



Bearing Box Process Specification and Tooling Design

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Abstract: Reasonable process regulations and fixtures can ensure the high efficiency of parts processing and the economy of the enterprise. I started with data collection, then part analysis, then process design, then process specification design, and finally fixture design. In the process design, I obtained the best process route based on the experience of the production site to achieve the effect of saving time and increasing labor productivity. The design of the process specification was based on the production program, the production type was determined, and the process specification was compiled. Production, so the process card of parts and the card of machining process of parts were compiled. The fixture design is to design two sets of tools for the bearing box car mold and the bearing box drilling mold. The bearing box car mold is based on the processed large surface and the two right angle surfaces are used as positioning surfaces. The workpiece is fastened with bolts and nuts. The other large surface is up to size 70, $\phi 180H7$ holes; the bearing box drilling mold is based on the processed large surface, and is positioned at $\phi 180H7$ holes. The workpiece is fastened with bolts and nuts, and 6- $\phi 13$ holes are drilled to improve the part. Processing efficiency to ensure the quality of parts processing. In summary, the above-mentioned special fixture design scheme is adopted to ensure the production requirements of parts in batches and improve labor efficiency.

Keywords: Bearing Housing, Process Specification, Car Model, Drilling Die, Dimensional Accuracy, Positional Accuracy, Work Efficiency

1. Part Analysis

The bearing housing is the main part of the end jumper. The parts are made of HT200 gray cast iron for annealing treatment to ensure the mechanical strength and vibration damping of the parts. The structure of the parts is relatively complicated, so the cast blank is used.

1.1. Benchmark Selection

For parts, choose a non-machined surface as a rough reference. For workpieces with several unmachined surfaces, the unmachined surface with higher relative positional accuracy with the machining requirements should be used as the reference rough reference. The selection of the fine benchmark should mainly consider the problem of benchmark overlap. When the design basis and the process benchmark do not coincide, the size conversion should be performed [1]. When the part is machined, the machined large surface is used as the reference, and the two right angle surfaces are used as the positioning surface: the large surface limits 3 degrees of

freedom, and the two right angle surfaces limit 3 degrees of freedom. When drilling the part, the part is positioned with $\phi 180H7$ hole as the reference, and the two right-angled faces are used as the positioning surface: the large surface limits 3 degrees of freedom, the $\phi 180H7$ hole limits 2 degrees of freedom, and the right-angled surface limits 1 Degree of freedom.

1.2. Determine the Type of Production

The production program of the known parts is 120 pieces/year. Check the "Machinery Manufacturing Process and Equipment Design Manual" to determine that these parts are in the middle batch production.

1.3. Process Design Basis

Since the workpiece has an annual output of 120 pieces, it is a medium-volume production. Due to the complicated structure of the part, high dimensional accuracy and geometrical tolerance requirements, it is difficult to guarantee the dimensional accuracy and positional accuracy by ordinary

processing methods, which is time consuming and laborious, the processing efficiency is low, the processing quality is difficult to guarantee, and the scrap rate is high (parts are shown in the figure 1). Therefore, it is necessary to design the

process specification for the part, compile the part process card, draw the part blank drawing, compile the part machining process card, and design the part processing die and the drilling die [2] to improve the work efficiency.

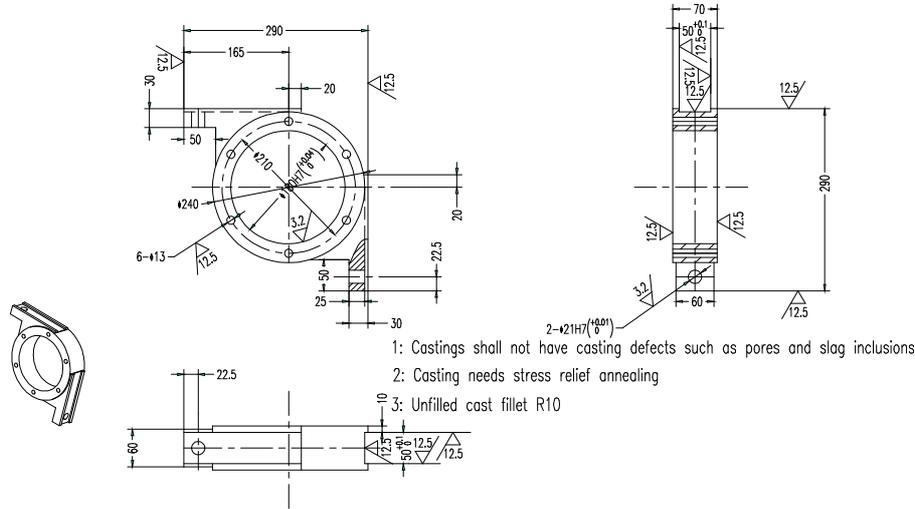


Figure 1. Bearing housing.

