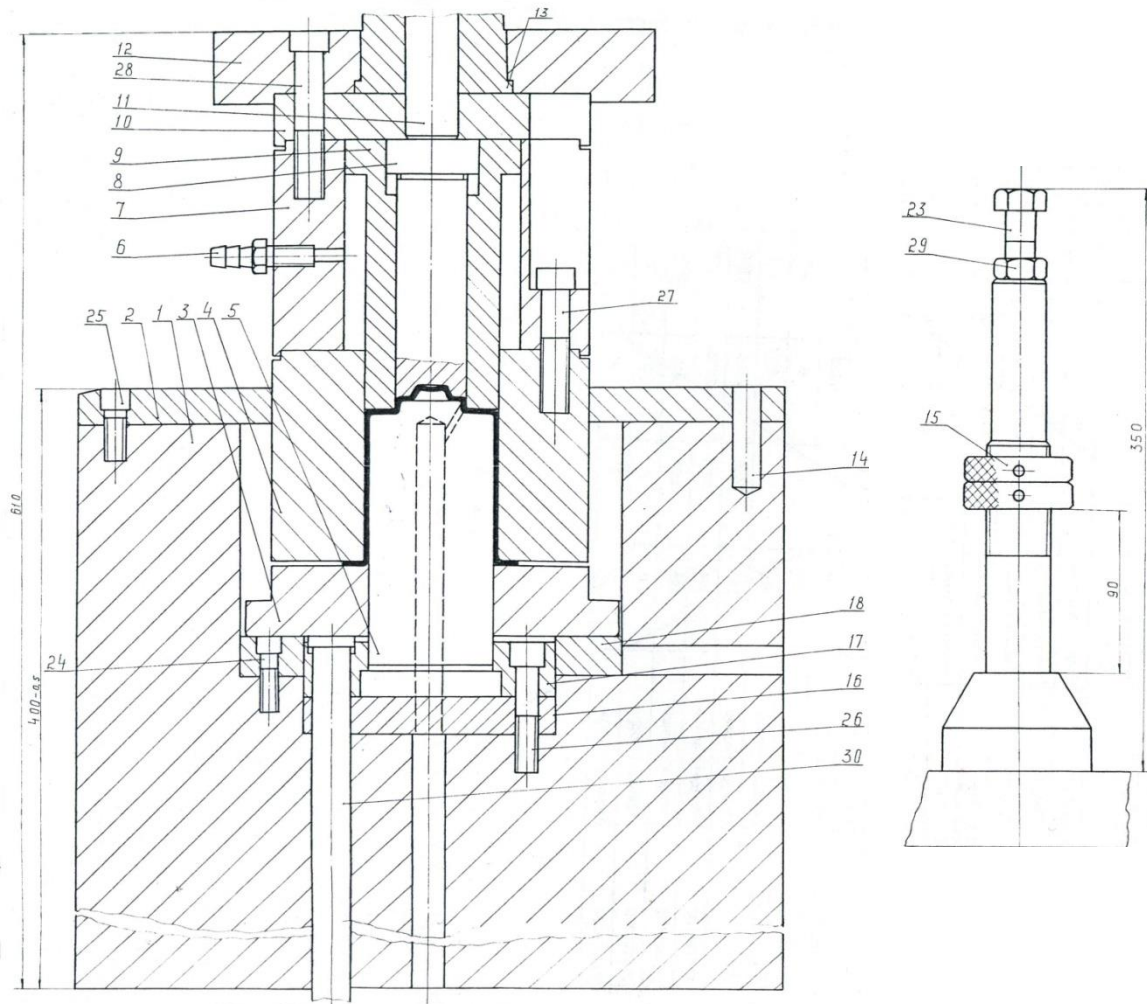
Figure 6 – The assembly drawing of the sizing die for performing of the fourth step of the part drawing.

