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Design and Estimation of Force Indices Pertaining to Mechanically Operated Refrigerator Door by Means of Pedal Lever

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A B S T R A C T

Refrigerators are becoming most frequently used device in modern time. The refrigerator serves all of these purposes, from keeping food fresh to cooling drinks and storing blood. However, sometimes the use of a home refrigerator is impractical, especially when working with grocery bags or large dishes without an extra hand to open and close the refrigerator door. The foot-operated refrigerator door opener and mechanical closure helps in opening and closing the refrigerator door, even if we are busy holding it with both hands. The foot lever refrigerator door opener uses a foot lever to activate the lock with a cable release mechanism. A torsion spring attached to the refrigerator door hinge opens the door. and closes the door after the termination of job. The present research paper focus on achieving opening and closing of refrigerator door by mechanical foot operated lever. Then calculation of force needed to be countered during opening and closure process was performed within its safe design limits.

Keywords: Door, foot lever, hinge, pedal, refrigerator, torsion spring.

1. Introduction

Refrigerator is a most commonly used household and commercial equipment which helps us to store variety of products like food, chemicals etc. [1] While operating a refrigerator with a wide variety of stuff it becomes cumbersome for the operator to open and close the refrigerator door without an extra helping hand. In order to eliminate this problem, the design of foot lever operated refrigerator door opener and motor operated closure is being purposed. The design contains four basic elements other that a refrigerator viz, foot lever, lock, cable opening assembly, torsion spring and an electric motor, one touch relay switch. With the help of these additional equipments to an existing refrigerator the opening and closure of the refrigerator door can be made semi-automatic, which can help in reducing the effort of the user to open and close the door and properly and safely place and extract the stuff from the refrigerator. The design also helps in eliminating the requirement of a helping hand to open, close and hold the refrigerator door during the time of operation.

2. Literature Review

The door opening device for the refrigerator, provided by the invention, comprises an operation detecting device, a human body sensing module and a control module, wherein the operation detecting module is configured to generate one or more operation signals according to the external operation at the front part of the operation detecting module [4].The operation detecting module is started when the human body stands nears the refrigerator, and is used for detecting the operating action of a user to open the door, and further the mistaken operation for opening the door can be prevented when the user can make an operation of opening the door at a distance place; or a door body is only enabled to be opened when the user stands nearby the door body.The refrigerator is provided with a somatosensory detector and an ultrasonic sensor which face towards the front area of the refrigerator. The opening method for the refrigerator door body comprises the steps that the front area of the refrigerator is detected through the somatosensory detector to judge whether a user appears in an area away from the refrigerator by a first preset distance; after the user appears in the area away from the refrigerator by the first preset distance, the ultrasonic sensor is started to obtain an ultrasonic signal reflected by the user, ultrasonic sensor is started to obtain an ultrasonic signal reflected by the user, the sensing range of the ultrasonic sensor is configured to be an area away from the refrigerator by a second preset distance, and the second preset distance is smaller than the first preset distance; and after the ultrasonic signal is obtained, a power-assisted switch assembly of the refrigerator door body enters a work preparing state.[5]The refrigerator is provided with at least one door body, and a touch screen for receiving touch

operation is arranged on at least part of the door body. The door opening control method of the refrigerator comprises the following steps that after the touch screen is lit, operation information for indicating operation action applied to the touch screen is received; whether the operation action is valid or not is judged according to the received operation information; if the operation action is valid, after the operation action ends for a first preset duration, an automatic door opening signal for indicating the opening of the corresponding door body is output according to the operation information; and the corresponding door body is driven to be automatically opened according to the automatic door opening signal.The refrigerator includes: a user detection sensor provided at a first side of at least one door and detecting a user located in front of the door, the user detection sensor at the first side of the door being arranged to incline by a predetermined angle toward a center line of a width direction of the door.The user detection sensor may detect the presence of the user in front of the refrigerator, and when the user is detected by the user detection sensor, a button device manipulated to automatically open at least one door, or to automatically lift a container provided in the door may be activated. [6] Door-in-door refrigerators are becoming increasingly popular on the market. To save energy, items that are most frequently used are stored between.doors. Thus, only the outer door needs to be opened for access. This invention is used for standard energy performance laboratory tests for these kinds of refrigerators. In conjunction with an automated refrigerator door opener, it allows the refrigerator door opener to open either the outer door only or both inner and outer doors together.[7]

3. Research Methodology

In a google search we can find that there are some proposed technologies which helps us open the fridge door when both of our hands are employed in material handling. These technologies dates back to 1950's, the first one being proposed by General Electric Company. Hoshizaki Europe and Gram. Commercial proposed a pedal opener with some innovative benefits like the is reversible foot pedal. All these technologies were studied and analyzed. It was found, that all these technologies focused only on opening the fridge. There were no provisions to close the door in case we are extracting something out from the refrigerator. In such a situation a refrigerator door should not be closed with the help of foot jerk as it can be dangerous, and makes the door dirty as well as can make the operator's body imbalance which may result in material to fail.