Process card											page 1	Total 1 Page				
product name		End jumper		Part Name		Bearing housing		Pieces per unit	6		Blank type	casting		Parts per blank	1	
Product number		Part drawing number		Material grade		HT200		Blank size		Part weight						
empl oyee ID	Workshop name	Type of work	Process name						device ID	Process equipment and number	Working hours		Remark			
			Basic	ready												
1	Production Office	outer	Outsourcing of casting slab, need annealing													
2	Metalworking workshop	clamp	Mark each processing surface and each hole processing line													
3	Metalworking workshop	Milling	Align with the line and mill a large surface with a roughness of 12.5 to size 75 (see process card 1)						X53							
4	Metalworking workshop	Milling	Based on the processed large surface, milling the surface and grooves with a roughness of 12.5 (see process card 2)						X53							
5	Metalworking workshop	clamp	Slot drill hinge 2-φ21H7 (see process card 3)						Z3050							
6	Metalworking workshop	Turning	Take the processed large surface as the reference, use two right-angled surfaces as the positioning surfaces, and fasten the workpiece with bolts and nuts. The other large side of the car reaches size 70, and the car φ180H7 hole (see process card 4)						C620	Turning tooling						
7	Metalworking workshop	clamp	Based on the processed large surface, position it with φ180H7 hole, fasten the workpiece with bolts and nuts, drill φ13 holes (see process card 5)						Z3050	Drilling die						
			Check transfer													
Basemap number																
modi fy	Edit tag	File Number	Sign	Date	Draw up	Proofreading	Working hours	Signed	Audit	Approve						

Figure 2. Parts Process Card.

2. Process Design

2.1. Part Process Card Design (See Figure 2)

Process 1: slab blank, need to be annealed

Step 2: Draw each processing surface and hole processing line

Step 3: Align the line and mill a large surface with a

roughness of 12.5 up to size 75 (see process card 1) (X53 vertical milling machine)

Step 4: Milling the plane and groove map of each roughness 12.5 based on the processed large surface (see process card 2) (X53 vertical milling machine)

Step 5: Drill the hinge 2-φ21H7 hole (see process card 3) (Z3050 radial drilling machine)

Step 6: Based on the processed large surface, the two

right-angled surfaces are used as the positioning surface, and the workpiece is fastened with bolts and nuts. The other large surface of the car reaches the size of 70, and the car is $\phi 180H7$ (see the process card 4) (C620 lying Lathe)

Step 7: Position the $\phi 180H7$ hole on the basis of the processed large surface, and fasten the workpiece with bolts and nuts, and drill 6- $\phi 13$ holes (see process card 5) (Z3050 radial drilling machine)

2.2. Part Blank Design (See Figure 3)

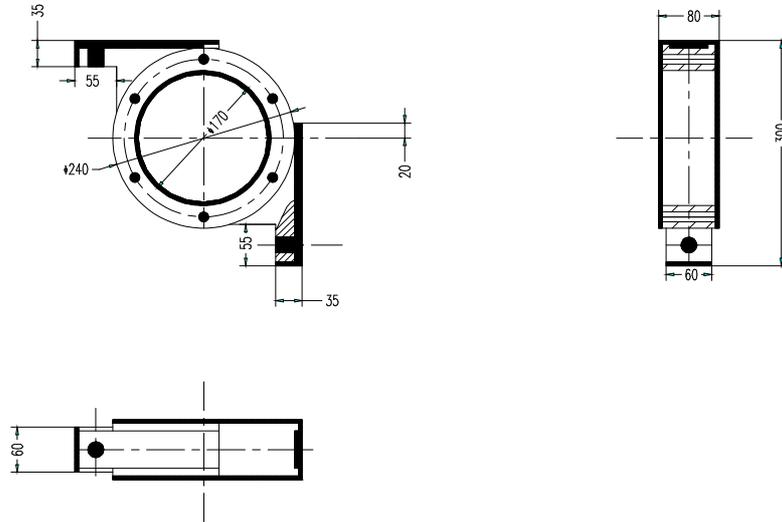


Figure 3. Part blank drawing.

