International Journal of Scientific Research in Science, Engineering and Technology
Print ISSN: 2395-1990 | Online ISSN : 2394-4099 (www.ijsrset.com)
doi : https://doi.org/10.32628/IJSRSET2293172

Design and Fabrication of Chairless-Chair using Pressure Cylinder and Flow Control Valves

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Article Info
Volume 9, Issue 3
Page Number : 509-519

Publication Issue :
May-June-2022

Article History
Accepted : 15 June 2022
Published: 28 June 2022

ABSTRACT

Today the world is now going to be compact. For suitability to the world, things are also going to be made of compact and smaller in size. Now the battle is also done between machines instead of man to man. Machine, which is fighting, are operated and driven by man sitting instead the vehicle or being in touch with the machines. Also, the human has to win the war against the increasing oil prizes and tremendously increasing pollution level in the air. To win this war and to thought regarding another parallel motive force to the auto- mobile, we have thought of manufacturing **"CHAIRLESS CHAIR"** through the mission of project. Project is a mission of creating something new, which is innovative i.e. manufacturing of a new product.

Keywords: Chair, Back Pain, Standing, Belt

I. INTRODUCTION

If you work somewhere such as a factory, warehouse, or restaurant kitchen, then you'll know how tiring it can be to stand for several hours at a time. Unfortunately, however, it isn't always practical or safe to carry a stool around with you wherever you go. That's why Swiss start-up noonee has created the Chair less Chair. Worn as an exoskeleton on the back of the legs, it lets you walk or even run as needed, but can be locked into a supporting structure when you go into a sitting position.Company CEO Keith Gunura started developing the Chairless Chair in 2009, when he was a student in the Bioinspired Robotics Lab at the ETH Zurich research institute. He was inspired to do so by memories of his first job, in which he worked while standing at a packaging line.

Now in prototype form and being actively marketed, the device utilizes a powered variable damper to support the wearer's body weight. The user simply bends their knees to get themselves down to the level at which they'd like to sit, and then engages the damper. The Chairless Chair then locks into that configuration, directing their weight down to the heels of their shoes, to which it is attached – it also attaches to the thighs via straps, and to the waist using a belt.

II. OBJECTIVE

The Chair less Chair is an exoskeleton that allows workers to sit without straining their muscles.

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STANDING IS GREAT for your health—Burn calories! Live longer! Tone those calves! —but only if you're not forced to do it for hours on end. As with sitting on your bum, everything is best in moderation.

The thing is, if you work in a factory, you don't get to choose when you sit and when you stand. You're mostly standing. Employees in Audi's manufacturing plants, for example, stand for nearly eight hours a day. And much of the time they're stooped over in uncomfortable positions, fine-tuning some detail on an engine or console cluster.It's ergonomic nightmare, one Audi is trying to correct with a unique piece of technology: the Chairless Chair. Created by Swiss startup Noonee, it's a hydraulic powered chair that lends lower-body support to people who have to stand all day long. You can think of it as a really bad-ass wearable or an especially lame exoskeleton. The design is straightforward: A titanium frame hugs the back of the worker's leg like a flexible brace, while a support belt is strapped around their torso. Workers can stand and walk like normal, but when they want to sit, pushing a button locks the frame into place at the desired angle. The weight the body is transferred through the frame to the floor or the heels. "You get the sensation of sitting on a barstool," says Keith Gunura, a Noonee co-founder.Why not simply sit on a chair? Companies like Audi have optimized factory floorplans designed to maximize efficiency, with little room, literally or figuratively, for chairs. The Chairless Chair effectively lets employees carry a seat with them at all times.The approach posed some ergonomic challenges. Noonee designers say the biggest problem was ensuring workers can move freely. After a close study of how the leg moves when walking, they decided against creating a single rotation point at the knee in favor of a frame that moves more freely, accommodating many different gaits. (Noonee was vague on the details because it has a patent pending.)

