Design and development of a Multifunctional portable machine

Kevin Patel
Department of Mechanical Engineering Satyam Education and Welfare Society Group of Institution Bhopal, M.P., India

Niraj Kumar Shrivastav
Department of Mechanical Engineering Satyam Education and Welfare Society Group of Institution Bhopal, M.P., India

Prof. Surendra Agrawal
H.O.D of Mechanical Department.
Satyam Education and Welfare Society Group of Institution, Bhopal (M.P)

Abstract-This paper presents a development of a portable workshop which will be available for the small work. It is a multipurpose machine which can be used to perform various operation like drilling, milling, grinding of small work pieces very precisely. The purpose of developing and designing the portable workshop is to make aware the student about the basic operations at very minimum cost in the Institute ,they can learn the basic mechanism behind the operations, beside that it can be useful for the industries and also at home for repairing purposes, and in the industries small job preparation can be done without using the heavy machines.In the designing of a portable workshop a shaft of 40C carbon steel and a dc motor of 100 rpm12v is used.[1]

Keywords: drilling, screw fitting, grinding ,portable workshop.

I. INTRODUCTION

It is a compact, portable unit capable of doing many machining operations that normally require expensive single-purpose machines. With the different attachments that are available with the unit, drilling, milling, and grinding can be performed quickly and inexpensively. The power hand drill is used with drill bits to create or enlarge holes in a variety of materials (e.g., steel, plastic, wood). With other accessories the power drill can be used for grinding, buffing, wire brushing, or as a power screw driver or a nut driver[1]. Electric drills are named or grouped by the maximum size of the drill bit shaft that the drill chuck can hold. One-quarter inch (1/4-in.) drills run between 0 and 2250 revolutions per minute (rpm) and the three-eighth inch (3/8-in.) drills run between 0 and 2100 rpm. Both 1/4-in. and 3/8-in. drills use a small electric motor having a rating of 1/6 to 1/4 horsepower. A power drill is comprised of two sub-systems; mechanical and electrical.

The Mechanical subsystem is made up of components whose purpose is to transfer, translate or apply forces. The Electrical subsystem contains components that supply and control power flow.

II. WORKING PRINCIPLE OF THE MULTIFUNCTIONAL PORTABLE MACHINE

The “PORTABLE WORKSHOP” is based on the principle of screw drawing machine mechanism. In this portable workshop the movement of tools are in the horizontal direction It can move foreword & backward direction,for the movement power is drawn by the use of the d.c. motor and Similarly, the tool movement is occured in the vertical direction. The rotation of the drill bit or twist drill is also obtained by the motor. Motor worked as a prime mover in this all. The disk is also a ratatory member in the assembly. The protractor is used for the proper angular measurement of the drill. For controlling all the motor mechanism a switch box is provided with the machine.

III. LIST OF COMPONENTS WITH THE SPECIFICATION:

S.No.	Name of the Component	Specification
1.	Shaft	Diameter : 5mm Material : galvanized iron Length : 280mm(horizontal) Length :360mm(vatical)
2.	Channel	G.I. sheet :- 22 gauge
3.	Bearing	Type: Ball bearing Bearing no. N260
4.	Gear:	Material : galvanized iron Length 260 mm(horizontal) Length 220mm(vertical) Type; Spur No.of gear used:2
5.	Motor:	Voltage : 12V Type: D.C. Generator RPM: 100rpm & 60 rpm.