2.3. Part Process Card Design

2.3.1. Process Card 1 (See Figure 4)

Mechanical processing card		Product number	part drawing number		Total 5 pages						
		product name	End jumper	part name	Bearing housing	page 1					
		workshop	employee ID	Process name	Material grade						
		metalworking	3	Milling	HT200						
		Blank type	Blank size	Pieces per blank	Pieces per unit						
		casting		1	6						
		Device name	Equipment model	device ID	Number of simultaneous machining						
		Vertical milling machine	X53								
		Fixture number	Fixture name	Coolant							
				Working hours							
				Quasi-final	Single						
Step number	Step content	Craft equipment			Spindle speed (rev / min)	Cutting speed (m / min)	Feed amount (mm / min)	Knife depth (mm)	Number of passes	Working hours quota	
Tracing	1	Straighten by line, mill a large surface with a roughness of 12.5 to size 75								Maneuver	auxiliary
Proofreading											
Base map number											
Binding number											
		Establishment (date)		Review (date)	Working hours (date)	Countersigned (date)	Approved (date)				
mark	Number of pieces	Change the file number	signature	date	mark	Number of pieces	Change the file number	signature	date		

Figure 4. Parts Process Card 1.

2.3.2. Process Card 2 (See Figure 5)

Mechanical processing card										Product number	part drawing number			Total 6 pages		
										product name	End jumper		part name	Bearing housing	page 2	
										workshop	employee ID	Process name	Material grade			
										metalworking	4	Milling	HT200			
										Blank type	Blank size		Pieces per blank	Pieces per unit		
										casting			1	6		
										Device name	Equipment model	device ID	Number of simultaneous machining			
										Vertical milling machine	XS3					
										Fixture number	Fixture name		Coolant			
														Working hours		
														Quasi-Single		
Step number	Step content					Craft equipment					Spindle speed (rev / min)	Cutting speed (m / min)	Feed amount (mm / min)	Knife depth (mm)	Number of passes	Working hours quota
Tracing	1 Based on the processed large surface, milling the surface and grooves with a roughness of 12.5															
Proofreading																
Basemap number																
Binding number																
										Establishment (date)		Review (date)	Working hours (date)	Countersigned (date)	Approved (date)	
Mark	Number of pieces	Change the file number	signature	date	Mark	Number of pieces	Change the file number	signature	date							

Figure 5. Parts Process Card 2.

2.3.3. Process Card 3 (See Figure 6)

Mechanical processing card										Product number	part drawing number			Total 6 pages		
										product name	End jumper		part name	Bearing housing	page 3	
										workshop	employee ID	Process name	Material grade			
										metalworking	5	clamp	HT200			
										Blank type	Blank size		Pieces per blank	Pieces per unit		
										casting			1	6		
										Device name	Equipment model	device ID	Number of simultaneous machining			
										Rocker drilling	Z3050					
										Fixture number	Fixture name		Coolant			
														Working hours		
														Quasi-Single		
Step number	Step content					Craft equipment					Spindle speed (rev / min)	Cutting speed (m / min)	Feed amount (mm / min)	Knife depth (mm)	Number of passes	Working hours quota
Tracing	1 Drilling hole 2-φ21H7															
Proofreading																
Basemap number																
Binding number																
										Establishment (date)		Review (date)	Working hours (date)	Countersigned (date)	Approved (date)	
Mark	Number of pieces	Change the file number	signature	date	Mark	Number of pieces	Change the file number	signature	date							

Figure 6. Parts Process Card 3.

2.3.4. Process Card 4 (See Figure 7)

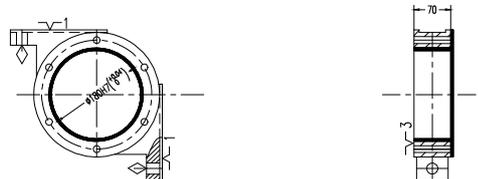
Mechanical processing card										Product number	part drawing number			Total 6 pages					
										product name	End jumper	part name	Bearing housing	page 4					
										workshop	employee ID	Process name	Material grade						
										metalworking	6	Turning	HT200						
										Blank type	Blank size		Pieces per blank	Pieces per unit					
										casting			1	6					
										Device name	Equipment model	device ID	Number of simultaneous machining						
										Horizontal lathe	C620								
Fixture number			Fixture name	Coolant															
			Turning tooling																
				Working hours															
				Quasi-final	Single														
Step number	Step content				Craft equipment		Spindle speed (rev / min)	Cutting speed (m / min)	Feed amount (mm / min)	Knife depth (mm)	Number of passes	Working hours quota							
Tracing	1 Based on the processed large surface, with two right-angled surfaces as positioning surfaces. The nut tightens the workpiece, and the other large side of the car reaches the size 70, and the				Turning tooling														
Proofreading	180H7.																		
Basemap number																			
Binding number																			
										Establishment (date)	Review (date)	Working hours (date)	Countersigned (date)	Approved (date)					
										Mark	Number of pieces	Change the file number	signature	date	Mark	Number of pieces	Change the file number	signature	date

Figure 7. Parts Process Card 4.