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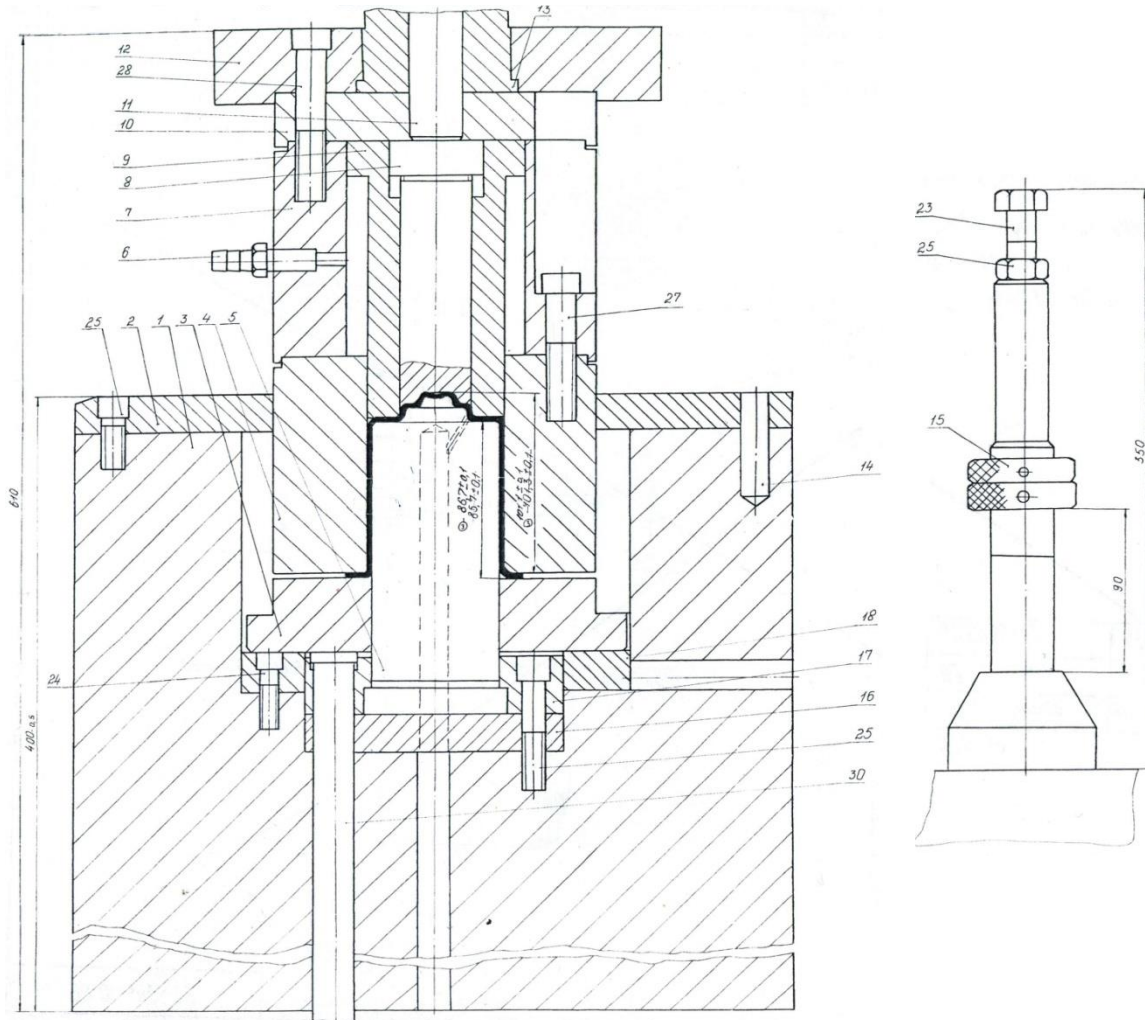