Audi envisions the device being a task-specific tool that will help workers at the engine, door and center console assembly stations. The company says the chair will let employees take "micro breaks" of three to 10 seconds while working, easing muscle fatigue and increasing productivity.

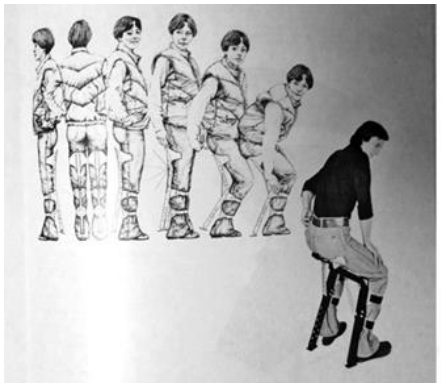
The Chairless Chair doesn't provide added strength like Lockheed Martin's Fortis exoskeleton, but it is lighter, more comfortable and uses far less energy, so you might see them beyond factory walls. "I've had hunters saythey'll pay a pretty penny to use the device,"Gunura says. Fishermen, surgeons, farmers and retail workers also have expressed interest. "Basically, anyone who's standing for long periods of time."The objective of our project is to enable the worker to have the ability to move around with absolute ease, with the use of a chairless chair.

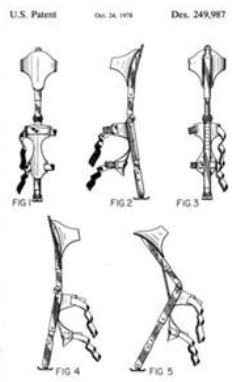
Salient features of the project:

1. A belt secures the chairless chair to the hips, and straps wrap around the thighs.
2. A variable damper engages and supports the bodyweight, which is directed towards the heels of the shoes.
3. An alternate version works with any footwear and touches the ground only when in a stationary position.
4. The user just moves into the desired pose and then powers the device using a control button.
    1. Pneumatic cylinder is used for smooth suspension which make comfort to operator
    2. it is light in weight.
    3. It is easy to wear
    4. Low cost

III. LITERATURE REVIEW

If your current job requires you to stand for long hours, this new “chair” will ease the aches in your thighs and calves as you work.Created by Zurich-based startup noonee, the ‘Chairless Chair’ helps users to rest their leg muscles by directing their body weight towards a variable damper attached to the battery-powered device.The “chair” is worn like an exoskeleton, allowing users to walk or run with the device while they work. To use, simply bend your knees to a comfortable stance to activate its damper that supports your body weight.Keith Gunura, the CEO and co-founder of noonee, told CNN that the Chairless Chair helps users maintain a good posture.“It keeps your back straight and can reduce the occurrence of bad postures for both healthy workers and those recovering from muscle related injuries,” said Gunura.Take a look at the Chairless Chair below, which will be used in a trial in Germany, starting with BMW in September, and with Audi later this year.