3.1Construction and Working of Equipment

The design uses a household refrigerator, in addition to a manufactured refrigerator, the following basic equipments are required to construct a working model.

3.1.1 *Foot Lever and Lock Assembly*

The function of the foot lever is to pull the cable assembly. The lock holds the refrigerator door in closed position unless the foot lever is pressed.

Fig 1- Foot lever

Fig. 2- Lock Assembly

3.1.2 ***Torsion Spring***

The torsion spring operates as soon as the lock is released and opens the door till the required opening angle or position. The open position of the door can be managed by attaching a stop at the hinge side of the refrigerator or using a spring of the required tension by calculating the weight of the door. The operation can be repeated the number of times we need to operate the refrigerator.

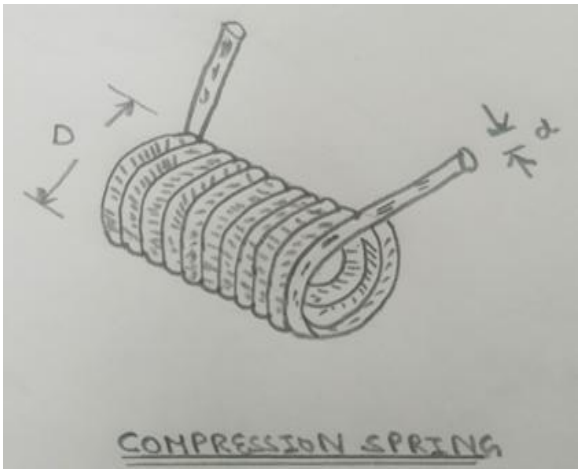

Fig.3-Compression Spring

Keeping all constraints into consideration an initial layout of model to be put into analysis can be framed as Fig.4

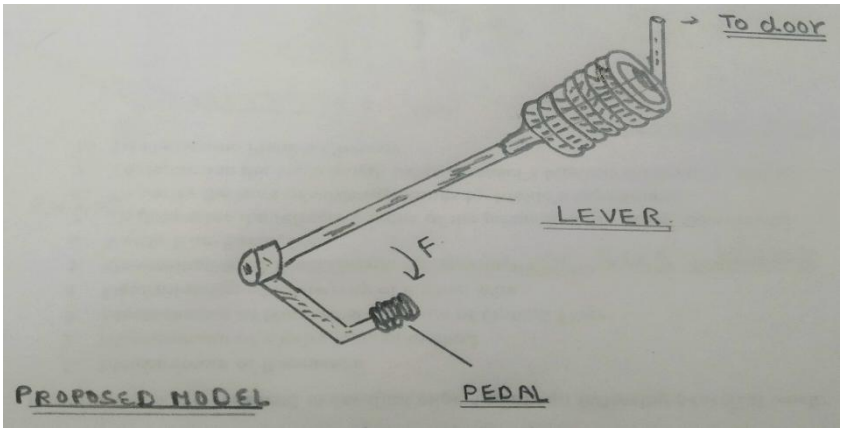

Fig 4. Proposed model of pedal lever assembly

4. Design Procedure

Assuming Parameters of normal domestic refrigerator (Single door) having single door, which is to be operated by user made of Aluminium with following dimensions

Height of Refrigerator door, h= 1.7m

Width of refrigerator, b = 0.7 m

Thickness of Aluminium Sheet of door, t = 0.002m

Density of Aluminium ρ = 2710 kg/m^2

Value of Acceleration due to gravity, g = 9.8 m/s^2

Total mass of Refrigerator door M is given by

M = Volume x Density

M = l x b x t x ρ

= 1.7 x 0.8 x 0.002 x 2710

= **7.372 Kg**

Also, door consist of plastic lining containing shelves weighing approx. 1.5 kg

Net mass of door = 7.372 + 1.5 = 8.872 Kg

Hence net weight W of door exerting force F given by

W = Mass x Acceleration due to Gravity

= 8.872 x 9.81

= **87.034 N**

Hence for operation of opening and closing of door the effort required will be **P = W = 87.034 N**

