

MONITORING OF CRANKSHAFT MACHINING

MONITOROWANIE OBRÓBKI WAŁÓW KORBOWYCH

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Abstract:

Within the MPO project which focuses on supporting lunettes control and crankshaft alignment automation it was necessary to measure time demands of some activities during machining of selected crankshaft types. The article evaluates the basic data measured.

Key words: maintenance, exploitation, maintenance management, modelling, maintenance organization

Słowa kluczowe: obróbka skrawaniem, wał korbowy, czas operacyjny

INTRODUCTION

Centre NS 770 – Mechanical Engineering Service is one of the centres of VÍTKOVICE MECHANIKA, s.r.o. (hereafter referred to as VM). The centre is the chief implementor of a project from the Ministry of Industry and Trade titled Research and Development of Automatic System for Active Control of Lunettes for Balancing of Crankshafts During Machining which is designated FR-TI1/522.

The entire project is focusing on simplification (automation) of crankshaft alignment on the turning machine so that this entire process, which represents the dominant time burden during manufacturing of crankshafts, is made as efficient as possible. This will reduce the total time

for crankshafts manufacturing and increase its cost efficiency.

DIMENSIONAL PARAMETERS OF THE MANUFACTURED CRANKSHAFTS

For selection of a suitable manufacturing technology it is necessary to know some important data which for crankshafts and turning machines include for example: turning diameter above the support, turning length, load capacity and possibly other data.

Below we are indicating the basic parameters of the crankshafts manufactured in the VM centre. The individual parameters – dimensions – are then connected with a specific technology that ensures the most cost efficient achieving of the parameter (fig. 1, tab. 1).

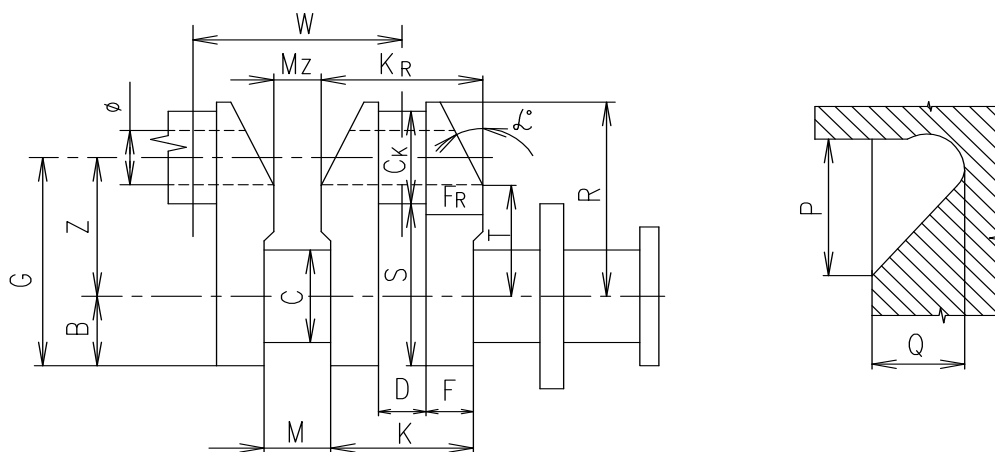


Fig. 1. Basic dimensional parameters of selected crankshafts
Rys. 1. Podstawowe wymiary wybranego wału korbowego

Table 1
Specific dimension of the shaft parameters
Tabela 1
Parametry wymiarowe wałów

Shaft TYPE	B	C/Ck	D	F	FR	G	K/KR	M/MZ	Q	R	S	T	α°	W	Z	\emptyset	WEIGHT
		314															683
S 26 MC	270	320	110	130	130	760	370	120	32,5	655	600	425,7	22,5	490	490	160	635
S 35 MC	318	390	142	147	156	1018	454	146	28	900	823	617,5	22,5	600	700	195	1232
																	1323
S 42 MC	365	500	154	197	210	1247	574	199	43,5	1137	997	772,5	22,5	748	882	250	2317
S 42 MC		472															
(Japan)	365	500	154	203	203	1247	561	187	43,5	1137	997	788,2	22,5	748	882		2480
S 46MC-C	462	560	152	213	213	1428	578	204	48	1255	1148	989,1	25	782	966	280	
S 46MC-C	430	560	152	213	213	1396	578	204	49	1255	1116	895,3	22,5	782	966		3345
S 46MC-C	455	560	152	213	213	1421	578	204	49	1255	1141	989,1	25	782	966		3727

TECHNOLOGICAL PROCEDURE FOR MACHINING

In order to make an analysis of the time demand for machining of the crankshaft (hereafter the CS) we need to consider the individual operations that need to be performed. Below we indicate the basic (brief) standard procedure for CS machining on a standard turning machine.

