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DESIGN AND FABRICATION OF A GAS PRESSING IRON

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***Abstract*—Various hand held devices have been invented and produced as far back as the 1st century B.C to smoothen fabrics. Over the years, irons have come in different shapes, sizes and principle of operation. Since the invention of electricity, electric irons have dominated the iron industry. In developing countries, Erratic and epileptic power supply owing to the inability of public power supply utilities to meet the demand of the populace has necessitates the need for an alternate or emergency type of pressing iron. The objective of the design centers at overcoming the shortcomings associated with other types of existing pressing iron and to be a reliable type of pressing iron. In order to achieve the objectives, the energy source for producing the heat required to press various materials considered in this study is a butane gas. Which is a cooking gas and it is generally available.The main design was carried out with a low cost stainless steel for the fabrication of the chambers and aluminum was used to fabricate the base of the pressing iron. Testing was carried out on various materials such as nylon, cotton, silk etc and the temperature for pressing those materials were recorded.**

Keywords—Automatic electronic ignitor; contact thermometer; gas iron; aluminum base

I . INTRODUCTION

Since the introduction of fabrics and linen, there has always been the need to straighten them when rumpled and this need has given birth to a series of innovation and technologies that can be use to perform the operation of straightening them. The need to press or straightening a type of material came from the unpleasant appearance of such material after washing it [1].

A pressing iron or simply an iron can be defined as a handheld appliance with a flat smooth nearly triangular surface, which when heated can be used to smoothen cloth thereby removing the creases in them. Ironing works by loosening the ties between the long chains of molecules that exist in polymer fiber materials. With the heat and the weight of the ironing plate, the fibers are stretched and the fabric maintains its new shape when cooled.

Steven [2] stated that in the 1st century BC, metal pans were filled with hot coals and used for smoothing fabrics in China. They were called pan iron. The pan iron looked more like a large ice cream scoop. This iron has an open compartment with a flat button and handle. Hot coal or hot sand was inserted into the compartment thereby heating up the bottom of the pan iron. Moving the pan iron across a given material removed the wrinkles around the applied area. From the 17th century, sadirons or sad irons or flat irons began to be used. They were thick slabs of cast iron, delta-shaped and with a handle attached to it. To hit the iron, it was held over or inserted in a fire until it was hot enough. When a garment was to be pressed with the flat iron, a paddle hold which is a long thin piece of metal would be used to pick up the heated flat iron from the fire. A glove is worn before holding the hot flat irons handle and a thin piece of cloth was placed in between the flat iron and the garment to be pressed so that sooth would not be transferred from the flat iron to the garment being pressed. It would be used continuously to press various cloths until it becomes too cool to perform such operation. Several flat irons were owned by individuals so that they could heat up one or more while pressing with another [3].

Later on, better designs which consisted of an iron box which could be filled with hot coals were being used to press fabrics. It had to be periodically aerated by attaching a bellow. An improved version of the flat iron came into existence in the fifteenth century called the hot box (with various names like box iron or slug iron). It consisted of a hollow metal with a smooth bottom and a handle. Heated coals, bricks, slugs (heated metal) and other heating element were inserted into the hollow metal box which in turn heats the smooth bottom and used to press a cloth. It eliminated the need for an extra cloth being inserted in between the cloth and the pressing iron as seen in flat irons because the iron will not get the cloth dirty with sooth. Also in India, in a city called Kerela, the use of burning coconut shells were incorporated instead of charcoal, as they have a similar heating capacity. The idea of using burning coconut shells as heating source for smoothening cloths was as a result of frequent power outage and it has the same heating effect on material as charcoal [4].

In the late 1800s, gas iron came into existence as gas became available in every home in America through gas lines. The iron contained a burner in which the gas flowed into and burned from when ignited by a match stick. It has several setbacks as the iron became very hot and gas sometimes leaked from various areas within the pressing iron. But generally the gas iron was lighter than sad iron. Within a few years, various fueled irons came into existence.

These irons operated on heated oil, gasoline, paraffin and other fuels [5].

