

Patented of Beverage Can Crusher Machines: Design Overview

Ashraf Elfasakhany

Professor, Mechanical Engineering Department, College of Engineering, Taif University, Taif, Saudi Arabia
E-mail: ashrl2000@yahoo.com

Abstract - Recycling of Cans, beverage Cans, has rapidly increased in last decade; over recent years, the recycling of beverage Cans showed much more increasing as garbage disposal become great problem as well as recycling become economically feasible. One important need to support/help the increase of Can recycling processes is to develop the compulsory technologies for the crusher devices/machines. The aim of the current study is to present an overview of different designs for patents of the Can crusher machines. Such overview designs are believed to be useful for all inventors who worked on developing contemporaneous patents for the Can crusher machines.

Keywords: Patents; beverage; Can crusher; overview; design layout.

I. INTRODUCTION

The utilization of metal jars for Caned products and drinks has enormously expanded within recent years all over the world. The work of investment of aluminum and other metals in jars has encountered an impressive achievement in such field. Previously all jars were made of steel. Likewise, all jars are currently required to be considerably lighter with more established products to allow a drop in the shipping costs. The work of aluminum instead of other metals of jars has expanded in most industries. However, the aluminum ore is much more expensive than the other metals (steel). Accordingly, reusing of void jars is a one of respectable choices, which is not just saving aluminum ore, yet it additionally benefits as expelling jars from shorelines, campgrounds, interstates, and byways.

Reusing of refreshment jars has expanded quickly in the last years; rubbish transfer has turned into more noteworthy issues for the reason that the reusing has turned out to be financially plausible. The drink jars involve a moderately huge volume with generally little weight so that treatment of jars would be facilitated by compacting the jars. Additionally, simplicity of taking care in robotized treatment of jars for reusing, it is beneficial to squash each Can into considerably a similar shape; the jars ought to be pounded with the goal that they are smoothed from the sides as opposed to crushed descending from the best for acquire a compliment Can. It has been discovered that jars pressed from the void are changed to a ball-type shape.

Void jars without compacting take up large space in taking care of transportation and shipping. The extended space prerequisites of capacity and treatment of the non-compacted jars makes bothers as well as considerable

overhead costs. Void jars should be pressed before materials reused process; especially jars are more secure, easier, lighter, and simpler in compacting process before transport. The jars in regular size will essentially need much higher process costs.

Can crushers provide the advantages of decreasing the volume of returned jars to a very small size, which helps the transportation process with lower costs. Numerous types of Can crushers are known in the previous engineering sections, some basic and some advanced. The ubiquity of crushers results from the notoriety of light-weight metal or like jars as compartments for refreshments. In the early research, we have displayed an overview of Can crusher machines [1–10]. In the present work, we aim to display some detailed descriptions on different designs of Can crusher machines. This work is part of our going studies for review of different engineering topics and designs, see e.g., [11–58]. When jars are compacted by crushers, different jars are connected on the sides mixed up. Most Caned smashing process cause pressing two end countenances of the Can toward each other. This is unsuitable like the "jug charge" idea is needed to be avoided. Accordingly, different Can crushed design is required to be modified. One of the first steps of such modification of Can crusher machines is to study the design of available crusher machines in the market. The aim of the current study is providing an overview of different designs for patents of beverage Can crusher machines.

II. OVERVIEW DESIGN OF PATENT NO. 5203261

This crusher machine is a baling type with an external lodging and a prolong; it contains rectangular principle baling chamber with a release opening toward one side and on the other side a helper baling chamber converging the primary baling chamber. A bay opening coordinates jars into the chambers at the convergence.

An assistant cylinder is proportionally mounted in the helper baling chamber to pack jars to a first pressure weight in an underlying compaction arrange, while a principle cylinder is correspondingly mounted in the primary baling chamber to pack the compacted jars to a second pressure weight in a last compaction organize in which a bundle of foreordained measurements and weight is framed with no requirement for pre-measuring the jars, as appeared in Fig.1.

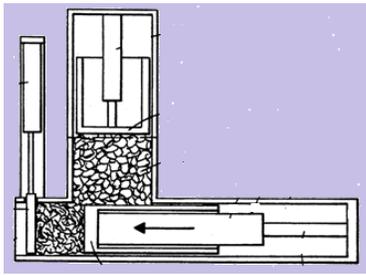


Fig.1 Overview design layout for Can crusher machine of patent No. 5203261

The present creation to give a better than baling machine and strategy. The development in subtle elements is exhibited as takes after. The Can baling machine is given to involve an external lodging having a prolonged, rectangular principle baling chamber and a lengthen helper baling chamber crossing the fundamental baling chamber. A bay opening is accommodated providing jars to the baling chambers at their crossing point. The principle baling chamber has a release opening toward one side which is regularly shut by an entryway. A fundamental cylinder is correspondingly mounted in the principle baling chamber and is moveable forward and backward by an actuator towards the release opening in an underlying pressure stage to pack the jars a foreordained sum before activation of the primary cylinder. An assistant cylinder is correspondingly mounted in the helper baling chamber and is moveable by an assistant actuator towards the principle baling chamber in a pressure stroke. A first detecting gadget detects when the helper cylinder has packed jars in the crossing point to a foreordained first pressure weight, and a framework controller actuates the fundamental cylinder when the principal pressure weight is come to. A second detecting gadget detects when the fundamental cylinder has compacted jars to a foreordained second pressure weight more prominent than the principal pressure weight. The measurements of the depression in the primary baling chamber between the principle cylinder and release opening are with the end goal that when a supply of jars packed to the main pressure weight fills the pit, they will be of the foreordained, wanted bundle weight and size when compacted to the second pressure weight by the fundamental cylinder. This game plan enables jars to be packed to a bunch of foreordained size and weight with no need t5 for pre-measuring the jars, and with no issues coming about because of the jars at first being in various phases of compaction. In a favored exemplification of the creation, the assistant chamber is opposite to the principle baling chamber to frame a for the most part T-molded convergence, and the release opening is guided downwardly opposite to the crossing point, with the goal that jars fill the accessible space in the helper and fundamental chamber. The helper cylinder is of lower control than the primary cylinder and Can work significantly speedier to give the underlying pressure weight, for instance to around \$ of the coveted last weight. As per another part of the present innovation, a strategy for packing jars into bundles of foreordained weight and measurements is given, which

includes the means of sustaining jars into a pit at the crossing point between a primary baling chamber and a helper baling chamber, working an assistant cylinder in the assistant baling chamber to pack the jars in the cavity until the point when a foreordained first pressure weight is achieved, halting the assistant cylinder when the principal pressure weight is come to and working a fundamental cylinder in the principle baling chamber to pack the jars more distant towards a release end of the baling chamber until the point that a foreordained second pressure weight is come to, and opening an entryway at the release end of the baling chamber and releasing the bunch of jars when the second pressure weight is come to. This contraption and technique enables a bundle of jars to be made considerably more rapidly and productively than was conceivable already, without the requirement for a pre-measuring step or estimation of the framed parcel and without the requirement for an expansive, ease back moving fundamental cylinder to play out the majority of the pressure strokes, for additionally subtle elements you may see the first patent [59].

III. OVERVIEW DESIGN OF PATENT NO. 5967029

This is a programmed Can crusher for compacting aluminum jars for transfer incorporates an upper lodging involved for a first compartment and a second compartment. the principal compartment has an open upper end with a cover hingedly coupled thereto. A devastating system is arranged inside the upper lodging. an enactment framework is arranged imteriorly of the upper lodging and is in correspondence with the devastating instrument.