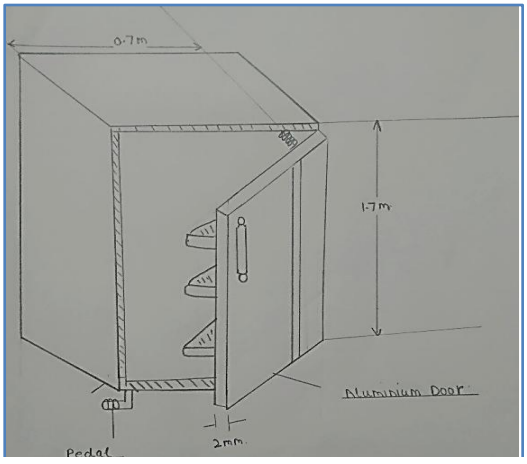

Fig .5- Proposed Design of refrigerator under Analysis

Now it is proposed that this effort will be provided be compression spring connecting foot lever to door. Assuming material of spring as Stainless Steel, SS-304 with following properties

Modulus of Rigidity, G = 84GN/m2

Modulus of Elasticity, E = 210 GN/m2

Shear Modulus τ = 80 GN/m^2

Spring index S = 7

Spring constant K= 200N/m^2

Net moment exerted by user in operating the pedal is given by the relation

T = P x l , where P is Force applied by user

= 87.034 x 0.7

= **60.93 Nm**

l = length of pedal or lever arm

If T is the net moment to be exerted by user, then diameter of Spring wire, d is given by the relation

$T = [\pi/16] \times d^3 \times \tau$

$d = [16T /\pi \tau]^{1/3}$

$= [16 \times 60.93/ 3.142 \times 80 \times 10^9]^{1/3}$

$= 1.57 \times 10^{-3}$ m
= 1.57 mm
Therefore, diameter of spring wire needed is d = 1.57 mm
Let us take values of Spring index S = 7
Now diameter of Spring **D = S x d**
= 7 x 1.57
= 10.99mm, **say 11mm**
This force or effort is to be provided by spring within certain deflection δ given by the relation
$\delta = 8PS^3/GD$
$= 8 \times 60.93^3 / (84 \times 10^9 \times 11 \times 10^{-3})$
= **1.96 mm**
The required stiffness in spring will be
s = P/ δ
= 60.93/1.96
= **31.087 N**/m per m
Now maximum stress σ, spring can carry is given by the relation:
$\sigma = 0.75 / d^{0.2}$
= 3.04 MPa
= **0.34 N/mm^2**
This value is within safe loading limits of permissible stress value of **0.38N/mm^2** for Stainless steel SS-304
Hence design is within safe limits

Future Scope

The technology is evolving day by day. The modernization in technology is helping the humans to explore more possibilities to make the human life comfortable. In this case the refrigerator door can be opened and closed by using hand gestures and we can also use a proximity sensor to operate the door.[2] These implementations can also help differently abled people to operate the door at their will according to their comfortability. In addition to this if we use rechargeable batteries to operate the circuit and the motor, we can also eliminate the constrain of using power supply from AC source. Moreover, modifications can be done to utilize the power output from alternative sources like invertor, solar light, etc.

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Disclosure of Interest

It is declared that there is no relevant or material financial interests of both authors pertaining to the research work. The data used in this research is proprietary in nature

REFERENCES

Anurag Bhardwaj, Sanjeev Gupta, Vageesh Baigra, Deeshant Jasrotia, Mohit Sharma, "*Foot Lever Operated Refrigerator Door Opener and Motor Operated Closure"*, GRD Journals, Vol. 3, Issue 1, Feb.2018, Page 44-46.
Musaab Hassan, Hammam Mahjoub, Mohammed Obed, "*Voice-Based Control of DC Servo Motor*", American J. of Engineering and Applied Sciences, Vol. 5, Issue 1, 2012, Page 89-92.
Prabhu.S, Sakulh Ameed, Suresh Kumar, Arun.S, "*Voice Enabled Speed Control of AC Motor*", International Journal of Research in Engineering and Technology. Vol. 3, Issue 2, 2014.
Bruno Fudge, "*Apparatus for opening and/or closing a door*", March17.2015.
R.S. Khurmi, J K Gupta. "*A Textbook of Machine Design*". 34th Edition. S. Chand Publications.
B.L Theraja, A K Theraja, "*A Textbook of Electrical Technology* Volume 2". 23rd Edition, S. Chand Publications.
Miao Jian Lin, Li Chunyang, Wang Ming "Door opening device, refrigerator and non-contact door opening method" 02 Jun 2015.
Yeom Tae Ji," *Refrigerator and control method* "2017.
Fully integrated soft closing convenience: requiring minimal installation space, www.hetich.com
J B Gupta, "*Electronic Devices and Circuits*". 6th Edition. S K Kataria & Sons