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|-----------------------------|--|
| 1 – lower plate (1 piece), | 15 – nut (2 pieces), |
| 2 – cover (1 piece), | 16 – plate (1 piece), |
| 3 – puller (1 piece), | 17 – holder (1 piece), |
| 4 – die (1 piece), | 18 – ring (1 piece), |
| 5 – punch (1 piece), | 23 – bolt M20×75 GOST 7805-70 (1 piece), |
| 6 – connection (1 piece), | 24 – screw M10×30 GOST 11738-84 (2 pieces), |
| 7 – frame (1 piece), | 25 – screw M12×30 GOST 11738-84 (4 pieces), |
| 8 – takeout (1 piece), | 26 – screw M12×60 GOST 11738-84 (4 pieces), |
| 9 – takeout (1 piece), | 27 – screw M16×70 GOST 11738-84 (3 pieces), |
| 10 – liner (1 piece), | 28 – screw M16×80 GOST 11738-84 (3 pieces), |
| 11 – pusher (1 piece), | 29 – nut M20 GOST 11871-88 (1 piece), |
| 12 – upper plate (1 piece), | 30 – pusher 1041-1201 GOST 18780-80 (4 pieces, |
| 13 – shank (1 piece), | before processing L = 360). |
| 14 – pin (2 pieces), | |

Figure 7 – The assembly drawing of the sizing die for performing of the fifth step of the part drawing.

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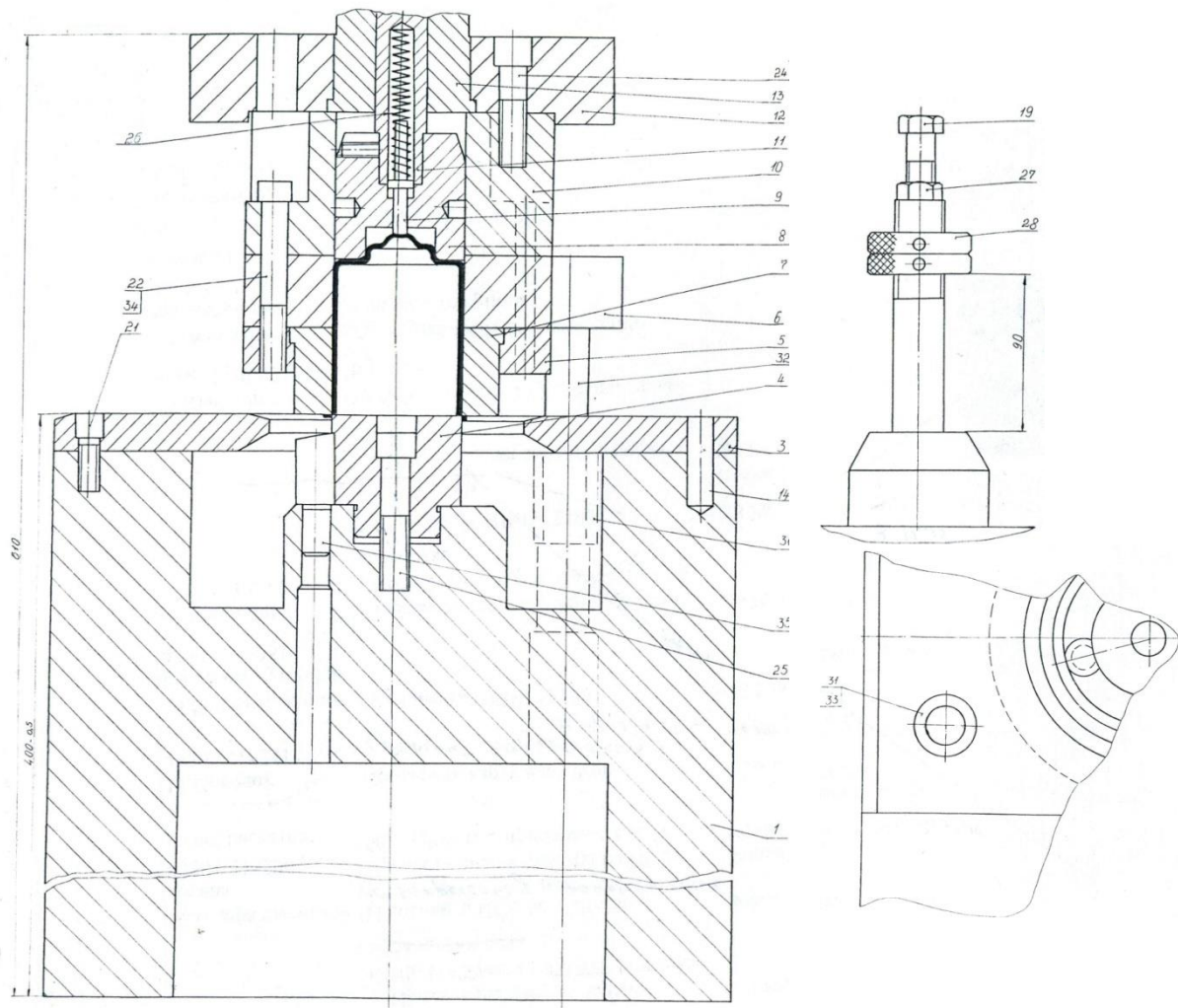


