

Output Power of a Ceiling Fan

By

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Introduction

Before the coming of age of air-conditioners, electric fans were for many years the most widely-used cooling devices in the world. In public areas and commercial premises, many electric fans are mounted under the ceilings and they are known as ceiling fans. For several years in the 1980's Hong Kong was the No. 1 manufacturer and exporter of ceiling fans in the world. Thanks to an invention described below, we were able to match the fan (wind) power with the motor output power, thus making our ceiling fans the most efficient and hence also the most economically marketable in the world. This was made possible by the ability of our fan manufacturers to measure the output power, i.e. wind power, of a ceiling fan. While we provided a matching motor for our fan, our competitors elsewhere provided "more powerful than necessary" motors for their fans to ensure that their fans were not subjected to overloads. Our fans were therefore cheaper in cost as there was no wastage of extra material for the motors. The phenomenon was made possible by my invention of a measuring device for the output power of a ceiling fan.

Innovation

As a part-time academic electrical engineering consultant to a couple of ceiling fan manufacturers, my duty was to study the fan motors with a view to improve their performances and to solve any problems arisen in the manufacturing processes. During one of my visits to such a factory, no problem was presented to me to solve so I decided to look for a problem myself. As I was gazing at a ceiling fan running on test, it suddenly dawned on me that the output power of the fan, namely the wind power, could not be measured or determined by any known method at the time. For the following two weeks, I gave the matter a lot of thought and eventually I was able to find a way to measure the output of the fan motor as described below:

A ceiling fan is usually hung on to the ceiling via a stationary vertical support rod. Let us consider the forces across a section of the support rod. In accordance with the well-known law of mechanics: "Action and reaction are equal and opposite." The lower portion of the section of the support rod is exerting two forces on to the upper portion of the section, namely: (i) a vertical downward force equal to the weight of the fan including the fan motor and (ii) a turning moment equal and opposite to the running torque of the fan. If the two sections of the vertical rod are mounted on to the inner and outer rings of a ball bearing and the lower section of the rod is held stationary by a strain gauge mounted radially to the centre of the ball bearing, the force measured by the strain gauge multiplied by the radius of the force from the centre of the bearing will be a measure of the motor torque. A photo of a ceiling fan with such a bearing and strain gauge inside a metal box connecting the two halves of the support rod is shown in Fig. 1. Below the metal box is a wheel in contact with the top of the fan for measuring the speed of the fan. Fig. 2 shows a section of the ball bearing to which the two halves of the steel rod are secured. The vertical support rod with the ball bearing and the strain gauge inside the box as described above. Fig. 3 is a photo of the ball bearing and the strain gauge inside the metal box. Hence the torque and the speed of the fan

can be measured and the fan output power which is the product of the torque and speed can be obtained.

Patents

A British Patent, No.1228070, was published in 1971 by the author on a device to measure transient torques of motors using the above action and reaction principle while another British Patent, No. 2119103, was published in 1983 by the author on the torque measuring device for ceiling fans as described above.

Promotion

Contrary to the general belief, a patented product can only bring a fortune to the inventor if the product can be sold in very large quantities. Clearly this is not the case with a torque and power measuring device for ceiling fans since each fan factory only needs one such instrument for measuring the output powers of their ceiling fans. To promote the sale and export of ceiling fans in the interest of Hong Kong economy, I invited the top management of all the ceiling fan manufacturers in Hong Kong to a tea reception one afternoon at the Mandarin Hotel where I demonstrated the operation of the torque and power measuring device for ceiling fans. In the event, representatives of some thirty companies came to the reception. In the course of the following few months, about twenty five fan companies undertook to purchase one such device each. The most enthusiastic user of the device was the Shell Electric Co. Ltd. whose late chairman, Mr. Yung Yau, also contributed some ideas on adapting the device to be used on a production line of ceiling fans in a factory. As the ceiling fan as a cooling device ran out of fashion a few years after the invention, so went its torque and power measuring device into the archives of history. As a matter of academic interest, one such device was presented to each of the top technologically-oriented universities in China and one device was sold to the University of Singapore.



Fig. 1
Ceiling Fan
With Torque Measuring Device (Above) and
Speed Measuring Device (Below)
between the fan and the ceiling

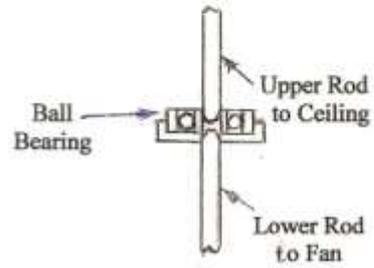


Fig. 2
Section of Ball Bearing



Ball Bearing
Strain Gauge

Fig. 3
Inside of Torque
Measuring Device