The innovation includes an upper lodging involved a first compartment and a second compartment. The main compartment has an open upper end with a cover hinged coupled thereto. A lower lodging is arranged underneath the upper lodging. The lower lodging has an opening through an upper end thereof in correspondence with the opening the base of the principal compartment. A devastating system is arranged inside the upper lodging. The devastating instrument squashes aluminumcan against a far mass of the primary compartment for being received inside the lower lodging. The devastating system incorporates an engine arranged inside the second compartment. The engine has a drive equip in correspondence therewith. The devastating component incorporates a strung shaft expanding deep down from an external mass of the second compartment. The strung shaft has a rigging arranged subsequently in correspondence with the drive equip. The strung shaft has a drive neckline coupled therewith. The neckline has a couple of precise arranged sections broadening apparently along these lines. Free closures of the sections have a drive slam anchored thereto. The drive slam has a couple of tabs expanding apparently of restricted sides thereof to be slid ably gotten inside tracks arranged on contradicted sides of the principal compartment. An initiation framework is arranged interiorly of the upper lodging. The actuation framework incorporates a circuit board that is in

correspondence with the engine. The circuit board incorporates an upper smaller scale switch in correspondence with the top of the primary compartment for enactment of the engine. The circuit board incorporates a lower miniaturized scale switch in correspondence with the drive smash for deactivation of the engine. The circuit board is in correspondence with a couple of lights arranged exteriorly of the upper lodging to demonstrate enactment and deactivation of the devastating component. A couple of turning sections are combined with a lower surface of the cover and the opening in the base of the main compartment. The rotating sections each serve to remove a squashed aluminum can from the drive slam.

There has in this manner been sketched out, rather comprehensively, the more essential highlights of the innovation all together that the definite depiction thereof that takes after might be better comprehended, and all together that the present commitment to the workmanship might be better valued. There are extra highlights of the innovation that will be portrayed hereinafter, and which will shape the topic of the cases annexed hereto, as appeared in Fig. 2.

In this regard, before clarifying no less than one epitome of the development in detail, it is to be comprehended that the creation isn't restricted in its application to the subtle elements of development and to the game plans of the parts put forward in the accompanying portrayal or showed in the illustrations. The development is equipped for different epitomes and of being drilled and completed in different ways. Likewise, it is to be comprehended that the diction and wording utilized in this are with the end goal of depiction and ought not to be viewed as restricting.

All things considered, those talented in the craftsmanship will value that the origination, whereupon this revelation is based, may promptly be used as a reason for the outlining of different structures, techniques and frameworks for doing the few motivations behind the present innovation. It is essential, thusly, that the cases be viewed as including such proportional developments seeing that they don't leave from the soul and extent of the present creation. Further, the motivation behind the prior dynamic is to empower the U.S. Patent and Trademark Office and people in general for the most part, and particularly the researchers, architects and professionals in the workmanship who are not acquainted with patent or lawful terms or diction, to decide rapidly from a careless investigation the nature and substance of the specialized revelation of the application. The conceptual is neither proposed to characterize the development of the application, which is estimated by the cases, nor is it expected to restrict with regards to the extent of the creation in any capacity. It is hence a protest of the present creation to give another programmed aluminum Can crusher mechanical assembly and technique which has a large number of the upsides of the Can blowers said up until now and numerous novel highlights that outcome in another programmed aluminum Can crusher which isn't foreseen,

rendered self-evident, recommended, or even suggested by any of the earlier workmanship Can blowers, either alone or in any blend thereof. It is another question of the present development to give another programmed aluminum Can crusher which might be effortlessly and proficiently produced and promoted. It is a further question of the present innovation to give another programmed aluminum Can crusher which is of a sturdy and dependable development. A much further question of the present development is to give another programmed aluminum Can crusher which is helpless of an ease of fabricate with respect to the two materials and work, and which appropriately is then defenseless of low costs of offer to the expending open, accordingly making such programmed aluminum Can crusher monetarily accessible to the purchasing open. Still yet another question of the present innovation is to give another programmed aluminum Can crusher which gives in the mechanical assemblies and techniques for the earlier workmanship a portion of the points of interest thereof, while at the same time defeating a portion of the inconveniences ordinarily related therewith. Still another protest of the present creation is to give another programmed aluminum Can crusher for compacting aluminum jars for transfer. However, another question of the present development is to give another programmed aluminum Can crusher which incorporates an upper lodging contained a first compartment and a second compartment. The principal compartment has an open upper end with a top hingedly coupled thereto. The primary compartment has an opening through a base thereof. A devastating component is arranged inside the upper lodging. An actuation framework is arranged interiorly of the upper lodging and is in correspondence with the devastating component. These together with different objects of the innovation, alongside the different highlights of oddity which portray the development, are brought up with distinction in the cases attached to and shaping a piece of this divulgence. For a superior comprehension of the creation, its working points of interest and the particular items achieved by its uses, reference ought to be made to the going with illustrations and enlightening issue in which there are delineated favored encapsulations of the innovation, for additionally subtle elements, you may see the first patent [60].

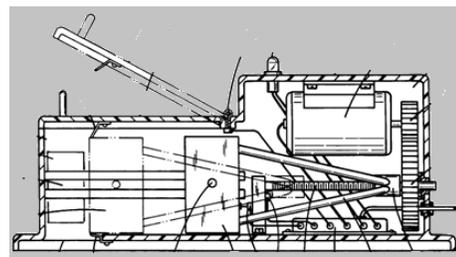


Fig.2 Overview design layout for can crusher machine of patent No. 5967029

IV. OVERVIEW DESIGN OF PATENT NO. 4103609

A compactor for metal jars, especially drink jars, which comprises of a lodging and a cover containing in that an essential chamber hole ending toward one side in transversely expanding pit augmentation. With the Can in position in the chamber a mechanized longitudinal slam smashes the Can a longitudinal way into the state of a circle whereupon a cross slam working in the hole augmentation transversely squashes the plate into a pellet. In task of the gadget the power-driven longitudinal slam packs the Can to a foreordained point whereupon the power-driven cross smash naturally begins and the longitudinal smash consequently stops. At the point when most extreme compaction has been acquired the two smashes naturally pull back to their unique position and the pellet falls through an opening in the floor of the cavity expansion, as appeared in Fig. 3 and for additionally subtle elements, you may see the first patent [61].

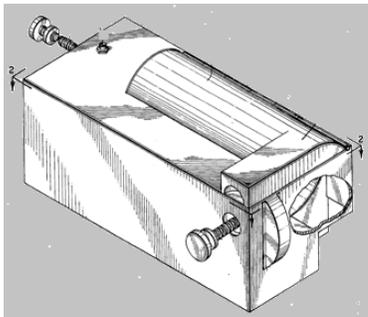


Fig.3 Overview design layout for can crusher machine of patent No. 4103609

V. OVERVIEW DESIGN OF PATENT NO. 5469783

An expansive round and hollow nook molded to resemble immense refreshment can has a recessed territory in its external divider containing an administrator's board and an opening into the inside for embeddings void recyclable drink jars. Inside the nook is a transport for getting the embedded jars, a discriminator for recognizing ferrous and non-ferrous jars and a pneumatic transporter for conveying the jars to a mechanical crusher which compacts the jars separately and releases them into an impermanent stockpiling region from which they are expelled every once in a while for reusing. The operator' panel incorporates a photoelectric sensor for starting activity of the systems in the inside of the structure and may incorporate different visual readouts and in addition an allocator for encouraging out coins, printed credit slips and receipts. The machine additionally contains programmable electronic hardware for giving data and controls important to task of the gear and for deciding the measure of payout and other valuable information and data.

The innovation addresses these and different issues of the earlier workmanship. An expansive vertically expanding tube shaped fenced in area, formed to resemble a colossal

drink Can has a moderate floor isolating the inside into lower and upper compartments or chambers. This moderate floor gives mechanical unbending nature to the structure and might be excluded or supplanted with other auxiliary backings to oblige other framework designs, completely inside the soul and lessons of the present development.

