A PROJECT REPORT

ON

"DESIGN OF AN AUTOMATED ASSEMBLY STAND FOR ASSEMBLY-DISASSEMBLY OF AIRCRAFT WHEEL"

Submitted by

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In partial fulfillment for the award of the Degree

Of

BACHELOR OF ENGINEERING

IN

MECHANICAL ENGINEERING

UNDER THE GUIDANCE

Of

Prof. ZOYA RIZVI

DEPARTMENT OF MECHANICAL ENGINEERING

ANJUMAN-I-ISLAM

KALSEKAR TECHNICAL CAMPUS NEW PANVEL,

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ANJUMAN-I-ISLAM

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CERTIFICATE

This is to certify that the project entitled

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To the Kalsekar Technical Campus, New Panvel is a record of bonafide work carried out by him under our supervision and guidance, for partial fulfillment of the requirements for the award of the Degree of Bachelor of Engineering in Mechanical Engineering as prescribed by **University Of Mumbai**, is approved.

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APPROVAL OF DISSERTATION

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(Internal Examiner) **(External Examiner)**

Date: __________

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ABSTRACT

As No. of Airlines has been formed, Competitiveness has been increased. All these Airlines use some of the methods for assembling the wheel of the Aircraft. This Assembly requires manpower and Human effort to a larger extent and this leads to problems for human beings like Back and neck problems. So we have found out a method to reduce man power by designing a fixture which could be rotated and aligned in any position (Automation).This also increases efficiency and saves time per assembly. A typical A-310 aircraft consists of 8 main wheels and 2 nose wheels. Currently 3 Service Engineers (S.E) are required to assemble the main wheel of the airbus. We hope to change the method of assembly of the wheel, so as to improve efficiency and to reduce the actual working time. As a result, we hope to change the current manual method of assembly of the wheel, so as to improve efficiency and to reduce the actual working time. As a result we hope to increase the total number of assemblies from the current capacity of 6 assemblies per shift to 12 assemblies per shift. Hence, as result a huge chunk of time will be saved in assembly and also manpower will be reduced.

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Chapter 1: Project Introduction

1.1 Selection Of Project

Air India is the national flag carrier of India with a worldwide network of passenger and cargo services. It is one of the two state-owned airlines in the country, the other being Indian Airlines. The merger of these two state-owned airlines has taken place to the major extent and will be completed by the end of this year. Officials, however, felt that there were some key areas including human resources, operations and infrastructure that needed to be looked into in greater detail before the merger could be finalized. Besides, a decision would also need to be taken on the future of subsidiaries that both the airlines have formed. [3]

"The merged entity will need to have some subsidiaries although whether there is a need to have all the existing subsidiaries are still being debated. For example, we should be able to do with one low-cost airline subsidiary rather than have two such entities," officials indicated. [3]

Indian Airlines is primarily a domestic carrier with a small number of foreign destinations, while Air India travels is an international airline. The Air India airline connects 95 destinations (on an average) around the world. The merger is expected to create considerable synergy for the state-owned airlines since the two can feed traffic to each other. The proposed merger of Air India and Indian airlines would churn out a mega carrier with over 130 aircrafts. This will place it in the top 30 airlines of the world and top 10 in Asia. This merger will help raise funds for major fleet expansion plans by both the airlines, which are coming under intensifying competition from new low-cost carriers such as Air Deccan, Spice Jet and Kingfisher Airlines. The new airline will also be benefited by combined ground operations, parking bays, check-in counters and ticket selling outlets.[3]

Due to this expansion in airlines it has become very important that efficiency with respect to time and manpower is improved considerably. The one of the majorly used aircraft used by Air India is Air bus A-320.[3]

In 1986 Air India took delivery of the Airbus A-320. The airline is the largest operator of this type in passenger service. India's aviation sector is witnessing 25 per cent annual growth in both cargo and passenger traffic, boosted by an expanding economy and rising incomes among the country’s estimated 300 million-strong middle class.[3] Changing the current procedure may be one of the steps to raise the competitiveness of the airline. Hence we have opted to design fixture which could be automated for assembling a wheel to reduce the man power.

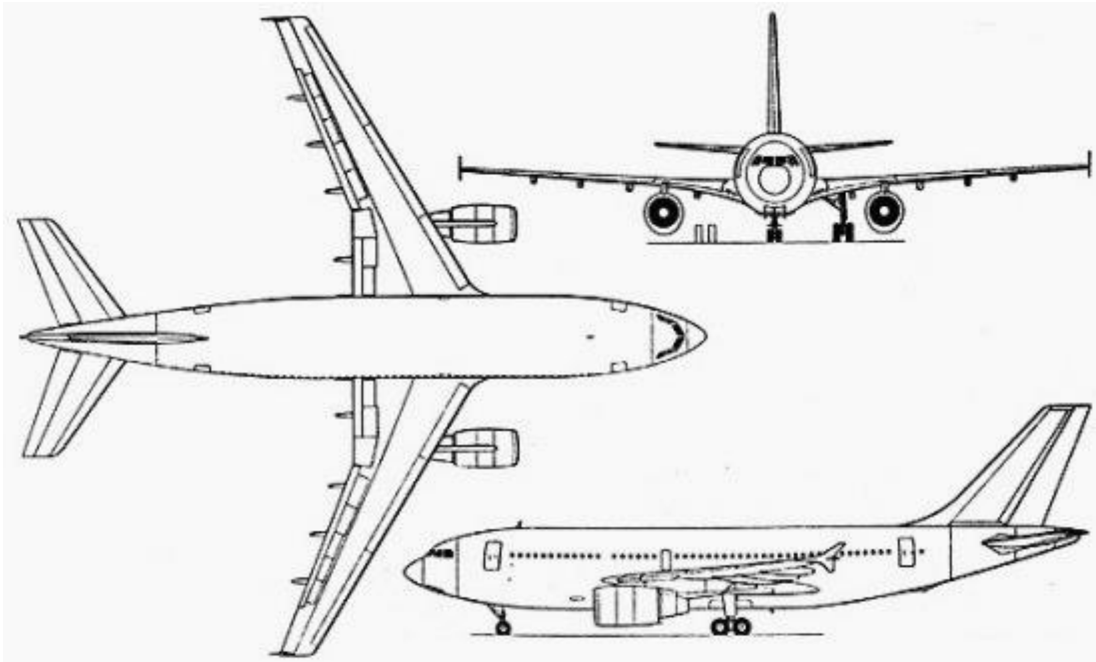

Figure 1.A Typical Airbus

A typical A-320 aircraft consists of 8 main wheels and 2 nose wheels. Currently 3 Service Engineers (S.E) are required to assemble the main wheel of the airbus. We hope to change the method of assembly of the wheel, so as to improve efficiency and to reduce the actual working time. As a result, we hope to change the current manual method of assembly of the wheel, so as to improve efficiency and to reduce the actual working time. As a result we hope to increase the total number of assemblies from the current capacity of 6assemblies per shift to 12 assemblies per shift. Hence, as result a huge chunk of time will be saved in assembly and also manpower will be reduced.

1.2 Objectives Of Project

- To reduce failure online for fixture assembly.
- To reduce the Time taken per assembly.
- To reduce cost and improve profit of company.

Chapter 2: Literature Survey

2.1 Process

In the existing assembly process the tyre was placed on the ground and held vertically with the help of Assembly stand and inner and outer hub was fitted with the help of bolt and nut. The whole assembly was done manually.

2.1.1 Layout Of Existing Process

Currently 3 Service Engineers (S.E) are required to Assemble/Disassemble the main wheel of the airbus. Following is the flow chart showing the same procedure.

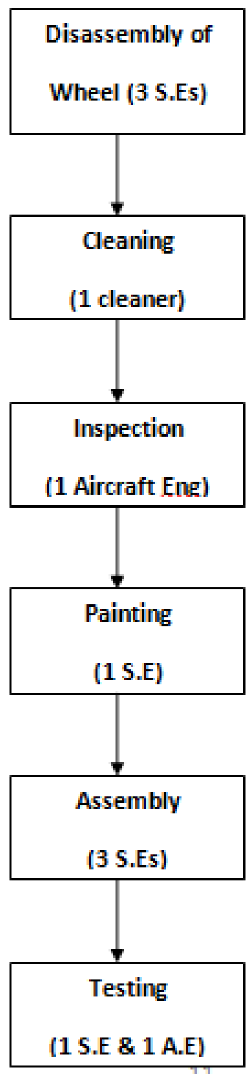

Figure 2.Layout of existing process

2.1.2 Existing Wheel Assembly Process

The main wheel of air bus A-320 consists of an inner hub, outer hub and a tire. They are fitted together with the help of 18 bolts and nuts for the complete assembly of the main wheel. The bolts and nuts are greased before the assembly. Once the hubs are ready for the assembly, the two service engineers align the two hubs into the tire in the vertical plane. With the help of 4 bolts they align the two hubs and the tire. To maintain this position they then clamp it with the help of a centre rod on which there are clamping plates/disks. By applying torque, these plates are tightened and the plates/disks clamp the three parts together till the entire assembly is completed. After clamping, one of the service engineers inserts the remaining bolts in the holes. The other service engineer inserts the nuts in the bolts from the opposite side. The nuts and bolts are now to be fitted with the specific value of torque.[1] There are two methods of tightening the nuts. They are:

Torque tightening method: A torque is to be applied to each nut. The preload induced in the bolts is dependent on the coefficients of friction of the mating parts which are variable (due to the greases used and existing surface finishes), although a different torque value is specified for each type of grease used.[1]

Angle tightening method: A torque slightly greater than self-locking torque is to be applied to the nuts. It settles the bolts. Then, each nut is to be tightened to a given angle. The preload induced in the bolts is independent from the typeof grease used. The angle tightening method is less dependent on the coefficients of friction of the mating parts than the torque tightening method.[1]

SERVICE ENGINEER HOLDING THE BOLTS AND TIGHTENING THE NUTS WITH THE HELP OF A HYDRAULIC TORQUE WRENCH

Figure 3.Tightening the Nuts with a Hydraulic Torque Wrench

SERVICE ENGINEER GIVING A FINAL SELF LOCKING TORQUE TO THE NUTS

Figure 4.Final Torqueing to Nuts

After the assembly is completed the assembled wheel is taken by the third service engineer.

