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Design and Fabrication of Foot Operated Round Ring Cloth Peg Assembly Machine using Spring and Sliding Bar Mechanism

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Abstract: Cloth pegs are used for holding clothes especially when kept for drying. There are different types of cloth pegs available in the market, made from different materials like plastic, metal or wood. The two pieces of the cloth peg are held together either by a metal ring, U-pin, or spring. The plastic parts and the metal ring are manufactured separately and then assembled together. Assembly of the plastic parts and the ring is done manually. This is a very tedious and troublesome process. So, the researcher has designed and fabricated a machine to reduce the human efforts and time.
Keywords: Cloth peg, Clothes, Plastic parts, Metal ring, Assembly machine

I. INTRODUCTION

A cloth peg is a fastener used to hang up clothes for drying, usually on a clothes line. They are made from plastic, metal or wood. A ring, spring or U-pin is inserted between the two parts of the cloth peg. The assembly of the cloth peg (two plastic pieces and ring) can be done manually by workers, or by semiautomatic or fully automatic machines.

Fig.1 Cloth peg assembly

II. NEED OF THE PROJECT

Inserting the ring in the two parts is very tedious and troublesome job for the workers. So, by developing the machine for the same will reduce the manual efforts of the workers which will ultimately benefit the company.

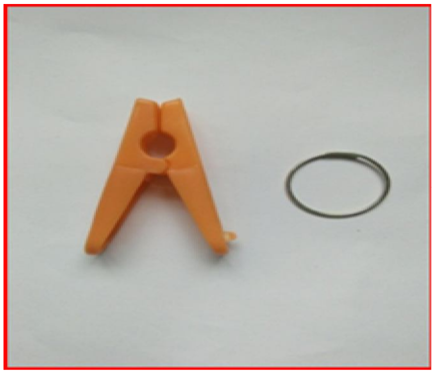

Fig.2 Cloth peg assembly parts

III. MACHINE DESCRIPTION

The machine consists of a table of dimensions 600×300×600mm over which a mechanism is mounted. The mechanism consists of a sliding bar of square cross section 10×10mm, two helical extension springs and a slider. The slider is made by welding two cross MS plates of dimensions 70×30×7.5mm and 90×20×10mm. The slider has an arrangement to hold the two plastic pieces of the cloth peg. The slider slides on the path which is provided on the top of the table. The length of the path made for the slider to slide is 210mm and width is 35mm. Actual length up to which the slider can travel is 150mm. Two stoppers are provided at both ends of the path so that the slider cannot move further. On the left side of the slider, a sliding bar of square cross section is mounted on the table. Guide ways are provided for the sliding bar to slide properly. On the right side of the slider a fixed bar is mounted on the table. Two vertical thin rods of diameter 2.5mm and height 35mm are provided each on the sliding bar and the fixed bar. These vertical thin rods are used for holding the ring. Small angle sections are welded on the sliding bar and the guide ways on either side. Two helical extension springs are attached to these angle sections. On the left side of the table an arrangement is made to hold the pulley over which a wire of diameter 1mm passes. The diameter of the pulley is 28mm. The pulley is made of Teflon material which is having very low coefficient of friction. The pulley is fixed with a nut and bolt in the arrangement provided. The one end of the wire is attached to the sliding rod and its other end is attached to the foot pressure plate at the bottom of the table. On the left side of the table a horizontal bar is welded between the two legs. At the middle of this bar a small plate is welded. A knob is provided on this plate for tightening or loosening the wire. At the bottom of the table an arrangement is provided for mounting the foot pressure plate. The foot pressure plate consists of three cross MS plates, two having equal dimensions of 250×50×2mm and one having dimensions 370×70×2mm welded to each other. Two helical compression springs are provided at the bottom of the foot pressure plate.