An opening into the lower compartment grants jars to be kept, ideally each one in turn, and means are given in the lower compartment to get, tally, and transport the jars to the upper compartment which contains an enhanced Can pounding machine for smashing every one of the jars and a capacity zone where the pressed jars are amassed. The crusher system incorporates a couple a roller with radially stretching out teeth to emphatically acknowledge, press, and release aluminum jars for impermanent capacity, as appeared in Fig. 4.

The present creation likewise gives methods for enhancing the partition of wanted aluminum jars from undesirable waste. The division implies builds up a vacuum suction to pull back lightweight waste and flotsam and jetsam, an improved attractive pulley/idler to evacuate ferrous materials, and a constrained draft gravity separator to expel heavier junk from the aluminum.

The lower part of the authority arrangement of the present innovation incorporates a transport for getting the kept jars. The transport has a magnet related therewith for attractively getting a handle on attractively penetrable or ferrous jars for transfer. The transport likewise conveys the majority of the kept non-ferrous or aluminum jars to an air pipe conductor opening. The present development incorporates an enhanced framework for isolating aluminum from non-aluminum reject utilizing a bewildered air-ducting portion. A curl folded over the air channel course gives an electrical flag to use in tallying the quantity of jars going through the air pipe conductor. The air pipe conductor utilizes high speed air to transport the jars to a devastating machine in the upper chamber. The opposite side of the blower instrument used to make the high speed air is utilized effectively to create a vacuum used to get paper, plastic, and light waste ("junk") from the transport and for transporting this waste to a separator system for capacity and ensuing transfer.

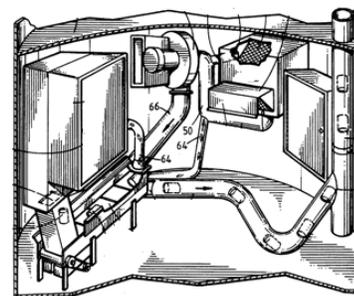


Fig.4 Overview design layout for can crusher machine of patent No. 5469783

Another kind of upper access is given to the upper compartment to expulsion of the squashed jars every once in a while, for transportation to a reusing station. The outside of the structure has a board zone with working directions and video show for correspondences between the client and the proprietor/administrator of the reusing gatherer. The outside board region likewise incorporates a chute to get jars for reusing and additionally photoelectric sensors for beginning the task of the machine.

The information accumulation and dealing with arrangement of the present development gives signs to visual pointers and control guidelines to a container for dispatching coins and additionally a printed credit slip for installment for the stored jars and a printed receipt. The PC framework that is a vital piece of the authority of the present creation gives two-path correspondence to revealing from the gatherer to a focal station and in addition information and control correspondence from the focal station to the gatherer. Inside the structure is a small scale processor which can be customized to control up the gatherer component, to track the quantity of aluminum jars that are kept, to trigger the payout instrument which administers coins, and to control a printer for printing out a credit clasp, coupon, or commercials in installment for the stored jars and a receipt. At the point when utilized in this design, the machine capacities as an invert candy machine, i.e., making installment for jars stored as recognized from the typical candy machine which apportions a canned refreshment upon the receipt of kept coins. The small-scale processor can likewise be customized to perform other record-keeping undertakings, to interface with an area remote from the authority, and to empower and control a printer to print out information as wanted. These and different highlights of the present development will be instantly evident to those of expertise in the craftsmanship when they contemplate the accompanying natty gritty depiction in conjunction with the going with illustrations, for additionally points of interest, you may see the first patent [62].

VI. OVERVIEW DESIGN OF PATENT NO. 5211109

A drink Can crusher has a couple of rollers which turn toward each other to smash a Can between them. The crusher has a store window and chute which put the jars over the rollers and guarantee that the jars are straightened from the sides instead of crushed from the best. This accommodates a repeatable, baleable smashed can. An actuator set short of what one Can length over the rollers in the chute empowers the drive engine to turn the rollers and keeps on having the rollers pivoting insofar as there is a Can drawing in the actuator. The rollers have an exceptional accepting surface and connecting with surfaces which grasp the sides of the Can to limit slipping so that the Can will be pulled down between the rollers. Likewise, pins broaden radically outward from the external surface of the rollers to additionally hold the can.

The present creation is coordinated to a Can crusher for smashing void jars, and particularly to crush drink jars to ease taking care of for reusing. As per the present development, a Can crusher uses a safe window and joined chute which prompts a couple of rollers for squeezing void jars amongst them and leveling out the jars into a simple, level, baleable last shape. At the point when jars achieve the base of the conveyance chute, an actuator of a switch is stumbled by the Can in the lower bit of the chute which enacts an engine to pivot a couple of rollers.

The Can has its base laying on the upper segment between the rollers so that as the rollers turn toward each other, after getting the can, the Can will be pulled down between the rollers and pressed. The state of the rollers is vital for holding the Can to safeguard that the Can is pulled down between the rollers as opposed to more than once ricocheting off the highest points of the pivoting rollers. To encourage holding, the rollers have surfaces which get the base of the Can with the goal that the base of the Can leans against these level surfaces. A solidified drawing in surface broadening radically outward from the focal point of every roller shapes a corner with the outskirts of the spiral surface of the roller, as appeared in Fig. 5.

The connecting with surfaces holds the sides of the Can and pull the Can down between the rollers. Ought to the Can without the main connecting with surface, the Can will remain basically set up while the rollers pivot so when the rollers turn 180 degrees, getting surfaces will position the Can and another match of drawing in surfaces will hold the Can and pull it between the rollers. To guarantee that no slipping happens as the Can is being pressed, pins broadening radially outward from the spiral surface of the rollers are separated and corresponding on the contradicting rollers for holding the can. The pins connect with the sides of the Can to keep any slippage as the Can is being squeezed between the rollers. It very well may be valued that as per the present development, the rollers will keep on rotating if more than one Can is in the chute and the switch is activated. It can likewise be valued that the present development accommodates smashing a Can into a level baleable shape which leaves the Can unblemished for conceivable recovery.

These and different focal points and highlights of oddity which describe the creation are called attention to with distinction in the cases added hereto and shaping a section in this regard. In any case, for a superior comprehension of the development, its favorable circumstances, and the articles gotten by its utilization, reference ought to be made to the illustrations which frame a further part in this regard, and to the going with distinct issue, in which there is delineated and portrayed a favored encapsulation of the innovation, for additionally subtle elements, you may see the first patent [63].

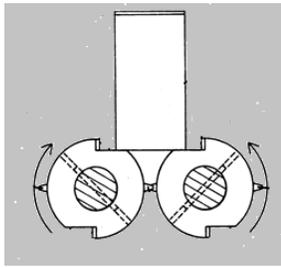


Fig.5 Overview design layout for can crusher machine of patent No. 5211109

VII. OVERVIEW DESIGN OF PATENT NO. 4962701

A refreshment Can crusher including divider mountable magazine for holding a vertical column of jars arranged in stacked connection with their lengths even for serial release downwardly through a lower Can-leave end, and a divider mountable can-pressing component arranged underneath and for getting jars from the magazine unit, described in that the devastating instrument and magazines are basically separate units and the devastating unit contains a unitary flat base as an upwardly-confronting channel having a level base and designed to get a Can lying the long way in that, said base having an upright internal end vital with and ascending from the base and adjusted for mounting on a divider and an external end dispersed from said internal end a separation more noteworthy than the length of a Can lying on the base between said closes, said external end having turn implies fundamental with and ascending from the base and giving a transverse rotate hub dispersed firmly over the base, a plunger having an internal can-drawing in end and furthermore an external end and riding longwise of the channel between a withdrawn position in which said can-pounding end is dispersed no less than a Can length ostensibly from the base internal end to a devastating position in which said can-squashing end is firmly neighboring the base inward end for shortening the hub length of a can, a chime wrench essentially mounted to said turn implies and including a short arm having a crucial association with the external end of the plunger and a long arm associated with said short arm at said turn implies and said long arm being adjusted for manual task, said ringer wrench having plunger-withdrawn position in which the long arm expands downwardly from said rotate hub and the short arm broadens .apparently from said turn hub, said ringer wrench being physically rockable about said turn hub to move the plunger to its can-smashing position wherein the long arm moves upwardly and the short arm swings upwardly and deep down and after that downwardly and further internally as it ignores a middle position in respect to the turn pivot.