COMPLETELY ASSEMBLED AIR-BUS A 320 MAIN WHEEL

Figure 5.Complete assembly of Main Wheel

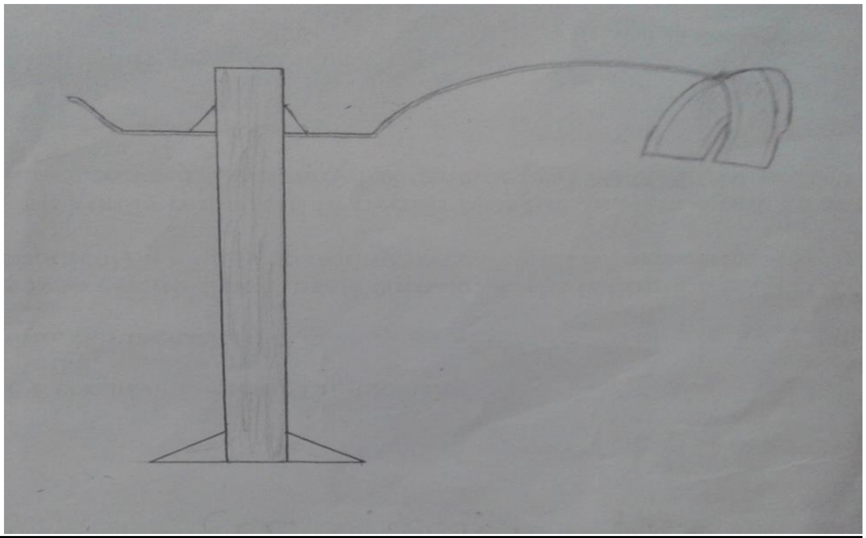

Figure 6.Sketch of Conventional -Assembly Stand

2.1.3.Proposed Process

This project has been undertaken to develop a one man operated, "Automated Assembly Stand". It aims at optimum usage of manpower, reduction of lead/down time and increasing the productivity output.

The "Automated Assembly Stand" consists of the following components:

1. **Fixture** - For ease of alignment of the outboard and inboard wheel half and the tire. It also provides an ergonomically comfortable working height for the service engineer.

2. **Torque Wrench** – For tightening the bolts and the nuts. Two types, one pressurized torque wrench and the other manual torque wrench, are used for the assembly of the wheel.

3. **Jib Crane** - For easy loading and the unloading of the wheel hub, tire and the final assembled wheel

The working of the "Automated Assembly Stand" is explained below:

The wheel assembly stand consists of a base plate, used to elevate the fixture to the appropriate comfortable working height and a fixture. This will be Electrically and Hydraulically operated (Automation) so that it can be aligned to a Comfortable Position with the help of Push Buttons Arrangements. The assembly of the wheel takes place in a horizontal plane.

The fixture is an assembly of a base plate, a centre rod, bolt holders (sockets) and clamping disks.

- The rim of the fixture has 18 sockets. The bolts are placed in these sockets. Bolts have to be greased before assembly. The bolts used for the wheel assembly are special bolts with 12-point bolt heads, with specification of 11/16. Corresponding to the bolts, the sockets are special 12-point sockets with the specification of 11/16. The bolts when placed in the sockets act as the part of the fixture and help in guiding the inboard and outboard wheel half on the fixture.

- The lower disc or the larger clamping plate is arranged at the correct location and the inboard wheel half is loaded onto the fixture. The operator picks the inboard half and guides it onto the fixture using the jib crane. Being electronically operated and able to carry such a heavy weight, a single service engineer is able to accomplish this task with just a push of the button. The inboard half is now guided to its proper assigned place on the fixture.

- The operator then uses the same jib crane to load the tire onto the fixture and aligns it with the already placed inboard wheel half. The next step in the assembly is to load the outboard half onto the fixture. The operator, using the jib crane, guides the outboard half into the desired position. The centre rod and the bolts placed, placed in the sockets, act as the guides for alignment of the inboard half – tire – outboard half.

- Once the entire alignment is fixed, the upper disc or clamping plate is placed on the centre rod and screwed. This is done so that the inboard half the tire and the outboard half are held together as a single unit, while the bolts are tightened.

- The service engineer then fits the nuts on the bolts. The nuts are to be tightened with the specific torque loading which is between 4 and 6 N-m. This tightening of the bolts is done with a Torque Wrench. A pressurized or hydraulically operated Torque Wrench is used to tighten the bolts to the desired position. The final locking of the nuts is done with the help of the manual torque wrench.

- Upon the final locking of the nut, the centre clamp is loosened and removed. The final assembled Wheel is then unloaded with the help of the jib crane and sent for further processes.

By adopting the proposed “Automated Assembly Stand” we propose to reduce manpower from the current existing ‘Three Service Engineers’ to ‘One Service Engineer’, per assembly. This is achieved by the introduction of the fixture to guide the wheel half’s and the sockets/ bolt holders to perform the function of holding the bolts, while being tightened. The fixture also reduces the lead time taken for alignment of the wheel half’s before tightening of the bolts. The use of the jib crane eliminates the necessity of extra manpower necessary to lift or hold the wheel half’s during assembly.

It is estimated that the new process would increase the production rate by almost double per shift. Ergonomically, too the new process is far superior to the existing process as the assembly is carried out in the horizontal position and at a comfortable height from the ground, unlike the vertical position and an uncomfortably low height from the ground.

2.1.4 Comparison Of Existing Process With The Proposed Process

Table 1.Comparison of Existing and Proposed Process

Existing Process	Proposed Process
1.Existing process requires 3 service engineers to assemble the wheel.	1.Proposed process requires only one service engineer to assemble the wheel.
2. Existing process requires the wheel to be kept in a vertical Position for assembling.	2. Proposed process aligns the wheel horizontally on the fixture at a comfortable working height.
3. In the existing process assemblies done per shift are 6.	3. In the proposed process assemblies estimated per shift are 12.
4. Existing process requires more set up time for aligning the hubs and assembling the wheel.	4. Proposed process requires less set up time for aligning the hubs and assembling the wheel.
5. In the existing process as soon as the hubs are aligned, the center rod is removed.	5. In the proposed process center rod is a part of the fixture itself.
6. Existing process requires the hubs and the tire to be handled manually.	6. Proposed process makes use of a crane to handle hubs and the tire.

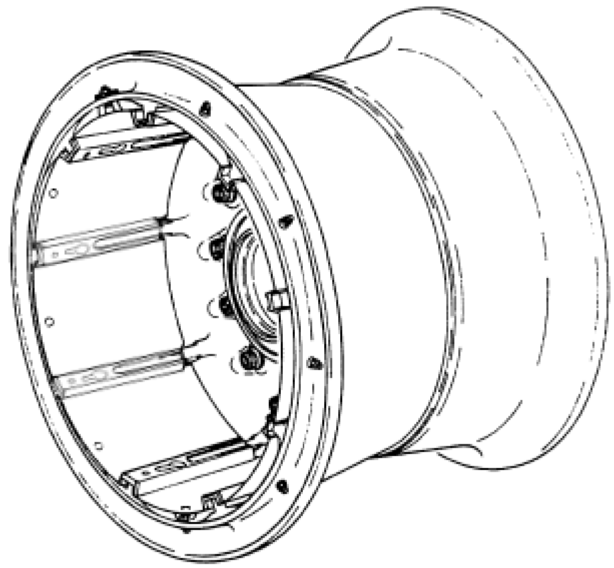

Figure 7.3D view of main wheel hub

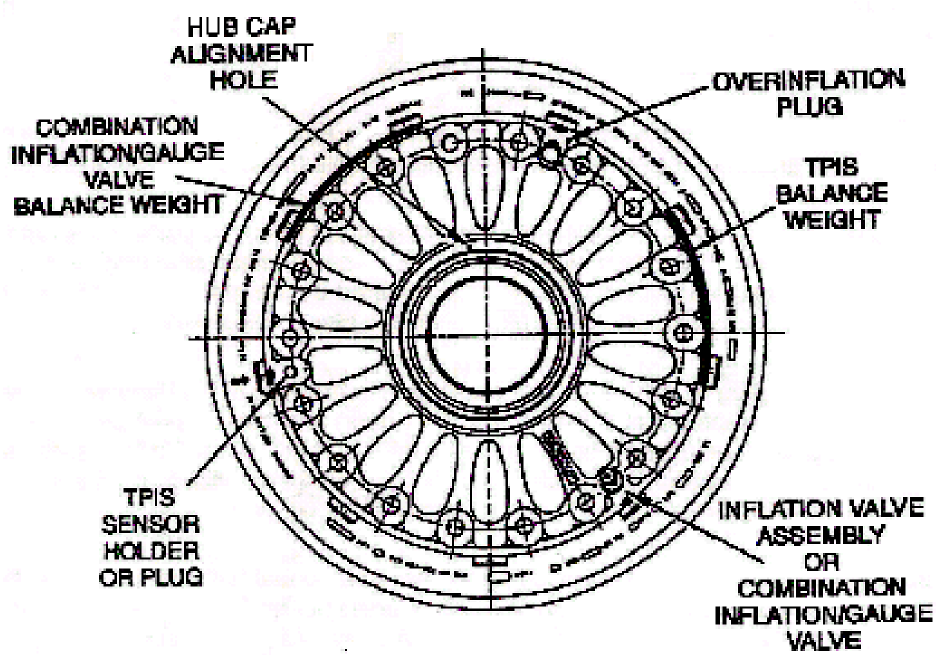

Figure 8.Side view of main wheel hub

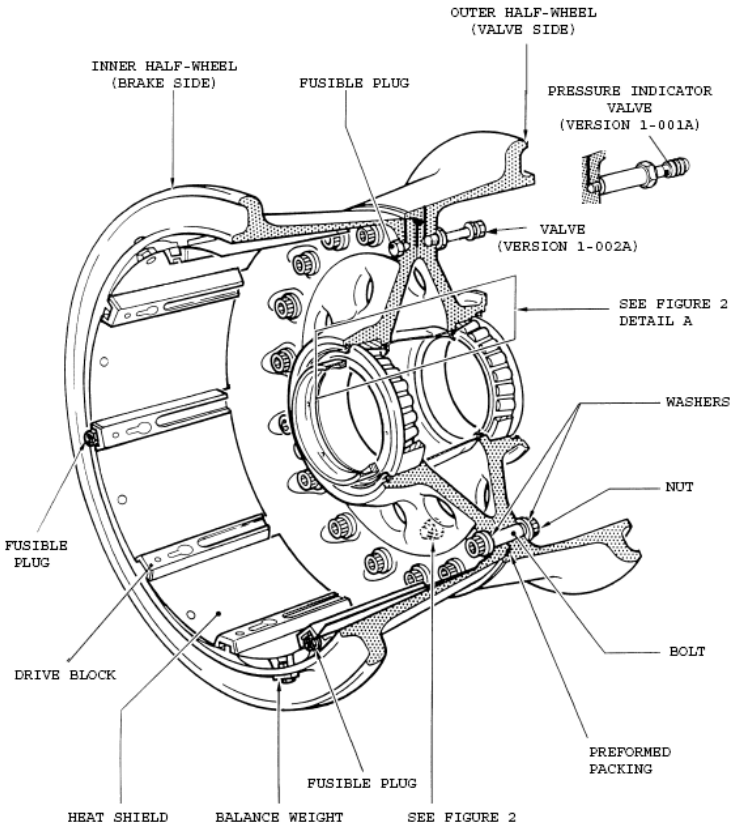

Figure 9.Half sectional view of Airbus A320 main wheel hub

2.2.Main Wheel Description

- General Data:

