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Closed Cycle Thermal Engine: One Comparative Study for Battery Supply of Mobile Phones

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Abstract

The proposal here highlights the usefulness of cycle motors for use in the supply of mobile phones in locations far from urban centers, where the supply of electricity is poor or nonexistent. The perspective is to make a comparative study on the ability to charge the mobile device, even located in regions without signal from operators. The need for communication is a challenge, as rural people move to the city to negotiate their products, with the handsets charged as they approach the signal operators can already make their contacts and business. For this work the highlight is the Stirling combustion range type engine, as it has advantages, especially in terms of pressure. The research is a bibliographical study and developed in a qualitative way, observing the data available in the literature, as a starting point, making an analysis of the parameters related to the engine selection, specification making a compilation of data that explain the factors for the use of the same. The *works that address the theme show that they are easy to operate and build, allowing improvements that can be implemented with low-cost materials. The trajectory of using the Stirling engine is identified by the fact that it is obsolete, as it has limitations when compared to more suitable engines such as the Otto (1877) and diesel (1893) engines that showed higher power, which makes it possible to make adjustments for specific applications, and feature cost-effective functionality enhancements, making them more suitable and able to match Otto and diesel engines. The way to visualize factors that can corroborate the use of simple mechanisms, however, capable of solving punctual and social interest problems is the premise of this paper, discussing in the light of studies already presented, the solutions to such problems.*

Keywords: Combustion Engine. Smartphones. Power. Loads

Resumo

A proposta aqui destaca a utilidade de motores de ciclo para utilização na alimentação de aparelhos celulares em localidades distantes dos centros urbanos, onde o fornecimento de energia elétrica é deficiente ou inexistente. A perspectiva é fazer um estudo comparativo sobre a capacidade de dotar de carga o aparelho celular, mesmo localizado em regiões sem sinal das operadoras. A necessidade de comunicação é um desafio, uma vez que os habitantes das áreas rurais se deslocam para a cidade para negociar seus produtos, com os aparelhos carregados ao aproximam do sinal das operadoras já conseguem fazer seus contatos e negócios. Para este trabalho o destaque é o motor Stirling tipo Gama com combustão, pois, apresenta vantagens, principalmente quanto à pressão. A pesquisa é um estudo bibliográfico e se desenvolveu de modo qualitativo, observando os dados disponibilizados na literatura, como ponto de partida, fazendo uma análise dos parâmetros que tange a seleção do motor, especificação fazendo uma compilação de dados que explicitam os fatores pró a utilização do mesmo. Os trabalhos que tratam do tema mostram que são de fácil operação e construção, permitindo melhoramentos que podem ser implementadas com materiais de baixo custo. A trajetória da utilização do motor Stirling se identifica pelo fato de sua obsolescência, por apresentar limitações quando comparados com motores mais *adequados como o motor Otto (1877) e diesel (1893) que mostraram maior potência, o que permite se fizer adequações para aplicações pontuais, além da possibilidade de melhorias de funcionalidade com custos menos efetivos, tornando-os mais adequados e aptos a equiparar aos motores Otto e diesel. A forma de visualizar fatores que podem corroborar com a utilização de mecanismos simples, porém, capazes de solucionar problemas pontuais e de interesse social é a premissa deste trabalho, discutir diante de estudos já apresentados, as soluções para tais problemas.*

Palavras-chave: Motor de Combustão. Smartfones. Potência. Cargas.

INTRODUCTION

Today's technology is in all social environments, but for this technology to be efficient, electricity is required. This study brings, among other applications, the study on the application and use of a combustion engine to power the battery of cellular devices in regions with little energy supply or the lack of it, using a Gamma type Stirling engine with adaptations. The initiative proves to be relevant when observing the situation of the riverside populations that deal daily with the need to use cell phones to move their production and contacts with family members who live in the city. Many communities of the affluents of Rio Negro, such as the Tarumã stream, even some of them, having connection with the power distribution system interconnected to the city, has limitations to reach the community as a whole. This concern that permeates the current situation of rural communities, which is still an evident limiting factor in communication in the riverside regions, that even in the 21st century, electricity is limited, in some situations, local energy generators are very expensive, due to maintenance condition and the price of fuel is high and difficult to obtain, often the rationed use of electricity is insufficient, not counting with the populations that their homes are far from the agglomerations, as in places and residences producing agricultural inputs.

