IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
Volume 2, Issue 3, April 2022
Impact Factor: 6.252

Design and Development of Broach Cleaning Mechanism

Dr. Prakash Kadam[1], Jarande Sagar[2], Memane Prajwal[3], Kamble Prathmesh[4], Kadam Nilesh[5]
Faculty, Department of Mechanical Engineering[1]
Students, Department of Mechanical Engineering[2,3,4,5]
JSPM's Jayawantrao Sawant College of Engineering, Pune, Maharashtra, India

Abstract: *Broaching is most commonly used in industries for rapid and correct profiling of metal work piece. Broaching can be used to generate any desired shape by means of tool called broach. The profile that is largely produced is keyway and Splines. The keyways and splines are required in automotive components such as gears and pulleys. The closure relates to Design and development device used for cleaning broach tool compromising of a circular brush that rotate around the broach through a compressed air (Pelton Wheel turbine Like Mechanism) designed specifically for broaching machine to remove the metal chips accommodated in-between broach tool tooth and thus improve productivity of the broaching machine. A basic overview of burr formation and removal is presented in this paper. The main advantages, disadvantages, limitations, part quality and precision of these operations are presented.*

Keywords: Broach, Cleaning Mechanism, Productivity, Cycle Time.

I. INTRODUCTION

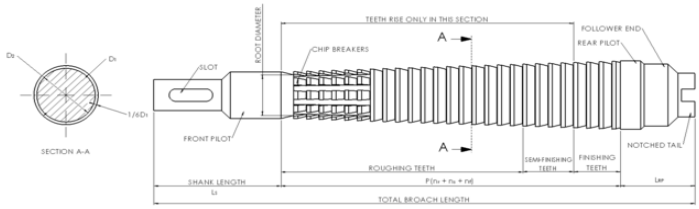
This mechanism relates to an improved broaching tool chip remover, and more particularly to a rolling brush cleaning assembly for removing metal chips from a broaching tool without a rubbing or scrubbing action of the brush and without power drive assistance to the brush assembly. One example of a large machine mounted broaching tool comprises an elongated metal cutting bar of generally rectangular cross-section having a longitudinal row of spaced apart metal cutting tool projections projecting laterally from along a longitudinal edge of the bar. The bar is generally passed perpendicularly to a surface of a workpiece to cut or gouge a groove or slot therein with a peripheral shape comparable to the shape of the cutting tool projections. The size of the cutting tool projections on the bar vary progressively along the bar so that all or a part of the periphery of the slot being cut, is progressively increased in size to a final dimension correlated to the size of the largest cutting tool projections in the row. The cutter bar may also have its cutter tool projections extending upwardly from its horizontal plane, an arrangement similar to a gear rack, the cutter projections being represented by the gear teeth of the rack.

As the cutter bar passes along the workpiece to remove a layer of metal, a chip of the removed metal curls into the space between cutting tool projections. Ordinarily this curled chip will fall from between cutter projections when the cutter bar passes away from the workpiece. However, should these chips not fall from the cutter bar, they may accumulate between cutter projections to an extent which deleteriously interferes with the cutting action of the broach. Among the more common reasons for failure of the metal curl chips to fall away from the cutter bar are (1) the curled chip becomes frictionally engaged or wedged in the space between spaced cutter projections, and (2) because of the high temperatures involved in metal cutting processes, cutting oils are used in large quantity to provide cooling as well as cutting efficiency. However, it is difficult for this oil to penetrate deep into the workpiece at the precise location of the metal cutting action with the result that the temperatures of the cutting tool projection edge and the curled chips are sufficient to cause a welding reaction which firmly attaches the chip to a cutter projection. The foregoing description is indicative of a need for metal chip removal and particularly a need for auxiliary and positive means to remove wedged or joined metal curls from the cutter bar. Passing the bar through a steel wire brush in abrading or rubbing contact with the cutter projections to forcibly remove metal curls causes the cutter edges to cut of the wire bristles and rapidly lead to ineffectiveness of the rubbing brush procedure, particularly for smaller or thinner cutter bars which the cutter shortened bristles fail to reach. Power drive wire brushes have been employed to vigorously scrub a broach cutter bar to remove metal chips. Power driven brushes tend to cause

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
Volume 2, Issue 3, April 2022
Impact Factor: 6.252

undesirable wear on the broaching tool and are not readily adjustable for broaching tools of different thicknesses with the result that larger broaching tools tend to cut the wire bristles from the brush.

