A Technical Talk on: **Inventions, inventions….**

by: Professor Vincent W.S. Leung on May, 9, 2006.

INTRODUCTION

Mr. Chairman, Distinguished Guests, Fellow Members of the Electrical Engineering Division of the Hong Kong Institution of Engineers, Ladies and Gentlemen:
It has been some years since I attended a similar meeting in this room.
It has been many more years since I spoke at a meeting in this room.
When I was invited by our chairman, Mr. Tai, to be the speaker at our A.G.M. today, I felt a little bit uneasy as I am not really as up-to-date in the latest development and progress of our endeared profession as many of you are.
In order that I shall not make a fool of myself, I have chosen to speak to you on a historical subject of which I have personal knowledge.

Ladies and gentlemen:
As you may know, the Hong Kong Institution of Engineers and its Electrical Engineering Division in particular were for a number of years very much a part of my professional life. On my return to the Institution today, I feel somewhat emotional as I am reminded of the days when I made my humble contributions to the birth and the growth of the Electrical Engineering Division of the Institution.
I am very glad to see that at the age of 25, the Electrical Engineering Division is now in excellent shape thanks to the devotion and efforts made by members of the successive committees and members of the Division during the last 25 years. In particular, I have noticed that in last year's annual report, there have been 14 technical talks 12 technical visits including one to overseas and one to mainland China. Mr. Chairman, please accept my heartiest congratulations upon a job very well done.

Ladies and gentlemen:
You may wonder, with full justification, why and how I am standing here and speaking to you tonight in view of the fact that I have not been playing an active role in the Division for some time. Well, it all began at a dinner of past chairmen of the Division six months ago. On that occasion, our chairman, Mr. Tai, announced that a publication of the Division was under preparation and he called for contributions to go into the publication. For my sin to have responded to his call by submitting an article in support of the publication, Mr. Tai followed the matter up by requesting me to speak to the Division at to-day's meeting.

Ladies and gentlemen:
Here I am standing in front of you, hopefully, not to make a fool of myself.

FROM DISCOVERIES TO INVENTIONS

When I went to England as a teen-ager to study and to receive practical training more than half a century ago, I came across the proverb which says that:

THERE IS NOTHING NEW UNDER THE SUN

Actually the proverb is probably only valid for the period of history from the beginning of the existence of the human race many thousands of years ago to the end of the Middle Ages in Europe and it refers to the discoveries which mankind had made up to

that time. By then, everything on earth that could be discovered had already been discovered and the above proverb was written to proclaim that no more new things could be found on earth. The period of discoveries was followed by a period of inventions, possibly, beginning with the four major inventions of China, namely:

PRINTING, PAPER, DYNAMITE AND THE COMPASS

The Europeans were so inspired by the Chinese inventions when they first visited China that when their industrial revolution came in the 18th and the 19th centuries, they followed our foot-steps by producing many more inventions, the majority of which were science-orientated. The inventions at the time included a variety of electro-mechanical machinery and devices. Inventions continued to prevail into a good part of the 20th century. To-day I shall be talking about inventions and in particular about some of my own inventions which have been registered as British Patents more than twenty years ago. By the way, I am not worried about publicizing the patents since all their copyrights, which lasted for only 15 years, have already expired.

Ladies and gentlemen,
Fig. 1 shows:

THE WORLD'S FIRST COMMERCIAL MAGNETICALLY-LEVITATED TRAIN OPERATING IN SHANGHAI

I think some of you must have seen it if not have also travelled on it as it is the airport express train between the Potung Airport and its city air terminal . As you probably know, Germany manufactured the train which is the first and only such train put into commercial use in the world. Prior to this first train commercially-exploited by Germany, Japan manufactured a prototype train based on the same principle of magnetic levitation but the Japanese project was halted at the prototype stage because the train is considered to be uneconomical to run. Prior to the Japanese prototype train, believe it or not, I had invented the experimental magnetically-levitated train in Hong Kong. To justify my claim, the photo in Fig. 2 shows:

THE MODEL TRAIN DRIVEN BY A LINEAR MOTOR & SUPPORTED BY MAGNETIC LEVITATION MADE IN DEPT. OF ELECTRICAL ENGINEERING OF THE UNIVERSITY OF HONG KONG IN 1975

I shall now explain briefly the principle of operation of the magnetically-levitated train. The train is lifted above the ground by the opposing magnetic forces between the steel rail and magnetic poles on the train. The related British Patent No. 1518520 was issued on my invention in 1978.The train was propelled by the reaction between the linearly-moving magnetic field produced by the winding in the train and a short-circuited winding in the track. While the principle of lifting the weight of the train by a magnetic force is sound, it is an uneconomical proposition since the additional cost of the magnetic force which is produced by a very large electric current is higher than the reduced cost for overcoming the mechanical friction of a train running on the rail.
There are pros and cons of the magnetically-levitated train propelled by the linearly-moving magnetic field. I described the principles of operation of such a train in a couple of international conferences. One of such papers, shown in Fig. 3, was my joint paper with Mr.