The observation of the factors that accredit the need to understand the logic that makes life difficult for these populations, since electrification is a vector of development, there is no way not to want to integrate the citizens of these regions to leverage their production and improvements in their lives. Public policies have even expanded to rural regions, but there is still a void that is hardly expressed in statistics.

This work intends to validate a more emergent look to mediate a problem that plagues the communication of the riverside communities, doing a thorough search on the use of the Stirling engine adapted to generate charges and power cell phones type smartphones, giving the riverside the possibility When approaching the city, your phone is charged and receives the signal from the operators to make your contacts with suppliers and buyers. In the face of such a situation that requires a more adequate view to subsidize solutions to problems that have extended for centuries in the riverside region of the Amazon. Electricity did reach riverside regions, but many localities still do not take advantage of this current, which is at the mercy of studies that can be verified and bring to the attention of the authorities the need for a more equal distribution of energy. However, while this integration is not promoted, actions such as the one described in this work promote an integration link between communities and technology.

The story reports that it was by the power of creation that Robert Stirling managed to invent the engine with this peculiarity, which was called "Stirling engine" (MEDINA, 2017; FARIA, 2018).This invention took place in Scotland, adding in the period of its discovery great advantages, since, the engine it invented proved to be relevant compared to the other discoveries of the time, the high point that accredits the engine as relevant is the pressure factor. As you can see, the discoveries come from a time and the perception of society in its experience, but with the advancement of technologies, these discoveries, which were once of social impact, are being abandoned and replaced by more robust ones, but there are It should be noted that even these technologies, considered absolute, tend to be used in situations where more creative capacity is required than the use of high-standard and very high-cost materials. In the case of the Stirling engine, a lot has been used to solve problems in isolated locations.

In the case of the starling internal combustion engine, even though it has been surpassed by more efficient ones, the technology and ways of operating the engine are still useful for point systems, in this case, people who do not have enough electrical energy, and who demand communication for conducting their work activities and communicating with family members, in this context, the sterling engine proves to be a possible option to subsidize the battery power of cell phones to facilitate access to the phone call, since when arriving in the city, it does not have accessible power sources port and fair locations. This paper seeks to discuss the factors that contribute to the development of regions that receive little assistance from the state and public policies aimed at local development.

EXTERNAL COMBUSTION ENGINE: A LOOK AT THE STIRLING ENGINE

The global energy crisis is spreading and forces society, through research and science entities, to seek more balanced solutions in the face of environmental problems, the use of technologies and other forms of energy generation moves the renewable energy initiative to those that show themselves efficient due to the abundant supply of resources. Currently, these alternative sources of energy are factors of much study and dynamism, because the alternative leads to thinking about a better treatment of the environment, offering a more dignified life, and options for better use of available technologies. It is known that the body dedicated to the balance factor on the planet has been looking for alternatives to reach more and more people, reducing the isolation of communities and seeking to integrate universal knowledge.

The technology does not reach all sectors effectively, for this reason adaptations must be implemented to minimize limitations that cause inconvenience to people, as is the case of riverside communities far from large urban centers. The generation of energy and the use of technologies are realities in the most varied social environments and the alternative where this generation is lacking is to use systems designed to solve localized problems with a specific focus.

Based on this need, it speculates ways of generating low cost and reasonable efficiency to produce solutions. The Gamma-type Stirling engine analyzed in this work is one of those alliances that prove to be efficient in difficult situations, since its functionality is easily accessible and its costs are reasonable to sustain the proposed load. History records that in the year 1816, Scotland, Robert Stirling invented the engine that received this name in honor of his patron. At the time of its discovery, the inclusion of an engine that proved to be safer than existing steam engines was widely celebrated, as the basic principle of its operation was due to the low level of pressure.