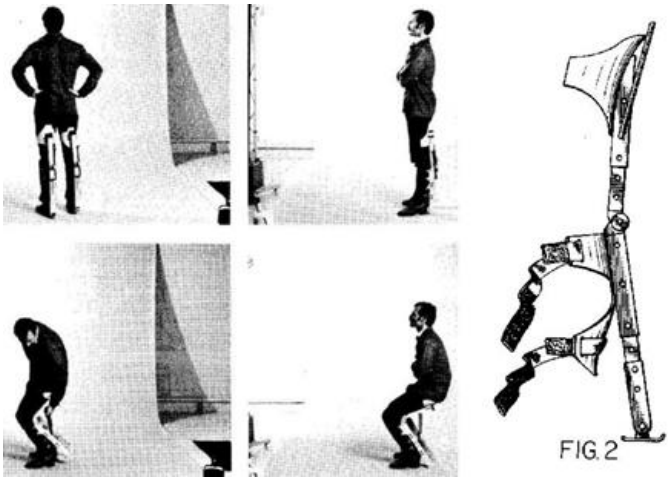


So, it looks like the honor of Design Crossover Hit of the Week goes to Noonee's Chairless Chair, and while the mainstream media took to hailing it as a futuristic exoskeletal paramedical breakthrough, it so happens that the basic idea dates back to the late 70's. Upon seeing my post about it earlier this week, eagle-eyed reader Gary Cruce sent a note with a photo from an old exhibition catalog, indicating that the product may well have been invented several decades ago. "I doubt Noonee was aware of this earlier concept, but they may want to know of it as they work to take the product to market," Cruce writes. "The exhibit was at the Kohler Arts Center (yes the toilet company) in 1978, based in Sheboygan, Wisconsin. That show featured many studio furniture pieces including selections from Sam Maloof and Wendell Castle." Along with the image and anecdote, Cruce provided an all-important snapshot of the caption from the catalog; crediting the "Wearable Chair (1977)" to Darcy Robert Bonner Jr., it reads:

The "Wearable Chair" consists of two identical "chairs," one strapped to each of the wearer's legs. Bonner states that "It is important for the 'Wearable Chair' to be adjusted to each user. Just like a piece of clothing, if the chair doesn't fit, it will not feel good. When adjusted correctly, you can comfortably relax with all your weight on the chair.

"With the lower member of the chair strapped to the calf, a spring presses the upper member against the back of the thigh. As the user squats, the released compression bar pushes the leg of the chair to a locked position, thereby supporting the body. When the user rises, the lower member is unlocked and is retracted by a spring to its oriMSnal position, where it will not interfere with the user's movements."

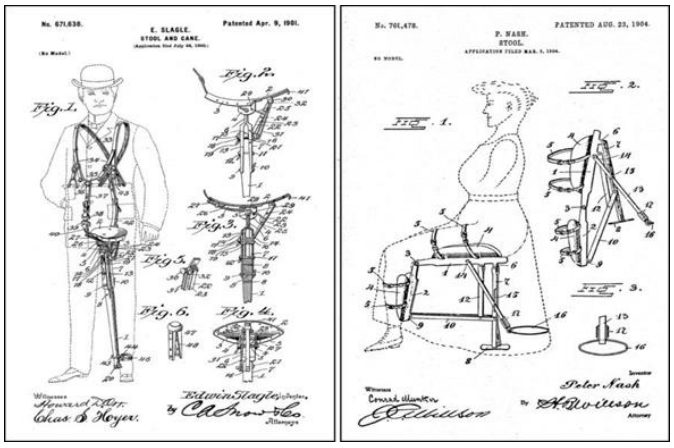
Curious to learn more, a de rigueur Google query revealed that Darcy Robert Bonner had actually filed a patent for his invention, which inspired this "more-than-you-cared-to-know" history of the wearable chair— a bit of rechairche du patents perdu, if you will—gleaned mostly via the USPTO (though tangential sleuthing reveals that one Darcy R. Bonner now heads up an eponymous architectural practice in Chicago).



The oriMSnal patent is simply entitled "Wearable Chair," which also happens to describe Noonee's

product. Filed in 1977 and granted as D249,987 in October 1978, Bonner's initial design patent is described in Twitter-friendly terms as "the ornamental design for a wearable chair, as shown and described." Although this first iteration briefly resurfaced in the post-Google era in 2008, when the images above made blog rounds, it turns out that Bonner subsequently filed a second patent, US4138156 A, granted in February 1979, which is far more detailed in tenor and scope. Where the former is classified as a "footed," "collapsible or folding" article of furniture, the latter is subject to an entirely different taxonomy of patent-worthiness.