The crusher, in which the lower end of the magazine is separated adequately upwardly from the devastating component so that, with the chime wrench in its plunger-withdrew position, the plunger might be physically swung upwardly and ostensibly about its significant association

with the ringer wrench short arm to a position clear of the channel whereby a Can might be physically laid in or expelled from the channel without going through the magazine, as appeared in Fig. 6.

The crusher concurring, in which the magazine has a specifically position able upright divider empowering the magazine to hold jars of various level lengths. The crusher, in which the internal end bit of the plunger, is given an upwardly confronting pocket for accepting a Can in an upright position when the plunger is in its devastating position, and the inward end of the plunger has an upwardly coordinated lip characterizing the internal end of the pocket and adjusted to connect with an upright Can for affecting turning of the Can to a flat position when the plunger is withdrawn, for additionally points of interest, you may see the first patent [64].

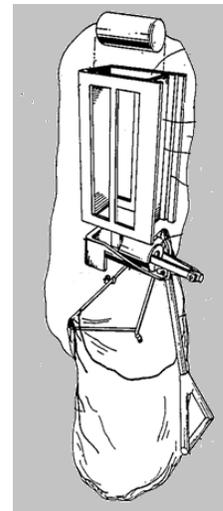


Fig.6 Overview design layout for Can crusher machine of patent No. 4962701

VIII. OVERVIEW DESIGN OF PATENT NO. 8448570

A versatile electric Can crusher to along the side pound jars, involving: a help structure having an unbending vertical divider with an extended rectangular opening shaped there through appended on a level plane to an engine gearbox get together; a prolonged rectangular squashing plate having a devastating plate drive parcel carried on the help structure for forward and backward development relative thereto through the lengthened rectangular opening in the help structure vertical divider; a slam plate conveyed by help arms against the vertical divider, said bolster arms being associated with a drive plate, the smash plate being mobile with said push plate toward and far from the vertical divider; a rucksack bolster fenced in area anchored underneath the help structure vertical divider, the nook characterizing a pressed Can drop space for capacity in that and evacuation hence; a switch and a battery-powered battery joined on said bolster fenced in area for controlling an engine; a Can squashing chamber characterized by the space inside the vertical divider and slam plate over the help

nook; a lodging mounted to the help structure vertical divider, said lodging having a handle for simplicity of transport; said drive plate and said pounding plate drive partition including double drive plates having double drive cam and double space implies for moving the double plates in a foreordained connection interpretation movement wherein the devastating plate is moved to smash the center of a Can in the devastating chamber and the slam plate is moved to squash the finishes of a Can in the devastating chamber; and said engine gearbox get together associated on a level plane to said engine which is drivingly associated with said double drive cam and double opening means by a power exchange hinder for working said double drive plates agreeably to impart said foreordained connection interpretation movement of the plates because of movement of said compel exchange square wherein jars Can be monotonously squashed in said pounding chamber.

The versatile electric Can crusher is displayed that rapidly presses and stores any can, anyplace Like Turner of the earlier craftsmanship, the enhanced Can crusher pounds jars into a squashed relationship wherein the upper and lower round end faces are by and large unaltered and adjusted in a co-planar position, the smashed example achieved by the consequence of setting the Can in an opposite position neighboring a slam plate and a stretched rectangular smashing plate which is utilized for wrinkling a middle bit of the Can took after by moving the smash plate against the Can into contact with an unbending vertical divider. The devastating movements of the crusher are accomplished through double cam and space implies helpfully drivably associated with a power exchange square which grants a foreordained connection interpretation movement of the plates considering turn of the exchange square. A powerful, however light, battery-powered battery gives the power important to press jars speedier and accordingly more beneficially at the "purpose of accumulation", with the goal that more jars Can be gathered and pounded per unit of time. Since lithium particle batteries are significantly lighter, longer enduring, and more ground-breaking per unit volume than their lead and nickel partners, battery-powered lithium particle batteries are the favored power source, as appeared in Fig. 7.

Not at all like Turner of the earlier craftsmanship, the enhanced Can crusher has a handle shaped on the highest point of the lodging for conveying the gadget by hand, and a help walled in area, for example, a capacity canister or rucksack joined to the base of the lodging for briefly putting away the squashed jars preceding emptying. The heaviest piece of the earlier workmanship, to be specific the T molded structure of Turner, has been supplanted with a vertical divider which currently Can be specifically joined to the engine adapt box get together. As a result, a solitary guide might be utilized, instead of the two utilized in Turner, made conceivable by the abbreviated and lighter development occasioned by supplanting the heavier T formed structure. The gearbox get together is by and large rectangular and would now be able to be made piece of a

"virtual divider" throwing or shape of the vertical divider, or joined to it with stray pieces, in this way making the vertical divider as inflexible, yet substantially lighter and having a shorter length, and along these lines faster squashing activity. This change not just serves to abbreviate the whole length of the gadget, yet since the whole level bit of the "T" bolster structure of the earlier workmanship Turner gadget has now been disposed of, the heaviness of the gadget is decreased generally significantly, influencing it to lighter for conveying long separations by people, without losing quality and strength.

The numerous items and focal points of the present development will end up obvious to those gifted in the craftsmanship when the accompanying depiction of the creation and its different encapsulations are looked into in backup with the appended illustrations wherein like reference numerals allude to like segments all through. The already portrayed exemplifications of the present innovation have numerous focal points. Although the present creation will be depicted in significant detail with reference to certain favored epitomes thereof, other elective exemplifications are conceivable. In this manner, the soul and extent of the cases ought not be constrained to the depiction of the favored exemplifications, nor the elective epitomes, contained thus, for additionally subtle elements, you may see the first patent [65].

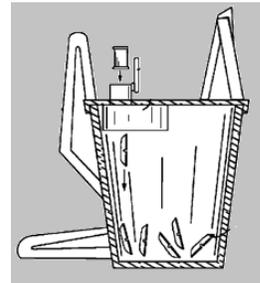


Fig.7 Overview design layout for can crusher machine of patent No. 8448570

IX. OVERVIEW DESIGN OF PATENT NO. 422873445

A metal Can crusher for deformable pivotally compacting a round and hollow metal Can to a little part of its length containing mounting implies mounting the crusher and steadily supporting a finish of the barrel shaped Can and pounding implies joined to the mounting implies, said smashing means involving a case gathering appended to the mounting implies, a post get together joined to the mounting means and box get together, and versatile handle implies, the crate get together holding the metal Can while the handle implies applies hub compressive power on the finish of the Can inverse the finish of the Can upheld by the mounting implies, blacksmith's iron means for conveying said hub compressive power to the can, said handle implies having a post turn toward one side thereof for vital association with said post get together, said post rotate being arranged above said blacksmith's iron means, said

handle additionally having a middle post medially arranged between the closures of said handle, connecting implies involving a significantly direct flip crucially associated at its upper end to said focus post and urgently associated at its lower end to said blacksmith's iron means at a blacksmith's iron turn for changing over manual rotational development of said handle intends to straight compressive development of said blacksmith's iron means, said focus post portraying a fragment of a roundabout curve amid hub pressure of the tube shaped metal can, the circular segment being fixated on the post turn, said post rotate, focus post, and blacksmith's iron turn framing an edge in a considerably vertical plane which incorporates said handle and said flip characterizing the sides of an edge with the inside post constituting the vertex of the edge, said point expanding as said handle turns downwardly in regards to said post turn and as said focus post depicts said bend amid hub pressure of the tube shaped metal can, said edge expanding to a straight edge upon greatest hub pressure, whereby movement of the blacksmith's iron means toward the mounting implies pivotally packs the Can might little division of its length and whereby most extreme mechanical favorable position is endless supply of said straight edge and whereby a snap is thereupon recognizable in manual task of the metal Can crusher, said blacksmith's iron means including a drag through which a rotate stick critically interfaces said bring down end of said flip to the blacksmith's iron, said haul being removably appendable to said blacksmith's iron and being described by a selectable separation from said blacksmith's iron rotate to said blacksmith's iron, whereby the situation of the blacksmith's iron when said straight edge is delivered is selectable to allow control of said squashing division and to adjust the crusher to jars of a shifting size, as appeared in Fig.8.