Preparation of the machine – Place 4 lunettes in line with bearing no. 3, 4, 6, 7 on the turning machine bed. On the lunette under bearing no. 6 set the pistons according to the machined diameter of the lunette to the dimension of bearing no. 6.

Placing the CS on the machine – Using the transport pivots fasten the CS to the crane. Clamp the end journal of the CS to the jaws and place the bearing pivot no. 6 on the lunette. Insert a wooden beam between the end journal flange and the front plate.

Centring the CS – Using the micrometric screw control the alignment of the pistons under bearing no. 6, align precisely. Centre the CS in line with bearing no. 4. After centring, support the bearing by the lunette.

Machining of the bearing – Undercut both sides of the bearing to a depth of 1 mm/area, but keep the bearing width of approx. 130 mm and then rough machine the bearing width with a min. draft to the clean state using the high speed steel tool.

Machining of the CS with a run-out lower than 2.5 mm – Place the CS on bearing no. 6 to the lunette and re-centre in line with bearing no. 4. Machine bearing no. 2. Re-centre the CS in line with bearing no. 4

Turning the CS – Release the CS, release the top two jaws and move them in order to create a clearance of approx. 50 mm from the flange diameter.

Perform measuring of the length dimensions of the CS – Measure out and decide on the possible corrections of the dimensions between the web and the pushing flange.

Rough machine the end journal – Front surfaces with the allowance of 1.5 mm/area. Flange diameters with the allowance of 1 mm/area. Centring recess, diameter, including the face with the allowance of 1 mm/area

Rough machine the bearings which are not supported by the lunette – Gradually rough machine bearings no. 3, 5,

7, 8 with the allowance of 1 mm/area. Rough machine radii of bearing journals to the mirrors.

Machine auxiliary bearings on journals no. 3, 5 and 7 – Gradually on bearings 3 and 5 machine the centring strip, finish the bearings with a feather tool, sand down.

Machine the unsupported bearing journals no. 2, 4, 6 – Re-centre in line with journal no. 7. Rough machine the diameters of bearings 2, 4, 6 with the allowance of 1 mm/area

Check auxiliary bearings no. 3, 5, 7 - Centre in line with journal no. 7. Check run-out of bearings 3 and 5. Release the side pistons on the lunettes. If the run-out of bearings 3 and 5 is lower than 0.04 mm then continue with further processing. Otherwise it is necessary to repair bearings 3, 5, 7.

Machine the flange journal – the CS is placed on bearing journals no. 1, 3, 5, 7, in case of repair it is placed on bearing journals no. 1, 2, 4, 6, 7. Machine the centring strip. The mirror is 0.2 mm/area. The diameter of the bearing journal with the allowance of 0.4 mm to the diameter including the diameter between the collar and the flange.

Turn the CS – Release the CS, release the top two jaws with a clearance of approx. 50 mm from the flange diameter. Clamp the CS as per the requirements for re-balancing of the CS, turn the CS for clamping by the end journal. Align the lunettes under bearing no. 3, 5, 7, 8, or no. 2, 4, 6, 8.

Rough machine the flanges of the flange journal after turning – Diameters of the flanges with the allowance of 1 mm/area. The flange face (outside) with the allowance of 1 mm/area. The centring diameter or the centring collar -- machine the face and the diameter with the allowance of 1 mm/area.

Check of the bearings – Re-centre in line with bearing no. 2 or 3. Check the run-out of the bearings on the lunettes, the maximum run-out is 0.02 – otherwise it is necessary to repair the bearings with moving the lunettes.

Finish machine the main journals – Machining procedure (with positioning of the lunettes on bearing 2, 4, 6, 8). Finishing of bearing no. 7 – place a new lunette under the bearing, bearing no. 5 – move the lunette from bearing no. 6, bearing no. 6 – place a new lunette under the bearing,

bearing no. 3 – move the lunette from bearing no. 4, bearing no. 4 – place a new lunette under the bearing. Re-centre in line with bearing no. 3 – release bearing no. 2.