1. Goodrich assembly number 3-1540 (Boeing part number S294W511-370).
2. Tires permitted: radial, tubeless only, of 50x20R22 size.
3. Material: Forged aluminum (7050-T74 outer half) (2014-T6 inner half).
4. Weight: 211.0 lbs (95.7 kg).

- Eighteen ¾ inch (180 ksi) bolts and nuts hold the inner and outer wheel half assemblies together. A preformed packing at the wheel half mating surfaces seals the tubewell joint. A spacer at the hub mating surfaces transmits axial loads and keeps out dirt and moisture.
- Nine inconel torque bars with tungsten carbide coating for wear durability in the inner wheel half engage slots in the brake rotor disks to turn the rotor disks to turn the rotor disks with the wheel.
- A three piece heat shield is between the torque bars and the tubewell of the wheel. Torque bar spacers are attached to the heat shield, reducing the number of loose parts.
- A rigid stainless steel protective chin ring, louvered for convective cooling, attaches to the inner wheel half.
- Each wheel half assembly is individually balanced. The outer wheel half assembly is balanced with the inflation valve, over-inflation plug,a stimulated TPIS sensor, and a TPIS balanced weight installed. If a combination inflation/guage valve is installed, a special weight isinstalled on the outer wheel half assembly.

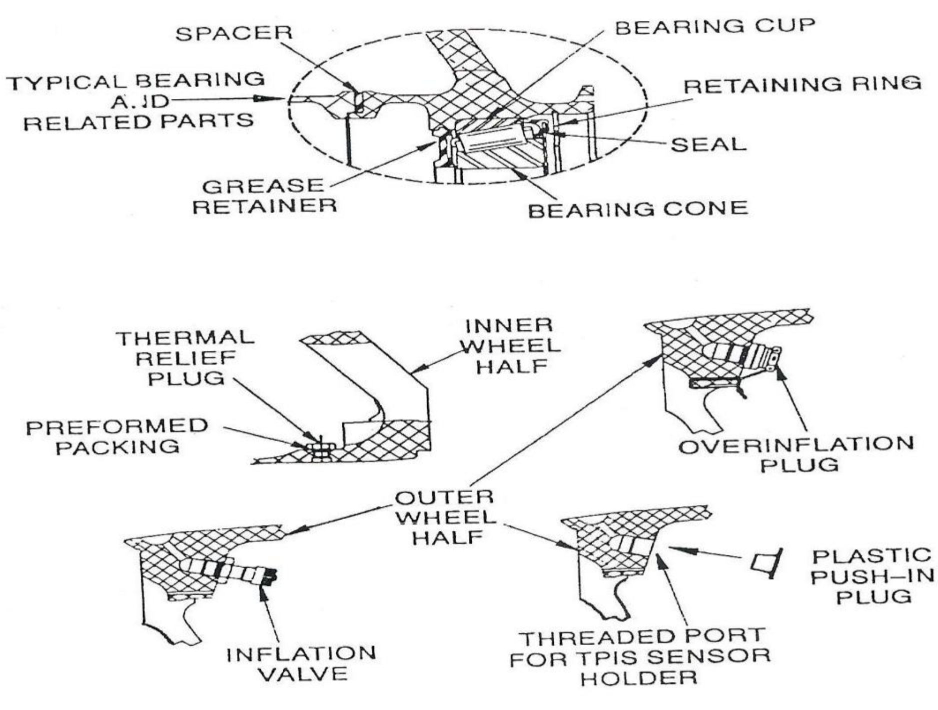

Figure 10.Parts of main wheel hub

- A retaining ring in each wheel half holds the seals and bearing cone in place when the wheel is removed from the axle. The seals keep the bearing grease in the hub and keep out dirt and moisture. A greaseretainer that is behind each bearing cup prevents the flow of grease into the center area of the wheel. Tapered roller bearing cones and cups hold the wheel assembly on an axis sleeve.

- A tubeless tire inflation valve assembly is installed in a treaded port in the web of the outer wheel half. A grommet, below the valve assembly, seals the plug in the wheel half.

- An over-inflation plug is installed in a threaded port in the web of the outer wheel half. The over-inflation plug ruptures at 375-450 psi(26-31 bars) and releases tire pressure. A preformed packing, below the head of the over-inflation plug, seals the plug in the wheel half. Two preformed packings, visible on the body of the over-inflation plug,keep dirt and moisture off the rupture disk that is inside the over inflation plug.
- A plastic plug is installed in a threaded port in the outer wheel half.This plug can be removed to permit installation of a sensor (transducer) holder for a Tire Pressure Indicating System (TPIS) that is installed by the operator. A threaded plug and preformed packing is available to seal the port if the TPIS sensor holder is not used.

- A special balance weight is used when the TPIS is used. If the TPIS is deleted, the balance weight should be removed.
- If the standard inflation valve is replaced by a combination inflation/gauge valve, a special balance weight is required.

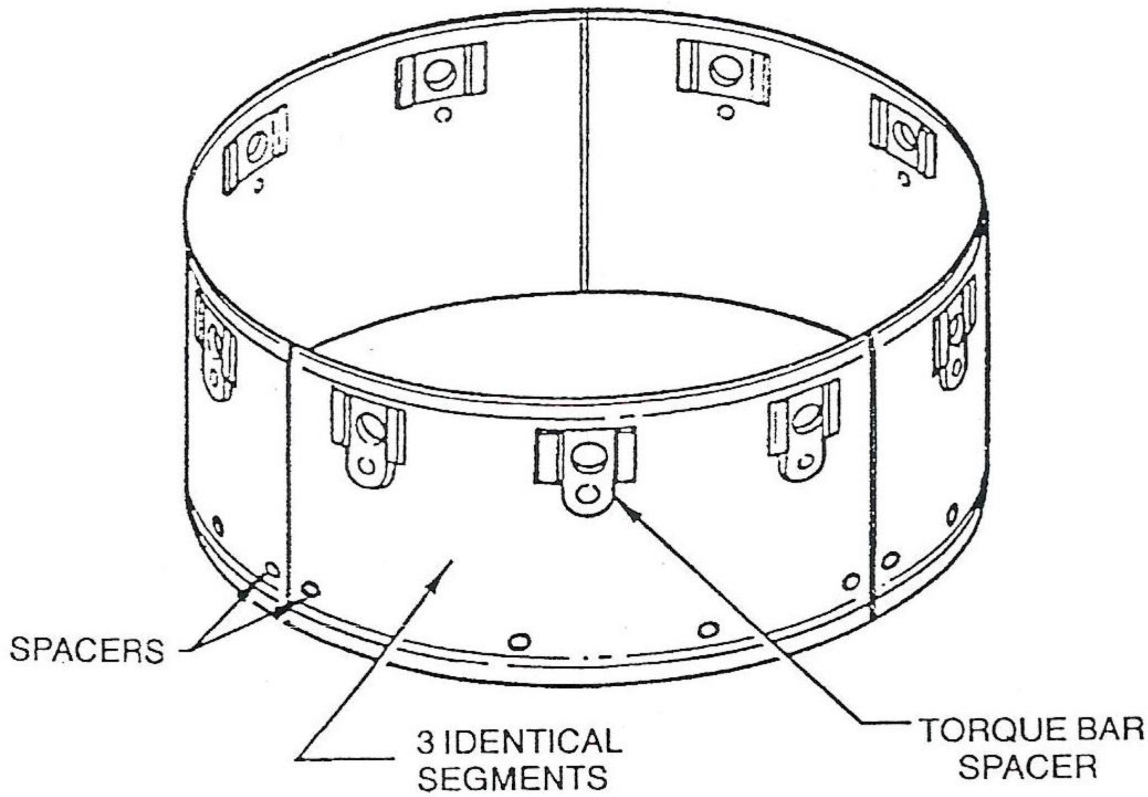

Figure 11.Segment heat shield

● Heat shield is comprised of three (3) identical stainless steel segments that overlap each other to form a closed circle.

1. Torque bar spacer is attached to heat shield, reducing number of loose parts.
2. Spacers prevent heat shield from rubbing wheel.
3. Common part for both main wheels.