A new era for the evolution of pressing irons began when electricity became widely available in homes throughout Europe and part of Asia. As other forms of pressing iron were over shadowed by the introduction of electric iron by Henry W. Seely in the year 1882. His iron was hooked up to an electrical source by wires which were detachable from the electric iron. The electricity powered the iron by stimulating the iron internal cores into producing heat but did not have electric cords to constantly heat the iron during pressing. These made the iron to be heated on a stand. One of the major problems with Seelys invention was that it heated slowly on the stand and cooled quickly while in use. Thereby posing a problem of constantly reheating the iron every now and then before use. The early electric irons had no easy way to control their temperature [6]

By the end of the nineteenth century, iron technology had advanced considerably. Electric iron which uses resistive heating from an electric current was in production. This irons had hot plate called the sole plate, which is made out of aluminum or steel. The heating element is controlled by thermostat that switches the current on and off to maintain the selected temperature [6].

In Africa and some other across the world, electricity supply and availability has been a major problem and has hindered the use of electric irons. This had led to the use of other types of pressing iron which do not operate with electricity but are time consuming, difficult to use, injury prone and dangerous. In view of this, there is a need to design a pressing iron that will overcome the shortcomings associated with electric irons and other forms of pressing irons, efficient and cost effective.

II. FABRICATION AND METHOD

In the design and fabrication of the gas pressing iron, various materials are needed to achieve the construction. They include; an automatic electronic ignitor, 2mm stainless steel, 5kg of aluminum scrap, mild steel pipe of 10mm internal diameter, transparent rubber hose, butane gas, flame gun, nipple, clip, wooden handle, fiber wool and a contact thermometer.

The stainless steel which would be referred to as steel sheet through out this work will be used to fabricate the heat chambers which would consist of two parts; inner chamber and outer chamber. The outer chamber acts as the body of the pressing iron while the inner chamber represents the main heat chamber where combustion of the gas would take place. The aluminum scrap was melted and used to cast the base of the pressing iron. The automatic electronic ignitor to be used is gotten from a gas cooker and would be referred to as the control element to provide control and automatic ignition of the gas within the inner chamber. It will also be used to control the flame produced after igniting the gas. Butane gas which would come in a small hand held cylinder, almost the same size of an insecticide container would be used as the energy source for producing the needed heat for pressing materials. A flame gun was used to extract the gas from the gas cylinder. A transparent rubber hose would be used to monitor the gas flow from the gas cylinder to the control element. Fiber wool was used as thermal insulator between the chambers to reduce the heat emancipating from the pressing iron to the handle. A nipple was used as an interconnector between the control element and the transparent rubber hose and a digital contact thermometer will be used to determine the temperature of the pressing iron at all time.

A. FABRICATION OF THE BASE OF THE PRESSING

The intended size of the iron base was specified to be 20mm in height, 225mm in length and about 120mm in breath.

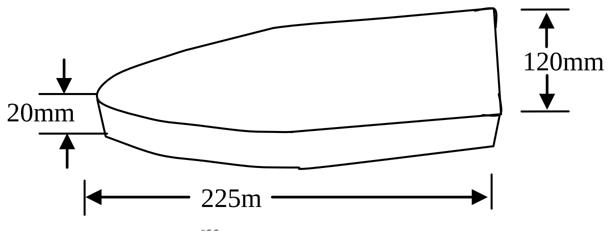

Fig 1. The sketched pattern of the base with dimensions

Using sand casting, the aluminum scrap was melted and casted to produce the base of the pressing iron. In order to include the chambers into the base of the iron, it has to contain the spacing for the chambers to fit it. The base is further worked upon using two precision machines called milling machine and the pantograph

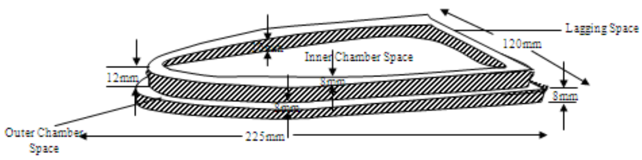

Fig. 2. Sketch of the base containing both chambers

The pantograph was used to create the spacing for the outer chamber by milling about 3mm around the base of the pressing iron through a depth of 12mm. A gap of 8mm was left on the base before creating the inner chamber spacing with a milling machine. A depth of 16mm was milled throughout the base to create a profile. The bottom face of the base that would make contact with materials during pressing was treated with sand papers and diesel as lubricant. While the rough and machined edges were dressed with sand papers, flat and half round fill to create a smooth surface and edges.