Finish machine bearing no. 2 (between web 1 and the pushing flange) – Machine auxiliary bearing to bearing no. 1b. – use feather tool. Place the lunette under bearing 1b. Face of the pushing flange from web no. 1 with an allowance of 0.2 mm/area. Mirror of 0.2 mm/area.

Finish machine the end journal – Make opening of the CS to 0.02 mm. Re-centre in line with bearing no. 2. Machine the strip on the face of the pushing flange within the tol. 0.01 - max. 0.02. Diameter of the bearings with the allowance of 0.04 mm for the diameter. Diameter of the pushing flange with the allowance of 0.4 mm for the surface.

Finish machine the flange journal – Check opening to 0.02 mm. Machine the centring strips on the diameter as well as on the face. Machine the run-out of the inside face; perform only when the run-out is more than 0.04 mm. Diameter of the bearings with the allowance of 0.04 mm for the diameter. On the face of the flange machine two auxiliary strips for measuring of the thickness of the central recess in a length of approx. 40 mm. Central recess, diameter with the allowance of 0.4 mm for the diameter, the face with the allowance of 0.2 mm for the surface.

Turn the CS – Clamp the flange journal to the front plate. Furnish the jaws with the protection inserts against im-

prints on the finish machined diameter. Further procedure as described above.

Machining of the end flange of the end journal – Centre in line with the flange journal. Make opening to 0.02 mm. Machine the centring strips to the diameter and to the flange face, it must go identically with the pushing flange. Diameters of the flanges with the allowance of 0.2 mm/area. Finish machine the diameters, the faces, and the radius. Sand down in all directions.

Check the CS on the machine as per the prescription.
Write down the measured values to the measuring sheet.

Remove the CS from the machine.

THE TIME DEMAND OF CRANKSHAFT MACHINING

The charts and table below (from fig. 2 to fig. 10, tab. 2) indicate the time demands for the individual operations that are necessary for the machining of the selected types of crankshaft assemblies. As we can see, the longest values are allocated for machining and for aligning.

This means that the team should focus mainly on the aforementioned areas. Reduced demands in these areas by several percent will result in a significant acceleration of crankshaft manufacturing and thus in improved efficiency and productivity.

Table 2
Type of shaft assembly
Tabela 2
Sposoby montażu wału

ASSEMBLY of type S 26, 35, 42 MC, S 46 MC-C								
Pressing and finishing								
OPERATION	6	5	6	7	8	6	6	Tar.
ASSEMBLY TYPE	S 26	S 35/5	S 35/6	S 35/7	S 35/8	S 42	S 46-C	St.
OVERLAP	9,35	10,20	11,05	11,90	12,75	11,90	11,90	6
SCRIBE	7,65	8,00	9,00	11,00	13,00	14,00	14,00	7
PRESSING	18,70	19,55	21,25	22,10	23,80	24,65	27,20	8
TRANSPORT PIVOTS	1,70	1,70	1,70	1,70	1,70	1,70	1,70	6
LATHE	212,50	242,25	259,25	277,95	303,45	297,50	320,00	8
SCRIBE	6,80	9,00	10,00	11,00	12,00	12,00	13,00	7
MOLL MACHINE	59,50	64,60	74,80	85,85	96,90	93,50	113,05	8
SCRIBE	6,80	10,00	10,00	10,00	10,00	12,00	13,00	7
MILLING MACHINE	35,70	44,20	45,05	45,90	46,75	41,65	50,15	8
RUN-OUT AND THREADS	85,85	79,90	89,25	99,45	109,65	90,10	90,95	8
SEGMENT CALLIPER	22,95	26,35	26,35	26,35	52,70	33,15	40,80	8
FITTING	323,00	293,25	339,15	393,55	456,45	439,45	459,85	8
DRILLING	3,40					4,25	4,25	5
QUALITY INSPECTION	65,45	62,05	68,85	76,50	84,15	73,10	73,95	7
SURFACE INSPECTION	1,70	1,70	1,70	1,70	1,70	1,70	1,70	5
TOTAL	861	872	967	1074	1225	1150	1235	