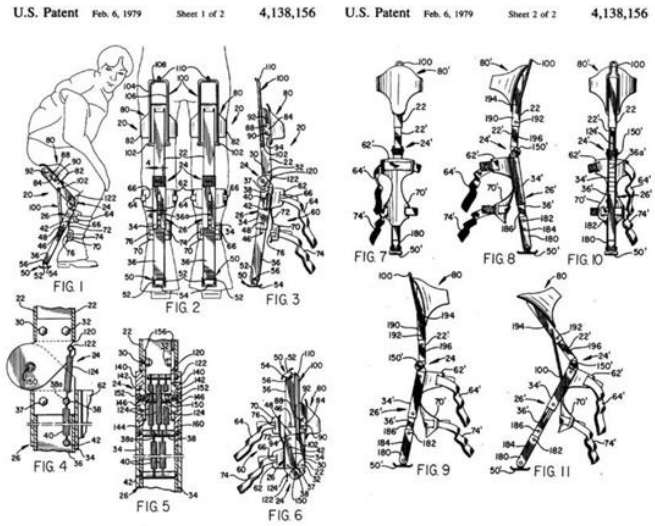
US4138156 A is a "device for supporting the weight of a person in a seated position including chairs, seats, and ancillary devices not elsewhere classifiable," specifically a "portable bottom with occupant attacher" (Subclass 4) with "occupant-arising assist" (Digest 10). (In the interest of due diligence, there are 148 patents in the former subclass and 353 in the latter; Noonee's Chairless Chair does not appear to be among them. Fun fact: "Digests" [denoted by DIG followed by a number] are considered secondary subclasses, which are used for indexing purposes only, i.e. as meta tags.)



The U.S. Patent Office being the accessible archive that it is, I was curious to explore the prior art (extant patents that are interpolated in the one at hand) for the second patent, including a sort of ejector toilet seat (1953)—the schematic evokes a prank but it is of course an assistive device—as well as a couple of long superannuated patents: an extremely elaborate 1901 "Seat and Cane" (above left) and a 1904 "Stool" (above right). As kinky as the former device looks, it's actually intended for the very same purpose as the Wearable and Chairless Chairs, though it should hardly come as a surprise that humans have suffered from extended periods of standing since the dawn of industrialization. Per the OCR'd 1901 patent:

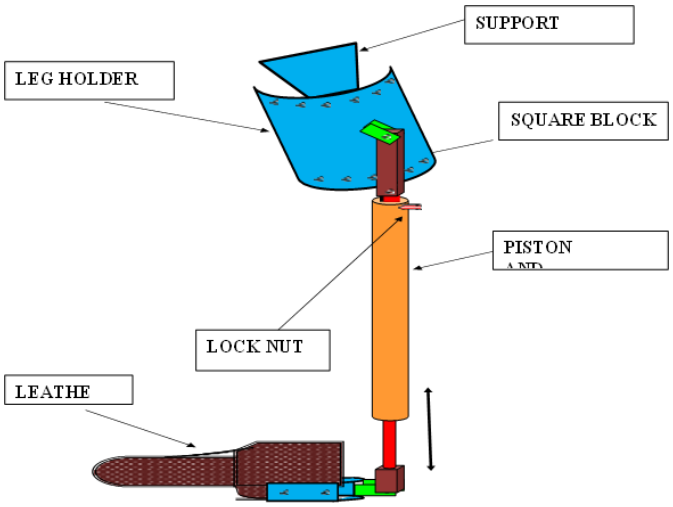
This invention relates to a combined stool and cane; and the object of the same is to provide simple and effective means for supporting a person while at labor or during the pursuance of those classes of vocations requiring an upright or standing posture or for other purposes, the improved device being in connection with supporting devices on the person of the user and transportable with the latter from place to place without interference with the free movement of the person carrying the same...

I was also interested to see that Bonner's patent 4138156 was cited as prior art for handful of Nike patents. I'll admit that my armchair investigation was summarily scuppered by the itemized technical jargon of Patent No. 7591919 ("Fluid-filled chambers with foam tensile members and methods for manufacturing the chambers") and the rest, though I would gladly be enlightened by anyone who can parse the legalese.