IV. DESIGN CALCULATIONS

A. Design of Upper Vertical Spring

Maximum spring force required, P = 1*9.81= 9.81N

Deflection of the spring, δ = 15mm

Spring material: Alloy steel (SS)

Ultimate tensile strength, S_{ut} = 723.8256 N/mm^2

Permissible shear stress for the spring wire, $\tau = 0.30S_{ut}$

$$\tau = 0.30*723.8256$$

$$\tau = 217.15 \text{ N/mm}^2$$

Consider spring index, C=7

Wahl's factor, $K = \frac{4C-1}{4C-4} + \frac{0.615}{C}$

$= \frac{4(7)-1}{4(7)-4} + \frac{0.615}{7}$

$=1.2128$

Wire diameter (d)

$\tau = K\left(\frac{8PC}{\pi\times d^2}\right)$

$217.15= 1.2128\times\left(\frac{8\times 9.81\times 7}{\pi\times d^2}\right)$

d = 0.98mm or 1mm

Mean coil diameter, $D_m = C\times d$

$D_m = 7\times 1$

$D_m = 7$mm

No. of active coils (N)

$\delta = \frac{8PD_m{}^3N}{Gd^4}$

Modulus of rigidity (G) for steel wires is 81370 N/mm^2

$15= \frac{8\times 9.81\times 7^3\times N}{81370\times 1^4}$

N= 45.34

N= 45

Total number of coils, N_t = Active coils (∵ it is a helical extension spring)

$N_t = 45$

$N_t = 45$

Solid length of the spring, $L_S = N_t \times d$

$= 45\times1$

$L_S = 45$ mm

Actual deflection of the spring, $\delta = \frac{8PD_m^3N}{Gd^4}$

$\delta = \frac{8\times9.81\times7^3\times45}{81370\times1^4}$

$\delta = 14.88$ mm

Total axial gap between coils = $(N_t - 1) \times$ gap between two adjacent coils

It is assumed that there will be a gap of 1mm between the adjacent coils.

Total axial gap between coils = $(45-1) \times 1$

$= 44$ mm

Free length of the spring, L_F = solid length+ total gap+ δ

$= 45+44+14.88$

$L_F = 103.88$ or 104 mm

Pitch of the coil, $p = \frac{free\ length}{(N_t-1)}$

$p = \frac{104}{45-1}$

$p = 2.36$mm

Required stiffness, $k = \frac{P}{\delta}$

$= \frac{9.81}{15}$

$k = 0.654$ N/mm

Actual stiffness, $k = \frac{Gd^4}{8D_m^3N}$

$= \frac{81370\times1^4}{8\times7^3\times45}$

$k = 0.658$ N/mm

2. Design of lower compression spring

Maximum spring force required, P = 1*9.81= 9.81N

Deflection of the spring, $\delta = 8.5$mm

Spring material: Alloy steel (SS)

Ultimate tensile strength, $S_{ut} = 723.8256$ N/mm^2

Permissible shear stress for the spring wire, $\tau = 0.30S_{ut}$

$\tau = 0.30*723.8256$

$\tau = 217.15$ N/mm^2

Consider spring index, C=7

Wahl's factor, $K = \frac{4C-1}{4C-4} + \frac{0.615}{C}$

$= \frac{4(7)-1}{4(7)-4} + \frac{0.615}{7}$

K =1.2128

Wire diameter (d)

$\tau = K\left(\frac{8PC}{\pi\times d^2}\right)$

$217.15 = 1.2128\times\left(\frac{8\times9.81\times7}{\pi\times d^2}\right)$

d= 0.98mm or 1mm

Mean coil diameter, $D_m = C \times d$

$D_m = 7 \times 1$

$D_m = 7mm$

No. of active coils (N)

$$\delta = \frac{8PD_m^3N}{Gd^4}$$

Modulus of rigidity (G) for steel wires is 81370 N/mm^2

$$8.5 = \frac{8 \times 9.81 \times 7^3 \times N}{81370 \times 1^4}$$

N= 25.69

N= 26

It is assumed that the spring has square and ground ends.

The number of inactive coils is 2.

∴Total number of coils, N_t = Active coils+ Inactive coils

$N_t = 26+2$

$N_t = 28$

Solid length of the spring, $L_S = N_t \times d$

$= 28 \times 1$

$L_S = 28$ mm

Actual deflection of the spring, $\delta = \frac{8PD_m^3N}{Gd^4}$

$$\delta = \frac{8 \times 9.81 \times 7^3 \times 26}{81370 \times 1^4}$$

$\delta = 8.6$mm

Total axial gap between coils = (N_t -1) × gap between two adjacent coils

It is assumed that there will be a gap of 1mm between the adjacent coils.