Fig. 3. Image of the finished aluminum base.

B. FABRICATION OF THE CHAMBERS

Steel sheet of about 2mm thickness was used in creating the chambers, housing and handle holder. The sketch of the chambers with dimensions and ventilation holes were drawn before cutting the steel sheet.

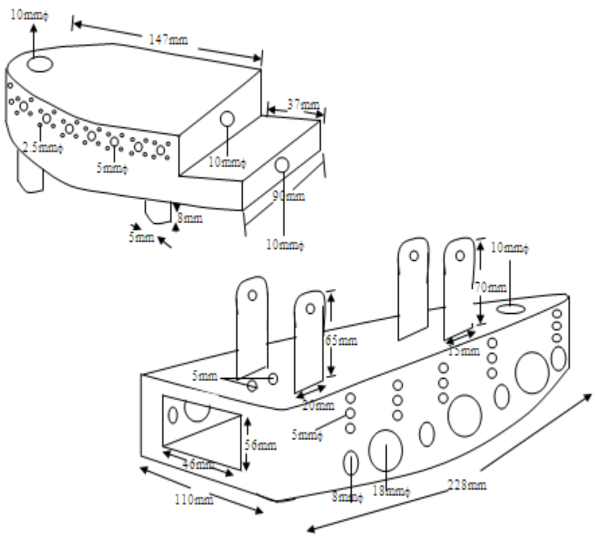

Fig 4. Sketch of the chambers.(L)inner chamber (R)outer chamber

From the outline, the first part to be cut out from the steel sheet is the top of the chambers alongside their various heights. They are then welded using electric welding to get the given profile and shape. A leg of 5mm by 8mm is cut out and attached to the inner chamber by welding to allow air flow from underneath the inner chamber. A 10mm drill bit was used to drill a hole on the top of the inner chamber and also at the back. These holes function are as follows.

1. The top hole is an inlet hole for a pipe (mild steel) that would serve as a chimney for the escape of hot air and smoke when necessary.
2. The back holes would serve as the input hole for the gas from the control element.

Behind the outer chamber, an opening of 56mm by 46mm was created and it is a rectangular passage through which the control element could be introduced to the inner chamber.

Fig 5. Image of the drilled holes at the back of the inner chamber

A drill bit of 5mm and also 2.5mm was used to create holes at the top side of the inner chamber to serve as ventilation holes or outlet through which oxygen could support combustion within the inner chamber. Also an organized array of holes were drilled on the outer chamber using drill bit of 18mm for the large hole, 8mm for the small holes beside it. The upper matrix holes were drilled with 5mm drill bit. And all these holes serve as ventilation holes for the inner chamber through the outer chamber.

Fig 7. (L) Ventilation hole of the inner chamber. (C) Ventilation holes of the outer chamber. (R) Created passage for the control element

Providing ventilation holes is a critical aspect of this work as it is seen that the following would happen if the ventilation holes are not properly considered.

1. There would be no flame in the inner chamber if there are no ventilation holes because oxygen supports combustion.
2. If the ventilation holes are too small, the flame would take the vent holes as nozzles and the flame would be coming out through those holes
3. If the holes are too big or too much, the flame would try to escape from them, air disturbance would occur thereby causing an uneven distribution and loss of heat.
4. If the ventilation holes are not properly arranged, the flame would go off during pressing because of the irregular directional movement during pressing. This creates a void-like air movement in the inner chamber causing the flame to go off.

It is to be noted that the inner chamber is a very sensitive chamber as it is disturbed by air and gas flow pressure.

C. FABRICATION OF THE BURNER AND CHIMNEY

A mild steel pipe of 12mm internal diameter was used to fabricate the burner as any pipe could be made use of provided that such pipe is strong and thick enough to withstand the heat being generated in the inner chamber during combustion. A length of 100mm was cut out to be used and a 2.5mm drill bit was used to create four holes underneath it to serve as gas outlet and burning surface. It was then welded using gas welding to the lower hole from inside located at the back of the inner chamber. Another 20mm length pipe (mild steel) was also cut out and held using gas welding to the upper part from inside to the hole drilled at the back of the inner chamber to serve as opening through which the spark created by the control element could ignite the gas in the chamber.