But I digress. As you can see in the images above, Bonner's 1979 "Wearable Chair" patent includes both a heavily annotated version of the drawing from the oriMSnal design patent (right) and several additional depictions the mechanism of the spring-loaded "brace member" (left), which is explained in great detail.

Meanwhile, the "Background of the Invention" section sets a clear precedent for the advantages and use cases of Noonee's Chairless Chair:



Numerous occupations and recreational activities require long periods of standing or use of the legs but do not readily permit the use of seating structure on which an individual can rest. For example, assembly line workers who must have freedom of movement from one workstation to the other normally have no ready access to a chair or other seating support during intermittent idle periods between work projects. Also, where

seating is provided, it is usually not readily accessible to the worker but rather is located out of the immediate work area.

The same absence of any seating exists in numerous sporting events where the spectator or even the participant must move from one location to the other. For example, while observing a golf tournament or other similar event, a seating structure would be desirable but has not heretofore been practical. Also, hikers and campers having generally done without the luxury of seating simply because of the added inconvenience or the inability of carrying a chair in addition to other equipment.

Thus, a need has arisen for a simple and lightweight body support which is readily accessible to the user but which does not necessarily have to be hand carried.

Of course, Bonner's patents are long expired by now, and nor should these revelations detract from Noonee's mission in the least. After all, their innovation certainly has more to do with the actuated damper system— the startup reportedly "spun out of the NCCR Robotics lab at enMSneering university ETH Zurich"—than the concept itself, not to mention the incremental improvements in lightweight materials such as carbon fiber. That said, I'm a bit out of my element as it is, and I wouldn't know where to beMSn when it comes to plunMSng the depths of Geschmacksmuster, so keep those tips coming.

Previously: Noonee's So-Called Chairless Chair Offers Wearable Seating Solution; see also: The Design of Design Patents: What Every Designer Should Know About Protecting Your Work

IV. PROPOSED SYSTEM

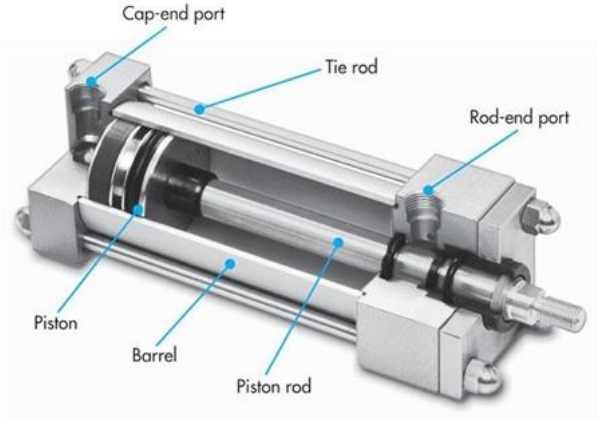
CONSTRUCTION AND WORKING

We will buy a leather safety shoe for which we will make a C- frame, the frame is fixed with shoes with the help of stud passed through heels of the shoe, both end

of stud is tightened with the help of nut. It will hold the shoe (shoe holder).

Now we will make a small square box one end of which is pivoted to shoe holder and another end is fixed to the bottom end of Piston connecting rod.

Here we will use 10 bar pressure cylinder half filled with air and half with oil, depends upon the weight of user. The cylinder has 25 mm bore diameter, 250 mm stroke length and is provided with two flow control valves.



Now, we make leg holder which will hold the thigh and is made by taking 2mm MS sheet bended to the shape of thighs. Two nylon laces are fixed to the thigh holder with the help of pop rivet so that it can hold the leg. The leg holder is pivoted to square block and square block is fixed to cylinderThe cylinder pivoted with the help of this component to leg holder. We have used M-10 nut bolts for all pivots.

The assembly will look like this.