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|-----------------------------|--|
| 1 – lower plate (1 piece), | 15 – nut (2 pieces), |
| 2 – cover (1 piece), | 16 – plate (1 piece), |
| 3 – puller (1 piece), | 17 – holder (1 piece), |
| 4 – die (1 piece), | 18 – ring (1 piece), |
| 5 – punch (1 piece), | 23 – bolt M20×75 GOST 7805-70 (1 piece), |
| 6 – connection (1 piece), | 24 – screw M10 GOST 11738-84 (2 pieces), |
| 7 – frame (1 piece), | 25 – screw M12×30 GOST 11738-84 (4 pieces), |
| 8 – takeout (1 piece), | 26 – screw M12×60 GOST 11738-84 (4 pieces), |
| 9 – takeout (1 piece), | 27 – screw M16×70 GOST 11738-84 (3 pieces), |
| 10 – liner (1 piece), | 28 – screw M16×80 GOST 11738-84 (3 pieces), |
| 11 – pusher (1 piece), | 29 – nut M20 GOST 11871-88 (1 piece), |
| 12 – upper plate (1 piece), | 30 – pusher 1041-1201 GOST 18780-80 (4 pieces, |
| 13 – shank (1 piece), | before processing L = 360). |
| 14 – pin (2 pieces), | |

Figure 8 – The assembly drawing of the sizing die for performing of the sixth step of the part drawing.