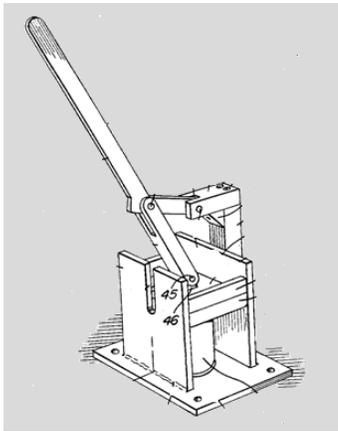


Fig.8 Overview design layout for can crusher machine of patent No. 422873445

The present development uncovers a gadget and strategy for addressing the requirement for protection and reusing of significant aluminum metal in void aluminum drink jars by giving a gadget which smashes such a can, using a variable mechanical preferred standpoint for applying expanding power on the Can experiencing pivotal pressure, at last to a straightened arrangement which is just a small amount of its

unique length. As needs be, it is a vital protest of the creation to give a physically worked metal Can crusher which builds the mechanical favorable position feasible amid pivotal pressure of a metal Can to a small amount of its unique length. Another protest is to give a metal Can crusher which is versatile and can be utilized at different areas where void aluminum refreshment jars are created in amount. Still another question is to give a technique and gadget to pounding aluminum jars which spares vitality by staying away from utilization of electric parts, in this way decreasing the cost of produce and task. However, another protest is to give a basic, tough gadget having close to three moving parts and requiring just negligible upkeep. A further protest is to empower recovered pounded metal jars to be put away in a littler volume, in this way diminishing the space necessities for capacity, and additionally the number or size of compartments, for example, plastic sacks, required for capacity of recouped void jars. Another further protest is to advance litter control by advancing accumulation of void drink holders which would some way or another be discarded in broad daylight or private areas and subsequently make a litter issue. Still another further protest is to empower administrators of foundations which deliver void refreshment compartments in amount or administrators of deny gathering organizations, to recuperate a bit of expenses of activity by advancing proficiency of accumulation of metal drink holders with utilization of the strategy and gadget of the present innovation. These, together with different protests and focal points which will turn out to be in this manner obvious, live in the subtle elements of development and activity as more completely hereinafter portrayed and asserted, reference being had to the going with illustrations shaping a section concerning this, wherein like numerals allude to like parts all through, for additionally points of interest, you may see the first patent [66].

X. OVERVIEW DESIGN OF PATENT NO. 4316410

The Can crusher portrayed thus is a minimized cupboard compose unit which can be introduced in or under a bar or counter or situated in any helpful area in at least space. Jars are put in a container in the highest point of the unit and fall into a chute, in which a crusher plate sways from side to side. Jars are squashed between the crusher plate and no less than one contiguous mass of the chute, the leveled jars tumbling from the open lower end of the chute into a reasonable container. The crusher plate is driven by an engine through a twofold wrench and interfacing bar component, which is adjusted with the goal that most extreme power is connected at the two furthest reaches of movement of the plate. This guarantees jars will be pounded as level as conceivable toward the finish of the stroke. In one setup, springs are compacted amid one stroke and the put away vitality adds to the engine control toward the beginning of the arrival stroke. In different designs, arrangement is made for keeping the system from sticking on an article which can't be smashed adequately to enable the machine to finish a stroke. The system is contained in a

basic casing structure, which can be encased as an unsupported unit or incorporated with other structure. In task the machine is sensibly peaceful and would not be exasperating in a bar or eatery condition. The essential question of this creation, hence, is to give an as good as ever smaller Can crusher, as appeared in Fig.9. Another question of this innovation is to give a Can crusher which can be introduced in or under a bar, counter, or comparative structure. Another question of this innovation is to give a Can crusher which squashes jars on one or the two sides of a swaying crusher plate, with most extreme smoothing power occurring toward the finish of each stroke. A further protest of this creation is to give a reduced Can crusher which is easy to build and work and requires at least upkeep, for additionally subtle elements, you may see the first patent [67].

XI. OVERVIEW DESIGN OF PATENT NO. 4953682

A device pounds aluminum jars at a quick rate and administers pay for the smashed jars. The device smashes the jars on the longitudinal hub instead of the long way which results in a more minimal unit along these lines sparing storage room. The mechanical assembly additionally forms the jars quicker than most existing machines. The device includes a fenced in area with an opening for getting jars prompting a chute for the jars to fall each one in turn with the tube-shaped pivot significantly vertical. A distributor discharges one Can at once from the chute past an identifier to dismiss any jars that are not aluminum, through a door which closes and allows a platen to pound the Can on the shut entryway. The squashed Can is shot out into a release holder and pay comparable with the quantity of jars handled is issued.

The present creation identifies with a mechanical assembly intended to get aluminum jars, press the jars at a quick rate and apportion pay for the pounded jars. More particularly, the mechanical assembly gets a bunch of aluminum jars smashes the cluster of jars and afterward administers a receipt or cash comparable with the quantity of aluminum jars in the group. Aluminum jars might be encouraged one can at once into the mechanical assembly. Reusing of aluminum drink jars is a critical factor in the accentuation that has been happening as of late in vitality preservation and ecological insurance. At first gadgets known as turnaround candy machines were created to smash aluminum jars and give pay, either a receipt or money, in view of the heaviness of aluminum. A significant number of these gadgets are huge and cumbersome, they for the most part is situated outside, frequently in auto parks and such, and consume up the room of a stopped auto. Most of these gadgets take substantial bunches of jars and press them up longwise. Although, there is great budgetary return in squander aluminum, numerous individuals are not inspired to utilize these gadgets. These gadgets are exorbitant and furthermore because of their absence of utilization, they have not ended up being monetarily suitable. Governments have ventured into the field of natural assurance and have

elevated a store to be paid on every aluminum refreshment can. Little indoor turn around candy machines are by and by accessible, yet they for the most part get aluminum jars on a one Can at once premise and process them gradually. On the off chance that one has countless, at that point they should be bolstered into the machine each one in turn, and this has demonstrated inadmissible as it takes too long, and individuals don't try to restore the jars which does not fathom the reusing and ecological insurance necessities, as appeared in Fig.10.