Now, as the person can sit stand and walk comfortably. The "Chairless Chair" consists of two identical "chairs," one strapped to each of the wearer's legs. It is

important for the Chairless Chair to be adjusted to each user. Just like a piece of clothing, if the chair doesn't fit, it will not feel good. When adjusted correctly, you can comfortably relax with all your weight on the chair.

"With the lower member of the chair strapped to the calf, a cylinder presses the upper member against the back of the thigh. As the user squats, the released compression bar pushes the leg of the chair to a locked position, thereby supporting the body. When the user rises, the lower member is unlocked and is retracted by a cylinder to its original position, where it will not interfere with the user's movements."

MATERIAL SELECTION

The proper selection of material for the different part of a machine is the main objective in the fabrication of machine. For a design enMSneer it is must that he be familiar with the effect, which the manufacturing process and heat treatment have on the properties of materials. The Choice of material for enMSneering purposes depends upon the following factors:

1. Availability of the materials.
2. Suitability of materials for the working condition in service.
3. The cost of materials.
4. Physical and chemical properties of material.
5. Mechanical properties of material.

The mechanical properties of the metals are those, which are associated with the ability of the material to resist mechanical forces and load. We shall now discuss these properties as follows:

Strength: It is the ability of a material to resist the externally applied forces

Stress: Without breaking or yielding. The internal resistance offered by a part to an externally applied force is called stress.

Stiffness: It is the ability of material to resist deformation under stresses. The modules of elasticity of the measure of stiffness.

Elasticity: It is the property of a material to regain its oriMSnal shape after deformation when the external forces are removed. This property is desirable for material used in tools and machines. It may be noted that steel is more elastic than rubber.

Plasticity: It is the property of a material, which retain the deformation produced under load permanently. This property of material is necessary for forming, in stamping images on coins and in ornamental work.

Ductility: It is the property of a material enabling it to be drawn into wire with the application of a tensile force. A ductile material must be both strong and plastic. The ductility is usually measured by the terms, percentage elongation and percent reduction in area. The ductile materials commonly used in enMSneering practice are mild steel, copper, aluminum, nickel, zinc, tin and lead.

1. Brittleness: It is the property of material opposite to ductile. It is the property of breaking of a material with little permanent distortion. Brittle materials when subjected to tensile loads snap off without MSving any sensible elongation. Cast iron is a brittle material.
2. Malleability: It is a special case of ductility, which permits material to be rolled or hammered into thin sheets, a malleable material should be plastic but it is not essential to be so strong. The malleable materials commonly used in enMSneering practice are lead, soft steel, wrought iron, copper and aluminum.
3. Toughness: It is the property of a material to resist the fracture due to high impact loads like hammer blows. The toughness of the material decreases when it is heated. It is measured by the amount of absorbed after being stressed up to the point of fracture. This property is desirable in parts subjected to shock an impact loads.
4. Resilience: It is the property of a material to absorb energy and to resist rock and impact loads. It is measured by amount of energy absorbed per unit volume within elastic limit. This property is essential for spring material.
5. Creep: When a part is subjected to a constant stress at high temperature for long period of time, it will undergo a slow and permanent deformation called

creep. This property is considered in designing internal combustion enMSnes, boilers and turbines.

6. Hardness: It is a very important property of the metals and has a wide verity of meanings. It embraces many different properties such as resistance to wear scratching, deformation and machinability etc. It also means the ability of the metal to cut another metal. The hardness is usually expressed in numbers, which are dependent on the method of making the test. The hardness of a metal may be determined by the following test.

a) Brinell hardness test
b) Rockwell hardness test
c) Vickers hardness (also called diamond pyramid) test and
d) Share ScalarScopes.

The science of the metal is a specialized and although it overflows in to realms of knowledge it tends to shut away from the general reader. The knowledge of materials and their properties is of great significance for a design enMSneer. The machine elements should be made of such a material which has properties suitable for the conditions of operations. In addition to this a design enMSneer must be familiar with the manufacturing processes and the heat treatments have on the properties of the materials. In designing the various part of the machine, it is necessary to know how the material will function in service. For this certain characteristics or mechanical properties mostly used in mechanical enMSneering practice are commonly determined from standard tensile tests. In enMSneering practice, the machine parts are subjected to various forces, which may be due to either one or more of the following.