2.3.5. Process Card 5 (See Figure 8)

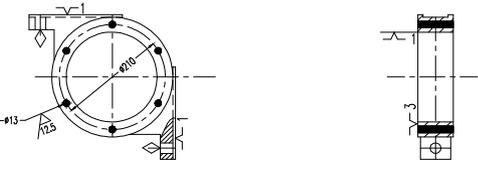
Mechanical processing card										Product number	part drawing number			Total 6 pages					
										product name	End jumper	part name	Bearing housing	page 5					
										workshop	employee ID	Process name	Material grade						
										metalworking	7	clamp	HT200						
										Blank type	Blank size		Pieces per blank	Pieces per unit					
										casting			1	6					
										Device name	Equipment model	device ID	Number of simultaneous machining						
										Rocker drilling	Z3050								
Fixture number			Fixture name	Coolant															
			Drilling die																
				Working hours															
				Quasi-final	Single														
Step number	Step content				Craft equipment		Spindle speed (rev / min)	Cutting speed (m / min)	Feed amount (mm / min)	Knife depth (mm)	Number of passes	Working hours quota							
Tracing	1 Positioned with $\phi 180H7$ holes based on the processed large surface, using bolts and nuts workpiece, drill 6- $\phi 13$ holes				Drilling die														
Proofreading																			
Basemap number																			
Binding number																			
										Establishment (date)	Review (date)	Working hours (date)	Countersigned (date)	Approved (date)					
										Mark	Number of pieces	Change the file number	signature	date	Mark	Number of pieces	Change the file number	signature	date

Figure 8. Parts Process Card 5.

3. Fixture Design

3.1. Bearing Housing Model

The bearing housing has a complicated structure and an irregular shape. It is impossible to realize the machining of the hole and its end face without special tooling. For this reason, in the design of the tooling, the large surface of the workpiece has been used as the positioning reference, and the two right-angled surfaces of the workpiece are used as the positioning surface. The workpiece is fastened with bolts and nuts, and the auxiliary support is used to clamp the workpiece with the ejector pin. The large face is 70 in size and the car is $\phi 180H7$ [3].

3.1.1. Bearing Box Body Tooling Structure

The bearing box body tooling structure is shown in Figure 9. The bearing box body tooling is mainly composed of bottom plate, support plate, auxiliary support, ejector pin, support, bolt M20×90, nut M20, screw M20×100, bolt M10×60., nut M8, handle M8 and so on.

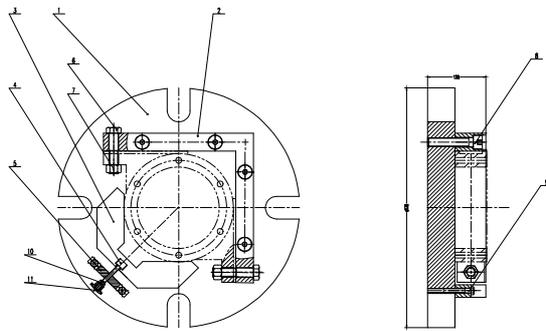


Figure 9. Bearing housing model.

- 1: Base plate 2: Support plate 3: Auxiliary support 4: Plunger 5: Support 6: Bolt M20×90
- 7: Nut M20 8: Screw M20×100 9: Bolt M10×60 10: Nut M8 11: Handle M8

3.1.2. Working Principle of Bearing Box Body Tooling

Place the bearing housing model on the four-jaw chuck of the C630 horizontal lathe, so that the end surface of the bottom plate fits on the end surface of the claw, adjust the claw to initially clamp the bottom plate of the tooling, and then use the table to find the end surface and outer circle of the bottom plate of the tooling, and then Clamp the bottom plate with four claws. The large surface of the workpiece has been machined on the bottom plate of the tooling, and the two right-angled faces of the workpiece are used as the positioning surface. The workpiece is fastened with bolts and nuts, and the auxiliary support is used to clamp the workpiece with the ejector pin. 70, car $\phi 180H7$ hole [4].

By using the self-designed bearing housing model, the other large surface of the bearing housing and the $\phi 180H7$ hole can meet the dimensional accuracy requirements of the drawings, ensure the consistency of mass production, solve the problem of low processing efficiency, and improve Work efficiency and various performance indicators [5].

3.1.3. Main Parts Design of Bearing Box Body Tooling

i. Backplane

The design of the bottom plate is shown in Figure 10. The part is connected with the workpiece, the support plate, the auxiliary support, the support, the screw and the bolt, and is the basic part of the tooling. The bottom plate material selects 45# medium carbon quenched and tempered structural steel, which has high strength and good machinability after quenching and tempering treatment, and has certain toughness, plasticity And wear resistance [6].

