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Development of Anelectrically Operated Tyre Removing Machine

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***Abstract* - Removal of vehicle tyres has being so strenuous for road side vulcanizers in Nigeria due to the manual labour exerted during the process. In reducing the labour requirement as described by ergonomist Phelani in his book,[7], an electrically operated tyre removing machine was developed. The objective of the project is to make the process of tyre removal from vehicles for repair purpose easier than the local method commonly used. The machine comprises of the actuator, plunger blade, tyre seat, switch control and frame supports. The elements of the machine were assembled and coupled together using both fastening and welding method. [2] It was found that the efficiency of the machine was very high and it removes tyres with ease.**

Keywords: T*yre, Actuator,Vulcanizer, Efficiency, Compactness*

I. INTRODUCTION

Tyre is a dough-nut shaped rubber covering that fits round a rim to protect it and to enable better vehicle performance by providing a flexible cushion that absorbs shock while keeping the wheel in close contact with the ground [1]. The word tyre is derived from the word 'tie' referring to the outer steel ring part of a cart that ties the wooden together. [10] Tyre removing machine originated from Los Angeles in United State of America (USA)in the early 18th century, where a crude implement like pointed cast iron rod, long wood, chisel and hammer were used as a means of removing tyres [1].The wheels of automobile were first made of woods coupled into a steering mechanism. The wheels were simply bands of metal that fitted around a wooden vessel in order to prevent wear and tear. The iron was heated in a forged fire, placed over the wooden wheel and quenched, causing the metal to contrast and fits tightly on the wheel. The outer served to tie the wheel segment together for use, providing also a wear-resistant surface for the perimeter of the wheel. The word tire emerges as a variant spelling to refer to the metal bands used to tie the wheels [1].The first practical pneumatic tyre was made by John Boyd Dunlop, scot in 1887 for his son's bicycle. This is an effort to prevent the headache this son had while riding on roads. Dunlop was credited with realizing rubber that could withstand the wear and tear of being tyre, while retailing its resilience. The pneumatic tyres are made of flexible elastomer materials such as rubber with reinforcing materials such as fabric and wire [10].The distinguishing features of this development machine over the existing ones are: the use of actuator to produce the required force, powered by electricity supplied and provision of adjustable tyre seat. Its advantages over the other tyre removing method are: the compactness of its components reduces space and ease the transportation of the equipment. The application of electrical actuator reduces the working noise and improves working efficiency, and its adjustable tyre seat reduces the time required in rotating the tyre during operation [4,7].

II. MATERIALS AND METHOD

A. Design Drawings

The isometric and orthographic drawings of the tyre removing machine are presented in Fig. 1 and Fig. 2 respectively.