1. Energy transmitted
2. Weight of machine
3. Frictional resistance
4. Inertia of reciprocating parts
5. Change of temperature
6. Lack of balance of moving parts

The selection of the materials depends upon the various types of stresses that are set up during operation. The material selected should with stand it. Another criterion for selection of metal depend upon the type of load because a machine part resist load more easily than a live load and live load more easily than a shock load.

Selection of the material depends upon factor of safety, which in turn depends upon the following factors.

1. Reliabilities of properties
2. Reliability of applied load
3. The certainty as to exact mode of failure
4. The extent of simplifying assumptions
5. The extent of localized
6. The extent of initial stresses set up during manufacturing
7. The extent loss of life if failure occurs

1. Mild steel is readily available in market
2. It is economical to use
3. It is available in standard sizes
4. It has good mechanical properties i.e. it is easily machinable
5. It has moderate factor of safety, because factor of safety results in unnecessary wastage of material and heavy selection. Low factor of safety results in unnecessary risk of failure
6. It has high tensile strength
7. Low co-efficient of thermal expansion

Properties of Mild Steel:

M.S. has a carbon content from 0.15% to 0.30%. They are easily wieldable thus can be hardened only. They are similar to wrought iron in properties. Both ultimate tensile and compressive strength of these steel increases with increasing carbon content. They can be easily gas welded or electric or arc welded. With increase in the carbon percentage weld ability decreases.Mild steel serves the purpose and was hence was selected because of the above purpose

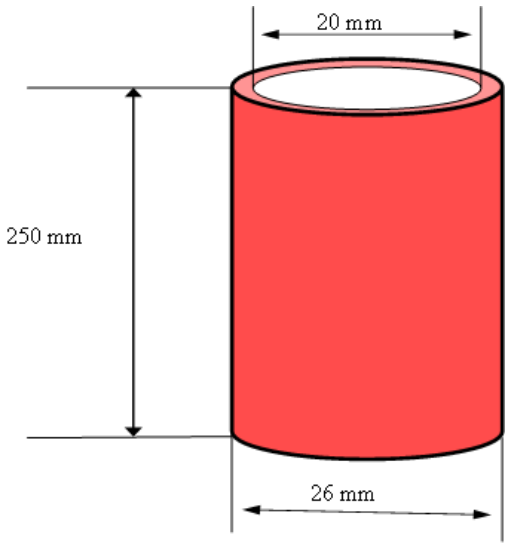
BRIGHT MATERIAL:

It is a machine drawn. The main basic difference between mild steel and bright metal is that mild steel plates and bars are forged in the forMSng machine by means is not forged. But the materials are drawn from the dies in the plastic state. Therefore, the material has good surface finish than mild steel and has no carbon deposits on its surface for extrusion and formation of enMSneering materials thus MSving them a good surface finish and though retaining their metallic properties

RAW MATERIAL & STANDARD MATERIAL

1	CYLINDER 20 BORE 250 STROKE	STD	2	5000
2	PAD	MS	2	800
3	BELT	NY	4	600
4	SHOE	LE	2	1500
5	PIVOT JOINT	MS	2	700
6	SHOE HOLDER	MS	2	300
7	POP RIVIT	AL	24	50
8	NUT BOLT M-10	MS	1 kg	199
9	ROUND PIPE	MS	5 KG	300
10	MS FLAT BARS	MS	1 KG	60
11	BLOCK NUT	SS	2	20
9	NUT BOLT M-6	MS	4	150

DESIGN OF CYLINDER: -



We have, t = pd/2 σtensile where p = internal pressure= 3.12N/mm2 , & d = diameter of cylinder=20 mm selected, ft1 = permissible stress.