∴Total axial gap between coils = (28-1) × 1

= 27 mm

Free length of the spring, L_F = solid length+ total gap+ δ

= 28+27+8.6

L_F = 63.6 or 64 mm

Pitch of the coil, $p = \frac{free\ length}{(N_t - 1)}$

$$p = \frac{64}{28-1}$$

p = 2.37mm

Required stiffness, $k = \frac{P}{\delta}$

$= \frac{9.81}{8.5}$

k = 1.15 N/mm

Actual stiffness, $k = \frac{Gd^4}{8D_m^3N}$

$= \frac{81370 \times 1^4}{8 \times 7^3 \times 26}$

k = 1.14 N/mm

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V. FABRICATION

For fabrication of this machine various lathe operations like turning, facing, drilling, boring are done. Shaper, milling, drilling and grinding machines are used. For joining the different parts of the machine electric arc welding is used.
Fabrication consists of the following steps:-

A. First a table of dimensions 600×300×600mm is fabricated. This table is fabricated by cutting a MS sheet of dimensions 600×300mm and welding four rods of diameter 30mm and height 600mm to it.
B. On the top of the table two bars of square cross section 10×10mm and length 210mm are welded at 35mm apart for moving the slider.
C. The slider is made by welding two cross MS plates of dimensions 70×30×7.5mm and 90×20×10mm.
D. Three small square shaped MS plates are welded on the top of 90×20×10mm plate for making an arrangement to hold the two plastic pieces of the cloth peg.
E. Two small bars of square cross section 10×10mm and length 30mm are welded on the two ends of the slider path which acts as stoppers so that the slider cannot move further.
F. On the right side of the slider path a bar of square cross section 10×10mm, length 120mm and height 45mm is welded.
G. On the left side of the slider path a platform of height 30mm is made by welding MS plate.
H. Over that platform a sliding bar of square cross section 10×10mm and length 230mm is attached.
I. Guide ways are provided for proper sliding of the bar.
J. Two vertical thin rods of diameter 2.5mm and height 35mm are welded each on the sliding bar and the fixed bar.
K. Two angle sections are welded on the sliding bar and the guide ways to attach helical extension springs on either side.
L. On the left side of the table a Teflon pulley of diameter 28mm is fixed by nut and bolt between the two plates.
M. A wire of diameter 1mm is allowed to pass over the pulley. One end of the wire is attached to the sliding bar and the other end is attached to the foot pressure plate at the bottom.
N. On the left side of the table a horizontal bar is welded between the two legs.
O. At the middle of this bar a small plate is welded.
P. A knob is provided on this plate for tightening or loosening the wire.
Q. At the bottom of the table an arrangement is provided for mounting the foot pressure plate.
R. The foot pressure plate consists of three cross MS plates welded to each other.
S. Two helical compression springs are provided at the bottom of the foot pressure plate.

Fig.3 Foot operated Round Ring Cloth Peg Assembly Machine

VI. WORKING OF THE MACHINE

The ring is put into the two vertical rods. Then the two plastic parts of the cloth peg are held in the arrangement provided in the slider. Then the slider is moved through the path until it reaches near the two vertical rods. As soon as the slider reaches near the vertical rods, foot pressure is applied on the foot pressure plate. This pressure is transmitted along the wire to the springs which ultimately moves the sliding rod. Due to this the ring gets stretched and gets inserted into the lower rectangular grooves of the cloth peg. Then the cloth peg is removed. Then the overlapping portion of the ring is brought to the upper position. Then the cloth peg is kept such that the ring is inserted into the two vertical rods. Then the required foot pressure is applied on the pressure plate so that the ring gets inserted into the upper circular grooves. Now the cloth peg is removed and is ready for use.

VII. TESTING OF THE MACHINE

The machine reduces the time and efforts of the worker in inserting the ring into the two plastic parts of the cloth peg. The machine is handy, portable, economical and simple in construction. The machine is more easy to use than the hand operated round ring cloth peg assembly machine as the use of plier is eliminated.

VIII. CONCLUSION

Cloth peg consists of two plastic parts and a metal ring. The plastic parts and the ring are manufactured separately and then assembled together. Assembling of the plastic parts and the ring is a tedious and troublesome process. So, the "Foot Operated Round Ring Cloth Peg Assembly Machine" is designed and fabricated which will reduce the human efforts and time.

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