Service Station Design of Ink-Jet Printer

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Abstract

In the Inkjet Printer, service station is to maintain the function of inkjet head, capper and wiper are the basic component; When cartridge is not printing, capped head can avoid the clogging of nozzle, wipping can clean the stack ink around the nozzle.

To drive the motion of capper and wiper is a technique of mechanism design, most of traditional design, wiper is not moveable, capper is always fixed on a moveable sled along a pair of cam surface, and the sled is driven by the moment of cartridge. These disadvantages are that service station need a horizontal space to let the sled move, it will increase the dimension of service station.

This paper proposes a new service station design to overcome these problems with a DC-motor as driving power, capper and wiper are fixed on two base partly that can be up-down along two pairs of slot. Two sets of worm gears are used to deliver the power of DC-motor to drive two base up and down; Hence, it don't need the horizontal space of service station and reduce its dimension; Compare with prior art of service station driven by motor, this design is more simple. In the testing robot we used to test the capping and wipping mechanism, the capper and wipper had been capped and wipped for about 120,000 times, from the experimental result, it is proved that function of capper and wiper is normal.

Introduction

The principle is the same for ink jet printer and ink jet facsimile machines, that is, the head prints the ink drop-on-demand on paper. However, residual ink often stays around the head and clogs the nozzles. It is imperative to design a service-station to keep the printing module of the ink jet machine functioning regularly and smoothly. Cap and wipe are the main components of the service-station the ink jet facsimile machine printing module and the ink jet printer. When the ink jet machine is not in use, the caps cover up the nozzles and prevent the ink from drying. When ink rests around the nozzles through use, the wipe may clean up the residual ink, restoring printing quality.

The service station is designed to keep caps and wipes in good shape and functioning. Under the traditional design for a service station, a carriage is set in motion to drive a movable cap base, which rolls in a set of cam surface and push the caps to rise and cover the head. The wipe is fixed to the left side of the cap base. To clean the printer head, the carriage is driven back and forth the wipe to be cleaned. However, there is a main disadvantage in this traditional design : the cap must move laterally in order to cover the cartridge, requiring a large width for the service-station and subsequently a large width for the product. The traditional design has prevented the ink jet machines from competing with smaller models.

Moving from traditional requirements of lateral displacement of the carriage, the new design features the use of a small direct current motor to drive the service station, and keep the product in proper condition to compete with smaller models.

The mechanical structures are shown in Fig.1 and Fig.2. A direct current motor and two sets of worm gears are used to drive the cap and wipe, moving longitudinally.

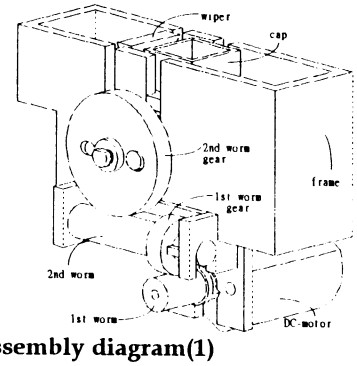

Fig.1: **assembly diagram(1)**

As Fig.1 and Fig.2 show, a combination of the two sets of worm gears with the direct current motor can obtain excellent speed reduction ratio and torsion force. The 2nd worm gear has two long rounded guide slots, which can drive the guiding shields located beside the worm gears of cap base and wipe base. The 2 guiding shields move through the two vertical guide slots located on the service

frame. This alignment can set the cap and wipe in motion up and down in turn.

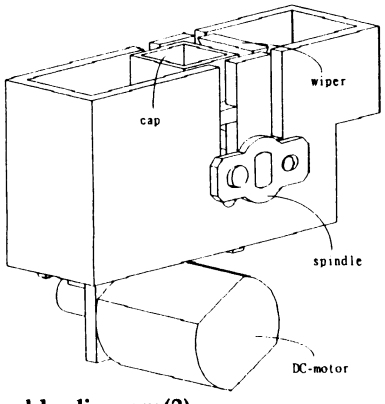

Fig.2: **assembly diagram(2)**

Furthermore, making the force on the cap base and wipe base even requires a revolving spindle that can go through a twist arm to connect to the 2nd worm gear. The revolving spindle uses the axle holes by the 2nd sides of the bases and the revolving axle.

Therefore, when the cartridge needs to be capped, the motor turns clockwise to raise the cap and lower the wipe to cover the cartridge. When the cartridge needs to be wiped, the motor turns anti-clockwise to make the cap descend and the wipe rise to clean it. So the cap and wipe can be set fixed and separately in an up and down positon, with no need for space for lateral movement. This can dramatically reduce the required width for the product.

The use of worm gears can change the direction of the turn, achieve a greater speed reduction ratio and torsion force. As a result, motors of smaller torsion export and size can be chosen for lower costs.