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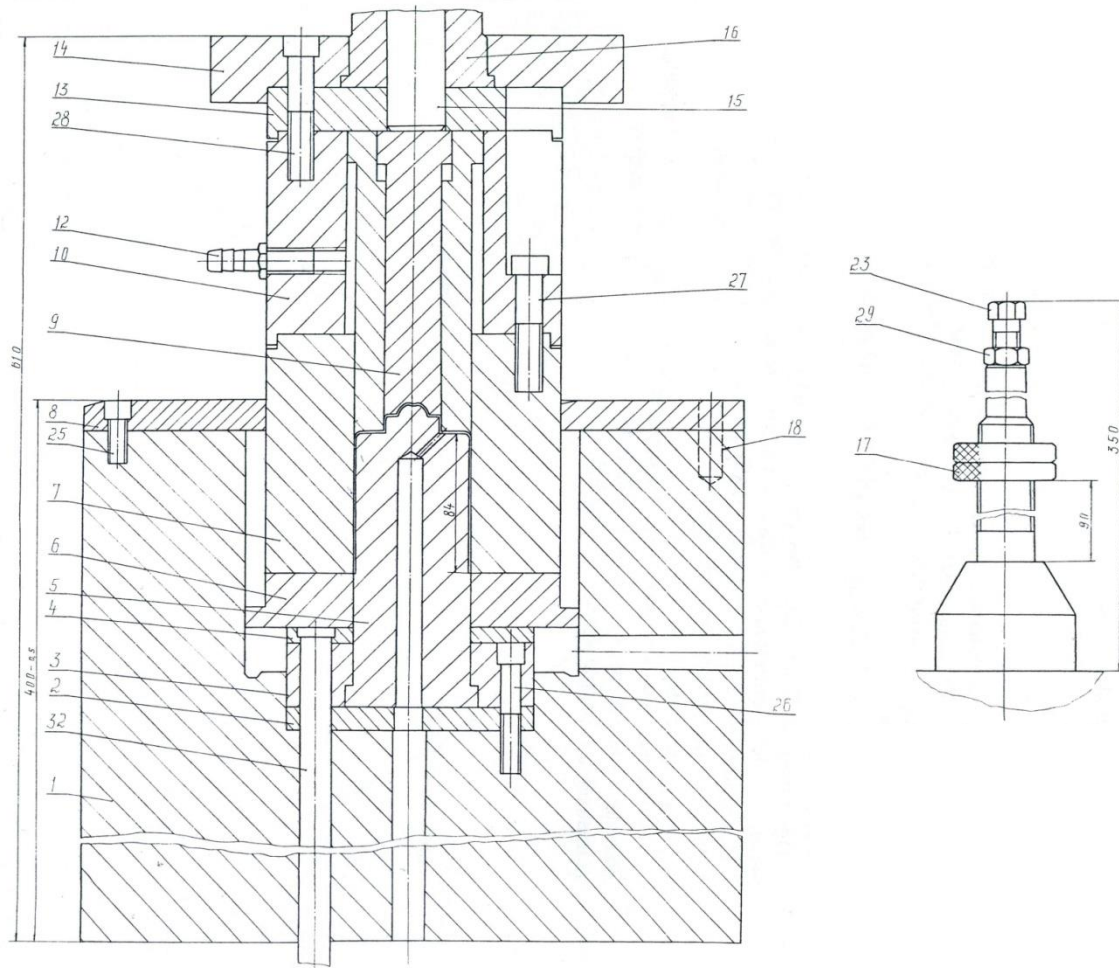


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|---|--|
| 1 – lower plate (1 piece), | 23 – screw M12×85 GOST 11738-84 (3 pieces), |
| 3 – cover (1 piece), | 24 – screw M16×55 GOST 11738-84 (3 pieces), |
| 4 – punch (1 piece), | 25 – screw M16×65 GOST 11738-84 (1 piece), |
| 5 – holder (1 piece), | 26 – spring 1086-0795 Proprietary Standard 453-070-82 (1 piece, Ø2×12×80), |
| 6 – plate (1 piece), | 27 – nut M16×1.5-6H GOST 11871-88 (1 piece), |
| 7 – die (1 piece), | 28 – nut M36×1.5-6H GOST 11871-88 (2 pieces), |
| 8 – takeout (1 piece), | 30 – bush 1032-4166 Proprietary Standard 453-241-80 (1 piece, 25L45), |
| 9 – unstucker (1 piece), | 31 – bush 1032-4175 Proprietary Standard 453-241-80 (1 piece, 28L45), |
| 10 – case (1 piece), | 32 – column 1030-4092 Proprietary Standard 453-240-80 (1 piece, 25L150), |
| 11 – pusher (1 piece), | 33 – column 1030-4117 Proprietary Standard 453-240-80 (1 piece, 28L150), |
| 12 – plate (1 piece), | 34 – pin 12m6×80 GOST 3128-70 (2 pieces), |
| 13 – shank (1 piece), | 35 – knife 1140-0153 GOST 18734-80 (2 pieces). |
| 14 – pin (2 pieces), | |
| 15 – chute (2 pieces), | |
| 19 – bolt M20×70 GOST 805-70 (1 piece), | |
| 21 – screw M12×30 GOST 11738-84 (4 pieces), | |
| 22 – screw M10×30 GOST 11738-84 (4 pieces), | |

Figure 9 – The assembly drawing of the trimming die for performing of the seventh step of the part drawing.