Broaching is a precise process in metal working area despite the high cost of tooling as it is largely applied in automobile and various other industries. DivgiTorq Transfer System PVT. LTD. is one of the largest transfer case machine manufacturers and thus requires large no of gears. As there is large demand of broached parts for various machines it is necessary to improve productivity to meet the demands. The study under sees the problems in association with cleaning process of broaching tool in the view of work study which reduces cycle time, worker fatigue and improves productivity.



1.1 Objectives

1. To remove the metal chips accommodated in-between broach tool tooth.
2. To manufacture cleaning device for cleaning of broaching tools which can be simply operated.
3. To clean the tool so tool stays in good quality without any damaged.
4. To improve quality of cleaning as compare to mandatory cleaning.
5. To reduce/consume time of cleaning.
6. To remove stress on worker to cleaning of machine and broaching tools every time while its use.

It is another object of this invention to provide an improved chip removal brush assembly for broaching machine cutter tools.

1.2 Study

The work is focused on method involved in the cleaning operation of broaching tool. The work also focused on improving productivity by reducing cycle time and worker's fatigue. The data required to be collected in this study are elemental cycle times, process flow chart, details for each process and number of jobs machined in the specific period.

1.3 Problem Identification

During broaching it is observed that after cutting stroke burr is accommodated on broach which is necessary to remove to produce defect free product. Broach cleaning is performed by manually by using wire brush which increase the cycle time of product. Which causes stress on operator, sometime burr remains on broach even after cleaning which may result in defective product, it also affects the life of tool and also on of the main cause of reduction in production rate.

Image: Manually cleaning of Broach

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
Volume 2, Issue 3, April 2022
Impact Factor: 6.252

II. LITERATURE SURVEY

After studying the various research papers of broach cleaning machines, we have concluded that there are certain limitations in broach cleaning machines which can be worked upon. For example, some cleaning machines are made with an aim to clean broach use for key ways or single spline. This means that they are only sufficient in the cleaning of broach used for key ways or spline and not useful for broach which is used for producing number of splines on whole periphery. So, we are developing the machine which can use to clean broach having teeth on whole periphery.

The literature review covered by W. Ferris acknowledged that by placing a roller is well adapted for the purpose of cleaning the broach tool as shown in fig. 1. He had discovered that by passing a roller, under light spring pressure, along the broach so as to contact with successive teeth thereof, the chips are effectively loosened from the teeth so engaged. Due to pressure of contact, the slight impact which affect as the roller strikes each tooth will help to loosen the adhere chips and remove it.

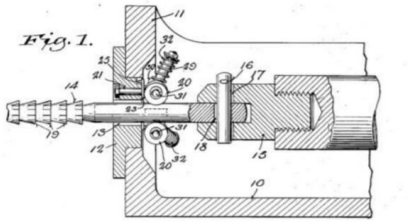


Fig.1: Broach Cleaner by W. Ferris

The Design by Paul C. Brown was a cutter tool cleaning assembly comprises a pair of peripherally opposed wire brush wheels mounted on a metal cutting broach machine as shown in fig. 2, so that the machine cutter bar engages and passes between the wheels to cause rolling contact of the wheels with the cutter bar dislodge metal chips.