Theorem

1.The arrangement of two worm gear sets

As Fig.3 shows, a combination of the first worm gear set, make modulus $M_1 = 0.4$

assuming pitch diameter of worm gear $D_1' = 9mm$,

pitch diameter of worm $d_1' = 5mm$

$$M_1 = \frac{D_1'}{N_1} = 0.4,$$

the teeth number of worm gear $N_1 = \frac{D_1'}{M_1} = 22.5$

make $N_1 = 22$, the actual pitch diameter of worm gear

$D_1 = N_1 \times M_1 = 8.8mm$

center distance of worm and worm gear

$$C_1 = \frac{D_1' + d_1'}{2} = \frac{D_1 + d_1}{2},$$

so the actual pitch diameter of worm $d_1 = 5.2mm$

pitch circle $P_1 = \pi \cdot M_1 = 1.257mm$

make the screw number of worm is 4,

and lead $L_1 = 4 \times P_1 = 5.028mm$,

screw angle ϕ_1, $\tan\phi_1 = \frac{L_1}{\pi \cdot d_1}$, so $\phi_1 = 17°55'$

velocity ratio $(VR)_1 = \frac{n_1}{N_1} = \frac{4}{22}$

As Fig.3 shows, a combination of the second worm gear set, make modulus $M_2 = 0.4$

assuming pitch diameter of worm gear $D_2' = 19mm$,

pitch diameter of worm $d_2' = 5mm$

$$M_2 = \frac{D_2'}{N_2} = 0.4,$$

the teeth number of worm gear $N_2 = \frac{D_2'}{M_2} = 47.5$

make $N_2 = 47$, the actual pitch diameter of worm gear

$D_2 = N_2 \times M_2 = 18.8mm$

center distance of worm and worm gear

$$C_2 = \frac{D_2' + d_2'}{2} = \frac{D_2 + d_2}{2},$$

so the actual pitch diameter of worm $d_1 = 5.2mm$

pitch circle $P_2 = \pi \cdot M_2 = 1.257mm$

make the screw number of worm is 1,

and lead $L_2 = P_2 = 1.257mm$,

screw angle ϕ_2, $\tan\phi_2 = \frac{L_2}{\pi \cdot d_2}$, so $\phi_2 = 4.4°$

velocity ratio $(VR)_2 = \frac{n_2}{N_2} = \frac{1}{47}$

2.The calculation of cap stress

While driven by direct current motor and worm gears, the cap rises by 3mm. The distance between the upper end of the cap, before it rises, and the bottom of the print head is 1.6mm. Therefore, the intervention force of the cap and cartridge is 1.4mm, which means that the cap will be compressed by 1.4 mm.

Assuming the rubber part of cap is solid, the compression has to be absorbed by the spring below the cap. The spring's constant is K = 40 gf/gmm, and its free length L = 12.5 mm. When installed, the spring is pre-compressed 7mm, and when the cap rises, the spring is further compressed by 1.4

mm again. The total transfigure amount $\delta = 7 + 1.4 = 8.4$ mm.

spring force $F = k \times \delta = 336gf$

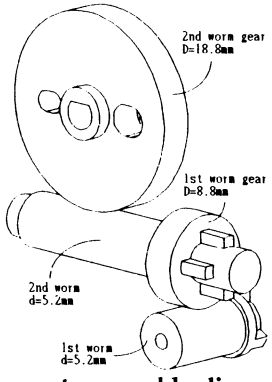

Fig.3: **worm gear sets assembly diagram**

The turning moment for the center of the gear which raises the cap is $\tau_1 = Fr = 336 \times 4.5\text{mm} = 1512$ gf-mm. The direct current motor is Mabuchi-Motor FF-030PK-08250. The specifications of the motor points out the characteristic curve that the motor can export torque $\tau =$ 38 g-mm under the operation of 5V pressure. While through speed reduction of 2 sets of worm gears, the torque exportation can be magnified as :

$$\tau_0 = \frac{\tau}{(VR)_1 (VR)_2} = 9823gf - mm$$

Therefore, this motor can provide necessary torque for the service-station.

Conclusion

In comparison with its characteristics, this new model has the following advantages :

1. The ups and downs of the cap and wipe are set with a fixed space, eliminating lateral displacement for reduced width of the product.

2. A combination of a direct current motor and two sets of worm gears can provide sufficient transmission power for swift function. A 3 month static experiment proved that the nozzles of cartridge are far from dry. Also, in the experiment, the machine had a revolving life of more than 60,000 times.

3. This new design requires only a limited space. This feature can add to the product strong appeal for its reduced size, a great competitive advantage for ink jet products.

References

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