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|-----------------------------|--|
| 1 – lower plate (1 piece), | 17 – nut (2 pieces), |
| 2 – plate (1 piece), | 18 – pin (2 pieces), |
| 3 – holder (1 piece), | 23 – bolt M20×75 GOST 7805-70 (1 piece), |
| 4 – ring (1 piece), | 24 – screw M10×25 GOST 11738-84 (2 pieces), |
| 5 – punch (1 piece), | 25 – screw M12×30 GOST 11738-84 (4 pieces), |
| 6 – puller (1 piece), | 26 – screw M12×60 GOST 11738-84 (4 pieces), |
| 7 – die (1 piece), | 27 – screw M16×70 GOST 11738-84 (3 pieces), |
| 8 – cover (1 piece), | 28 – screw M16×80 GOST 11738-84 (3 pieces), |
| 9 – unstucker (1 piece), | 29 – nut M20 GOST 11871-88 (1 piece), |
| 10 – frame (1 piece), | 30 – spring 1086-0795 GOST 19794-80 (1 piece, Ø1.6×12×110), |
| 11 – takeout (1 piece), | 31 – plug 7009-0231 GOST 12202-66 (1 piece, M16), |
| 12 – connection (1 piece), | 32 – pusher 1041-1201 GOST 18780-80 (4 pieces, before processing L = 360). |
| 13 – liner (1 piece), | |
| 14 – upper plate (1 piece), | |
| 15 – pusher (1 piece), | |
| 16 – shank (1 piece), | |

Figure 10 – The assembly drawing of the sizing die for performing of the eighth step of the part drawing.

The assembly drawing of the die for performing of the second step of drawing of the part "Case" is presented in the Fig. 4. The assembly drawing of the die for performing of the third step of drawing of the part "Case" is presented in the Fig. 5. The assembly drawing of the sizing die for performing of the fourth

step of drawing of the part "Case" is presented in the Fig. 6. The assembly drawing of the sizing die for performing of the fifth step of drawing of the part "Case" is presented in the Fig. 7. The assembly drawing of the sizing die for performing of the sixth step of drawing of the part "Case" is presented in the

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JIF = 1.500	SJIF (Morocco) = 5.667	OAJI (USA) = 0.350

Fig. 8. The assembly drawing of the trimming die for performing of the seventh step of drawing of the part "Case" is presented in the Fig. 9. The assembly drawing of the sizing die for performing of the eighth step of drawing of the part "Case" is presented in the Fig. 10.

The some steps of the technological process of drawing of the part "Case" are imprinted in the photos

(the Fig. 11). Sampling rate for the sizes control is carried out through 5 parts. The operations of the flange trimming on a turret lathe, cutting down of transverse holes and final calibration of a bottom of the thin-walled part were not considered in the technological process.

