https://toshiba-mirai-kagakukan.jp/en/learn/history/ichigoki/1981aircon/index.htm

Excerpt from Toshiba Science Museum Official Website

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World's First Residential Inverter Air Conditioner

Initial stage of development saw many compressors broken when used with inverter. Engineers gave up summer holidays and worked naked in the heat, making prototypes and checking their performance.

In the early 70s, cooling/heating type air conditioners had a limited heating capacity and most of them needed auxiliary heaters in their indoor units to complement their heating capacity.

As energy-saving awareness rose in the wake of the 1973 oil crisis, the emergence of new technology was long awaited for reducing energy loss by a continuous control of compressor capacity so that the conventional on-off control for temperature adjustment was to be replaced. Many had predicted that the use of an inverter, or frequency converter, would be an optimal choice to serve the purpose, but inverters in those days were too large and expensive to be built into air conditioners. Despite these challenges, Toshiba, with a state-of-the-art high-power transistor and microprocessor-controlled sinusoidal pulse width modulation, achieved a significant downsizing in its inverters. An inverter whose size and weight was only one-sixth that of a conventional inverter, was instrumental in Toshiba's launch of the world's first air conditioner for commercial use in October 1980.

Toshiba's next quest was to apply this inverter technology to residential air conditioners in the hope that the technology would also allow flexible capacity changes for residential air conditioners. The development started in December 1980. The biggest challenge was the price and size of the inverter, an electric circuit used to control the rotation speed of a compressor; and in addition, the engineers also had to deal with other big challenges. Prior to the emergence of inverter air conditioners, air conditioners operated with a compressor, the heart of an air conditioner, which rotates at a fixed speed. However, with this new inverter technology, the engineers did not know what trouble or damage to expect on the compressors that run at variable speeds controlled by the inverter.

So, the engineers started the development of an inverter air conditioner with trial and error, witnessing many compressors broken through the course of their development activities. The first issue found was that the compressor saw lubricant oil flowing out from its mechanical parts when operated at a high speed and lacked lubrication when operated at a low speed. The second problem was found in the discharge valves; all of them were found broken,

resulting from an increased intensity of the impact on the valves as the roller speed increased. Some vane wear was also found due to a similar cause. The third problem was an abnormal high-pitched noise that occurred during the operation. The engineers worked hard to overcome these problems one by one.

Since residential air conditioners operate on AC 100V, the voltage doubler rectifier was utilized to convert the power into AC 200V for supply to the compressor. To reduce the size of the inverter, a larger transistor (so-called giant transistor) was needed. The transistor was an important component for controlling via computer the circuit connecting the compressor with the inverter, and development of that transistor was done in cooperation with the engineers in the semiconductor division.

The compressor and inverter were nearly complete by the end of August 1981. The size of the inverter was reduced to one-third that of a commercial inverter, which was small enough to be mounted above the compressor in an outdoor unit of the residential air conditioner, and the cost was reduced to 40% of the original value. The engineers also worked through challenges in developing the refrigeration cycle. They gave up their summer holidays and worked naked in the heat as the factory had a power outage due to some renovations in progress, making prototypes, and checking their performance.

The product was finally completed in September 1981, and received a rave review after a press release on December 12, 1981. For the revolutionary innovation in the history of air conditioning technologies, Toshiba won the Ichimura Industrial Award in 1984 from the New Technology Development Foundation. The product was one of the first-ever registered as “One-Step on Electro-Technology” in 2008 by the Institute of Electrical Engineers of Japan.

Inverter Circuit

The "One Step on Electro-Technology" recognition awarded by the Institute of Electrical Engineers of Japan