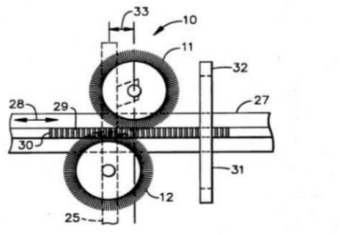


Fig. 2: Broach Tool Chip Remover by Paul C. Brown

III. METHODOLOGY

Work study of broaching operation was conducted at and problem was found in DivgiTorq Transfer System PVT.LTD. cleaning stroke. After finding the problem a mechanism to reduce the cleaning time of tool was designed. Then time study of various jobs machined in broaching machine was conducted. Broaching is a machining operation which uses a tool called broach, moving past the work piece to remove material, cutting a predetermined shape commonly circular or odd shapes. Both internal and external profiles are obtained by broaching.

The broaching machines are mainly of two types :

1. Push broaching machine
2. Pull broaching machine

The broach is either pulled or pushed past the work piece. These machines are operated hydraulically and thus requires less maintenance as there is less wear and tear of machine parts. After studying the process, it is found that during cutting stroke the broaching tool goes past the work piece inside the machine. The tool comes up during return stroke and the tool is cleaned. The cleaning of tool is necessary after each cycle because the metal cut by tool gets stuck in between the tooth and gets temporarily welded due to heat.

As per our observation at DivgiTorq Transfer System PVT. LTD. Shivare, it was found that the cleaning process was carried out manually by a paint brush which consumes excess time and a separate stroke i.e., cleaning stroke. Our research

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
Volume 2, Issue 3, April 2022
Impact Factor: 6.252

in local industries found that no industry has broaching machine that had addressed a solution to this problem. Mathematical calculations proved that the productivity of broaching machine could be improved. This problem can be tackled by a mechanism that would remove the metal chips between teeth which would save cleaning time.

Table 1: Observation without Mechanism for Input Shaft TATA

Shift-1st Operator- A

Cutting Stroke (sec)	Return Stroke (sec)	Cleaning Time (sec)	Total Cycle Time (sec)
29	8	40	77
30	10	36	76
32	9	38	79
29	9	35	73
31	9	41	79

Shift- 2nd Operator-B

Cutting Stroke (sec)	**Return Stroke (sec)**	**Cleaning (sec)**	**Total Cycle Time** (sec)
30	9	35	74
31	8	41	80
30	8	39	78
32	9	33	74
29	10	39	78

Shift- 3rd Operator-C

Cutting Stroke (sec)	Return Stroke (sec)	Cleaning Time (sec)	Total Cycle Time (sec)
32	10	35	77
30	8	40	78
29	9	39	77
31	11	38	80
30	9	40	79

The above observation table shows the elements of broaching operation consisting of cutting, return and cleaning strokes. Above observation shows that the cutting and return stroke are the machine element and it is consistent, whereas the cleaning stroke is varying in each cycle. Due to which the total cycle is varying by 76 to 80 sec.

Table 2: Observation with Mechanism for Input Shaft TATA

Shift-1st Operator- A

Cutting Stroke (sec)	Return Stroke (sec)	Total Cycle Time (sec)
29	19	48
29	18	47
30	19	49
31	20	51
30	21	51

Shift- 2nd Operator-B

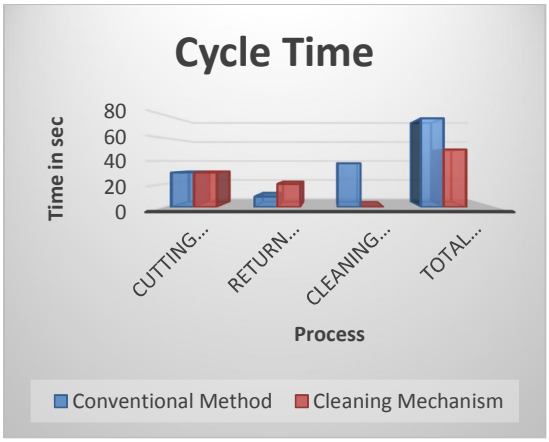
Cutting Stroke (sec)	Return Stroke (sec)	Total Cycle Time (sec)
30	19	49
28	21	49
31	21	52
30	22	52
29	20	49

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
Volume 2, Issue 3, April 2022
Impact Factor: 6.252

Shift- 3rd Operator- C

Cutting Stroke (sec)	Return Stroke (sec)	Total Cycle Time (sec)
30	19	49
31	18	49
30	20	50
32	21	53
29	19	48

The observations in table 2 are recorded for Input Shaft after the implementation of the Broach cleaner on Broaching machine. In this the return stroke is increase and cleaning stroke totally eliminated by cleaning mechanism. After implementation of broach cleaner, Total cycle is varying by 47 to 52 sec and average saving in time is 30 sec in each cycle.