Fig 8. (L) Image of the burner. (R) Image of the chimney

A 5mm long cut out mild steel pipe was used to represent the chimney as it was welded using gas welding on the surface of the hole on the top of the inner chamber.

D. FABRICATION OF THE HANDLE HOLDER

The handle holder can be seen as the linkage between the wooden handle and the pressing iron. It consists of four small long pieces of steel sheet welded at different areas at the top of the outer chamber. Cutting out a length of 15mm by 70mm twice from the steel sheet which would represent the front handle holder and another 20mm by 65 mm is also cut out twice from the steel sheet to represent the back handle holder.

The difference in length and size of the handle holders is to create rigidity and style, as any given length could be used depending on the design.

The cut outs were then drilled at one end with a 5mm drill bit. This hole would enable the handle holder to be held by screw and nut to a wooden handle. The cut outs are then welded using electric welding to the top of the outer chamber.

Fig 9. Image of the handle holder welded on the outer chamber

E. FABRICATION OF THE HOUSING

To prevent direct exposure of the control element, a cover had to be created for it called the housing. It encloses the control element and prevents external wind and breeze disturbance due to some little openings in the control element where the gas passes through. Proper studying and measurement is done to enable proper balancing and fitting of the control element in the housing.

A sketch of the housing must first be done with adequate dimensions due to the irregular shape and design of the control element.

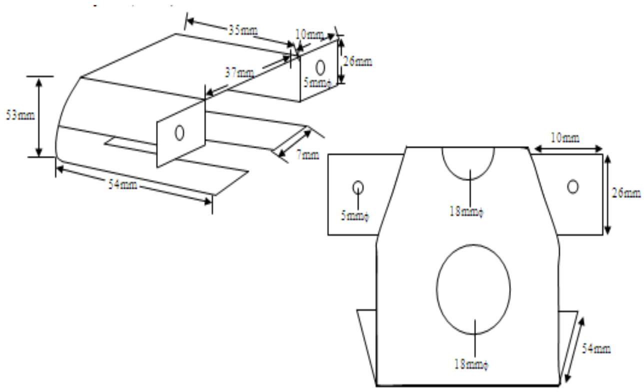

Fig 10. Sketch of the housing intended to be produced

From the given sketch, the parts were cut out and welded using electric welding and the holes were drilled respectively. The 18mm diameter hole serves as the outlet for the control nub for regulation of the gas flow and also switching on and off of the pressing iron. The 5mm diameter drilled holes act as interconnection hole between the housing and the outer chamber to be held by screw and nut.

Fig 11. Image of the housing

F. FABRICATION OF THE INSULATOR PLATE

The insulator plate helps hold the insulating material (fiber wool) from falling off when placed in between the inner chamber and the outer chamber. Thereby reducing the heating effect occurring at the surface or top of the outer chamber and also protects the contact thermometer and the wooden handle from direct heat.

The same measurement of the outer chamber top is drawn on a steel sheet but with a 1.5mm reduction in its overall dimension and cut out. A rectangular shaped part is cut from the lower part of the plate to allow little air flow from the drilled hole on the outer chamber.

A 5mm drill bit is used to create a hole on the plate to allow passage of the metal part of the contact thermometer down to the base of the pressing iron and a 10mm drilled hole through which the chimney could exit to the top of the outer chamber.

Fig 12. An image of the insulator plate

G. PRODUCTION OF THE NIPPLE

A nipple is a device used to introduce gas into another device through the use of a hose. The design of the nipple was done in such a way as to increase the pressure of the gas that flows through it into the control element.

The following procedures are followed in constructing the nipple;

i. The sketch of the nipple with dimensions was first be done. This would enable accurate production of the end product.

ii. A cylindrical mild steel rod of length 60mm and height 13mm was inserted into the chuck of the late machine and a high speed steel cutting tool was used to reduce the size of the mild steel to about 9.5mm through a length of 15mm.

iii. A hole of 5mm was drilled through the mild steel by inserting a 5mm drill bit into the tail stock of the lathe machine and fed through to a depth of 45mm during which lubricants were applied to reduce friction and avoid the breaking of the drill bit.

iv. The mild steel is further reduced again to a height of 7mm through a length of 25mm.

v. The ripple shape is formed by feeding the tool post in and out the mild steel at a given distance to produce the required shape. The ripple shape serve as a form of friction that holds the rubber hose firmly to it when inserted together and held with a clip.

