SPECIAL EQUIPMENT FROM AN OPERATION IN CRISIS SITUATIONS POINT OF VIEW, THE RESULTS ACHIEVED ON PARTICULAR EQUIPMENT

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Abstract

Operation of special equipment is possible in crisis situations. It is because special equipment is designed for operation in non-standard often extreme conditions and situation. Today, everyone tries to become independent [1] with regard to persons and load transportation and number of cars increases and their comfort improves. Almost all cars are equipped with heating, ventilating and air conditioning systems [2] which make effect on environment as the cars destroy an ozone layer because of refrigerants as chlorofluorocarbon and hydro fluorocarbon used for air-conditioning and refrigeration. Other minuses of present heating, ventilating and air-conditioning systems include a significant reduction of driving range [3] of the vehicle, as a compressor is driven by the crankshaft of the engine. Maintenance and repairing cost of this system is very high.

Keywords: Peltier element, cooler, thermoelectric features, current, semiconductor

1 Introduction

This paper is seeking to overcome the demerits by replacing the existing heating, ventilating and air-conditioning system [4] by a long ago known thermoelectric couple which works on a Peltier effect. Thermo electric cooling can be considered as one of the major applications of thermoelectric modules (TEM) [5] (Fig. 1) or thermoelectric coolers (TEC). The main objective of this project is to design a cooling system installed on a conventional car ventilating fan [6]. The idea of cooling is based on Peltier effect, as when a direct current flow through TE modules it generates a heat transfer and temperature difference across the ceramic substrates causing one side of the module to be cold and the other side to be hot. The purpose of the project is to make use of the cold side to cool the ambient air to a lower temperature, so that it can be used as a personal cooler and to decrease a load of the system.

2 Generally, about a Peltier element

Cooling with a Peltier element belongs to an alternative method of cooling. A French physicist Peltier as far back as in 1834 took a think about a well-known Seeback's phenomenon. When two conductors made of different metals are connected in a close circuit and they have a different temperature, then electric current occurs in a circuit. Such connection is called a Seeback circuit. Peltier found out, that this phenomenon can be used vice-versa. If direct-current is driven into Seeback circuit, then there is a heat difference between both links. A Peltier element is based on this finding. It is formed from two semiconductor elements and a conducting bridge. Special materials (bismuth- telluride), are used as semiconductors, that have suitable thermoelectric properties, namely a low specific resistance and a low heat conductivity [7]. Copper having a low electric resistance is used for connecting links. When several elements are connected (Fig. 2), [8] so called thermo battery is created. Thermoelectric effect covers three different identified effects namely; the Seeback effect, Peltier effect and the Thomson effect. A thermoelectric device will create a voltage when there is temperature difference on each side of the device. On the other hand, when a voltage is applied to it, a temperature difference is created. The temperature difference is also known as Peltier effect. Thus TEC operates by the Peltier effect, which stimulates a difference in temperature when an electric current flows through a junction of two dissimilar materials. A good thermoelectric cooling design is achieved using a TEC, which is solid state electrically driven heat exchanger. This depends on the polarity of the applied voltage. When TEC is used for cooling, it absorbs heat from the surface to be cooled and transfers the energy by conduction to the finned or liquid heat exchanger, which ultimately dissipates the waste heat to the surrounding ambient air by means of convection. Thermoelectric generation bases on the fact that in electrical circuit consisting of different materials, connected in series, an electromotive force emerges when contacts are maintained at different temperatures. Such circuit, composed of two different materials (semiconductors of n-and p-type conductivity), is called a thermocouple or a thermo element. The device usually consists of tens or hundreds of thermo elements, connected in series.[9]

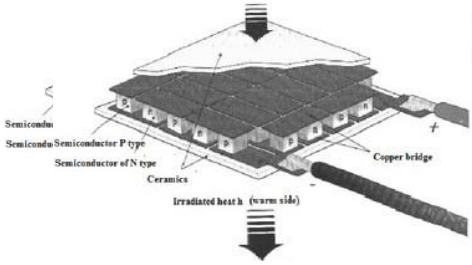
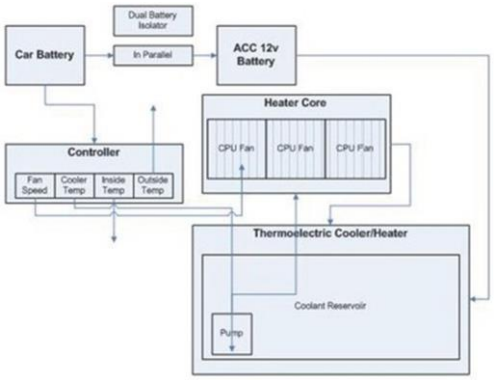


Fig. 1 Cutaway of a thermoelectric module

Fig. 2 Peltier elements composed in a cascade TE assembly with cooling capacity of 67W with 12 V nominal voltage

2.1 Temperature control with Peltier systems

Peltier systems are the temperature devices for a broad range of applications. The systems feature high heating (Fig. 3) and cooling rates (-40 °C to 200 0C) and excellent temperature accuracy. A Peltier cooler heater or thermoelectric heat pump is a solid-state active heat pump which transfers heat from one side of the device to the other, with consumption of electrical energy depending on the direction of the current [10].[can also be used as a temperature controller that either heats or cools (Fig. 4)].