Regarding the Stirling engine, (BARROSI, 2001) in his studies describes that its most commonly used use occurred until the middle of the year 1920, a period of discovery of new electric, internal combustion engines that made it out of competitiveness. With new roles and functionality standards that mirrored the new engines, the Stirling engine had a limited production scale, as the industry prioritizes the large-scale production of products that enhance advantages, in the case of the stirling engine, problems such as difficulties in sealing cylinders, for example, was a serious impediment, since the allocation of materials adapted to suit the operation generated costs and dedication in studies, therefore, in a competitive universe, problems that hinder the operation of the engine under pressure and high temperatures.

As time went by and the discovery of new engines, the use of srtiling engines was less attractive, as highlighted (HIRATA, 1995) than the Otto engine, invented in 1877 and diesel in 1893, were more effective due to the power that the large-scale use of the stirling engine (DRUMOND, 2017).

But what is the reason for using an engine that has historically been abandoned due to structural and power impediments? The reason is obvious, within a range of solutions that problems are detected, engineering has to seek solutions, so combining the condition of simple functionality and the low cost of adaptation, Stirling engines receive special attention in the academic class, as many works are executed to show the applications of such engines as highlighted (BARROS, 2004); (WILKE, 2004); (BARROS, 2005); (SANTOS, 2012) among others that highlight the applications of Stirling engines in diverse sectors always focused on solving specific and versatile problems, since the combination of lower manufacturing cost and the ratio of the generated power that does not reach the level of internal combustion engines, but that are sufficient to generate solutions in adapted systems.

The use of innovative materials, such as stainless steel, the advancement of studies in the area of engineering and materials led to the development of cheaper and more efficient engines, as for the Stirling engine, as reported (BARROS, 2018) after the Second World War, these many mechanisms have corroborated for the explanation of the operation of the engine cycle, triggering technologies more adapted to increase the capacity of and diversify the use of fuels, which made its use attractive again.

For the use of the Stirling engine, the advantages that can be noticed by its use, some that are presented in the works (DIAS, 2016) and (CAETANO, 2018): The Stirling Engine is quiet, vibration-free, due to the interior there are no explosions, so regular maintenance is not necessary; it is less polluting when compared to internal combustion engines; the generation of energy occurs by fuel that manifests a constant heat source; it has a high fuel diversification capacity; in its operation the internal wear is relatively low so the consumption of lubricating oil is also minimal; another advantage is the possibility of different physical arrangements, allowing to diversify the forms of operation; these arrangements can generate a wide energy efficiency value and its entire structure is simple, allowing the use to be uncomplicated and suitable for adaptations.

(VIDAL, 2012) and (DIAS, 2016) the disadvantages for using the Stirling Engine can be considered the initial difficulty of rotation, since the existence of great variation of instantaneous movement, which makes its installation in vehicles unfeasible, for example; Another limiting factor is the sealing system, as it needs punctual sealing of the chambers that accommodates the working gases, otherwise the contamination of the gas by the lubricant, can compromise the operation, since the performance of the Stirling engine develops around the gas pressure, which knowing the isobaric principle, if the pressure is high and the seal must withstand a high force, therefore the difficulty of sealing perfectly; in addition to the factors mentioned, cost may be a disadvantage, since these engines are no longer used.

HOW DOES THE STIRLING ENGINE WORK?

For this discussion, it is necessary to understand who the drivers of Stirling Engines are, how they are classified, among other aspects. So, according to the cylinders and pistons, the Stirling engines can be of the Alpha, Beta and Gamma type (BEATO, 2018). As for the basic operating mechanism, Stirling motors in general have a dynamic operating mechanism that steam engines of the time of the invention, which motivated their inventor to improve the engine's performance, thus proposing the insertion of a thermal regenerator with the function of a regenerative heat exchanger, this mechanism would be responsible for the storage and transmission of heat endotherms to the working fluid during the cycle, thus sustaining an improvement in performance (DIAS, 2016).

Among the diversity of Stirling engines, the Gamma type engine was selected for this study because of the difference in configurations, when compared to the Alpha and Beta types that are widely discussed in numerous studies (SILVA, 2019); (PEREIRA, 2015); (BUOSI, 2016). The peculiarity that motivated the choice of the range type motor is that it presents simpler aspects, among them the highlight is a working piston, a displacer. Figure 1 shows the configuration diagram for the Gamma-type Stirling engine.