Fig.01 Picture of the portable workshop (Top view)

Fig.02 Picture of the portable workshop (Front view)

1. Design of a multi-functional portable machine
2. [I .] Firstly we are considering the Grinding mechanism
3. Grinding feeds and speeds
4. improves Ra as well. Small grit sizes are very important when very small finishes are required. [6]
5. Terms and Definitions
6. aa=depth of cut
7. ar=radial depth of cut, mm
8. C =fraction of grinding wheel width
9. CEL =cutting edge length, mm
10. CU =Taylor constant
11. D =wheel diameter, mm
12. DIST =grinding distance, mm
13. dw=work diameter, mm
14. ECT =equivalent chip thickness = f(ar,V,V w,f s), mm

15. = 1 ÷ (V÷Vw÷ar + 1 ÷fs) = Vwfs(ar + 1)
    1. ----------------- V
16. = approximately Vw×ar÷V = SMRR÷V÷ 1000
17. = z×fz×ar×aa÷CEL÷ (πD) mm
18. FR =feed rate, mm/min
19. = fs×RPMw for cylindrical grinding
20. = fi×RPMw for plunge (in-feed) grinding
21. f i= in-feed in plunge grinding, mm/rev of work
22. fs =side feed or engaged wheel width in cylindrical grinding
23. = C ×Width = aa approximately equal to the cutting edge length CEL
24. Grinding ratio = MRR÷W* = SMRR×T÷W* = 1000 ×ECT×V×T÷W*
25. MRR =metal removal rate = SMRR×T = 1000 ×f
26. S ×ar ×Vw mm3 /min
27. SMRR =specific metal removal rate obtained by dividing MRR by the engaged wheel width (C×Width) = 1000 ×ar ×Vw mm3 /mm width/min

28. Note: 100 mm3 /mm/min = 0.155 in3 /in/min,
29. and 1 in3/in/min = 645.16 mm3 /mm/min
30. T, TU = wheel-life = Grinding ratio×W÷ (1000 ×ECT×V) minutes
31. tc= grinding time per pass = DIST÷FR min = DIST÷FR + t sp (min) when spark-out time is included
32. = # Strokes × (DIST÷FR + tsp) (min) when spark-out time and strokes are included t sp=spark-out time, minutes
33. V, V U = wheel speed, m/min
34. V w, VwU = work speed = SMRR ÷ 1000 ÷ar m/min
35. W* =volume wheel wear, mm3
36. Width =wheel width (mm)
37. RPM =wheel speed = 1000 ×V÷D÷π rpm
38. RPMw =work speed = 1000 ×Vw ÷Dw ÷π rpm

39. [II] Drilling mechanism
40. Design of shaft

The original motor provided a 3/4" shaft with 3/16" keyway, on which was mounted a specific cone pulley (step pulley). The DC motor provides a 5/8" shaft and the same keyway. Rather than try to find this same pulley with the 5/8" shaft size, machined a bushing to allow the original pulley to fit the new motor shaft. This bushing is simply 3/4" (+0) outside diameter and 5/8" (+0.002") inside diameter, turned on the lathe from 6061 aluminum. The length is 2" to cover the entire shaft length of the new motor.And cut the 3/16" keyway on the mill-drill using side-milling on a 3/16" end mill.

IV. SHAFT SUBJECTED TO TWISTING MOMENT ONLY

When shaft is subjected to a twisting moment only, then diameter of the shaft may be obtained by the torsion equation.[1]

$$T/J=\tau/R \qquad \text{eq (1)}$$

where ,

T= twisting moment acting upon the shaft

J= polar moment of inertia of the shaft about the axis of rotation

τ= torsional shear stress

R = distance from neutral axis to the outer most fibre

We know that for a solid shaft, polar moment of inertia

$$J=\pi d^4 / 32$$

Then eq (1) can be written as, $T=\pi\tau\, d^3/16$

From this equation we can find the diameter of round solid shaft (d)

We also know that for a hollow shaft, polar moment of inertia

$$J = \pi\{d_1^4 - d_2^4\}/32$$

Where,

d1 and d2 = Out side and inside diameter of shaft and r= d1/2

substituting these values in eq (1), we have

$$T=\pi\tau[d_1^4 - d_2^4] /16 d_1$$

IT MAY BE NOTED:

(1) The twisting moment may be obtained by using the following relation

Power transmitted by shaft [5]

$$P=2\pi NT/60 \quad \text{or} \quad T= P*60/(2\pi N)$$

Where ,

T = Twisting moment in N-mm

N = Speed of the shaft in r.p.m.