B.K. Mak, who is currently a senior executive in the Hong Kong Electric Co. Ltd. The paper which was presented at a conference in Australia was entitled:

AN INVESTIGATION ON A MODEL A.C. LINEAR TRACTION MOTOR

Fig. 4 shows the general principle of operation of a magnetically-levitated train in greater details. The upper and lower parts of the diagram represent the train and the track respectively. The electric current in the polyphase winding on the train provides a linearly-moving magnetic field while the short-circuited winding on the track produces a magnetic field which lifts the train above the track and another magnetic field which reacts with the magnetic field on the train to propel the train forward.

One way to construct a model magnetically-levitated train is to have ferro-magnetic cores for both the train and the track. A 3-phase winding in the train is energized and the train will be lifted up and be propelled forward along and above the track. On the model train designed and built in the University of Hong Kong, the windings in the track and the train are reversed for ease of supplying electrical power to the stationary primary winding. The track is in the form of a laminated core with a 3-phase winding while the train carries an aluminum plate which serves as the shorted secondary winding of an induction motor. Actually, the core in the train can be made of solid steel since the slip frequency of the a.c. magnetic field on the train is very low. The power loss due to the eddy current in the solid steel core is negligible when the model train is running at its cruising speed.

MEASUREMENT OF MOTOR TORQUE

One of the principles of applied mathematics which has made a very deep impression on me states that :

ACTION AND REACTION ARE EQUAL AND OPPOSITE

and it has led to my invention of several instruments for measuring the torque of rotating machines such as motors. A motor normally consists of a rotating part, commonly referred to as the rotor, and a stationary part, commonly referred to as the stator. The torque of a motor in motion is a dynamic torque and to measure a dynamic torque implies that the measurement has to be made on the rotating part of the motor, namely the rotor. However, basing on the principle of "action and reaction are equal and opposite" the stator of a motor is also subjected to a torque of the same magnitude but in the opposite direction. When the rotor of a motor rotates , the stator of the motor is prevented from rotating (in the opposite direction to that of the rotor) by being held steady onto a bedplate. Unlike the dynamic rotor torque, the stator torque is a static torque which can be measured much more conveniently.

Fig. 5 shows a motor which rests on two pedestal bearings instead of being secured on a bedplate. When the motor shaft rotates, the motor frame (which accommodates its stator) is held steady by a strain gauge. The static force on the strain gauge can then be measured of the dynamic torque of the motor. Fig. 6 shows a motor which is vertically secured on to a turn-table. When the motor rotates, the turn-table is held stationary by a strain gauge. Similarly, the static force on the strain gauge is proportional to the dynamic torque of the motor. All the above motor torque related inventions have been registered as British Patents a list of which is given in the Reference Section of the paper.

MEASUREMENT OF OUTPUT POWER OF A CEILING FAN

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 ceiling 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 the invention described below, we were able to match the fan (wind) power with the fan motor output power, thus making the ceiling fans made in Hong Kong the most efficient and 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. the wind power, of their ceiling fans. While we provided a matching motor for our fan, our competitors elsewhere provided a "more power than necessary" motor for their fan to ensure that their fan was not subjected to an overload. Ceiling fans made in Hong Kong were thus lower in cost and therefore more competitive in the world market. A brief description of the torque meter for ceiling fans is given below:

A ceiling fan is usually hung on to the ceiling via a stationary vertical support rod as shown in Fig. 7 a. At any cross-section of the support rod, there is a vertical force which supports the weight of the fan. In addition, there is also a turning moment which provides the fan motor with its torque..If we cut the rod into two halves and join the two halves back by a ball bearing, the section of which is shown in Fig.7b. The torque between the two halves of the bearing can be measured by a strain gauge mounted in the torque measurement device. The reading on the strain gauge multiplied by its radius from the centre of the bearing will give the output torque of the ceiling fan. Fig. 7c shows a ceiling fan with the torque-measuring device in a container between the fan and the ceiling. Below the container is a wheel which, being in contact with the top of the fan, measures the speed of the fan. Hence the output power of the fan motor can also be obtained as the product of its torque and speed.
Contrary to the general belief, an invention 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 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's 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 fan 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. 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.

Ladies and Gentlemen:

Just as ceiling fans ran out of fashion twenty years ago, so did inventions run out of fashion several years ago. Today, inventions are by and large replaced by innovations and we have now a new situation where:

THERE IS ALWAYS SOMETHING NEW EVERYDAY UNDER THE SUN .

Ladies and Gentlemen:

I know that some of you expect me to tell you one or two stories related to my inventions. I know too that some of you are in a hurry to get away. Let me conclude my talk now and tell you my stories at the end of our dinner party.

REFERENCES

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5. Leung W. S. "Measuring and recording system for steady-state and transient torques," British Patent No. 2127549,1984.
6. Leung W. S. "Motor torque measuring and recording systems," British Patent No. 2197956,1986.