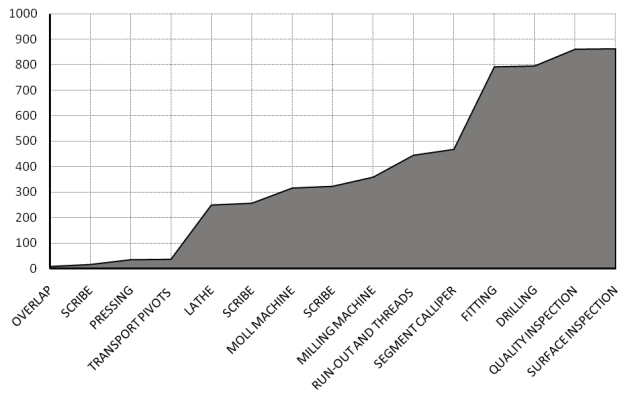


Fig. 2. Cumulative time demand of S 26 assembly type
Rys. 2. Skumulowany czas potrzebny do montażu typu S 26

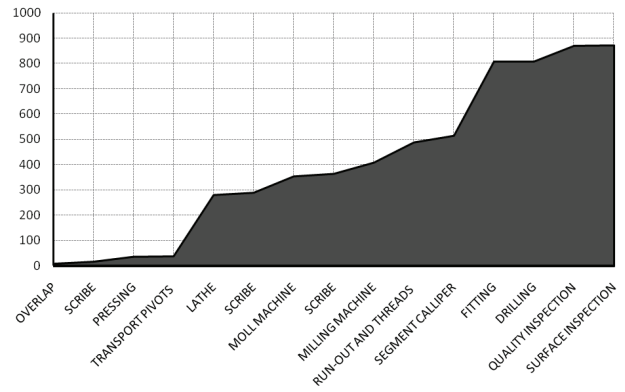


Fig. 3. Cumulative time demand of S 35/5 assembly type
Rys. 3. Skumulowany czas potrzebny do montażu typu S 35/5

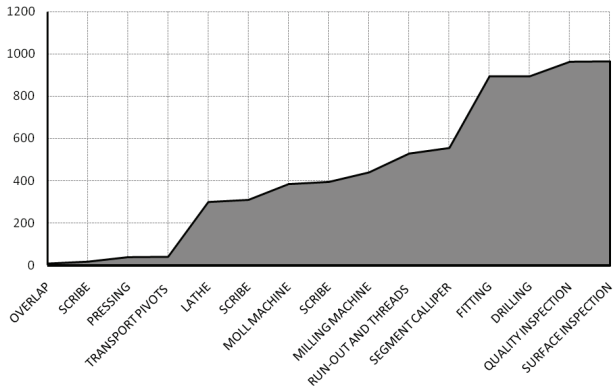


Fig. 4. Cumulative time demand of S 35/6 assembly type
Rys. 4. Skumulowany czas potrzebny do montażu typu S 35/6

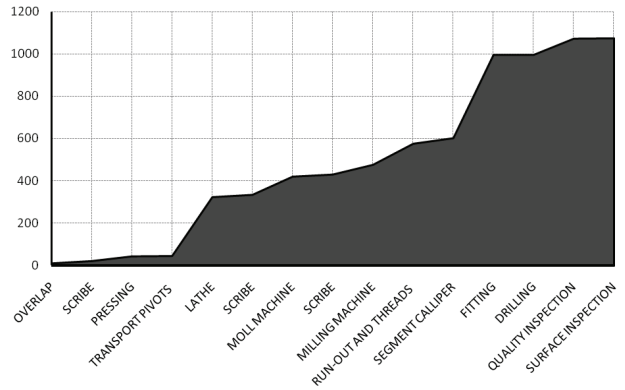


Fig. 5. Cumulative time demand of S 35/7 assembly type
Rys. 5. Skumulowany czas potrzebny do montażu typu S 35/7

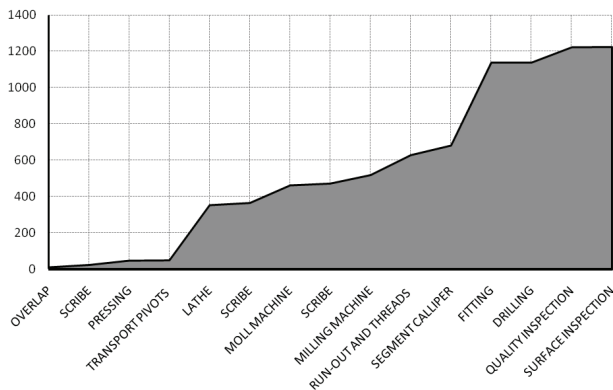


Fig. 6. Cumulative time demand of S 35/8 assembly type
Rys. 6. Skumulowany czas potrzebny do montażu typu S 35/8