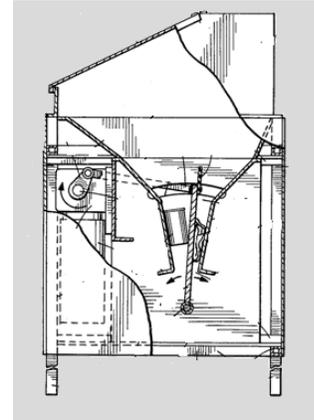


Fig. 9 Overview design layout for Can crusher machine of patent No. 4316410

It is a point of the present innovation to give a little indoor invert candy machine that gets aluminum jars it is possible that each one in turn or in mass, and procedures a bunch of jars at a high rate apportioning a printed receipt or money consequently similar with the quantity of jars in the group. It is a further expect to give a machine that squashes every aluminum Can through and through, leaving a compacted Can with the best and base for all intents and purposes unaltered. This element permits an acknowledgment stamp to be put on the best or base of aluminum can, so the smashed Can could be distinguished, either naturally or physically.

The present development gives a mechanical assembly to accepting aluminum jars it is possible that each one in turn or in mass, wherein aluminum jars Can be tipped into a machine where the jars are handled at a high rate and after that cash or a receipt is apportioned naturally proportionate with the quantity of aluminum jars in the clump. The jars are handled at a quicker rate than existing kinds of machines. Along these lines long sits tight to return jars are maintained a strategic distance from. The present creation gives a machine that gets single jars or clusters of various sizes of aluminum jars, rejects the jars that are not aluminum and whatever other things that may get into the machine. Every aluminum Can is pounded end to end to around 5% of its unique stature and after that is released into a release holder.

The present creation gives a contraption to getting aluminum jars, recognizing and dismissing ferrous metal and non-metal jars or different things, pounding aluminum

jars, and giving pay to the smashed aluminum jars, including; a sheet metal walled in area; opening in the front of the sheet metal nook for accepting aluminum jars and different things prompting a chute to manage aluminum jars and different things, to fall each one in turn with a round and hollow hub of each Can significantly vertical; apportioning implies at the base of the chute to discharge one aluminum Can or other thing exclusively through a gap in a sole plate under the chute; identifier intends to distinguish if a Can or other thing to be discharged by the administering implies is ferrous metal or non-metal; dismiss diverter intends to avoid ferrous metal and non-metal jars or different things falling through the gap in the sole plate, to a reject chute; no less than one door with opening and shutting intends to close on the underside of the sole plate over the gap; water driven barrel with vertical moving chamber pole situated under the sole plate, the barrel bar having a platen at the best to press an aluminum Can against the shut entryway on the underside of the sole plate; launch plate situated over the platen with rotate intends to flip up and release a squashed aluminum Can into a release holder at the base of the fenced in area, and pay apportioning implies for apportioning pay similar with the quantity of aluminum jars pressed.

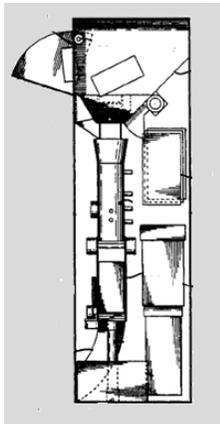


Fig.10 Overview design layout for can crusher machine of patent No. 4953682

In a favored exemplification, the opening in the sheet metal walled in area for getting aluminum jars and different things prompts a container situated in the best part of the nook, the container being situated over the chute. In different exemplifications, get to is given from the front of the walled in area for expelling and supplanting the release holder, subsequently allowing the mechanical assembly to be encased on three sides and just approaching from the front. In another encapsulation, an opening entryway is given in the front of the fenced in area over a portal to get a cluster of aluminum jars and different things and feed them into the container. The opening entryway is ideally pivoted downwards and has a solenoid worked bolt with the goal that once a clump of jars has been saved through the portal, the entryway is shut and can't be revived until the point that that group has been handled through the mechanical assembly. Vibrators are ideally given to vibrate and shake the aluminum jars and different things in the container and

guarantee they don't stick at the passageway to the chute or in the chute, for additionally points of interest, you may see the first patent [68].

XII. OVERVIEW DESIGN OF PATENT NO. KSA4610

In this machine, considering the patent no. KSA4610, 2016, we show another composed machine to press jars with substantially less powers than others. The new outline applies two powers in level and third one in vertical ways; the flat powers are connected right off the bat amidst the Can (in focuses just) and in this way the Can ends up frail and needs a little vertical power to be squeezed to the coveted size. Furthermore, the machine utilizes a sustainable wellspring of vitality as a power source, i.e. no charge of its task. The machine comprises of multi cylinders, two even and one vertical, sun powered cell framework to work the machine, pneumatic framework, sensor, servo engine, controller, programming, and a wooden structure to contain all the machine parts. The machine is intended to be utilized in numerous spots (ordinarily uncontained such machines, for example, in air ships, bathrooms, workplaces and even in autos; this innovation, in perspective of that, may constrain tossing drink jars in avenues or trash, as appeared in Fig.11.

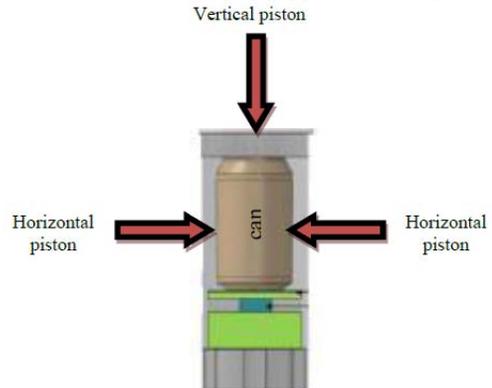


Fig.11 Pistons to Crush the Can for Patent No. KSA4610.

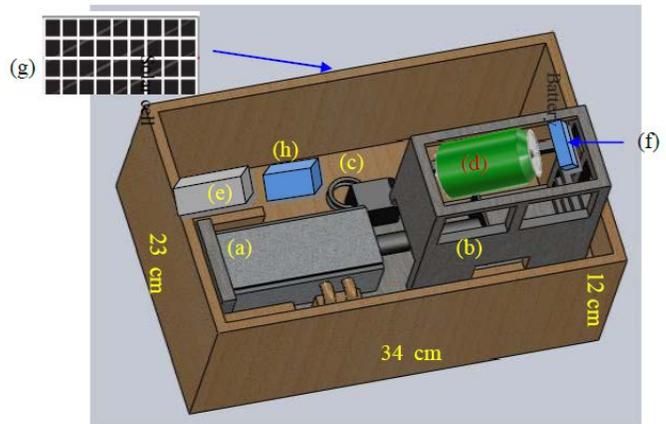


Fig.12 The wooden structure of Can Crusher Machine Containing Different Components Inside; (a) Pistons Operating System (pneumatic system), (b)BodyMetal, (c)ServoMotor, (d)Can,(e)Controller,(f) Sensor, (g) Solar cell, and (h) Battery.

The machine design is based on encouraging one can at a synchronized time. At the point when the Can brought into the machine, it experiences a track till the cylinders outlines, as appeared in Fig.12; the light sensor identifies a Can in the field and sends a flag to the controller; the controller initiates the cylinders to pack the Can where the two level cylinders work essential and after that the vertical one; at that point, the pressed Can moves out of capacity to a holder. The machine has favorable circumstances as its restricted size and requires low vitality supply; the plan is a domain cordial, conservative and utilizations sustainable wellspring of vitality; it tends to be set all around, as in the parks, houses, eateries, shopping centers, air ships, and even in autos. This innovation of the new composed would crusher be able to machine may improve the devastating procedure and could be a piece of future mechanical reusing framework, for additionally points of interest, you may see the first patent [69].

XIII. CONCLUSION

This study aims to benefit inventors for Can crusher machines. The study presents an overview design of different patents for Can crusher machines. More than ten patents are presented and explained in brief. Such work may help inventors via process towards a new design for Can crusher machines; moreover, it may enhance the crushing process, and, in turn, it may develop the coming industrial recycling systems. The study may emphasize that Can crusher machine is compulsory for recycling process. It can also be seen that different strategies would be applied for the Can crusher and each strategy has advantages and drawbacks; the Can crusher machine still needs more research to overcome the drawbacks in the current designs.