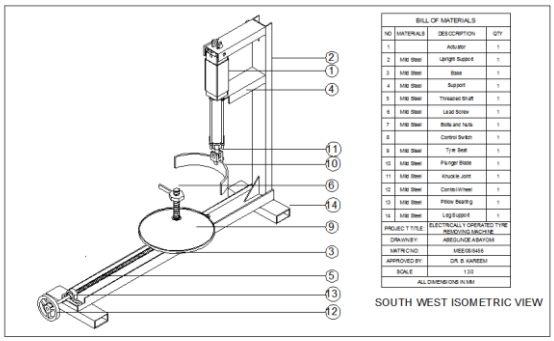

Fig. 1: Isometric view of the tyre removing machine

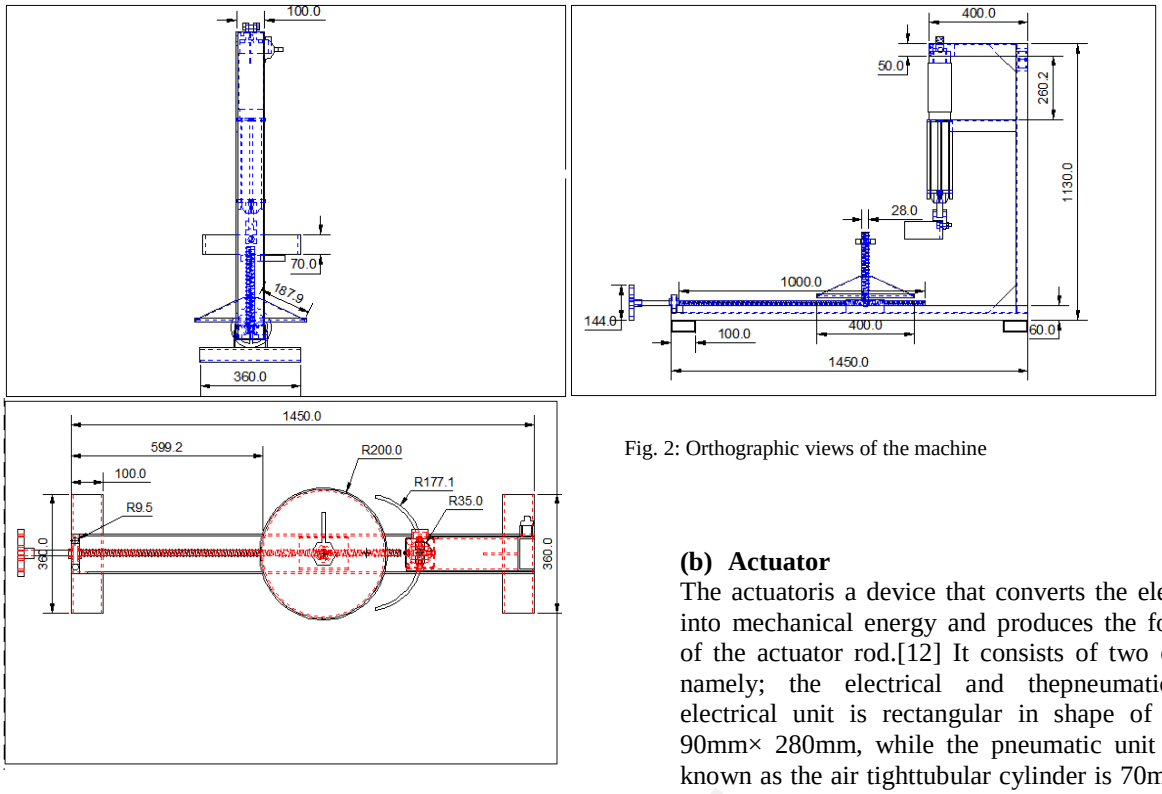

Fig. 2: Orthographic views of the machine

B. Materials and Components

The materials used in construction of this machine were majorly iron steels, welding electrodes, actuator, bolts and nuts for fastening, paint and electrical wire.The main parts of the extractor are the base saddle, the frame supports, the actuator, the plunger, blade, switch control and the adjustable tyre seat. The components are described as follows:

(a) Frame

The frame of the equipment is the backbone of the structure [6]. It is made up of two rectangular hollow mild steel of sizes 320mm×100mm ×45mm and 2mm thick. The frame supports consist of the base support made of H-channel beam and upright support of U-channel beam. The base support of the machine is made of mild steel of sizes 1450mm × 120 mm × 65mm and 5mm of web thickness. The U channel beams are the upright support, top actuator's support on which the actuator is hanged on, the bottom actuator's support upon which the actuator is rested on. All the weights of actuator, knuckle joint, and the plunger blade are on these beams. Tyre seat is the base made of mild steel plate of 5mm thick and of diameter 400 mm with oval shaped made of mild steel sheet of 2 mm thick, and a U- channel beam of sizes 155 mm×100 mm× 45 mm with 5 mm web thick. Attached underneath is the nut that was connected to the shaft.