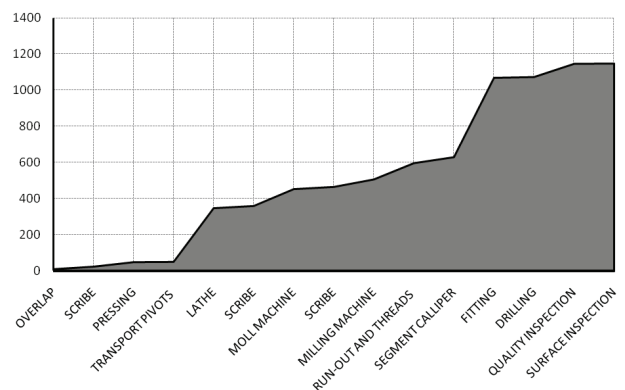


Fig. 7. Cumulative time demand of S 42 assembly type
Rys. 7. Skumulowany czas potrzebny do montażu typu S 42

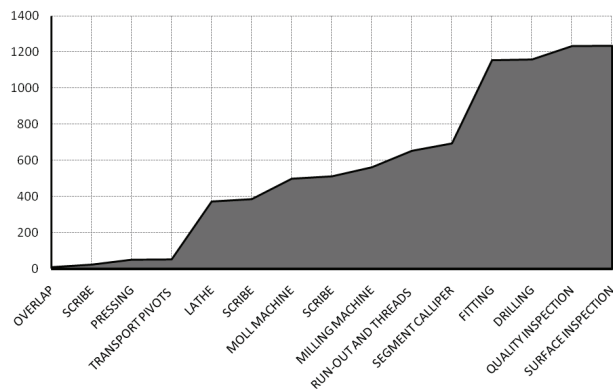


Fig. 8. Cumulative time demand of S 46-C assembly type
Rys. 8. Skumulowany czas potrzebny do montażu typu S 46-C

TIME DEMAND OF MACHINING
 Pressing and finishing of selected crankshaft assembly
 [h]