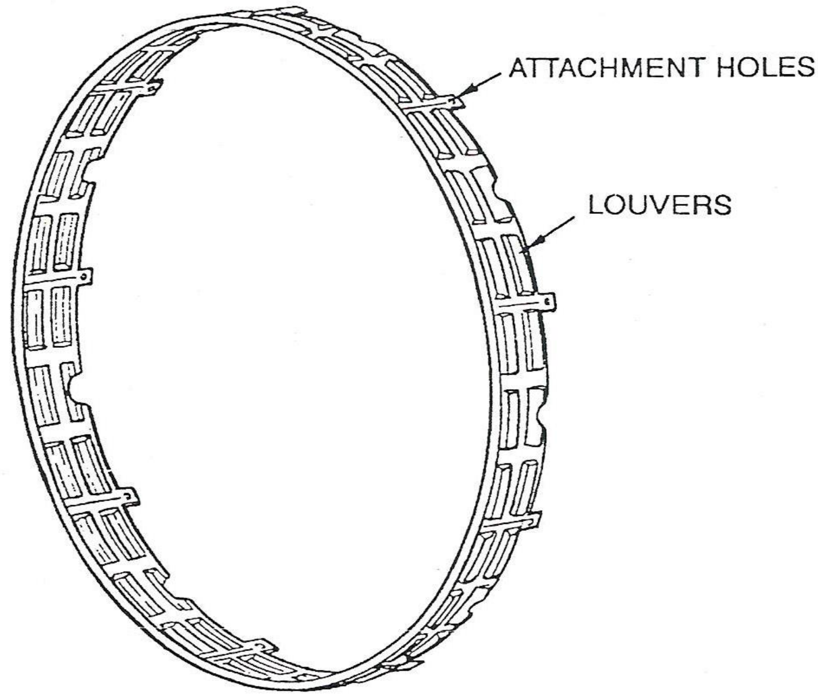

Figure 12.Main wheel Ching Ring

● The chin ring is a rigid stainless steel component protecting both the wheel heat shield and the carbon heat sink.

1. Louvered to promote convective cooling.
2. Attaches with separate fasteners from torque bar and head shield.
3. Common part for both main wheels.

Dissassembly

NOTE: The detail parts of the wheel are shown on the figure in the illustrated part list.

1. PREPARATION

WARNING: DEFLATE THE TIRE BEFORE ANY WORK.

A. Deflation

B. (1) Remove the cap (3-160) or (3-161)

(2) Gradually loosen core (3-151) of pressure indicator valve (3-131) or core (3-150) of valve (3-130) to deflate the tire.

(3) When deflation is completed, remove the core from the pressure indicator valve or from the valve

2. REMOVAL OF BASIC COMPONENTS

WARNING: MAKE SURE THAT THE TIRE IS DEFLATED.

A. Removal of fusible plugs (2-250) and (2-270).

(1) Loosen fusible plugs (2-250) and (2-270).

(2) Remove fusible plugs (2-250) and (2-270).

(3) Discard preformed packing (2-240) and (2-260).

B. Removal of the pressure indicator valve (3-131) or valve (3-130)

(1)Loosen pressure indicator valve (3-131) or valve (3-130).

(2)Remove the body of pressure indicator valve (3-131) or valve (3-130).

(3)Discard preformed packing (3-135).

C. Removal of plugs (3-180) or (3-181), and plugs (3-190) or (3-191)

(1) Loosen plugs (3-180) or (3-181).

(2) Remove plugs (3-180) or (3-181).
(3) Discard preformed packing (3-170).
(4) Removal of plugs (3-190) or (3-191) after SB 470-32-722 or SB 580-32-3080
(a) Loosen plugs (3-190) or (3-191).

(b) Remove plugs (3-190) or (3-191).

(c) Discard preformed packing (3-175).

D. Removal of bearing cones (2-170) and (3-80)

(1) On the inner half-wheel assembly (2-10)
(a) Remove clip (2-230).

(b)Remove bush (2-220).

(c) Remove the stop and seal assembly (2-180).

(d) Remove bearing cone (2-170).

(2) On the outer half-wheel assembly (3-10)
(a) Remove clip (3-110).

(b) Remove retainer (3-100).

(c) Remove packing (3-90).

(d) Remove bearing cone (3-80).

3. DISASSEMBLY OF HALF-WHEEL ASSEMBLIES (2-10) AND (3-10)

WARNING: MAKE SURE THAT THE TIRE IS DEFLATED.

A. Removal of bolts (1-60).

(1) Break the bond of the tire beads to the flange with a tire removal

press.

(2) Release nuts (1-80).

(3) Loosen nuts (1-80) in a criss-cross sequence.

CAUTION**:** BEFORE YOU REMOVE THE BOLTS (1-60), IDENTIFY THEM. THIS IDENTIFICATION IS NECESSARY FOR NDT INSPECTION (REFER TO THE CHECK SECTION)

NOTE 1: If a bolt is broken, discard it. Also discard the 2 bolts which are on each side of the broken bolt. Do an NDT inspection of the remaining bolts (refer to the CHECK section).

NOTE 2: If there is more than one broken bolt, discard all the bolts.

NOTE 3: To loosen the nuts (1-80), turn each of them 2 turns and make sure that the half-wheel stay parallel when moved apart. Do this on wheel on which its tire is installed. Keep all nuts screwed a few turns on their bolt before you remove the first one. This will permit any remaining pressure to be removed when the half wheels are sufficiently moved apart. It is mandatory to obey these instructions to prevent any injury to the operator and/or damage to the wheel.

(4) Remove nuts (1-80).

(5) Remove washers (1-70).

(6) Remove bolts (1-60).

(7) Remove washers (1-70).

(8) Move the 2 half-wheels apart.

(9) Remove dust guard (1-40) and its preformed packing (1-30).

(10) Remove preformed packing (1-20).

(11) Remove the tire.

4. REMOVAL OF THE COMPONENTS OF INNER HALF-WHEEL ASSEMBLY (2-10)

A. Removal of drive blocks (2-60).

Do not do this removal procedure systematically but when it is fully necessary, refer to the sections “CHECK” and “REPAIR”.

B. Removal of heat shields (2-130)

(1) Remove nuts (2-160).

(2) Remove washers (2-140).

(3) Remove screws (2-150).

(4) Remove heat shields (2-130).

C. Removal of the balance weight (2-90)

NOTE: Before the removal of the balance weight, make a note of its location and its weight.

(1) Remove nuts (2-120).

(2) Remove washers (2-110).

(3) Remove screws (2-100).

(4) Remove balance weight (2-90).

D. Removal of bearing cup (2-80).

NOTE: Do not do this removal procedure systematically but when it is fully necessary, refer to the sections “CHECK” and “REPAIR”.

5. REMOVAL OF THE COMPONENTS OF OUTER HALF-WHEEL ASSEMBLY (3-10).

A. Removal of balance weight (3-40)

NOTE: Before the removal of the balance weight, make a note of its location and its weight.

(1) Remove nuts (3-70).

(2) Remove washers (3-60).

(3) Remove screws (3-50).

(4) Remove balance weight (3-40).

B. Removal of bearing cup (3-30).

NOTE: Do not do this removal procedure systematically but when it is fully necessary, refer to the sections “CHECK” and “REPAIR”.

Assembly

NOTE 1: The detail parts of the wheel are shown on the figures in the illustrated parts list.

NOTE 2: The suppliers of recommended mixtures and materials are shown in the first pages of this manual.

A. GENERAL INSTRUCTIONS

(1) Clean the parts.

(2) Dry the parts

(3) Lubricate the parts or apply to them the protective treatment

as shown on figure 701

CAUTION**:** DO NOT MIX MOBIL AVIATION GREASE SHC100 WITH OTHER TYPES OF GREASE.

Prior to application of Mobil Aviation Grease SHC100, clean the bearing to remove remaining grease.

CAUTION 1: ON A FELT SEALS EQUIPPED WHEEL; THE FELT SEALS MUST BE REPLACED BY NEW ONES AFTER BEARINGS REGREASING.

CAUTION 2: YOU MUST INSTALL THE SILICON PREFORMED PACKINGS, WHICH ARE RED, ONLY WITH VASELINE VVP-236A (AIR 3565) (TRRG6, FOR EXAMPLE)

CAUTION 3: YOU MUST INSTALL THE ETHYLENE-PROPYLENE RUBBER PREFORMED PACKINGS, WHICH ARE BLACK, ONLY WITH SILICON GREASE SI55 (NAS1602-905, FOR EXAMPLE)

B. ASSEMBLY OF THE COMPONENTS OF INNER HALF-WHEEL ASSEMBLY.(2-10)

(1) Installation of bearing cup (2-80).

(2) Installation of fusible plugs. (2-250) and (2-270)

NOTE: You must do the leakage test of the fusible plugs before installation on the half-wheel.

(a) Lubricate the parts as shown on figure.701

(b) Install preformed packing (2-240) on fusible plugs (2-250)

(c) Put the fusible plugs in position.

(d) Tighten the fusible plugs (2-250) with a torque loading between

9 and10 Nm.(6.6 and 7.4 lbf.ft)

(e) Install preformed packing (2-260) on fusible plugs. (2-270)

(f) Put the fusible plugs in position.

Tighten the fusible plugs(2-270) with a torque loading between 13 and 15 Nm.(906 and 11.1 lbf.ft)

(3)Installation of drive blocks (2-60)

(4)Installation of bearing cone (2-170) and of the stop and seal assembly (2-180)

(a) Lubricated the parts as shown on figure 701

(b) Put bearing cone (2-170) in position.

(c) Install the stop and seal assembly (2-180).

(d) Install bush (2-220).

(e) Keep bush (2-220) in position by the use of clip (2-230).

C.ASSEMBLY OF THE COMPONENTS OF OUTER HALF-WHEEL ASSEMBLY (3-10)

(**1**) Installation of bearing cup (3-30)

(**2**) Installation of plugs (3-180) or (3-181) and (3-190) or (3-191).

NOTE: The plug (3-180) or (3-181) must be fitted close to the 3, 5 mm

(0.1378in) diameter hole located in the outer half-wheel.

(a) Lubricate the parts as shown on figure 4.

(b) For wheel (1-001).

(1) Install preformed packing (3-170) on plug (3-180).

(2) Install plug (3-180).

(3) Tighten plug (3-180) with a torque loading between 20 and 23 Nm (14.8 and 17 lbf.ft).

(4) After SB 470-32-722 or SB 580-32-3080

* Install preformed packing (3-175) on plug (3-190).

* Install plug (3-190).

* Tighten plug (3-190) with a torque loading between 20 and 23 Nm. (14.8 and 17 lbf.ft).

(c) For wheel (1-002)

(1) Install preformed packing (3-170) on plug (3-181).

(2) Install plug (3-181).

(3) Tighten plug (3-181) with a torque loading between 20 and 23 Nm. (14.8 and 17 lbf.ft)

(4) After SB 470-32-722 or SB 580-32-3080

*Install preformed packing (3-175) on plug (3-191).