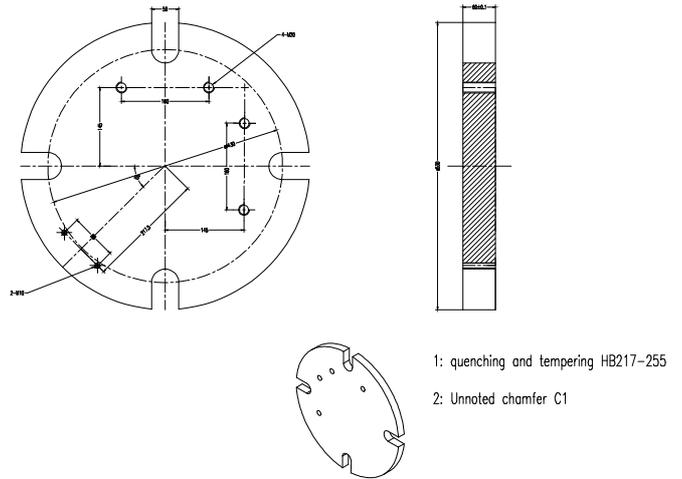


Figure 10. Bottom plate.

ii. Support Plate

The design of the support plate is shown in Figure 11. The part is connected to the workpiece, the bottom plate, the bolt, the nut and the screw for positioning and clamping of the workpiece. The material of the support plate is 45# medium carbon quenched and tempered structural steel. After quenching and tempering treatment, it has high strength and good machinability, and has certain toughness, plasticity and wear resistance [7].

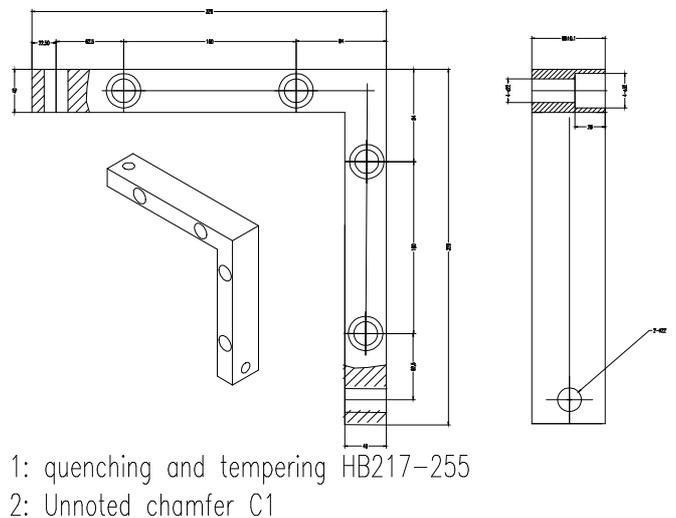
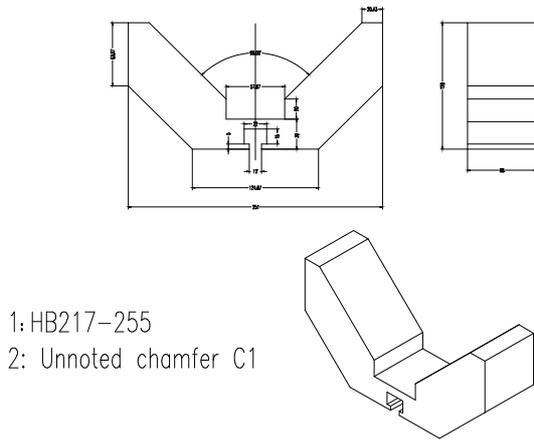


Figure 11. Support plate.

iii. Auxiliary Support

The design of the auxiliary support is shown in Figure 12. The part is used for auxiliary positioning of the workpiece and is connected to the ram, the bottom plate and the workpiece. The auxiliary support material selects 45# medium carbon quenched and tempered structural steel, which has high strength and good machinability after quenching and tempering treatment, and has certain toughness, plasticity and wear resistance.

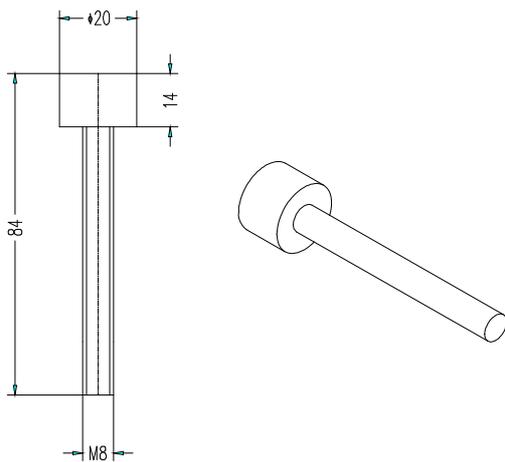


- 1: HB217-255
- 2: Unnoted chamfer C1

Figure 12. Auxiliary support.

iv. Ejector

The design of the ram is shown in Figure 13, which is connected to the support, the auxiliary support, the handle, and the nut. The top rod material selects 45# medium carbon quenched and tempered structural steel, which has high strength and good machinability after quenching and tempering treatment, and has certain toughness, plasticity and wear resistance.