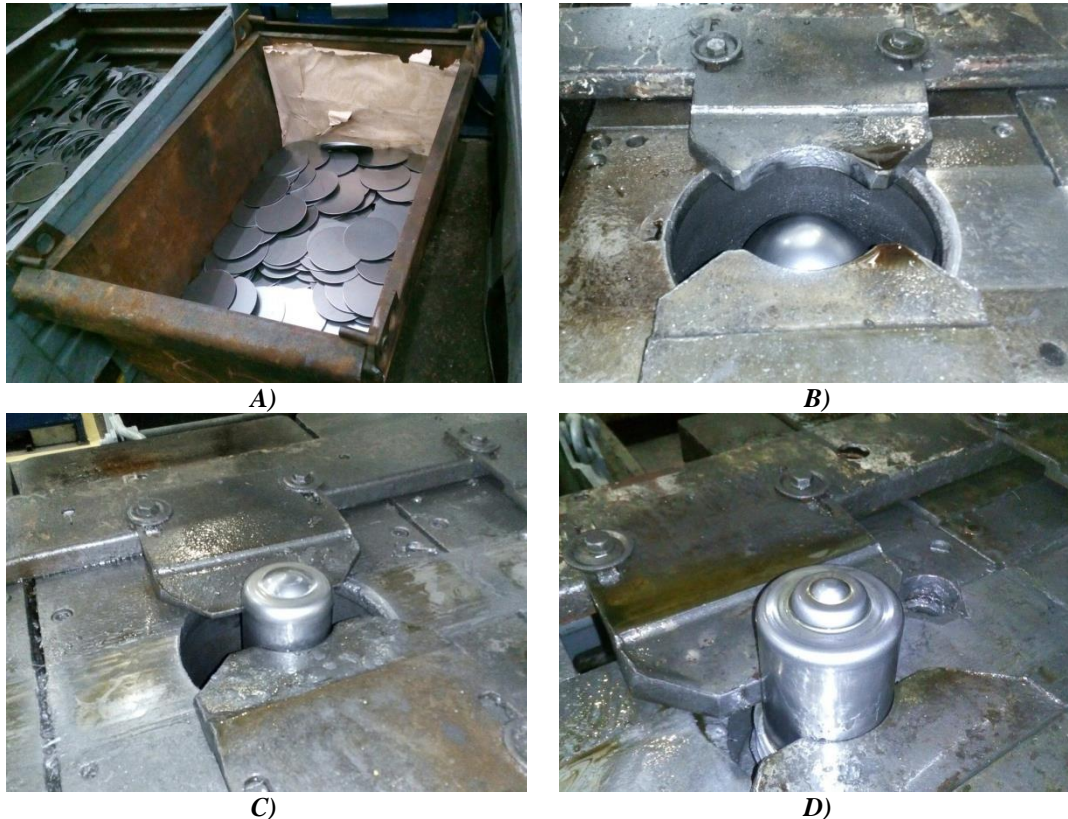


Figure 11 – The technological process of the part drawing: A – the container with the sheet billets, B – the sheet billet after plastic deformation on the first step of the operation 015, C – the sheet billet after plastic deformation on the fourth step of the operation 015, D – the sheet billet after plastic deformation on the seventh step of the operation 015.

Visual inspection of two hundred processed parts was carried out. Defects on one part were detected after multi-step drawing. Visual inspection of the parts revealed the following defects in descending order:

1. Deep dents on the outer surface.
2. Significant reduction of the size of wall thickness.
3. Wrinkles on the outer and inner surfaces.
4. Protruding burrs on the outer surface.

So as the considered part is not responsible then the detected defects do not significantly affect on its operation in an assembly unit.

Conclusions

On the basis of the considered technological process of manufacturing of the part "Case", and in

particular the operation of multi-step deep drawing of the sheet billet, the following conclusions can be drawn:

1. In constructions of the proposed dies, supply of lubricating fluid to the surfaces of the sheet billet is provided for the calibration steps of the drawing process. This contributes to easier removing of the deformed sheet billet from the punch. On the remaining steps of drawing, removing of the sheet billet from the die is provided by the unstucker.

2. The defects of the part material after forming is approximately 1% (from a whole batch). Thus, the proposed technology of manufacturing of the part "Case" is acceptable in conditions of serial production.

Impact Factor:

ISRA (India) = 3.117	SIS (USA) = 0.912	ICV (Poland) = 6.630
ISI (Dubai, UAE) = 0.829	PIHHI (Russia) = 0.156	PIF (India) = 1.940
GIF (Australia) = 0.564	ESJI (KZ) = 8.716	IBI (India) = 4.260
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