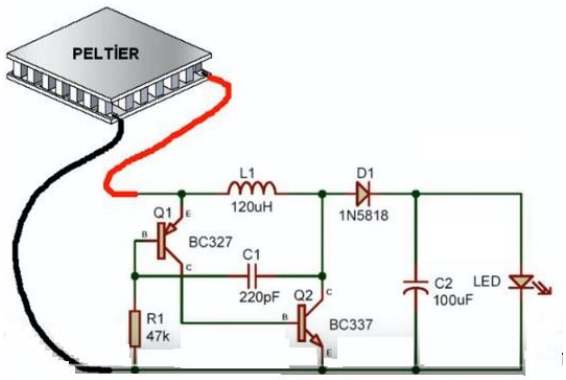


Fig. 3 Thermoelectric car air conditioner/heater

Fig. 4 Peltier- thermoelectric cooling box.

2.2 Heated/cooled thermoelectric steering wheel

Thermal comfort of vehicle occupants is an important aspect of the driving experience. Vehicle touch surfaces can gethot after being exposed to the sun. Existing steering wheels may reach temperatures that are well above the ambient temperature. Because the steering wheel may be exposed to more direct sun than other controls necessary for driving (e.g. ignition switch, shifter, brake, accelerator, seat cushions etc.), the steering wheel may be too hot to touch, thus preventing the driver from driving the vehicle until it has cooled. Traditional methods of cooling a vehicle interior space by air circulation involve opening a door or opening one or more windows. These known cooling methods require a user to be present for security reasons while waiting for the steering wheel to cool. Although it may be possible to remotely actuate a vehicle's air conditioning system in some instances, this is typically a very inefficient way to cool the steering wheel, (Fig. 5) and the steering wheel may still be too hot to touch for some time even if the cabin air temperature is comfortable. In view of the above, a need exists for an improved way to cool vehicle steering wheels. Also, if a user begins to use a steering wheel after it has been exposed to cold temperatures, the user may experience discomfort upon contact with the cold wheel. Although heated steering wheels have been developed, known heated steering wheels may suffer from various drawbacks due to limits in the amount of heat available to heat the steering wheel. There are many patented solutions dealing with a heated/cooled thermoelectric steering wheel supported with a Peltier device. A steering wheel includes a central portion connected to the steering column for rotation about an axis, and a rim extending around the central portion. A steering wheel includes a passageway extending through portions of the steering wheel. A plurality of

spaced apart rings are disposed on the rim, and a plurality of n-type and p-type thermoelectric elements are located on the rings. The thermoelectric elements may comprise Peltier devices in the form of relatively thin plate-like units having generally superficial opposite surfaces, and rectangular perimeters. An electrical conductor interconnects the p-type and n-type elements in series. The steering wheel includes first and second thermal conductors thermally connected to inner and outer surfaces of the thermoelectric elements. An air circulation device moves air through the passageway to cool the rim of the steering wheel.

Fig. 5 The set-up of the thermal steering wheel. The Peltier element can be seen on the left (red circle) mounted on a heat sink.

2.3 Air-conditioning in a car

In the cars with air cooled engines there is little room for conventional air compressors and therefore we are looking for electronic means of getting cooled air into the interior and Peltier devices could be a solution. There is about 2,5 m^3 so not a lot space is needed but with ambient external summer temperatures ranging from 30 ºC to 42 ºC and a large, almost horizontal windscreen, internal temperatures can get as high as 60 ºC.

2.4 Heated mirror

Heated mirrors (Fig. 6) on vehicles keep themselves free from ice and haze the same way the defroster keeps the windshield clear. A small amount of heat is applied to the glass surface of the side mirrors. The heat evaporates moisture on the glass' surface and melts any ice that has built up. Because of blind spots behind the car, the convex mirror can make a rear view more widely. Heating function is a basic function.

Fig. 6 A heated rear mirror

2.5 Advantages of a Peltier element

- No cryogen is needed. TEC modules can work constantly for hours. It contains no pollution or rotating components, which results in no noise and vibration, long life span and easy installation.

- Very short heating-up and cooling time due to small thermal lag in TEC modules. The maximum temperature difference will be achieved within one minute under the condition of good heat dissipation in hot side and no load in cold side.

- Thermal electric cooler is a kind of current-to-energy device. By controlling the current. High precision temperature control can be achieved. Plus temperature measurement and control, it is easy to make an automatic control system with the function of remote control, program control and computer control.

2.6 Disadvantages of a Peltier element

Thermoelectric coolers are constructed based on alternating junctions between n- and p-doted semiconductors. Subjected to electrical current, the desired heat flux will be generated (Peltier effect). However, the Peltier element's capacity to cool is not infinite: the more current the Peltier controller delivers, the more Joule heat is generated. This is a parasitic heating effect that will completely cancel out the desired cooling effect above a certain threshold [11]. In practice, this means that a thermoelectric cooler driven near its maximum current rating may hardly cool at all. However, if a more advanced TEC controller with DC output is chosen the Peltier controller is working at its nominal efficiency (85° C and more) and the Peltier module is working under optimal conditions.[11]

3. Conclusions

The authors in publication summarize results of research within the „Use of renewable sources of energy in practice“ project. System of modeling and computer-aided simulation of renewable sources of energy has been proposed within this project.

Application of a system for designing of power systems in logistic containers is expected. Peltier element is nowadays used in many ways as incorporated into thermoelectric modules. The parameters obtained from the devices used in car show that reduction of power used for heating, ventilating and air-conditioning systems in a car with Peltier elements is significant, the same relates to reduction of space needed for such devices. Moreover, Peltier elements are environment friendly. Such device is easy to mount even in home conditions however the costs for such assembly are almost the same as from factory. It is very important to take the size of temperature difference into account as this feature is important for operation.

Thermoelectric system working with Peltier elements is environment friendly, compact and affordable stability control system.

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