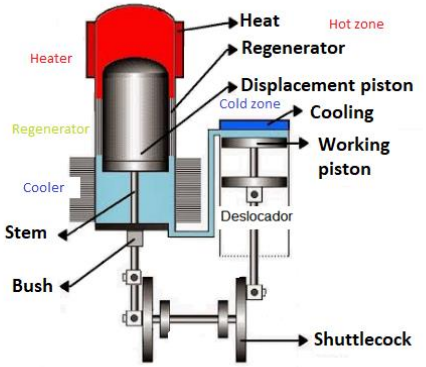

Figure 1. Gamma type Stirling Engine configuration system.
Source:https://images.app.goo.gl/n4R4UBWm. 2019 (adapted)

The detail that identifies the criteria for choosing the gamma engine is that the displacer is installed in the cylinder that has at its upper and lower end, the heat exchangers for heating and cooling, in that same order and interconnects to the other cylinder, thus working piston is installed. When looking at figure 2, it highlights the simplicity of the gamma-type stiling engine that has a similar structure to the beta type, but with the pistons mounted on different cylinders.

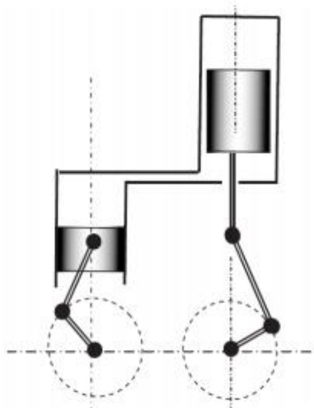

Figure 2- Basic diagram of the Stirling type engine.
Source: Dias, 2016.

Regarding the functional aspect of the gamma-type stirling engine, DIAS (2016) points out that the displacer moves towards the upper dead center making the fluid migrate to the cold cylinder. When moving the working piston, the movement displaces the fluid towards the upper dead center by compressing it and prevents the entry of heat to the cold source, when the working piston reaches the maximum of the dead center displacing the fluid, it is preheated in the regenerator, only then is it released into the expansion space. As for the gas, it undergoes expansion, since the heat received from an external source causes the work that acts on the piston to be carried out, moving it towards the bottom dead center. The displacer that moves towards the upper dead center forces the fluid to pass through the regenerator where it is pre-cooled, giving heat to the regenerator. The entire function of the Stirling Engine is performed as a production work production, as it happens from a change in the temperature of the gases depending on the variables that act on it, and as the temperature changes and the expansion of the gas volume happen, it generates the work effect, caused by the manipulation of valves. In the cooling and heating of the gases, the alternation that is caused triggers a citrus contraction and provides an expansion of the system, making the engine run, working through a thermodynamic cycle related to four phases and these phases are executed in two pistons. and as the temperature changes and the expansion of the volume of the gas happen, it generates the work effect, caused by the manipulation of valves. In the cooling and heating of the gases, the alternation that is caused triggers a citrus contraction and provides an expansion of the system, making the engine run, working through a thermodynamic cycle related to four phases and these phases are executed in two pistons. and as the temperature changes and the expansion of the volume of the gas happen, it generates the work effect, caused by the manipulation of valves. In the cooling and heating of the gases, the alternation that is caused triggers a citrus contraction and provides an expansion of the system, making the engine run, working through a thermodynamic cycle related to four phases and these phases are executed in two pistons.

According to BARROS (2004), FERNADES (2010) and DIAS (2016) the principle of operation of the Stirling engine is based on a closed cycle, where the working gas is kept inside the cylinders and the heat is added and removed from the space through the walls of these cylinders. In isothermal compression(A → B) the displacer moves in the direction of the upper dead center, displacing the fluid to the cold cylinder, followed by the working piston that moves towards the upper dead center, compressing the fluid that prevents the heat from migrating to the cold source; in isochoric heating (B → C), the working piston reaches its maximum in the upper dead center causing the fluid to be moved to a preheated one in the regenerator and only then is it led to enter the expansion sector; in isothermal expansion (C → D) when receiving the heat from the external source, the gas expands and performs the work on the piston, moving it towards the bottom dead center; and in isochoric cooling (D → A) the displacer when moving towards the upper dead point triggers the passage of the fluid through the regenerator providing a pre-cooled, The thermodynamic processes that the gas passes through the cylinder are shown in figure 3, demonstrating the relationships they demand in the engine's operating cycle.