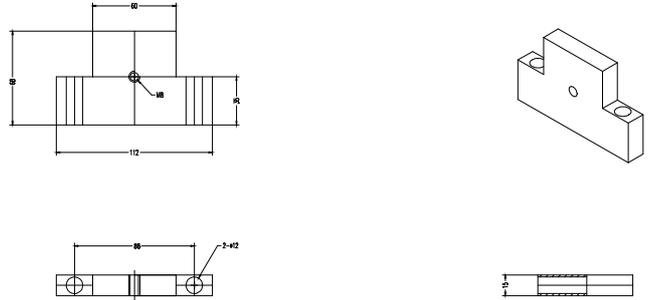
- 1: HB217-255
- 2: Unnoted chamfer C1

Figure 13. Ejector.

v. Support

The design of the support is shown in Figure 14. The part is connected to the bottom plate, the ejector pin and the bolt, and is mainly used for auxiliary positioning of the

workpiece. The bearing material selects 45# medium carbon quenched and tempered structural steel, which has high strength and good machinability after quenching and tempering treatment, and has certain toughness, plasticity and wear resistance



- 1: HB217-255
- 2: Unnoted chamfer C1

Figure 14. Support.

3.2. Bearing Housing Drilling Mold

There are 6-φ13 holes on the large surface of the bearing housing. If the scribing is used, the machining efficiency is very low, and the machining accuracy is difficult to guarantee. Therefore, it is considered to design a large surface, a hole and a right angle as the positioning reference. The die-casting machine has 6-φ13 holes on the large surface of the bearing housing.

3.2.1. Bearing Box Body Drilling Tooling Structure

The bearing box body drilling tooling [8] structure is shown in Figure 15: The bearing box body drilling tooling mainly consists of the bottom plate, the support, the drill template, the hinge pin, the pressure plate, the contour pin 1, the drill sleeve φ13×20×40, the stud M20 ×125, nut M20, screw M20×100, cotter pin φ10×45, stud M20×150, contour pin 2, etc.

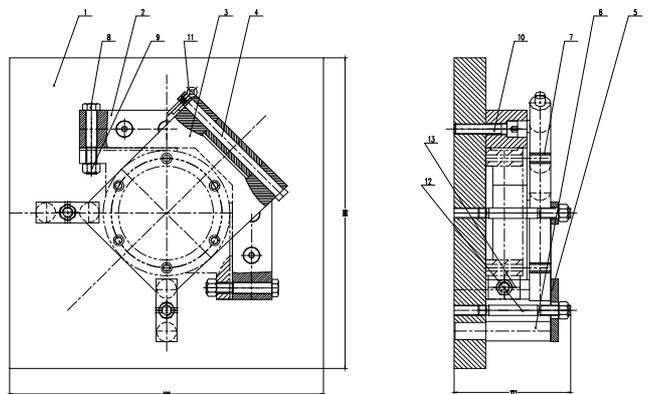


Figure 15. Bearing housing mold.

- 1: Base plate 2: Support 3: Drill template 4: Hinge pin 5: Press plate 6: Contour pin 1 7: drill sleeve φ13×20×40 8: stud M20×125 9: nut M20 10: screw M20×100 11: Cotter pin φ10×45 12: Stud M20×150 13: Contour pin 2

3.2.2. Working Principle of Bearing Box Drilling Tooling

Place the bearing box drill on the Z3050 radial drilling machine [9] table, press the bottom plate with the pressure plate, clamp the large-faced template of the workpiece, and drill 6- $\phi 13$ holes through the drill sleeve [10].

By using the self-designed bearing housing body to mold the bearing housing 6- $\phi 13$ hole, to meet the dimensional accuracy requirements of the drawings, to ensure the consistency of mass production, solve the problem of low processing efficiency, improve the ergonomics And various performance indicators.

3.2.3. Main Parts Design of Bearing box Drilling Tooling

i. Backplane

The design of the bottom plate is shown in Figure 16. The part is connected with the workpiece, the support, the contour pin 1, the contour pin 2, the screw and the stud, and is the basic component of the tooling. Since the contour pin $\phi 33k6$ is a positive tolerance, the cooperation of the bottom plate and the contour pin is an interference fit. Since the surface roughness of the 4- $\phi 33H7$ holes is 3.2, the process arrangement requires reaming [11]. The material of the bottom plate is selected from 45# medium carbon quenched and tempered structural steel [12], which has high strength and good machinability after quenching and tempering treatment, and has certain toughness, plasticity and wear resistance.