REFERENCES

- [1] A. Elfasakhany, J. Marquez, E.Y. Rezola and J. Benitez, "Design and Development of an Economic Autonomous Beverage Cans Crusher", *Int. J. of Mech. Eng. Tech.*, Vol. 3, No. 3, pp. 107–122, 2012.
- [2] A. Elfasakhany, "A new Patent of Beverage Cans Crusher Machine", *Current Alternative Energy*, Vol. 2, pp. 123–131, 2018.
- [3] A. Elfasakhany, "Beverage Can Crusher Machine Patents: A Review: Part I", *Asian Review of Mechanical Engineering*, Vol. 7, No. 2, pp. 62–69, 2018.
- [4] A. Elfasakhany, "Beverage Can Crusher Machine Patents: A Review (Part II)", *Asian Review of Mechanical Engineering*, Vol.7, No. 2, pp. 76–82, 2018.
- [5] A. Elfasakhany, "Beverage Can Crusher Machine Patents: A Review Part (III)", *Asian Review of Mechanical Engineering*, Vol. 8, No. 1, pp. 1–7, 2019.
- [6] A. Elfasakhany, "Beverage Can Crusher Machine Patents: A Review (Part IV)", *Asian Review of Mechanical Engineering*, Vol. 8, No. 1, pp. 11–17, 2019.
- [7] A. Elfasakhany, "Beverage Can Crusher Machine Patents: A Review (Part V)", *Asian Review of Mechanical Engineering*, Vol. 8, No. 1, pp. 31–38, 2019.
- [8] A. Elfasakhany, "Beverage Cans Crusher Machine Patents: A Review: Part VI", *Journal of Environmental and Soil Sciences*, Vol. 4, No. 3, pp.511–518, 2020.
- [9] A. Elfasakhany, "Beverage Cans Crusher Machine Patents: A Review: Part VII", *International Journal of Research and Scientific Innovation (IJRSI)*, Vol. 7, No. 4, pp. 239–247, 2020.
- [10] A. Elfasakhany, "Beverage Cans Crusher Machine Patents: A Review: Part VIII", *International Journal of Research and Scientific Innovation (IJRSI)*, Vol. 7, No.4, pp. 6–15, 2020.
- [11] L. Tao, N. Berge, A. Elfasakhany and X.S. Bai, "Experimental and Numerical Studies of APulverised Wood Flame", *6th Europ. Conf. on Industrial Furnaces and Boilers*, Portugal, 2002.
- [12] A. Elfasakhany and X.S. Bai, "Simulation of Wood Powder Flames in a Vertical Furnace", *3rd Medit. Combustion Symposium*, Marrakech, pp. 144, 2003.
- [13] A. Elfasakhany, X.S. Bai, B. Espenas, L. Tao and J. Larfeldt, "Effect of Moisture and Volatile Releases on Motion of Pulverised Wood Particles", *7th Int. Conf. on Energy for a Clean Environment*, Lisbon, Portugal, pp. 167, 2003.
- [14] A. Elfasakhany, "Modeling of Pulverised Wood Flames", PhD Thesis, fluid mechanics Dept., Lund, Sweden, ISBN-13/EAN: 9789162864255, 2005.
- [15] A. Elfasakhany and X.S. Bai, "Modeling of Pulverised Wood Combustion: A Comparison of Different Models", *Prog. Comp. Fluid Dynamics (PCFD)*, Vol. 6, No. 4/5, pp. 188–199, 2006.
- [16] A. Elfasakhany, T. Klason and X.S. Bai, "Modeling of Pulverised Wood Combustion Using a Functional Group Model", *Combustion Theory and Modeling*, Vol. 12, No. 5, pp. 883–904, 2008.
- [17] A. Elfasakhany, E.Y. Rezola, K.B. Quiñones and R.S. Sánc, "Design and Development of a Competitive Low-cost Robot Arm with Four Degrees of Freedom", *Modern Mechanical Eng*, Vol. 1, pp. 47–55, 2011.
- [18] A. Elfasakhany, J. Hernández, J. C. García, M. Reyes and F. Martell, "Design and Development of House-Mobile Security System", *Engineering*, Vol. 3, pp. 1213–1224, 2011.
- [19] A. Elfasakhany, A. Arrieta, D. M. Ramírez and F. Rodríguez, "Design and Development of an Autonomous Trash Sorting System", *Global J. of Pure and Applied Sciences and Tech.*, Vol. 01i3, pp. 56–64, 2011.
- [20] A. Elfasakhany, L. Tao, B. Espenas, J. Larfeldt and X.S. Bai, "Pulverised Wood Combustion in a Vertical Furnace: Experimental and Computational Analyses", *International Conference of Applied Energy*, 2012.
- [21] A. Elfasakhany, "Improving Performance and Development of Two-Stage Reciprocating Compressors", *Int. J. of Advanced Research in Eng. Tech.* Vol. 3, No. 2, pp. 119–136, 2012.
- [22] A. Elfasakhany, "Modeling of Secondary Reactions of Tar (SRT) Using a Functional Group Model", *Int. J. of Mech. Eng. Tech.* Vol. 3, No. 3, pp. 123–136, 2012.
- [23] A. Elfasakhany, J. A. Alarcón and D. O. S. Montes, "Design and Development of an Automotive Vertical Doors Opening System (AVDOS)", *Int. J. of Advanced Research in Eng. Tech.* Vol. 3, pp. 176–186, 2012.
- [24] A. Elfasakhany, J. L. Jiménez, I. A. Rentería, J. M. Rubio and W. D. Ricardez, "Design, Development, Testing and Validation of an Automower Machine", *Int. J. of Applied Mechanics and Physics*, Vol. 1, No. 1, pp. 1–15, 2013.
- [25] A. Elfasakhany, "Investigation on performance and emissions characteristics of an internal combustion engine fuelled with petroleum gasoline and a hybrid methanol–gasoline fuel", *Int. J. of Eng. Tech. (IJET-IJENS)* Vol.13, No. 5, pp. 24–43, 2013.
- [26] A. Elfasakhany, L. Tao, B. Espenas, J. Larfeldt and X.S. Bai, "Pulverised Wood Combustion in a Vertical Furnace: Experimental and Computational Analyses", *Applied Energy*, Vol. 112, pp. 454–464, 2013.
- [27] A. Elfasakhany, "The Effects of Ethanol-Gasoline Blends on Performance and Exhaust Emission Characteristics of Spark Ignition Engines", *Int. J. of Automotive Eng.*, Vol. 4, No. 1, pp. 608–620, 2014.
- [28] A. Elfasakhany, "Experimental study on emissions and performance of an internal combustion engine fueled with gasoline and gasoline/n-butanol blends", *Energy Conversion Manage*, Vol. 88, pp. 277–283, 2014.
- [29] A. Elfasakhany, L.X. Tao, and X.S. Bai, "Transport of pulverized wood particles in turbulent flow: numerical and experimental studies", *Energy Procedia*, Vol. 61, pp. 1540–1543, 2014.
- [30] A. Elfasakhany, "Experimental investigation on SI engine using gasoline and a hybrid iso-butanol/gasoline fuel", *Energy Conversion and Management*, Vol. 95, pp. 398–405, 2015.