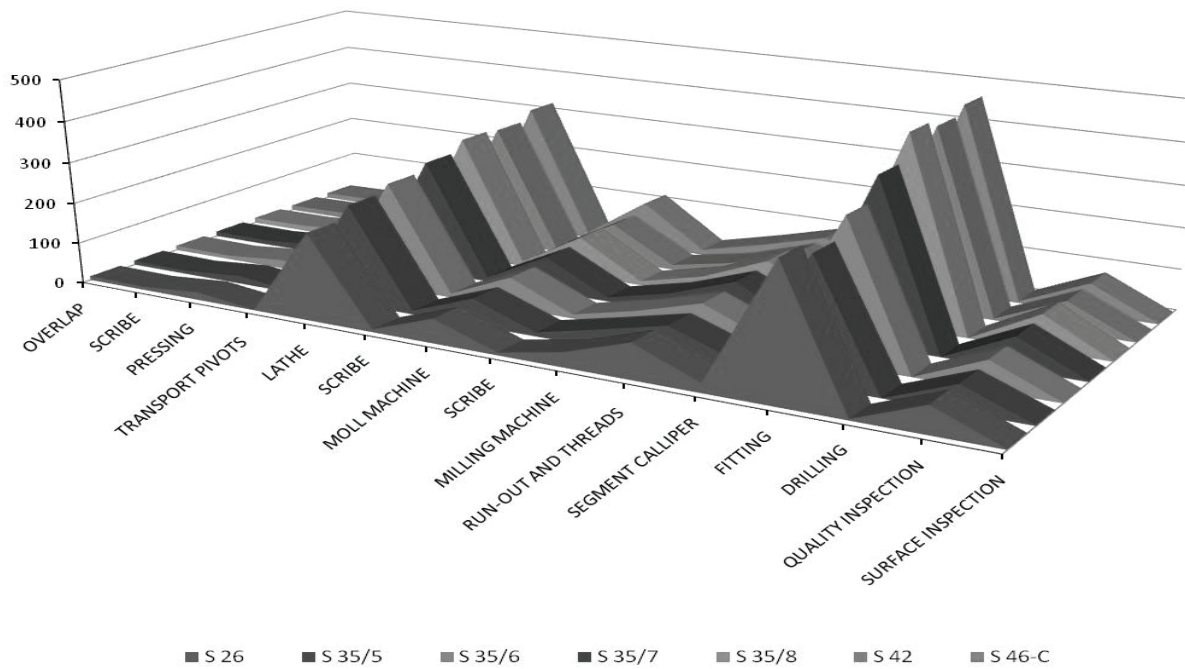


Fig. 9. Time demand of machining
Rys. 9. Zapotrzebowanie na czas obróbki

CUMULATIVE TIME DEMAND OF MACHINING
 Pressing and finishing of selected crankshaft assembly
 [h]

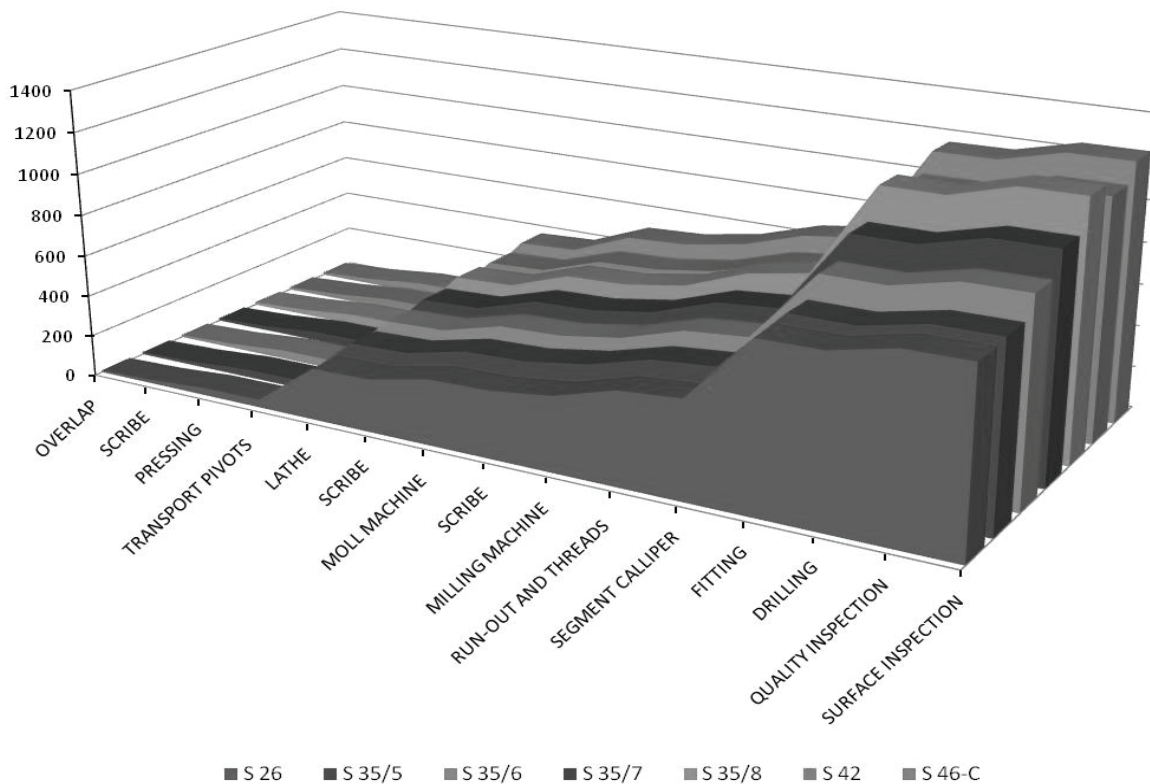


Fig. 10. Cumulative time demand of machining
Rys. 10. Skumulowane zapotrzebowanie na czas obróbki

CONCLUSION

From the aforementioned technological procedure and analysis of time demands of the individual selected types of crankshafts it is clear that the alignment of the crankshaft represents a substantial time demand during its production and so its automation or we could say acceleration of this process will contribute significantly to improved efficiency of crankshaft manufacturing.

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