Journal of Engineering and Applied Sciences 2 (3): 591-594, 2007

Development of an Oil Filter Spanner for Small-Scale Automotive Maintenance Industries

B.O. Akinnuli and B. Kareem
Department of Mechanical Engineering, Federal University of Technology, Akure, Nigeria

Abstract: Auto-mechanic technicians have been facing problem in loosening and tightening oil filters on engines while using traditional methods. The old approaches include the application of plain metal belts that do easily slips after a short period of use, another one used a short chain welded to a short rod locally fabricated and used to wrap the filter. In this study an oil filter spanner that can solve aforementioned problems with the application of little energy and at the same time accommodates all sizes of filter at an affordable cost, useable in automotive maintenance industries of the developing countries was designed and fabricated. The instrument is a conglomeration of components including handle, arm-base, movable nut, metal belt and a shaft. The use of the developed filter Can spanner has reduced the effort of the auto-maintenance industries by about 90% as compared to the use of traditional methods.

Key words: Auto-mechanic, oil filter spanner, maintenance industries, affordable cost, fabricated, conglomeration

INTRODUCTION

Engineering in the early days were confronted with diverse problems including inaccuracy in angle determination on the work-piece. The local blacksmithies who shouldered the whole responsibility of engineering, knew not of what the modern graduation of working tools and finished products is all about. Engineering was based and practiced in a rather crude manner, though a definite objective was achieved. For example, in loosening and tightening of oil filter Can; the common approach in the local industries is the use of hammer and chisel, which has largely caused the deformation of many oil filter Cans, injury to maintenance personnel and destruction of threads of the filter seat.

However, the dream of man towards achieving rapid development in engineering in line with the increasing standard in the world technology brought into the limelight many sophisticated equipment and machines with fundamental assembly called the machine tools. An oil spanner was designed for quick and easy loosening and tightening of the oil filter Can without deformation, in any form, on the Can and at the same time prevent the accident which is likely from using the old method of chisel and hammer blow. This new design/approach was able to increase the life span of the threaded seat of the filter Can, reduce the tediousness in changing of oil filter, which involved loosening and tightening processes.

The developed oil filter spanner consists of metal belt, arm-base, threaded shaft, screw and nuts coupled together. The belt can be adjusted to any size on the filter Can through the aid of nut bolted to the threaded shaft. The arm-base serves as a clip for griping the Can properly. The application of this instrument in maintenance industries has reduced considerable, the stress of tightening and loosening of filter Can. It has prevented the Can-base thread from worn-out and user from being injured while changing the filter.

The development of machine tools had started before 1850, but then it was largely the work of a few men of outstanding vision and technical ability who possessed additional great tenacity and strength of personality (Charles, 1908). In the second-half of 19th century, machine tool construction was profoundly affected by some developments such as the wider application of the principle of interchangeable manufacture and improvements in cutting tool materials. The increased demand for small-arms as a result of wars in Europe and America, the introduction of new inventions and the industrial application of electric powers and the tools for constructing them had been a challenge to machine tools industries. The influence of these factors penetrated into every aspect of machine tool development (Roe, 1906). Classifications of the conventional machine tools can be seen in literature (Sports, 1988).

There were many designs and manufactures of fasteners including bolts, nuts and screws in literature

Corresponding Author: B. Kareem, Department of Mechanical Engineering, Federal University of Technology, Akure, Nigeria

(James *et al*., 1989). The selection parameters of these conventional fasteners in machine design were also available (Holowenko *et al*., 1983). Fasteners were also classified in the literature based on the application, thread type, head style and the strength (Redford, 1975). In fastening and loosening processes, however, correct selection and use of hand tools are very important to do the job safely, with a minimum expenditure and time. Oil filter spanner falls into wrenches family; wrenches comprise a family of tools designed to assemble many types of threaded fasteners. They are made in a vast number of types and sizes. Types of wrenches include torque wrenches, adjustable wrenches, pipe wrench and box wrench. Spanner wrenches are also designed to turn flush and recessed types threaded fittings (Enridge and Walker, 1989). In this study, an oil filter spanner is developed for use in numerous small-scale automotive maintenance industries. This effort has gone a long way in solving the problem of tightening and loosening of oil filter Can from its seat. This has complemented various efforts, in recent times, at developing quick action equipment to alleviate the suffering of small scale industrialists from the use of crude and ineffective facilities. Among the industries torched include automotive (John and Onyeme, 2004; Ibhadode and Amadu, 2006; Raji and Nwachukwu, 2005), pulp and paper (Kareem and Ayodeji, 2006) and maintenance (Raji, 2005; Oyewale and Ibhadode, 2005).