Material	Yield strength (MPa)	Ultimate tensile strength (MPa)
Aluminum alloy 6061-T6	241	300

We have ultimate stress for cylinder material σultimate = 300 N/mm2 aluminum alloy considering factor of safety as 4.

We get permissible stress = ultimate stress/factor of safety

= 62.4/150= 0.416 mm.

t = 0.5 mm (say)

but standard available cylinder in the market is 3 mm thick, so our design is safe.

Outer Dia. of cylinder = 20 + (2 x 3) = 26 mm

The minimum outside diameter of cylinder is 26 mm.

Load of person on piston rod, so it may fail under bending.

AISI 4140 Alloy Steel (UNS G41400)

Introduction Alloy steels are designated by AISI four-digit numbers. They comprise different kinds of steels having composition exceeding the limitations of B, C, Mn, Mo, Ni, Si, Cr, and Va set for carbon steels. AISI 4140 alloy steel is chromium, molybdenum, manganese containing low alloy steel. It has high fatigue strength, abrasion and impact resistance, toughness, and torsional strength. The following datasheet gives an overview of AISI 4140 alloy steel. Chemical Composition The following table shows the chemical composition of AISI 4140 alloy steel

Mechanical Properties

$Z = \pi/32 \times d3$

$Z = \pi/32 \times 12.7\ 3$

$Z = 201\ mm^3$

$\sigma b\ (induced) = M/Z = 61312.5/201 = 304.8\ N/mm^2$

As induced bending stress is less then allowable bending stress i.e. 655 N/mm2 design is safe.

Design of bolt: - Tension

Bolt is to be fastened tightly also it will take load due to rotation. Stress for C-45 steel ft =420 kg/cm2 . Std nominal diameter of bolt is 9.31 mm. From table in design data book, diameter corresponding to M10 bolt is 8 mm

P = 981 N

Also, P = Π /4 dc2x ft

981 x 4

σ = 3924/201 = 19.51 N / mm2

3.14 x (8)2

the calculated ft is less than the maximum ft hence our design is safe.

M = 981x 25 = 24525 N-mm

And section modulus = Z = 1/6 bh.

Now using the relation,

Fb = M / Z

Fb= 24525/ 216 = 113.45 N/mm2

Induced stress is less then allowable so design is safe

Design of transverse fillet welded joint: -

Checking the strength of the welded joints for safety

The transverse fillet weld welds the side plate and the edge stiffness plates,

The maximum load which the plate can carry for transverse fillet weld is

P = 0.707 x S x L x ft

Hence let us find the safe value of 'ft'

981

Therefore ft = ----------

0.707 x 3.4 x 25

ft induced = 16.32 N/mm2

Since the calculated value of the tensile load is very smaller than the permissible value as ft=21 N/mm2. Hence welded joint is safe.

Here we are making assembly for holding this holder a cylinder with box pipe and MS flat.

For hold shoe rigidly with cylinder pivoted joint, we are making this assembly, In this we will drill the shoe through and bolt it with the help of stud by MS flat. So, operations are given below.

V. CONCLUSION

Hence our design is affordable and specially. Designed for the people at different assembly linework

- Due to this arrangement peoples felt relaxed who were suffering from the back pain and spinal cord diseases.
- Design project is a success based on tilting device.
- It reduced body fatigue and increased workability of the person in the office hours as well as in the

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Cite this Article
Adarsh P. D, Vinayak Bhajantri, Dr. Ravi Prakash M, "Design and Fabrication of Chairless-Chair using Pressure Cylinder and Flow Control Valves", International Journal of Scientific Research in Science, Engineering and Technology (IJSRSET), Online ISSN : 2394-4099, Print ISSN : 2395-1990, Volume 9 Issue 3, pp. 509-519, May-June 2022. Available at doi : https://doi.org/10.32628/IJSRSET2293172
Journal URL : https://ijsrset.com/IJSRSET2293172