(2) In case of belt drive , the twisting moment (t) is given by

$$T =(T1-T2)\ R$$

Where,

T1& T2 = Tension in the tight side and slack side of the belt

R = Radius of the pulley

V. SHAFT SUBJECTED TO BENDING MOMENT ONLY

When shaft is subjected to a bending moment only, then the maximum stress is given by the bending equation. We know that [5]

$$M/I=\sigma_b/Y \qquad eq(1)$$

Where ,

M= Bending moment

I = Moment of inertia of cross sectional area of the shaft about the axis of rotation.

σ_b = Bending stress.

Y = Distance from neutral axis to the outer most fibre.

We know that for round solid shaft, moment of inertia

$$I = \pi d^4/64 \quad \text{and} \quad Y = d/2$$

Substituting these values in equation (1)

$$M = \pi*\sigma_b*d^3 /32$$

From this equation diameter of the shaft d can be obtained

We also Know that for a Hollow shaft, moment of inertia,

$$I = \pi(d1^4 - d_2^4) / 64 \quad \text{and}$$

$$Y = d_1/2$$

VI. SHAFT SUBJECTED TO COMBINED TWISTING AND BENDING MOMENT

When the shaft is subjected to combined twisting and bending moment, the the shaft must br designed on the basis of the two moments simultaneously. Various theories have been suggested to account for the elastic failure of the material when they are subjected to various types of combined stress. The following are the theories important for the subject.[5.]

(1) Maximum shear stress theory or guest theory. It is used for ductile material such as mild steel.

(2) Maximum normal stress theory or rankine theory . It is used for brittle materials such as cast iron.

According to Maximum shear stress theory, the maximum shear stress in the shaft,

$$\tau_{max} = 1/2\ \sqrt{(\sigma_b)^2 + 4\tau^2}$$

n substituting the values we get

$$\tau_{max} = 16\ [\sqrt{M^2 + T^2}]\ /\pi\ d^3$$

The expression $[\sqrt{M^2 + T^2}]$ equivalent twisting moment (te)

$$t_e = \pi\tau d^3/16$$

VII. APPLICATION

The application of MULTI-FUNCTIONAL PORTABLE MACHINE:-

(1) For small industries
(2) In a institutes workshop
(3) In a house
(4) In a garage for grinding, drilling & milling.

VIII. ADVANTAGES

The advantages of MULTI-FUNCTIONAL PORTABLE MACHINE:-

It is a multiple functioning workshop its use in grinding, drilling & milling.
It is a highly efficient workshop.
It is a most reliable workshop.
It is required low maintenance & less power consumption
It is a chipper then other machine

IX. LIMITATIONS

- Its use for small work.
- It is a manual.

X. CONCLUSION

This project is done by the team of under graduate students with the aim to produce something new and innovative .The idea of the project is very much clear and having the practical implementation. For the students of technical college it will be very useful and effective.On the other hand it can be used for domestic purposes and also for the small commercial jobs.

REFERENCES

[1] Groover, Mikell P. (2007). "Theory of Metal Machining". Fundamentals of Modern Manufacturing (3rd ed ed.). John Wiley & Sons, Inc. pp. 491–504. ISBN 0-471-74485-9.

[2] Oberg, Erik; Jones, Franklin D.; McCauley, Christopher J.; Heald, Ricardo M. (2004), Machinery's Handbook (27th ed.), Industrial Press, ISBN 978-0-8311-2700-8.

[3] R.R.; Kibbe, J.E.; Neely, R.O.; Meyer & W.T.; White, "Machine Tool Practices", 6th edition, ISBN 0-13-270232-0, 2nd printing, copyright 1999, 1995, 1991, 1987, 1982 and 1979 by Prentice Hall.

[4] Dr. Pulak M. Pandey"Machining Operations and Machine Tools".

[5] Machine design by R.S.Khurmi

[6] http://en.wikipedia.org/wiki/Machining