MATERIALS AND METHODS

This study developed an oil filter Can spanner by considering appropriate design parameters, given in the past studies, while designing various components made up of the equipment. Components designed for include: filter spanner handle, the threaded shaft, the metal belt, arm base and the moveable nut. The components used for developing this filter

The production sequence of an arm-base, movable nut, threaded shaft, metal belt and handle coupled together to make oil filter spanner are presented as follows:

Production of the arm-base: The rectangular bar 23 width×31 mm height×61 mm long was cut. It was clamped on the shaping machine vice and shaped all the sides to sizes: 22 mm width×31 mm height×60 mm long. The piece was removed from machine vice and the shapes spanner were largely fabricated using mild steel that were available locally. This material lent itself to almost all machining operations such as turning, facing, treading and boring and non-cutting operations such as heat treatment, casting and welding. Besides its low cost, its level of ductility, strength and corrosion resistance is enough for being used in developing the filter spanner.

Design analysis of oil filter spanner: Design analysis of the oil filter includes determination of turning force, bending and torsion moments and shaft design.

Determination of the force: The amount of force needed to loosen the filter Can was carried out by free fall of 10 kg mass (m) on a punch that penetrated a filter Can and acting as a cantilever. Height of fall was varied until the filter turn loosened at height (h) 0.15 m. Using M_b= Fh and F = mg with g =9.81, then force, F was estimated to be 98.1 N and bending moment, M_b was 14.715 Nm.

Shaft design: Determination of the shaft diameter d was done using the relation (Holowenko *et al*., 1983), $d^3 = (16/\prod S_s) ((K_b M_b)^2 + K_t M_t)^2)^{1/2}$. With torsion moment, M_t of 9.81 Nm, bending moment, M_b of 14.715Nm, combined shock and fatigue factor for torsion moment, K_t of 1.5 and K_b, combined shock and fatigue factor applied to bending moment of 2.0, the diameter, d of the shaft was estimated to be 14 mm.

Bolts and nuts design: Design of movable 14 mm nut and 6 mm bolts for locking purposes was done based on International Standard Organisation (ISO), American National Standard (ANSI, 1974) and British Standard (BS, 1978).

Manufacturing procedure: Of holes and rectangular slots on the surfaces plate were marked out using the veneer height gauge. The hole centres were centre punched, drilled through with 6 mm diameter drill and 8 mm diameter drill was used to counter-bore. A drill was used to span out the rectangular slots for easy filling. The work was then clamped on bench vice to file out the rectangular slots and slants. The profile shaping was carried out on the shaping machine using round nose tool. The two slanted parts were then cut on bench by first marking them out and file to the required angle using flat files. Surface grinding operation was done on the two flat parts of the arm base.

Production of the movable nut: A round bar of 27 mm by 17 mm diameter was cut and turned on lathe to 26 mm by 15 mm diameter. Then 12 mm diameter was drilled out and the internal thread was produced using M14 tap. The hexagonal shape was cut as required and filed. It was drilled out using 4.2 mm diameter drill and then tapped using M5 tap for the sides' screw threads.

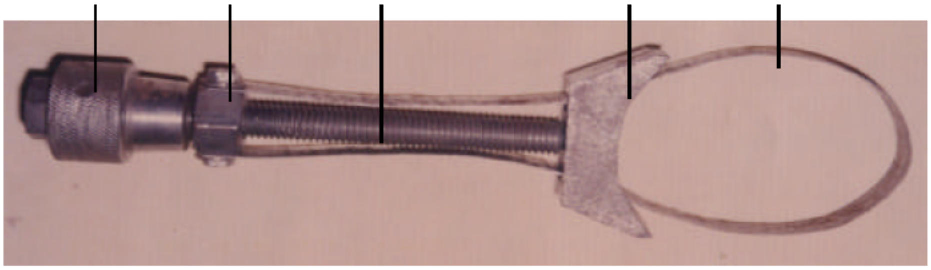

Fig. 1: Pictorail drawing of oil filter spanner

Production of the handle: A work-piece of diameter 36 mm by 35 mm was cut. It was then clamped on the lathe chuck and faced to length 32 mm. Step turning operation was performed on the piece to diameter 32 mm by 15 mm diameter. It was drilled through using 12 mm drill. Taper turning was carried out by tilting the compound slide to angle 3.81 °C. The work-piece was then reversed, held on the chuck and turned to size 35 mm×17 mm. M14 tap was used to produce the internal thread. V-block clamp was used to clamp the work in the drilling machine vice and drilled both opposite sides with 5 mm diameter drill and removed from the drill vice to the bench vice and tapped with M6 taper. M14 thread was then re-run.

Production of the thread/shaft: The round bar was clamped on lathe chuck. It was rough- and finish-turned to 14 mm diameter by 150 mm long. The piece was then reversed on the chuck and step turned to 8 mm diameter by 13 mm long. It was undercut to 6 mm diameter by 6 mm long using under cutting tool. The taper of the undercut was chamfered. The threading operation was carried out on the lathe by supporting the work piece with tailstock. The M14 thread was cut and it was smoothened by chasses.