*Install plug (3-191)

*Tighten plug (3-191)with a torque loading between 20 and 23 Nm.(14.8 and 17 lbf.ft)

(**3**) Installation of valve (3-130) on wheel (1-001) or pressure indicator valve (3-131) on wheel (1-1002).

(a) Lubricate the parts as shown on figure 4.

(b) Put valve core (3-150) in valve body or valve core (1-151) in pressure valve body and turn it. Tighten it with a torque loading between:

-0, 25 and 0, 5 Nm (0.185 and 0.370 lbf.ft) for the valve core (3-150).

-0, 4 and 0, 7 Nm (0.296 and 0.518 lbf.ft) for the valve core (3-151)

(c) Put valve cap (3-160) on valve body or pressure indicator valve cap (3-161) on pressure indicator valve body and turn it.

Tighten it with a torque loading between:

-0, 5 and 1 Nm (0.370 and 0.740 lbf.ft) for the valve cap (3-160).

-0, 3 and 0, 5 Nm. (0.222 and 0.370 lbf.ft) or finger tight it for the pressure indicator valve cap (3-161).

(d) Install preformed packing (3-135) on valve (3-130) or pressure indicator valve (3-131).

(e) Install valve (3-130) or pressure indicator valve (3-131) in the hole near the indication "DEFLATE BEFORE DISMANTLING WHEEL".

(f) Tighten valve (3-130) or pressure indicator valve (3-131) with a torque loading between 20 and 23 Nm. (14.8 and 17 lbf.ft).

(4) Installation of bearing cone (3-80) and of the seal (3-90)

(a) Lubricate the parts as shown on figure 4.

(b) Put the bearing cone (3-80) in position.

(c) Install the seal (3-90).

(d) Put the bush (3-100) in position.

(e) Keep the bush (3-100) in position by the use of clip (3-110).

D.BALANCING OF HALF-WHEELS (2-20), (3-20)

NOTE: Balance only overhaul or repaired half-wheels.

(1) Install the balancing shaft F26618000 into the half wheel.

(2) Put the washer of the balancing shaft F26618000 in position.

(3)Put the nut of the balancing shaft F26618000 in position and tighten it.

(4) Put the ends of the balancing shaft F26618000 on the knife-edges.

(5) With the half-wheel in the equilibrium position, make a mark to show the bottom dead center.

(6) Turn the half-wheel through 90^o to make sure of the bottom dead center.

(7) Put in the recesses for the balance weights, opposite the heaviest point, one or more lumps of modeling clay.

NOTE: The mass of the lumps of modeling clay will give an indication of the mass of the balance weights to be installed. In the set of balance weights (2-90) or (3-40) use the balance weights the mass of which is as near as possible the mass of the lumps of modeling clay.

E.INSTALLATION OF BALANCE WEIGHTS

(1) Drill the hole for the attachment of the balance weight.

CAUTION: DRILL THE HOLE FOR THE BALANCE WEIGHT ATTACHMENT IN ONE OF THE AREAS OF HALF-WHEEL (2-20)

(2) Apply a protective coating with Alodine 1200 (refer to section 14 of Manual 32-09-01) into the hole.

(3) Put in position the balance weights.

(4) Install screws (2-100) and (3-50).

(5) Install washers (2-110) and (3-60).

(6) Put nuts (2-120) and (3-70) in position.

(7) Make sure that, on each half-wheel assembly, the remaining imbalance is not more than 0.035 N.m (0.026 lbf.ft).

NOTE: Ignore this remaining imbalance when you assemble the half-wheels together.

(8) Tighten nuts (2-120) and (3-70) with a torque loading between 4, 5 and 6Nm. (3.3 and 4.4 lbf. ft).

(9) Mark the mass (in grams) of the balance weight in the area indicated in detail by stamping with mini stress types with a 1.5 mm (0.0590in) size of body.

(10) Restore the protective coating with Alodine 1200 (refer to section14 of Manual 32-09-01), and the paint coats (refer to section 36 of Manual 32-09-01).

F. INSTALLATION OF HEAT SHIELDS (2-130)

NOTE: Before to insert the heat-shields, apply Aluminum adhesive tape.

(1) Put heat shields (2-130) in position between drive blocks (2-60).

(2) Attach heat shields (2-130) with screws (2-150), washers (2-140) and nuts (2-160). Tighten nuts (2-160) to a torque between 4, 5 and 6 N.m (3.3 and 4.4 lbf.ft).

G. ASSEMBLY OF HALF-WHEELS (2-10) AND (3-10)

The instructions below are given for information only and are applicable to the assembly procedure for the wheel and its tyre.

NOTE: Fully clean and then dry the tyre beads. Do not, on any account, use grease or water to make the installation easier.

(1) Lubricate the parts or apply to them the protective treatment as shown on figure 4.

(2) Install preformed packing (1-20) on half-wheel assembly (2-10) and be careful not to cause damage to it.

(3) Before SB C20195-32-3134 or SB C20195-32-777, install black washers (1-70A) on bolts (1-60).

After SB C20195-32-3134 or SB C20195-32-777 install black washers (1-70B).

CAUTION: WHEN YOU INSTALL WASHERS (1-70), YOU MUST PUT THE INTERNAL CHAMFER TOWARDS THE BOLT HEAD.

(4) Put bolts (1-60) in the half-wheel (2-10) with the bolt heads on the brake side.

(5) Put the tire in position on half-wheel assembly (3-10). Do not apply any grease to the tire bead.

NOTE: Ignore the imbalance when you install the tire.

(6) Put preformed packing (1-30) in position on the dust guard (1-40)

(7) Install dust guard (1-40) in half-wheel assembly (3-10).

NOTE: The 159 mm (6.2598 in) diameter of the dust guard must be on the side of half-wheel assembly (3-10).

(8) Put the half-wheel assembly (2-10) in position on the assembly of the half-wheel and the tire.

NOTE: Make sure that the vent holes in each half-wheel are in line with one another.

(9) Make sure of the correct position of preformed packing (1-20) and of the half-wheels in relation to each other.

NOTE: Since there is no indication of the imbalance, the relative positions of the two half-wheels are not important.

(10) Compress the tyre.

(11) Push the half-wheel one against each other.

(12) Put a washer (1-70) on each bolt. (1-60).

CAUTION**:** WHEN YOU INSTALL WASHERS (1-70), YOU MIST PUT THE INTERNAL CHAMFER TOWARDS THE NUT.

(13) Tighten the nuts (1-80) until they touch the half-wheel.

(14) Tightening of the bolts.

CAUTION**:** AN OVER TORQUE MAY CAUSE THE FRACTURE OF THE HALF-WHEEL ATTACHMENT BOLTS.

CAUTION**:** THE AVERAGE LUBRICATING VALUE OF GREASE MIL-T-83483 IS GREATER THAN THAT OF GREASE MIL-T-5544.THERFORE; THE NUTS ARE TO BE TIGHTENED WITH A TORQUE SPECIFIC TO EACH TYPE OF GREASE.

NOTE: Make sure that the torque wrench used has an accuracy of +4%

Two methods of tightening the nuts can be used:

- TORQUE TIGHTENING METHOD:

A torque is to be applied to each nut. The preload induced in the bolts is dependent on the co-efficient of friction of the mating parts which are variable (due to the greases used and the existing surface finishes), although a different torque is specified for each type of grease used.

- ANGLE TIGHTENING METHOD:

A torque slightly greater than the self-locking torque is to be applied to the nuts. It settles the bolts. Then, each nut is to be tightened to a given angle. The preload induced in the bolts is independent from the type of grease used.

- The angle tightening method is less dependent on the co-efficient of friction of the mating parts than the torque tightening method.

NOTE: The utilization of those tightening methods may cause the torque value engraved on the outer half-wheel to become obsolete. Therefore, it is recommended to cross out the torque value marked on that half-wheel. Restore the protective coatings, if necessary

(a) Torque tightening method

(i) Torque the nuts in a criss-cross sequence (1, 2, and 3 etc.) to a preliminary value of:

-110 Nm (81.12 lbf.ft) with grease MIL-T-5544 or

- 90 Nm (66.37 lbf.ft) with grease MIL-T-83483.

(ii) Torque the nuts in a criss-cross sequence.

-220 Nm (162.25 lbf.ft) with grease MIL-T-5544

-180 Nm (132.75 lbf.ft) with grease MIL-T-83483

(iii) In order to rectify the possible omission of one or more bolts in the tightening procedure or an insufficient tightening, check the final tightening torque applied to each nut in the clockwise direction 1,15,5,3,etc.

(b) Angle tightening method (Refer fig: 6)

(i) Settle the bolts and nuts in criss-cross sequence by applying a torque of 40 Nm. (29.5 lbf.ft) to the nuts. This torque is slightly greater than the self-locking torque of the nuts.

NOTE: If a nut is not in contact with the wheel after the 40 Nm. (29.5 lbf.ft) torque has been applied, remove the bolt and nut inspect them

(ii) Set the torque wrench to the maximum torque indicated below:

-286 Nm (211 lbf.ft) with grease MIL-T-5544or

-234 Nm (172.5 lbf.ft) with grease MIL-T-83483.

(iii) Position the angle measuring tool for the nut to be tightened.

CAUTION: TAKE UP ALL THE CLEARANCES OF THE TOOL SO THAT

THE MESUREMENT OF THE ANGLE IS NOT MADE FALSE.

(iv) Line up the fixed index of the angle measuring tool with the zero on the torque angle gauge.

(v) While holding each bolt in a fixed position, tighten the nuts in a criss-cross sequence to an angle of 122o+ 2o.

NOTE: The torque wrench must not trigger before the complete rotation of the nut for angle tightening. If otherwise, remove the nut and the bolt and inspect/check them to determine whether the cause is damaged cadmium-plating on the bolt or a nut self-locking torque out of tolerance.

6. Set the torque wrench to the minimum torque indicated below:

- 154 N.m (113.5 lbf.ft) with grease MIL-T-5544 or

- 126 N.m (93 lbf.ft) with grease MIL-T-83483.

7. In order to rectify the possible omission of one or more bolts in the tightening procedure or a possible defect, check the minimum tightening torque applied to each nut in the clockwise direction 1,15,5,3,etc.

NOTE: The torque wrench must trigger for the minimum torque applied without any rotation of the nut. If otherwise, remove the nut and the bolt and inspect them to determine whether the cause is damaged threads on the bolt or the nut, or a split nut.