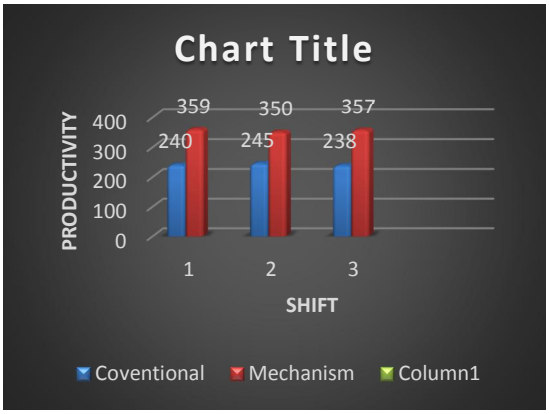


IV. RESULTS

Based on the observation from table 1 and table 2, graph 1 is obtained. In the graph

1. Cutting Stroke
2. Return stroke
3. Cleaning stroke
4. Total cycle time

From the graph it is clear that cutting stroke having a constant time, in return stroke time with cleaning mechanism (18 to 21) is higher than conventional method (8 to 10) whereas process 3 that is in cleaning stroke for conventional method time is varying from 35 to 41 sec and for cleaning mechanism separate cleaning stroke is totally eliminated, where the time consumed is less when using the mechanism as compared to conventional method. Due to which the total time for Broaching operation is substantially reduced.



IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
Volume 2, Issue 3, April 2022
Impact Factor: 6.252

The above graph indicates productivity for 1 day (8 hour shift)
Products produced without mechanism: 240
Products produced with mechanism: 360
Total cycle time without mechanism: 78
Total cycle time with mechanism: 50

4.1 Scop of Study

- Rotation of brush by compressed air through valve currently performed by manually;
- Can be automated by solenoid operated valve.
- There is accommodation of small burr in brush wire so need of development of brush design.
- Little bit difficulty to place the job in fixture.
- Need high pressurized air.

V. CONCLUSION

After implementing the Broach Cleaner to the machine the following benefits have been noticed:

1. 1. The productivity of broaching machine has been improved.
2. The excess time used in cleaning has been reduced.
3. The saved time can be utilized by the operator to do other productive work.
4. The improvement in productivity of Input Shaft per shift has been increased by 1.5 times the standard production rate. Hence the productivity of broaching process has been increased by 50%.
5. The improvement in productivity may vary according to different jobs, Operator and shifts.

REFERENCES

[1]. Broach Tool Chip Remover, United States Patent, Patent Number: 5,197,837, US005197837A, Date of Patent: 9/ 1988, Inventor: Paul Brown, Columbus, Ohro
[2]. Broach Cleaner. Application Filed: June 8,1922. Serial No. 566,777. Inventor: W. Ferris, 1,507,111,
[3]. Mayank Dev Singh, Shah Saurabh K, Patel Sachin B, Patel Rahul, "To improve productivity by using work study and design a fixture in small scale industry", International Journal on Theoretical and Applied Research in Mechanical Engineering 2319 – 3182, Volume-1, Issue-2, 2012.
[4]. Khalid S. Al-Saleh, "Productivity improvement of a motor vehicle inspection station using motion and time study techniques", Journal of King Saud University – Engineering Sciences (2011) 23, 33–41.
[5]. Hannu Rantanen, "Internal obstacles restraining productivity improvement in small Finnish industrial enterprises", Int. J. Production Economics 69 (2001) 85-91.