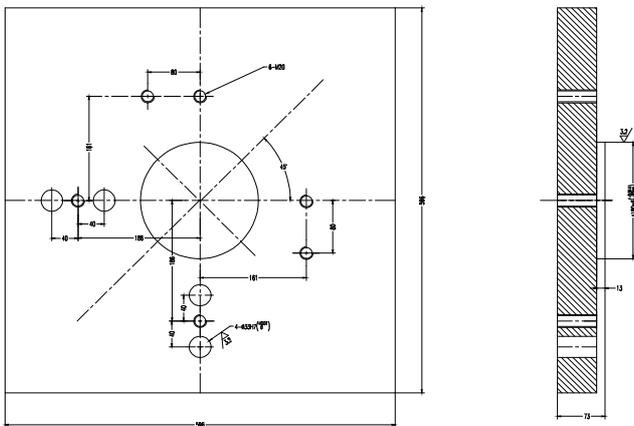


Figure 16. Bottom plate.

ii. Support

The design of the support is shown in Figure 17. The parts are connected to the workpiece, the bottom plate, the drill template, the hinge pin, the bolt, the nut, the screw [13], and the like. There are $\phi 20H7$ holes in the design of the support. Since the outer precision of the hinge pin is negative tolerance, the cooperation between the support and the hinge pin is a clearance fit. The surface roughness of the $\phi 20H7$ hole is 3.2, and the process needs to arrange fine boring. The HT200 gray cast iron parts are selected for annealing treatment, and the blanks are required to have no casting defects such as porosity and shrinkage to ensure the bearing has certain mechanical strength and vibration damping.

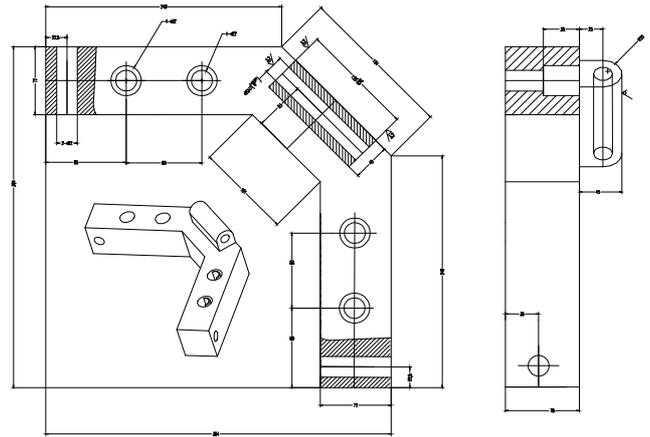


Figure 17. Support.

iii. Drill Template

The design of the drill template [14] is shown in Figure 18, which is connected to the support, the hinge pin, the pressure plate, and the drill sleeve. Since the hinge pin $\phi 20g6$ is a negative tolerance, the fit of the drill template and the hinge pin is a clearance fit to facilitate the rotation of the drill template; since the 6- $\phi 20H7$ hole is connected to the drill sleeve, and the outer tolerance of the drill sleeve is a positive tolerance, the drill template is drilled. The fit with the drill sleeve is an interference fit. Since the surface roughness of the $\phi 20H7$ and 6- $\phi 20H7$ holes is 3.2, the process arrangement requires reaming or fine boring. The drilling template material selects 45# medium carbon quenched and tempered structural steel, which has high strength and good machinability after quenching and tempering treatment, and has certain toughness, plasticity and wear resistance.

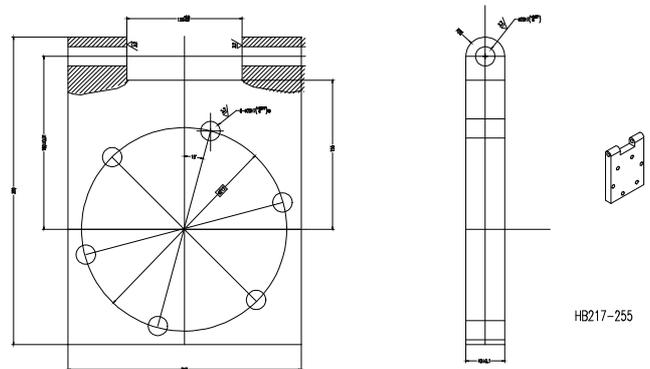


Figure 18. Drill Template.

iv. Hinge Pin

The design of the hinge pin [15] is shown in Figure 19, which is connected to the support, the drill template, and the split pin. The hinge pin is designed with a tolerance of $\phi 20g6$ outer circle. The size of the support and the drill template hole is $\phi 20H7$, so the fit of the hinge pin to the support and the drill template is clearance fit. The surface roughness of $\phi 20g6$ is 3.2, and the process needs to be ground. The hinge pin material selects 45# medium carbon quenched and tempered structural steel, which has high strength and good machinability after quenching and tempering treatment, and

has certain toughness, plasticity and wear resistance.