H. INFLATION TEST

CAUTION 1: INFLATE THE TYRES IN A METAL CAGE.

CAUTION 2: DO NOT EXCEED THE NOMINAL INFLATION PRESSURE. ANY OVERINFLATION MAY CAUSE THE BURSTING OF THE TYRE.

CAUTION 3: USE DRY NITROGEN ONLY TO INFLATE TYRES.

(1) Put aside the valve cap (3-160) on wheel (1-001) or (3-161) on wheel (1-002) removed during the inflation test.

(2) Inflate the tyre to the nominal pressure (refer to the instructions given in the Aircraft Maintenance Manual).

(3) Apply a solution of soap and water around the tyre beads, the valve (3-130) or pressure indicator valve (3-131), fusible plugs (2-250),(2-270) and the plugs (3-180) or (3-181) or (3-190) or (3-191). Look for bubbles to find leaks.

(4) At the end of this check, flush with water the solution of soap and water. After this, keep the inflated tyre and the wheel assembled together for 12 or 24 hours to get a correctly seated tyre.

(5) If necessary, adjust the inflation pressure to the nominal value. After this, keep the inflated tyre and the wheel assembled together for 12 hours or 24 hours again. Make sure that the pressure drop is less than 2.5% after 12 hours, or 5% after 24 hours.

STORAGE AFTER ASSEMBLY

A. Purpose

This paragraph gives the necessary instructions for the protection of the wheel during the storage time, in temperate continental, tropical or maritime climates. These instructions are applicable to all modes of travel (land, air and sea).

B. General

(1) Remove finger marks with methanol or an equivalent mixture.

(2) Put a protector U21899 on the inner half-wheel.

(3) Store the wheel without its preformed packing. This packing must be stored apart.

C. Preservation and packaging

(1) Preservation:

(a) Apply grease proof cloth to the parts to which a layer of anti-rust grease is applied.

(b) Put the preformed packing in a sealed bag.

(c) Put a stiffening piece of cardboard in the sealed bag.

(2) Packaging:

(a) Put a cover made of heat sealable cloth in the shuttle case (with a cap), type ATA 300, category1.

(b) Put in the case, a cardboard box with polyethylene foam padding.

(c) Put grease proof paper on the padding.

(d) Put the preserved unit on the padding.

(e) Put a correct quantity of desiccant on the unit.

(f) Make sure that the padding is in the correct position, then close the cardboard box.

(g) Put in the case, the wheel preformed packing, stored apart.

(h) Cut a window in the heat-sealable cloth cover.

(i) Place a desiccant bag and its humidity indicator card against

the window of the heat sealable cloth cover.

(j) Apply the heat sealable cover on the equipment.

(k) Make sure that the cover is as near to the shape of the unit as possible, then remove the air from the cover. Heat-seal the cover. Keep a strip of cloth sufficiently wide so that you can re-use the cover three times before it is necessary to replace it.

(l) Attach to the cover:

- An identification label,
- A “nomenclature” label,
- A label which gives the procedure you must use to open the reusable cover with no risk of damage.

(m) Write the instruction on the case by the use of a stencil and black paint.

(n) Put, on the case, the identification papers of the equipment.

(3) Storage:

(a) Store the unit in its packaging.

(b) If the storage life has expired, you can extend it. Extension of this storage life is permitted if an inspection of the preservation of a sample from the stored units is satisfactory.

(c) The length of this new storage life must itself agree with the results of the above inspection.

D. Removal from store and subsequent testing

(1) Removal from store

(a) Do not remove from store the new or overhauled equipment until it is necessary for use. Remove it on a first-in, first-out basis.

(b) Before installation on aircraft or at the time of a periodic inspection of the stored units. Do a visual inspection of the different components, to make sure that they are in a satisfactory state of preservation.

(c) After a periodic inspection, preserve the equipment again as specified in the paragraph "Preservation and Packaging".

(d) Before installation on aircraft, remove the anti-rust grease with a rag and white spirit.[2]

CAUTION: DO NOT USE CHLORINATED SOLVENTS.