Production of the metal belt: The required 350 mm length was cut using guillotine cutting machine. Two holes were drilled at both ends using pillar drilling machine. Drill mouth punch was used to create the metal belt.

Assembling of parts: Arm-base was inserted into the head of the lead shaft and rivet slightly. Movable nut was screwed-in on the lead shaft. Metal belt sheet was put-in through the rectangular slots and clamped the ends to the movable nut using M 5 screws (two pieces). The handle was then screwed-in and clamped into a fixed point on the lead shaft using two M 6 screws.

Mechanism of operation: The mechanism of operation of the oil filter spanner involved the used of movable nut to control the expansion and contraction of the metal belt to fit any size of the filter Can needed to be changed with the aid of arm base that serves as a grip. After tightening the metal belt to the Can using movable nut, the handle can now be used to tighten or loosen the filter Can.

Table 1: Production cost of the instrument

Parts/Materials	Specification	Quantity	Unit cost (N)	Cost (N)
Metal belt	(380×2)mm	1	300	300:00
Shaft (Mild steel)	(14×150)mm	1	550	550:00
General cost of machining of components to various sizes				1, 010:00
Total production cost				₦1, 860:00

Instrument maintenance: The maintenance of the developed oil filter spanner is very easy and achievable. The instrument will always be in a good working condition if all the bolts are tightened well before and after operations. The oil filter spanner must be kept away from the moisture; and the threaded shaft greased regularly to prevent corrosion. The production cost of the instrument was ₦ 1, 860:00 (₦ is the symbol for Nigeria currency called Naira) which is about $13 (US Dollars). The cost could be lower than the one shown in Table 1 if it was mass-produced. Pictorial drawing of the developed instrument is shown in Fig. 1.

RESULTS AND DISCUSSION

The developed oil filter Can spanner was tested in the Automotive Maintenance Workshop of the Works Department in the Federal University of Technology, Akure of Nigeria, for loosening and tightening various sizes of motor oil filter Cans. The results showed that the force required in performing these two aforementioned operations was reduced considerable (by about 90%) compared with the traditional methods of performing the same operations. Apart from this stress reduction, the filter base threads were prevented from worn-out and users were protected from accident.

CONCLUSION

This study has developed an oil filter spanner that performed efficiently in loosening and tightening oil filter Can in motor vehicles. This has replaced the tedious and time consuming traditional methods which were common in most of the small-scale automotive maintenance workshops in developing countries such as Nigeria. The instrument consists of shaft, arm-base, movable nut and metal belt mostly fabricated using mild steel. It is easy to use and also available at a very reasonable cost. It is highly recommended that the use of the instrument be extended to medium and large-scale auto-workshops.

REFERENCES

ANSI, 1974. American National Standard Int. for Bolt and Nut Design, ANSI B1.1.

BS, 1978. British Standard for Bolt and Nut Design, BS 18.3.

Charles, S., 1908. Late 19th Century History of Technology, pp: 636.

Enridge, S., 1989. Diesel Machines, (3rd Edn.), McGraw-Hill Inc. USA.

Holowenko, A.R., A.S. Hall and H.G. Langhten, 1983. Shaft Design. Schum's Outlines of Theory and Problems of Machine Design, McGraw-Hill Publishing Company, Singapore.

Ibhadode, A.O.A. and E.H. Amadu, 2006. Indigenous development of a 3 horse power petrolengine. Nig. J. Eng. Res. Dev., 5: 20-35.

James, B., M. Hartman and J. Siegel, 1989. Fastener-Mechanical Design for Machine, (2nd Edn.), Published in Michigan, pp: 201-240.

John, A.A. and V.C. Onyeme, 2004. Design and manufacture of a spark plug reconditioning unit. Nig. J. Ind. Sys. Studies, 3: 49-56.

Kareem, B. and S.P. Ayodeji, 2006. Development of manually operated cutting machine for a small scale paper industry, Nig. J. Eng. Res. Dev., 5: 45-53.

Oyewale, F.A. and A.O.A. Ibhadode, 2005. Design and manufacture of manual electrode coating machine for small scale arc welding electrode manufacture, Nig. J. Eng. Res. Dev., 4: 37-44.

Raji, N.A. and N.I. Nwachukwu, 2005. Indigenous development of a venturi meter, Nig. J. Ind. Sys. Studies, 4: 35-43.

Raji, N.A., 2005. Design and fabrication of narrow belt sanding machine for small scale workshop, Nig. J. Ind. Sys. Studies, 4: 52-57.

Redford, G.D., 1975. Mechanical Engineering Design, Macmillan Inc. Ltd., England.

Roe, J.W., 1906. English and America Tool Builder. Tale University Press New Haven, pp: 20.

Sports, M.F., 1988. Design of Machine Element, Prentice Hall of India (6th Edn.), pp: 591.

Walker, J.R., 1989. Machining Fundamentals, Hand Tool, McGraw-Hill Inc., USA.