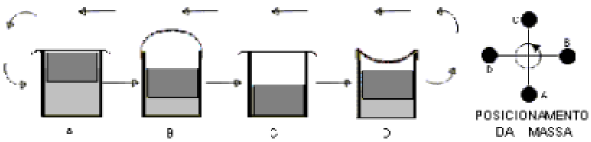

Figure 3- Schematic representation of the thermodynamic cycle.
Source: Fernandes (2010).

According to CULP (1991); MORAN (1995) and FERNADES (2010) the cycle consists of four internally reversible processes - processes in which the system and the neighborhoods can return to their initial state after completing the cycle - two isotherms and two at constant volume:

A → B: Isothermal expansion at constant temperature (temperature of the hot source from which it receives heat).

B → C: Cooling at constant volume

C → D: Isothermal compression at constant temperature (cold source temperature, where it loses heat)

D → A: Heating at constant volume

The form of functionality of the Stirling engine is a strong motivator for use in systems that need engines adapted to generate energy due to its easy mechanism and good results. There are no limits for areas of application of Stirling engines, which range from power generation to more complex systems, applied in agriculture, livestock, among others.

ENGINE STIRLING, COMPONENTS AND RELATIONSHIPS.

Here the particulars of the motorcycle are shown, because basically whatever the type, there are patterns of main components for the operation, these parts are essential for the use of the engine. As for the Stirling engine, it consists of a structure assembled with two piston chambers, and the gases that will produce the work are confined within one of these chambers, these gases go through different processes, the cyclical expansion, cooling, compression and heating being activated by an external heat source. This gas undergoes displacement and this alternating movement between the pistons transmits a form of force that activates the crankshaft, which when moving converts thermal energy into mechanical energy.

This simple and dynamic engine is formed by several combinations that can be highlighted: the regenerator, the heat exchangers and cooling heating, working pistons, crankshaft, shifter, connecting rod and steering wheel. These components are sufficient to generate energy from the work of the displacing gases. From the perspective of the Sterling engine's operation, the regenerator is the component capable of storing heat during part of the cycle and in the rest of the process, which enables the return of the confined gas in the chambers. In this way, the matrix of the regenerator absorbs heat from the working fluid, by heating, before it moves to the cold zone and consequently, and when the cooled fluid returns to the hot zone, the regenerator itself is responsible for delivering the heat to the fluid (VELAZQUEZ, 2007).

In the aspect of heat exchange for heating and cooling, LLOYD (2009) points out that the cooler is responsible for the heat exchange that dissipates from the fluid during the compression period. Cooling is generally done by the presence of air, by the exhaust cavities, or, when convenient with running water, the form of cooling can be done in a free or directed way, but the heater is in charge of transferring heat from the external source to the working fluid during expansion.

The gas transition process and the relationship with pressure are necessary to allow the proper exchange of heat and the exchangers must have a dynamism between volume and surface, as an amplifying factor, since the contact of the fluid with the surface of the exchanger can trigger factors that interfere with the motor cycle, in the event, the dimensioning of the relationship between surface and volume, must be adjusted so that the sections of the exchangers acquire a small diameter causing the pressure drop inside the exchangers due to the friction of the fluid, causing loss of pumping.

Regarding the work pistons, the energy generated by the useful expansion is used to perform the compression of the fluid, since it is located in the cold zone of the engine and in the shape of quality sealing rings around it to prevent gas leakage. The displacer, on the other hand, is able to move the working fluid from the hot to the cold zone, in this displacement space it is convenient to establish a temperature gradient due to the presence of impact from divergent sources. Regarding the crankshaft or crankshaft that is characterized as the central axis of the engine, it receives the force generated by the movement of the pistons and converts it into torque, and providing the rotation of the shaft, this in turn, receives numerous options, since that its tendency is to undergo torsions and flexions which culminates in the vibration in its movement.