(b) Actuator

The actuatoris a device that converts the electrical energy into mechanical energy and produces the forward motion of the actuator rod.[12] It consists of two compartments, namely; the electrical and thepneumatic units. The electrical unit is rectangular in shape of sizes 90mm× 90mm× 280mm, while the pneumatic unit which is also known as the air tighttubular cylinder is 70mm in diameter and 1500mm high, are made of steel metal plate. It uses the energy of compressed air to move a piston rod of diameter 18mm. The actuator creates a linear motion in its double acting (movement in two directions). The electrical impulses fired into the liquid, hit the water and transformed into a very powerful mechanical shock waves that radiates outward from the point of generation [10].

(c) Knuckle joint.

The knuckle joint is used to connect the actuator's piston rod to the plunger blade. It is made of mild steel of **h**-shaped and of high strength. It is welded to the blade plunger that was connected to the piston rod, using pin or bolt & nut of high strength for an adjustment or repairs, which is under the compressive force in between applied force from the actuator and impulsive force of the tyre to be removed.

(d) Plunger blade.

The plunger blade is made of mild steel spring of length 50mm long, 40mm wide and 5mm thick of high stiffness. The material is curved into a circular shape in order to remove the tyre.

(e) Power shaft

The shaft is the rotating element that is used to transmit power from driving wheel to the tyre seat. It is made of mild steel of 1000 mm long and 20mm diameter. The threaded part is 1000mm of 2mm pitch. It converts the wheel circular motion into linear motion of the tyre seat

C. Fabrication Process

The fabrication processes adopted in this project are majorly cutting, grinding, drilling and turning.The base made of H–channel beam of1450mm x125mm x65mm in height and 6mm thick. The upright, the top and the bottom

supports of the actuator are made of U–channel of sizes 970mm x 100mm x 450 mm and 2mm thick, 400mm x 100mmx 45mm and 2mm thick and 350 x100mm x 45mm and 2mm thick respectively were cut, using power cutting machine. A keyed shaft of 20mm diameter and 1200 mm long is turned through 200mm and threaded for a length of 1000mm. A wheel drive cast of aluminum of diameter 144mmand 20mm thick with a drilled hole of radius 10mm with keyway to accommodate the shaft at the turned end. Another face-down U -channel beam of sizes 155mm x 100mm x 45mm and 5mm thick was welded to the tyre seat with a 20mm across flat diameter nut was attached underneath the U-channel to accommodate the threaded shaft. A disc plate of 400mm diameter and 5mm thick is the adjustable tyre seat.

III.ASSEMBLY AND TESTING OF THE MACHINE

The major assembly process are welding and bolting.
The equipment base frame (H-beam) was welded at the two edges to the two rectangular hollow bar legs then to U – channel upright beam. The Upper support for actuator's hanging was welded to the top of the upright beam with the provision of two slotted holes for the hanging of the actuator. Shaft with pillow bearing was bolted onto the base support and connected to the nut welded to the underneath of the U-channel that was welded to the seat carriage. A plate that served as a tyre seat was welded to the lead screw which was also welded to the seat carriage.The actuator was hanged on the slotted end of the upper support using 19mm bolt and nut and rested on the bottom's support that was bolted to both upper and upright supports. The Knuckle joint was welded to plunger blade and bolted to the actuator; using 13mm bolt and nut.The switch control was bolted to the upper right side of the machine, connected to the actuator and to the alternating current source. The current flows from the alternating current supply to the actuator via the switch control energized the actuators then providing forces that will push out the plunger shaft that will press down the shoulder of the tyre from the rim. The adjustable seat is used to adjust the tyre to provide for a sequence operation.

IV. CONCLUSION

A tyre removing machine was designed, fabricated and tested. From the above evaluation it could be concluded that the objective of convenient operation, faster speed operation and very little or no experience is acquired before operating the machine. The equipment is very easy to assemble and disassemble.

V.RECOMMENDATION

Despite the fact that the tyre removing machine works effectively, the following recommendations are made;

1. The tyre removing machine should be redesigned in order to accommodate the bigger tyres such as the Lorries' tyres which are very big and heavy for this design.
2. The machine should always be kept clean, lubricated and in a dry environment in order to prevent corrosion and distortion of the support [3].

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