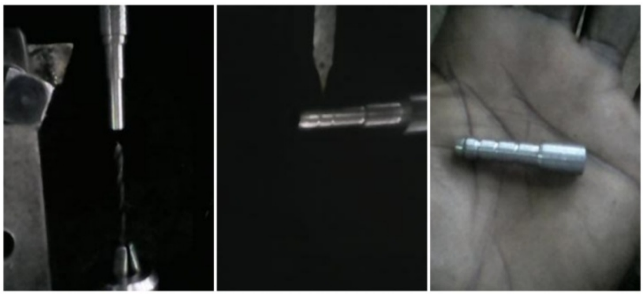

Fig 13. (L)5mm drilling process. (C) Ripple creation. (R) Finished nipple

H. RECALIBRATION OF THE CONTROL ELEMENT

The control element which is an electronic automatic ignitor used for this project was gotten from a gas cooker. It uses the principle of creating a small spark while passing gas across its outlet to produce flame at the tip of its nozzle.

Recalibration was done for increasing and controlling the pressure at which the gas flows within it and thereby saving some amount of gas that can be dissipated during combustion. It is a very tricky technique, as it involves dismantling the control element into component parts and locating the inlet and outlet holes of the gas within the control element.

The holes are sealed up and smaller holes were drilled to increase the pressure and reduce the flow rate. The sealing was done by gas welding using brass lead to seal up the given area. The nipple was then welded to the inlet pipe of the control element using gas welding.

Fig 14. (L) Image of the control element, (R) welded nipple to the inlet of the control element

I. RECONSTRUCTION OF THE FIRE GUN INTO A GAS REGULATOR

Fire gun or flame gun as it is popularly known was used as the major device for the gas regulator. A flame gun is a device used to produce flame when connected to a small gas container. It uses almost the same principle as the electronic automatic ignitor but it does not have an inlet for pipe or holes.

The flame gun was dismantled and its ignition component was removed so that when it is connected to a gas container, it only releases the gas from the container but does not ignite it. The extension parts were removed, leaving only the part which can be connected to a hose.

It was then coupled back to be used as a gas regulator to reduce and increase the flow of gas from the gas container to the rubber hose.

Fig 15. Image of the reconstructed flame gun with a transparent rubber hose attached to it

J. ADJUSTING THE CONTACT THERMOMETER

The thermometer used is a futek contact thermometer which is digital in nature and continuous in its reading with a long protruding stainless steel pin for the temperature sensing.

The stainless steel pin part of the thermometer was bent facing downwards due to the design of the pressing iron. The stainless steel pin was to run from the outer chamber down through the insulator plate within the region of the 8mm gap between chambers and touch down at the aluminum base.

Its basic function is to indicate the actual temperature gradient change of the aluminum base during operation. This temperature change would help determine what temperature could be used to straighten or press different materials.

Fig 16. An image of the contact thermometer

K. FABRICATION OF THE WOODEN HANDLE

The wooden handle is created with a lathe machine using the same principle applied in fabricating the nipple. A long cylindrical shaped wood was used. The following procedure was taken.

i. A cylindrical wood of about 200mm of height 40mm was placed in the chuck of the lathe machine and a high speed steel cutting tool inserted into the tool post is used to reduce the wood down to a size of 27mm through a length of 160mm being the exact length and height of the handle.

ii. The grip design was accomplished by artistically cutting deep through the wood at a point 40mm from each end to get the required shape.

iii. Then sand paper was used to smoothen the surface and design to get a nicer finishing.

iv. A flat profile was created by placing the required part on a grinding machine to grind away the aspect or portion to create a profile shape and 3mm hole was drilled into the flat profile.

Fig 16. (L) processed cylindrical wood on a lathe machine. (R) Finished handle

L. FABRICATION OF THE THERMOMETER SIT

A thermometer sit (which is optional) was made so that the thermometer once inserted into the pressing iron could rest and balance properly at the top of the outer chamber.