Another important component is the connecting rod whose role is to transform the linear movement of the piston and displacer into rotational motion to the crankshaft, since the piston and displacer are interconnected to the crankshaft through the connecting rod, has a strong tendency to lag around 90 ° to each other. What seems to be acceptable, when LLOYD (2009) indicates that the output power does not present a maximum value for the lag angle set at 90 °.

When driving, this mechanical component is capable of storing kinetic energy of rotation and minimizes the impulses caused by the pistons on the crankshaft. In the expansion process, it is the flywheel that accumulates energy and then releases it to execute the other time intervals in which the engine does not produce energy, this accumulation of energy favors the increase in angular speed. Thus, when the load is connected, the steering wheel makes part of this accumulated energy available to the load, thus, its speed is reduced. Figure 4 highlights the image of a Stirling engine type gamma assembled and working, for the detail it is possible to verify the simplicity of the system which motivates the studies on the application of this type of engine in point and problem solving systems.

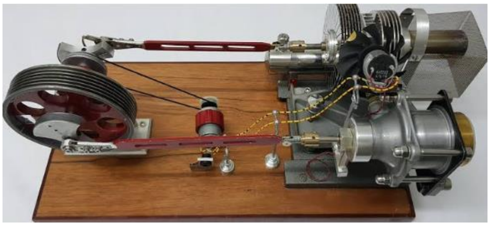

Figure 4- Image of a Stirling engine type gamma in the functionality platform.
Source: Quintela, 2017 (adapted).

The motor is usually modeled observing the specifications and operation mechanism, the model described above refers to a standard, which when applied can generate enough current to power a cell phone, it implies that certain adjustments are made. According to the works highlighted in the banks of journals and in the literature, the studies lead to understand the importance of studies related to the stirling engine, what highlights the gamma type engine is the simplicity of operation, but in general the stirling engines can be used in various applications. Like this; SILVA (2019); SANTOS (2015) ;; DIAS (2016); CRESTANI (2016); MEDINA (2017); BUOSI (2016); DE FREITAS LIMA (2017); BEATO (2018); CRESTANI (2016). and other works highlight that stirling engines are very versatile and possible for different applications.

Based on the information that weaves the capacity to adapt to stilirling engines and their variations, the literature highlights that they are widely studied and compared with more recent systems, both in terms of power, cost benefit, adaptations and combinations, sustainable use of fuels and others . Technology and advances in science allow professionals, with a creative and adaptive capacity, to take advantage of materials or devices considered obsolete, for useful and impactful applications for people who do not receive assistance from the state as it would be, either due to geographical difficulties or to ineffective distribution of public policies on an equal footing.

The form of functionality of Srling engines is the attractive factor in its choice for studies and applications, since the thermodynamic factor can be dynamized and recombined to produce better efficiency and diversified applications. It highlights that:

The structuring of the Stirling engine shows that the range engine incorporates both alpha and beta engines. Figure 5 highlights the scheme that compares the types of engines.

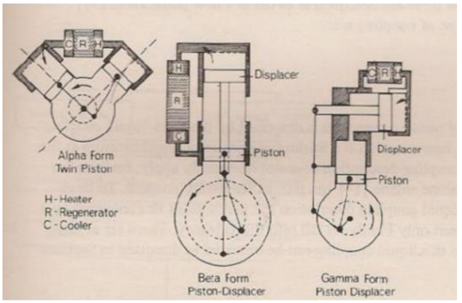

Figure 5. Design of the three types of Stirling engines: alpha type, beta type and gamma type.
Source: (HOOPER and READER, 1983).

Given this scenario, it stands out because the Stirling engine was selected for the work, because it has intriguing characteristics that allow adaptations and the exercise of tests for different applications, valuing the capacity of professionals in the way of creating, resizing and streamlining processes.