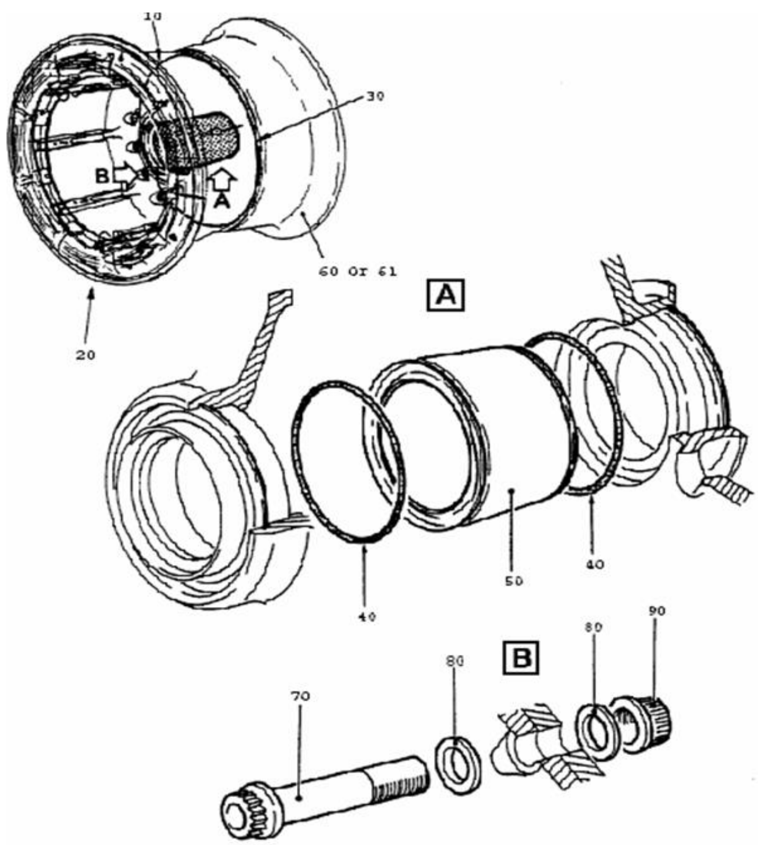

Figure 13.Exploded view of wheel

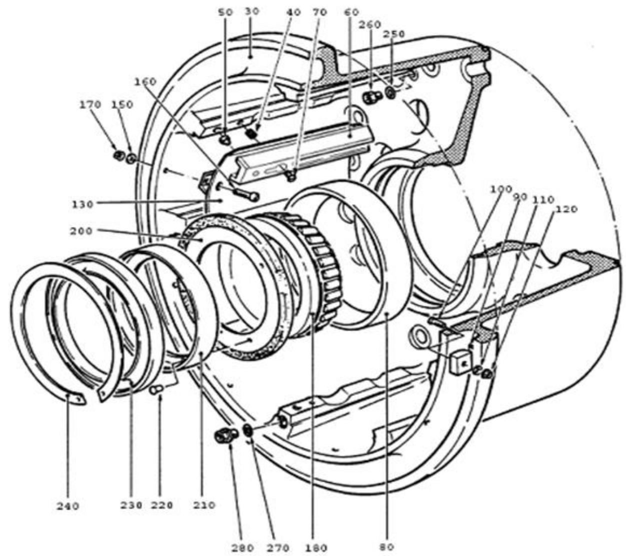

Figure 14.Exploded view of inner hub

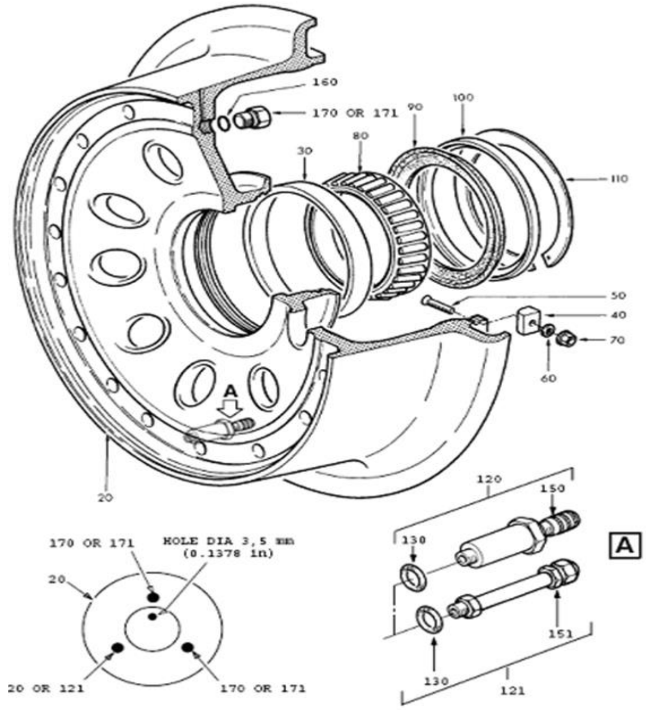

Figure 15.Exploded view of outer hub

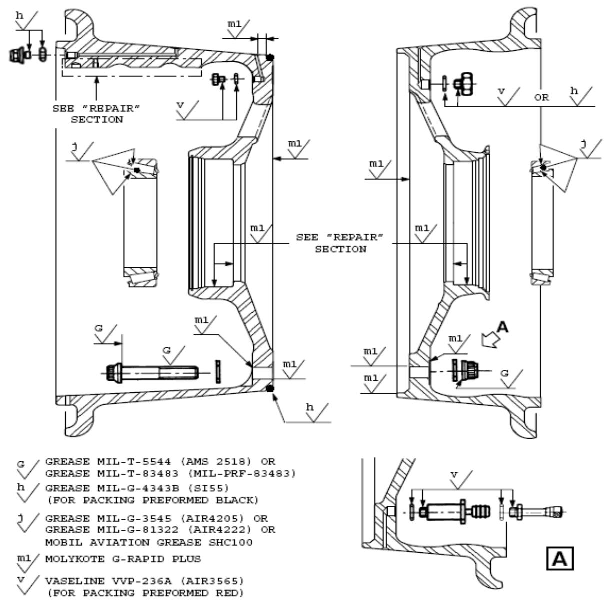

Figure 16.Protective treatment and Lubrication

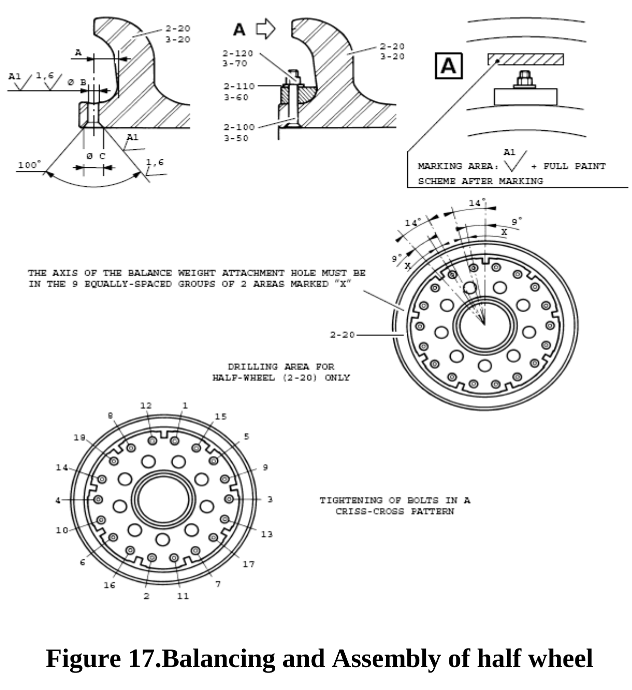

Figure 17.Balancing and Assembly of half wheel

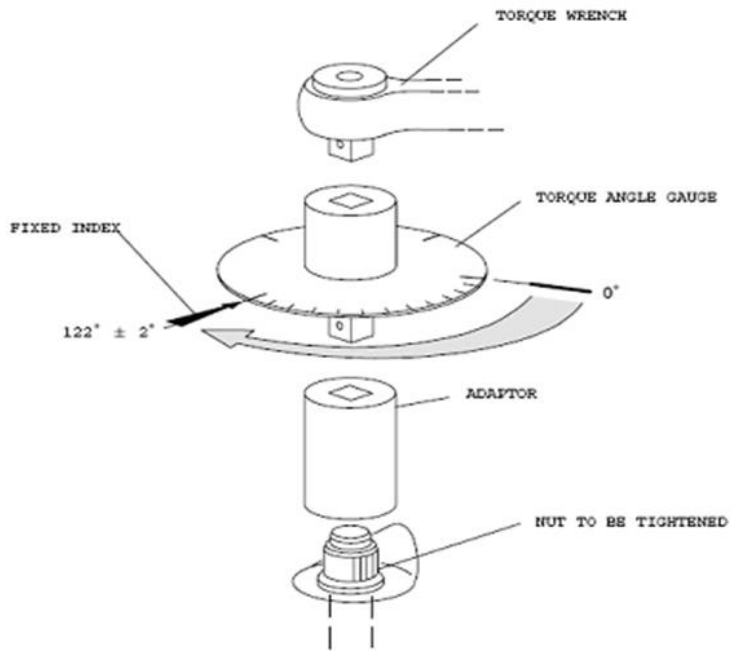

Figure 18.Angel Tightening Method

2.3 July 22, 1969 W. G. Bernhardt Aircraft Wheel And Tire Assembling Machine

Many aircraft wheels, and particularly those on military airplanes, are of the split type which have first and second halves bolted together with the tire between the two halves. In order to remove or replace a tire, it is necessary to use one tool to prevent the bolt heads from turning and to use a second tool to loosen the lug nuts. The use of the two tools normally entails the use of two men to disassemble a wheel. What is more difiicult, however, is the assembling of the wheel with the tire between the two wheel halves. In order that the tire be securely fastened or clamped between the two wheel halves, it is necessary to draw the two halves together a considerable distance, however, the natural resiliency of the tire tends to keep the two wheel halves apart. It is first necessary that the tire be squeezed or compressed so that nuts can engage the lug bolts. One heretofore used method of assembling a tire between the two wheel halves consisted of having one person stand on the wheel in order to compress the tire while another person started the nuts onto the lug bolts.[7]

The present invention relates to an assembling machine that readily permits one person to rapidly mount a tire between two wheel halves. The machine engages the heads of the lug bolts to prevent them from turning and at the same time provides a compressive force to move the two wheel halves together so that the nuts can be threaded onto the lug bolts. In order to more readily align the sockets on the machine with the lug bolts and in order to facitate the engagement of the sockets with the lug bolts, the sockets are spring mounted to permit vertical movement and also the sockets are rotatable a partial of a revolution. As wheels for different military airplanes are provided with different size lug bolts and nuts, the sockets are removably attached to the machine along with a removable guide plate, and different size sockets can be readily provided to accommodate different wheels.[7]

It is therefore a general object of the present invention to provide a machine for assembling a tire between the split halves of a wheel for an airplane.

Another object of the present invention is to provide an assembling machine for aircraft wheels which can readily accommodate dilferent size lug nuts.

Still another object of the present invention is to provide an assembling machine which will compress a tire to facilitate the mounting of the tire on an aircraft wheel.[7]

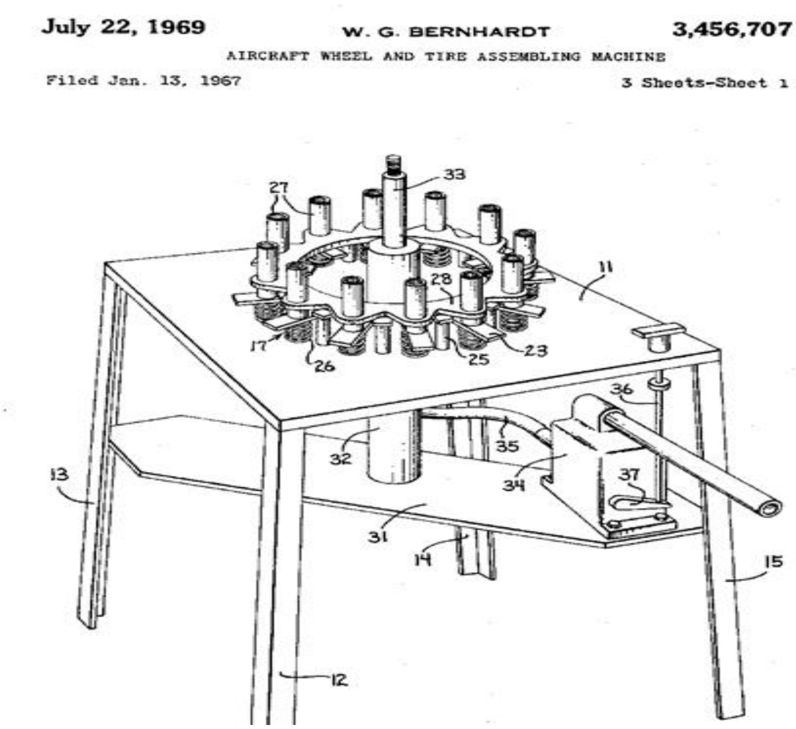

Figure 19.Aircraft wheel and tire assembly machine

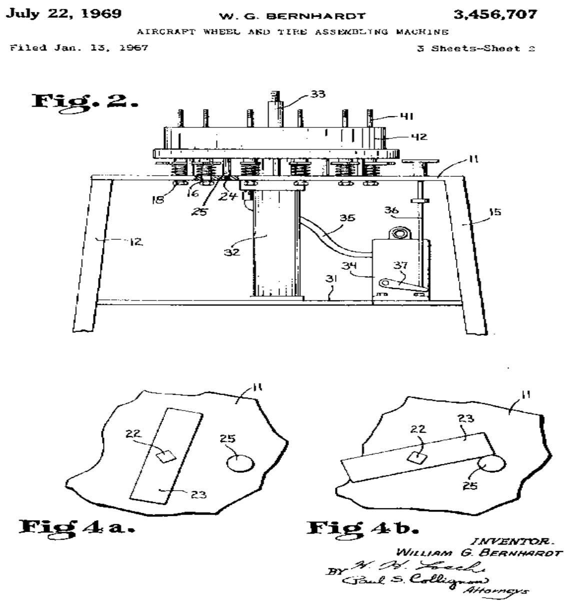

Figure 20.Front View Aircraft wheel and tire assembly machine

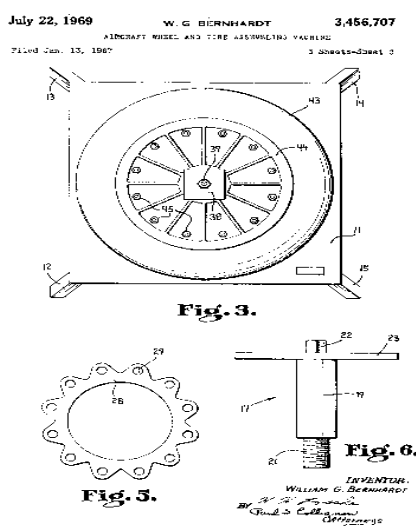

Figure 21.Top View Aircraft wheel and tire assembly machine

Fig 17 is a perspective view of a wheel and tire assembling machine embodying the present invention;

In Fig 18;FIGURE 2 is a side view of a wheel and tire assembling machine showing a wheel half mounted thereon and partially broken away to show parts in section;

In Fig 19; FIGURE 3 is a top view showing a wheel and tire mounted on the assembling machine;

In Fig 18; FIGURE 4(a) is a partial top view showing a socket holder in a first position;

In Fig 18; FIGURE 4(b) is a partial top view showing a socket holder engaging stops;

In Fig 19; FIGURE 5 is a top view showing a guide plate having holes for accommodating standard sockets; and

In Fig 19; FIGURE 6 is a side view of a socket holder.