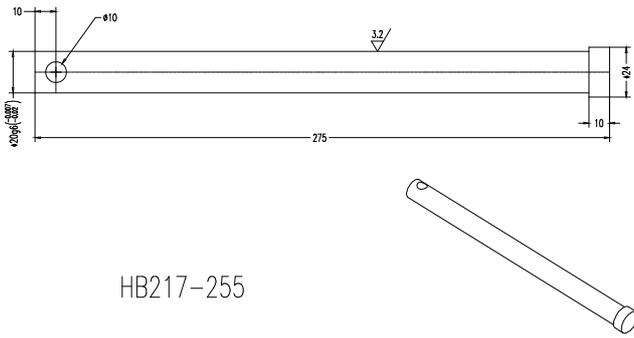


Figure 19. Hinge pin

v. Platen

The design of the pressure plate is shown in Figure 20. This part is used for the compression of the drill template, and is connected to the drill template, the contour pin and the nut. The pressure plate material selects Q235-A ordinary carbon steel, which is economical.

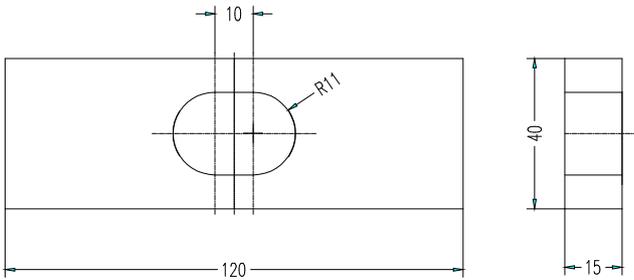


Figure 20. Pressure plate.

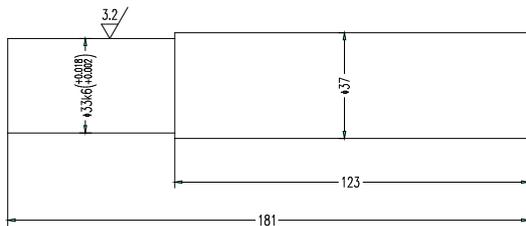
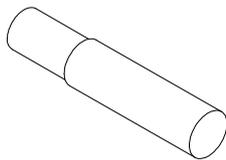


Figure 21. contour pin 1.

vi. Contour Sales 1

The design of the contour pin 1 is shown in Figure 21. The part is a transitional part connected to the bottom plate and the pressure plate. The contour pin design is marked with a $\phi 33k6$ outer circle tolerance, and the bottom plate $\phi 33H7$ hole is matched with an interference fit. The surface roughness is 3.2,

so the process arrangement needs to be ground. The contour pin 1 material selects 45# medium carbon quenched and tempered structural steel, which has high strength and good machinability after quenching and tempering treatment, and has certain toughness, plasticity and wear resistance.

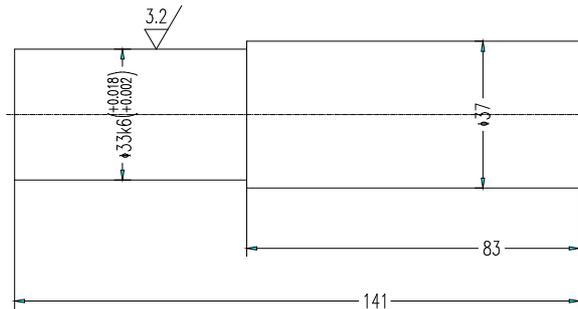
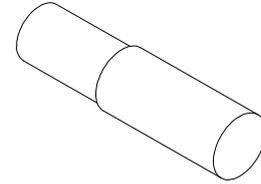


Figure 22. Contour pin 2.

vii. Contour 2

The design of the contour pin 2 is shown in Figure 22. The part is a transitional part connected to the bottom plate and the drill template. The contour pin design is marked with a $\phi 33k6$ outer circle tolerance, and the bottom plate $\phi 33H7$ hole is matched with an interference fit. The surface roughness is 3.2, so the process arrangement needs to be ground. Contoured pin 2 material selects 45# medium carbon quenched and tempered structural steel, which has high strength and good machinability after quenching and tempering treatment, and has certain toughness, plasticity and wear resistance.

4. The Conclusion

After the preparation of the process specification and the installation of the fixtures, the machining accuracy of the bearing housing is improved, the problem of machining and drilling of the bearing housing is solved, the processing load of the operator is reduced, the labor intensity is reduced, and the work is shortened. The production cycle greatly increases productivity and guarantees product quality.

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