EMPLOYED METHODS

A qualitative methodology was used in this study, with documentary characteristics, as it aims to compare the capacity of using the gamma-type stirling engine in cell phone charging, with the work being divided into stages:

1. Theoretical survey about the Stirling engines, with emphasis on the Gama type, a little of its trajectory and the use in academic reference works, as a way of supporting the use of technology and the comparison of the pro and contra factors of its application.
2. Description of the Stirling engine, comparing the data in the application test literature to verify the behavior of the engine and the load generation vrification within the need to be subsidized, the study focused on how to verify the sufficient voltage generation capacity to support the cell phone battery charge. Among the provisions and tests, some were shown to be inefficient, as they did not reach the expected and sufficient voltage to maintain the charge in the battery, but other attempts were shown to be promising, since, in the works, the system as thought, almost always, requires

adaptations, the motor with the best condition to maintain battery charge was selected. In that case it was necessary to analyze the specification of each engine, observe its tension meticulously, as charging the phone requires a minimum voltage of at least five (5) volts. Once these guiding aspects are verified, it is possible to select the Stirling engine capable of generating an output rotation on the steering wheel axis, satisfying the minimum voltage to ensure the battery's battery charge stability.

3. Once the engine was chosen, works were searched in the literature that boosted the need to identify persistent problems, study them and correct them. After sanctioning these adjustment steps, perform new tests, monitoring the current flow, making the necessary adjustments and improvements, aligning the mechanical and operational components, among other aspects. In order to discuss the action points in the system, the stirling engine is considered enabled to generate the energy capable of maintaining the necessary charge in cell phones. This work seeks to integrate a pattern analyzed in published studies and to analyze the results, comparatively, in devices of various shapes and characteristics in order to reconcile the ways of feeding and maintain the load in different devices.

RESULTS AND DISCUSSION

As seen in Figure 4, the Gamma-type Stirling engine is the result of component testing and analysis, and as it is an improvement in the usefulness of a device, the studies consulted show that there was a lot of variation in the results, for this reason it is necessary to produce an appropriate layout for each application to be inserted, as this work tends to raise arguments for organizing a motor with the capacity to maintain charge in cell phones type smartphones.

Observing the applications related to the sterling engine in this area of cell phone battery maintenance, highlights the work of MENDONÇA (2017), SOUZA (2018) because the engine presents functional problems, but other authors such as BARROS (2004, 2005); DIAS (2016); WILKE (2004); MAIA (2018) highlight that the applications of Stirling engines are made possible for various applications, whether in power generation, automotive processes, among others.

In this proposal, it was evaluated the application of the gamma-type stirlig engine for charging cell phones, from the bibliography consulted it was seen that, initially, the tests show results that did not support the predicted, since the engine may present problems related to the operation, requiring adjustments, but by the principle of functionality the parts form possible suitable arrangements, to make improvements in the cooling of the engine, for example. Regarding the voltage generated, the literature reports that the capacity generated initially does not support the load for a certain time, pending on the smartphone's battery support, it is understood that the radiator does not work correctly, compromising the system generating disordered heating, the opposite effect the results obtained, studies and application reports were consulted and it was found that, in the case of work to adjust the load, a battery with a voltage of 9 volts SOUZA (2018) was added. The result was that the system unlocked and the system was cooled, providing a load to maintain the device. SOUZA (2018) reports that the device was plugged in for a few hours and the charge was being added, but when the device was disconnected from the source, the charge slightly drained. If the system was adjusted again, the voltage was measured again and the cell phone was put back on charge and the available charge remained within a short period of time, not being efficient in the molds of the engine that had been designed for the activity.