A piece of steel sheet of about 40mm by 70mm was bent on a clamp to form a "u" shape. A 3mm hole was then drilled on it and also at the top of the outer chamber so that they could be held together by screw and nut

Fig 17. Image of the thermometer sit

M. COUPLING THE PRESSING IRON

In coupling the different parts of the gas pressing iron, the following steps were followed:

1. The thermometer sit was placed and tightened to the top of the outer chamber.
2. The outer chamber was turned upside down and the fiber wool was inserted carefully with hand gloves inside the chamber.
3. Next, the insulator plate was inserted into the outer chamber thereby holding the fiber wool (insulator) from falling off when turned upright.
4. The inner chamber was introduced and positioned

5. The chambers were then placed on the base of the pressing iron. Ensuring that each chamber lap properly on their respective opening or spacing. This is critical because if the inner chamber does not lap properly within the inner spacing, it could lead to excess or reduced air flow thereby causing some unexpected result.

6. Inserting the control element through the back of the outer chamber to the inner chamber was done next and carefully in order not to damage the control element.

7. The housing was then used to cover the control element and held with screw and nut to the outer chamber.

8. One end of the rubber hose was connected to the nipple of the control element and clipped firmly. While the other end of the rubber hose was connected to the regulator and also clipped firmly.

9. The gas container was then connected to the regulator

10. The wooden handle was fixed to the handle holder and held together with nut and screw.

11. Finally the thermometer was then introduced properly into the created passage on top of the outer chamber ensuring it touches the base of the pressing iron.

Fig 18. Image of the designed gas pressing iron

III. EXPERIMENT

As the gas regulator was opened, gas moved freely from the gas container into the transparent rubber hose to the control element. When the control element was switched on, it was observed that flames were produced from the burner within the inner chamber and could be controlled using the control element. There was the presence of smoke from around the iron which stopped after some few seconds and hot air followed through the chimney. Blue flames appeared at the tip of the burner and red at the end of the flame. Gradually, the base of the pressing iron got heated up and the thermometer reading increased as the temperature within the pressing iron increases.

Due to the increase in temperature, the pressing iron became hot but the body of the pressing iron was far hotter than the top where the thermometer and handle were located because of the lagging done inside the outer chamber. A temperature of 90°C was observed after two minutes. The pressing iron was moved in different directions and the flame did not go off. It was then switched off using the control element and a gradient increase of 110°C was seen as the thermometer reading.

It was also observed that sometimes the control element experiences difficulties in producing the flame in the inner chamber due to the enclosed environment surrounding it.

IV. TESTING AND RESULT

In the course of the experiment, the iron was used to press different materials and the temperature at which each material was pressed was noted. It was discovered that the gas pressing iron could be used to press different materials at the following temperatures. The gradient rise in temperature is the additional rise in temperature of the inner chamber once the heating source has been shut off by the control element.

Table 1: Materials and their pressing temperature.

MATERIALS	TEMPERATURE (°C)	GRADIENT RISE (°C)
COTTON	90	110 – 118
SILK	60	75 – 81
POLYESTER	40	56 – 65
WOOL	75	87 – 96
NYLON	35	43 – 54
LINEN	100	115 - 123

V. SUMMARY

The gas pressing iron designed and fabricated was conceived due to the short comings associated with the available pressing irons in the market.

Existing gas irons and other types of iron such as fuel iron and electric iron were researched and analyzed, findings from this research was used as a base for the design of the gas iron constructed in this work with a lower cost initiative. Also ease of use was highly considered during the design process.

The designed gas pressing iron uses cooking gas (butane) which is economical and generally available as the heating source to actualize its construction.

The control of the heating effect was successfully implemented using a recalibrated automatic electronic ignitor. The contact thermometer used in obtaining the temperature produced values. This values obtained was used for setting the temperature at which various materials can be pressed.

Pressing of different materials was successfully done using the designed gas pressing iron

VI. CONCLUSION

The design and fabrication of a gas pressing iron and its subsequent use for pressing cloths/materials have proven to be successful.

This gas pressing iron can be used as a cost effective replacement of other types of pressing iron and a reliable type of pressing iron when compared with electric iron.

Its extensive features like the inner hallow compartment allows for its use with diverse heating source.

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