- [31] A. Elfasakhany, "Investigations on the effects of ethanol-methanol-gasoline blends in a spark-ignition engine: performance and emissions analysis", *Engineering Science Technology*, Vol. 18, pp. 713–719, 2015.
- [32] A. Elfasakhany, "Experimental study of dual n-butanol and iso-butanol additives on spark-ignition engine performance and emissions", *Fuel*, Vol. 163, pp. 166–174, 2016.
- [33] A. Elfasakhany, "Performance and emissions analysis on using acetone–gasoline fuel blends in spark ignition engine", *Engineering Science Technology*, Vol. 19, pp. 1224–1232, 2016.
- [34] A. Elfasakhany, T. K. Kassem, A.-F. Mahrous and K. K. Matrawy, "Study of heat storage using of PCM in solar distiller", *WULFENIA*, Vol. 23, No. 5, pp. 19–31, 2016.
- [35] A. Elfasakhany and A.-F. Mahrous, "Performance and emissions assessment of n-butanol–methanol–gasoline blends as a fuel in spark-ignition engines", *Alexandria Engineering J.*, Vol. 55, pp. 3015–3024, 2016.
- [36] A. Elfasakhany, "Performance assessment and productivity of a simple-type solar still integrated with nanocomposite energy storage system", *Applied Energy*, Vol. 183, pp. 399–407, 2016.
- [37] A. Elfasakhany, "Engine performance evaluation and pollutant emissions analysis using ternary bio-ethanol–iso-butanol–gasoline blends in gasoline engines", *Cleaner Production*, Vol. 139, pp. 1057–1067, 2016.
- [38] A. Elfasakhany, "Performance and emissions of spark-ignition engine using ethanol–methanol–gasoline, n-butanol–iso-butanol–gasoline and iso-butanol–ethanol–gasoline blends: a comparative study", *Engineering Science Technology*, Vol. 19, pp. 2053–2059, 2016.
- [39] A. Elfasakhany, "Investigations on performance and pollutant emissions of spark-ignition engines fueled with n-butanol–, iso-butanol–, ethanol–, methanol–, and acetone–gasoline blends: a comparative study", *Renewable & Sustainable Energy Reviews*, Vol. 71, pp. 404–413, 2017.
- [40] A. Elfasakhany, "Design, analysis and optimization of the tail bearing housing of jet engine", *J. Advances in Vehicle Engineering*, Vol. 3, pp. 99–111, 2017.
- [41] A. Elfasakhany, "Reducing automobile pollutant emissions and re-using some of such emissions as a fuel", *Ciência e Técnica J.*, Vol. 32, No.11, pp. 160–176, 2017.
- [42] M. M. Bassuoni, A. Elfasakhany, K. K. Matrawy and A.-F. Mahrous, "Applying a hybrid air conditioning system for reducing energy consumption inside buildings using a desiccant cycle regenerated with solar energy", *Ciência e Técnica J.*, Vol. 33, No.2, pp. 54–70, 2018.
- [43] A. Elfasakhany, "Exhaust emissions and performance of ternary iso-butanol–bio-methanol–gasoline and n-butanol–bio-ethanol–gasoline fuel blends in spark-ignition engines: assessment and comparison", *Energy*, Vol. 158, pp. 830–844, 2018.
- [44] Kh. Abdel-Aziz, Abo El-Nasr A. A., A. Elfasakhany, D. Saber and M. Helal, "Influence of casting mould wall thickness on the properties and microstructure of A356 alloy reinforced with micro/nanoalumina particles", *Arctic Journal*, Vol. 71, pp. 26–39, 2018.
- [45] A. Elfasakhany, "Powder biomass fast pyrolysis as in combustion conditions: Numerical prediction and validation", *Renewable Energy Focus*, Vol. 27, pp. 78–87, 2018.
- [46] A. Elfasakhany, M. M. Bassuoni, B. Saleh, M. Alsehli and Ayman A. Aly, "Biomass powder as a renewable fuel for internal combustion engines", *Arctic Journal*, Vol. 71, pp. 42–52, 2018.
- [47] A. Elfasakhany and X. S. Bai, "Numerical and experimental studies of irregular-shape biomass particle motions in turbulent flows", *Engineering Science Technology*, Vol. 22, pp. 249–265, 2019.
- [48] B. Saleh, Ayman A. Aly, M. M. Bassuoni, M. Alsehli, A. Elfasakhany and Khaled I.E. Ahmed, "Performance assessment of an integrated desiccant air conditioning system powered by solar energy using back propagation artificial neural network", *Arctic Journal*, Vol. 72, No.3, pp. 1–18, 2019.
- [49] A. Elfasakhany, "Adjustable throat-area expansion valves used in automotive air conditioning systems: A mini review", *International J. of Automotive Eng.*, Vol. 9, No. 1, pp. 2868–2875, 2019.
- [50] A. Elfasakhany, "Tire pressure checking framework: a review study", *Reliability Engineering and Resilience*, Vol. 1, No.1, pp. 12–28, 2019.
- [51] A.A Aly, B. Saleh, M.M. Bassuoni, M. Alsehli, A. Elfasakhany and K. Ahmed, "Artificial neural network model for performance evaluation of an integrated desiccant air conditioning system activated by solar energy", *AIMS Energy*, Vol. 7, No.3, pp. 395–412, 2019.
- [52] B. Saleh, A.A. Aly, M. Alsehli, M.M. Bassuoni and A. Elfasakhany, "Performance investigation of a solar-driven ejector refrigeration cycle", *World Journal of Engineering*, Vol. 16/5, pp. 625–635, 2019.
- [53] A. Elfasakhany, "How Evaporator of Automotive Air Conditioner is Modelled? A Systematic Review", *Applications of Modeling and Simulation (AMS)*, Vol. 4, No.1, pp. 64–70, 2020.
- [54] M. Alsehli, B. Saleh, A. Elfasakhany, Ayman A. Aly and M. M. Bassuoni, "Experimental study of a novel solar multi-effect distillation unit using alternate storage tanks", *Journal of Water Reuse and Desalination*, in press, 2020.
- [55] A. Elfasakhany, Mishal Alsehli, Bahaa Saleh, Ayman A. Aly and Mohamed Bassuoni, "Renewable Pulverized Biomass Fuel for Internal Combustion Engines", *Processes*, Vol. 8, No.4, pp. 465, 2020.
- [56] A. Elfasakhany, "Gasoline engine fueled with bioethanol-bio-acetone-gasoline blends: Performance and emissions exploration", *Fuel*, Vol. 274, 117825, 2020.
- [57] A. Elfasakhany, *Alcohols as Fuels in Spark Ignition Engines: Second Blended Generation*, Book, Germany, ISBN: 978-3-659-97691-9, 2017.
- [58] A. Elfasakhany, *Benefits and drawbacks on the use biofuels in spark ignition engines*, Book, Mauritius, ISBN: 978-620-2-05720-2, 2017.
- [59] R. M. Davis and B. Calif, "Can baling machine and method", Patent No. 5203261, Apr. 20, 1993.
- [60] D. Mayo, "Automatic aluminum Can crusher", Patent No. 5967029, Oct. 19, 1999.
- [61] M. H. Hiatt, "3-Metal Can pelletizer", Patent No. 4103609, Aug. 1, 1978.
- [62] G. Fry and A. Tex, "Collector for empty used recyclable beverage cans", Patent No.5469783, Nov. 28, 1995.
- [63] J. A. Determan, "Beverage Can crusher", Patent No. 5211109, May 18, 1993.
- [64] C. J. Stralow, "Beverage cans crusher", Patent No. 4962701, Oct. 16, 1990.
- [65] J. A. Turner, "Portable electric Can crusher", Patent No. 8448570, May 28, 2013.
- [66] E. H. Parrish, "Metal Can crusher", Patent No. 422873445, Oct. 21, 1980.
- [67] C. M- Davis, "Compact Can crusher", Patent No. 4316410, Feb. 23, 1982.
- [68] S. Helbawi, "Automatic reverse vending machine for aluminum Can recycling", Patent No. 4953682, Sep. 4, 1990.
- [69] A. Elfasakhany, "Beverage cans crusher machine", Patent No. 4610, Jan 10, 2016.