This work proved to be challenging, since it intends to present solutions, based on experiences reported in the literature, for the use of stirling engines for charging cell phones, it does not have the character of testing the target engine of the work, but demonstrating its application flexibility and comparing the highlighted results. The analysis in the results showed that the engine generates a load that oscillates around 3.0 to 4.0 volts, as mentioned in the theory, it is known that to maintain the charge of a cell phone it is necessary at least 5.0 volts. It is highlighted in most studies that, when returning to the bench to study the factors that limit the generation of an efficient load, again new studies are readjusted and with the identification of the engine's flawed points, new arrangements and tests are promoted. With the disassembly and assembly of the system again, it is possible to organize the system by aligning the points of possible weakness, which have been highlighted, in terms of the disadvantages of the Stirling engine identified, due to the internal pressure being below the expected levels and that the work performed does not effectively support the load. For the works of SOUZA (2018); and MENDONÇA (2017) highlight that the results were surprising, since the engine was able to generate enough energy to feed the load of the system that was targeted for care, in the case of the cell phone, which when disconnected from the source remained for a relatively safe time. It is reported that in the tests several problems still arose, such as heating engine parts, water leakage and others, but which were solved as the system was monitored. in terms of the disadvantages of the Stirling engine identified, due to the internal pressure being below the expected levels and that the work done does not effectively support the load. For the works of SOUZA (2018); and MENDONÇA (2017) highlight that the results were surprising, since the engine was able to generate enough energy to feed the load of the system that was targeted for care, in the case of the cell phone, which when disconnected from the source remained for a relatively safe time. It is reported that in the tests several problems still arose, such as heating engine parts, water leakage and others, but which were solved as the system was monitored. in terms of the disadvantages of the Stirling engine identified, due to the internal pressure being below the expected levels and that the work done does not effectively support the load. For the works of SOUZA (2018); and MENDONÇA (2017) highlight that the results were surprising, since the engine was able to generate enough energy to feed the load of the system that was targeted for care, in the case of the cell phone, which when disconnected from the source remained for a relatively safe time. It is reported that in the tests several problems still arose, such as heating engine parts, water leakage and others, but which were solved as the system was monitored. For the works of SOUZA (2018); and MENDONÇA (2017) highlight that the results were surprising, since the engine was able to generate enough energy to feed the load of the system that was targeted for care, in the case of the cell phone, which when disconnected from the source remained for a relatively safe time. It is reported that in the tests several problems still arose, such as heating engine parts, water leakage and others, but which were solved as the system was monitored. For the works of SOUZA (2018); and MENDONÇA (2017) highlight that the results were surprising, since the engine was able to generate enough energy to feed the load of the system that was targeted for care, in the case of the cell phone, which when disconnected from the source remained for a relatively safe time. It is reported that in the tests several problems still arose, such as heating engine parts, water leakage and others, but which were solved as the system was monitored.

As observed in the reports of the works highlighted in the literature, it is that the result presented problems, initially in the tests, that it is always possible to realign and resize the problem points to improve solutions. The points of greatest problems are related to pressure, as it promotes the amplitude of the loads, since, whatever the situation that allows the pressure loss reduces the efficiency of the engine, then, it stands out that adjusting the factors, the sealing system the engine generates an attractive result, generating enough energy to charge the cell phone and applicable in different situations.

For this study it is based on how to produce enough charge to charge a cell phone in distant regions, but there are a multitude of applications where the presence of an adjustable motor can solve problems. The beta-type Stirling engine is flexible and allows students, professionals to produce adjustments that can be applied in indefinite situations, as it depends on the professional's eye to direct the applications.

CONCLUSION

This work shows a search for understanding the use of the Stirling engine of the gamma type to power the cell phone battery, for this purpose it searched in the literature works that tested the efficiency of the Stirling engine for power generation to solve a very peculiar problem in the region Amazon, since it was observed in the literature, little activity that highlights the use of such mechanisms to solve problem situations. The choice of the Stirling engine was due precisely to the fact that the literature reports functionality problems, but that shows its applications in various environments achieving certain efficiency, therefore the motivation to understand the functionality of the machine, understanding the factors that make the engine explicit, based on the specifications already known to solve a problem. But what is the difference of using a system that has been tested before? As processes that were limited by problems are questioned, their improvement becomes challenging. In this proposal, we sought to question the defects and advantages by comparing the ways of using the engine and its diversification. The idea is to streamline the failures and that discussing new solutions, such as a route, faced the challenge of poor engine functionality, serious structural problems that stand out from the situation that it is intended to achieve, it is up to engineering to question, discuss and seek solutions. But the role of the engineer is to visualize the challenge and take a position on it, to understand that the possibility of success or failure is in your hand and in this work it became evident that the obsession with achievement is a cause that comes from persistence, according to the reports, everything tends to fail, but the works were based on real theories, which led to presenting such an inadequate result? These are questions that are answered as the theory is used, steps are readjusted and questions are answered.

Based on the reports, in the compilation of data collected from websites, books and periodicals it is understood that it is possible to build solutions using the Stirling engine of the gamma type, as it is highlighted that even with functionality problems it is possible to resize points to improve applications. In the case of cell phones, it is convenient to use the idea to promote specific low-cost solutions and the application of knowledge within communities in the Amazon.

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