Referring now to the drawings, there is shown a base plate 11 that is supported on legs 12, 13, 14, and 15. A plurality of equally spaced holes 16 on a bolt circle are provided in base plate 11, and a socket holder 17 is inserted in each hole 16 and secured thereto by a nut 18. Each socket holder 17 has a cylindrical portion 19 and a threaded portion 21 on the bottom thereof. A square portion 22 is provided on the top of the cylindrical portion 19 and is adaptable for engaging a square hole in a socket. A stop arm 23 is provided adjacent the square portion 22 and extends on each side of the cylindrical portion 19. A plurality of tapped holes 24 are also provided in base plate 11. Holes 24 are on the same bolt circle as are holes 16 and are equally spaced between holes 16. A stop 25 is threaded into each hole 24. Socket holders 17, which are secured in holes 16, are mounted on springs 26 which are positioned around cylindrical portion 19 and between base plate 11 and stop arm 23. Springs 26 permit a short vertical movement of socket holders 17.[7]

A plurality of sockets 27 are provided, and the wrenchend, which has a square hole therein, is slip-fitted onto the square portion 22 of socket holder 17. A guide plate 28, as shown specifically in FIGURE 5 of the drawings, is supported by the top end portions of stop arms 23, and is provided with a plurality of holes 29 that are slightly larger than the outside diameters of socket-s 27 thereby permitting a slip-fit of the sockets 27 in holes 29. Guide plate 28 thus provides support for sockets 27 so that they are aligned parallel with one another. It is contemplated that standard size sockets 27 will be utilized to engage with the square portion 22 and that different size lug bolts may be utilized on different wheels. For example, one military airplane used lug bolts that took a three-quarter inch socket, while another airplane used lug bolts that took a nine-sixteenth inch socket. As the outside diameters of these standard size sockets are different, a separate guide plate 28 is provided for each different size socket that is to be utilized.[7]

Referring particularly to FIGURES 1 and 2 of the drawings, there is shown a horizontal support plate 31 that is attached to legs 13 and 15. A cylinder 32, which might either be of the air or liquid type, is attached to support plate 31. A piston rod 33, which is an operable part of cylinder 32, extends upwardly through a hole in base plate 11 and extends beyond the sockets 27. A hand pump 34 is also attached to support plate 31 and a fluid line 35 connects pump 34 to cylinder 32. Hand pump 34 is selected to be compatible with cylinder 32, that is, if cylinder 32 is an air cylinder, then pump 34 would be an air pump, and likewise, if cylinder 32 operates on fluid, then pump 34 would be hydraulic. A rod 36 is connected to a handle 37 on pump 34, which operates a valve to release the pressure on cylinder 32 when desired. A pressure plate 38 is attachable to piston rod 33 by means of a nut 39.[7]

In operation, the proper size sockets 27 and guide plate 28 are selected, depending upon the particular wheel that is to be assembled. Many military aircraft wheels have twelve lug bolts 41 and, accordingly, twelve sockets 27 are provided and engage with twelve socket holders 17 on base plate 11. The sockets 27 are maintained in vertical alignment by guide plate 28 and, as socket holders 17 are resiliently mounted on springs 26, sockets 27 have limited vertical movement. The heads of lug bolts 41 are inserted into sockets 27 and then the inner half 42 of an aircraft Wheel is placed on the machine with the lug bolts 41 passing through holes in the inner wheel half 42, as shown in FIGURE 2 of the drawing. The tire 43 and outer wheel half 44 are then placed in position upon the inner wheel half 42 with the lug bolts 41 passing into holes in the outer wheel half 44. Pressure plate 38 is then attached to piston rod 33 by threading nut 39 onto the threaded end of piston rod 33. Actuation of hand pump 34 retracts piston rod 33 which, in turn, causes pressure plate 38 to drawn the outer wheel half 44 into contact with the inner Wheel half 42. When the two wheel halves have been drawn into position, the threaded ends of lug bolts 41 are accessible and the wheel nuts 45 are threaded thereon and secured tightly. In order to facilitate the insertion of the heads of lug bolts 41 into sockets 27, sockets 27 can be rotated a short distance. However, upon tightening of the wheel nuts 45, the stop arms 23 of socket holders 17 rotate against stops 25 which prevent any further rotation of sockets 27. After the wheel nuts are made tight, the valve in hand pump 34 can be opened which releases cylinder 32, and pressure plate 38 can then be removed which allows the assembled wheel and tire to be removed from the machine.[7]

The assembling machine of the present invention can also be utilized to disassemble an aircraft wheel. The feature of having the sockets rotatable is essential when the machine is used for disassembly for the heads of the lug bolts are drawn securely against the wheel and cannot rotate relative to the wheel. Thus in order for the bolt head, which might be hexagons, to engage the sockets, it is necessary to rotate the sockets until there is proper alignment for engagement. The engagement of stop arms 23 with stops 25 limits, however, the amount of rotation of sockets 27.[7]

It can thus be seen that the present invention provides a relatively simple and inexpensive machine for facilitating the assembly and disassembly of an aircraft wheel and tire. The assembly or disassembly can be completed quickly and safely by one man. Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood, that within the scope of the appended claims, the invention may be practiced otherwise than as specifically described.[7]

What is claimed is:

1. A machine for assembling a tire bet-ween first and second wheel halves comprising:

a base plate,

a plurality of socket holders rotatably mounted to said base plate in a circular array,

a plurality of sockets removably attached one each to each said socket holder, said sockets being adaptable to engage one each of a plurality of Wheel lug bolts,

means for limiting rotation of said sockets,

a guide plate for aligning said sockets parallel to one another, and

means attached to said base for moving said first and second wheel halves together with said tire therebetween whereby said lug bolts can be threadedly engaged with wheel nuts.

2. A machine for assembling a tire between first and second wheel halves as set forth in claim 1 wherein said means for limiting rotation of said sockets includes a stop arm extending outwardly in two directions from each said socket holder and a plurality of stops attached to and extending upwardly from said base plate between adjacent socket holders whereby each said stop arm is engageable with adjacent stops.

3. A machine for assembling a tire between first and second wheel halves as set forth in claim 1 wherein'said means for moving said first and second wheel halves together includes a cylinder attached to said base plate, a piston reciprocable within said cylinder, a pressure plate removable attached to the outer end of said piston and engageable with said first wheel half, and means for actuating said piston in said cylinder whereupon actuation of said piston moves said first wheel half toward said second wheel half.[7]

2.4 General Problem Solving Process

An essential part of our problem solving method involves step-by-step analysis and synthesis. In it we proceed from the qualitative to the quantitative, each new step being more concrete than the previous one.

It is necessary to develop an approach adapted to the specific problem and modified it appropriately as the problem solving proceeds. When searching for solutions it is very effective to view the problem from different perspectives, such as different level of concretization. One can for example by analyzing a concrete idea be stimulated to develop a more abstract perspective that leads to new ideas and vice versa.

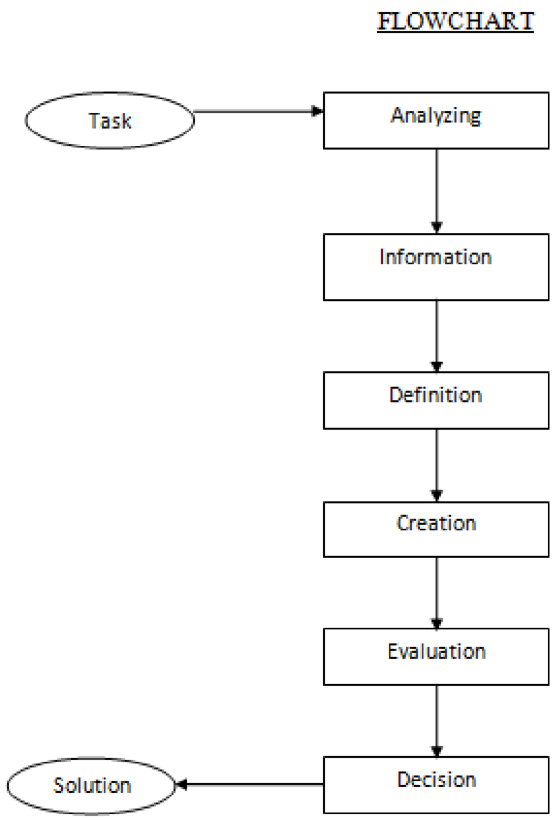

Figure 22.Flow charts for general problem solving

2.5 Significance Of Material Selection

Material consideration plays a very vital role in the design process. Radical materials advances can drive the creation of new products or even new industries, but stable industries also employ materials scientists to make incremental improvements and troubleshoot issues with currently used materials. Industrial applications of materials science include materials design, cost-benefit tradeoffs in industrial production of materials, processing techniques (casting, rolling, welding, ion implantation, crystal growth, thin-film deposition, sintering, glassblowing, etc.), and analytical techniques (characterization techniques such as electron microscopy, x-ray diffraction, calorimetry, nuclear microscopy (HEFIB), Rutherford backscattering, neutron diffraction, etc.

2.6 Company Profile

2.6.1 About Air-India:

Airlines flew One summer day in 1929, late Mr. Neville Vincent, a former Royal Air Force pilot came to India from Britain on a barnstorming tour during which he surveyed a number of possible air routes. He saw the immense potential for aviation in India. It came to pass that he met late Mr. J. R. D. TATA, A YOUNG INDIAN who was the first to get his A- license in India and that too in the shortest number of hours.[3]

Mr. Vincent worked out a scheme, secured Mr. TATA's approval and together they showed it to Mr. PETERSON, director of TATA Sons and Mr. J.R.D.TATA's mentor. Sir DORAB TATA, the then chairman of TATA Sons, presently surprised all by giving the scheme his ok. So they went ahead and drive plan for the operation of an air service from KARACHI to MUMBAI with one stop at AHMEDABAD.[3]

This time they offered to donate air service to government of India with no strings attached. The government agreed and thus, was born TATA AIRLINES, which later became AIR INDIA. On October 15, 1932, a light single engine Puss Moth took off from Karachi on its flight to Mumbai via Ahmedabad. At the controls of the tiny place was Mr. TATA, operating the first scheduled air service in the country. He landed with his precious load of mail on a grass strip at Juhu. Life was simple then. Then were no runways, no radio facilities in the aircraft or on the ground. There were no pretty hostesses, no aerodrome officers and no airport buildings. At Mumbai, Mr. Vincent took over from Mr. TATA and flew the Puss Moth to Chennai via Bellary.[3]

In 1933, the first full year of its operations, TATA 160000 miles, carried 155 passengers and 1.71 tones of mail. In next few years, TATA Airlines continued to rely on its revenue on the mail contract with the Government of India for carriage of surcharged mail, including a considerable amount of foreign mail brought to Karachi by Imperial Airways for destination in India.[3]

The transition to civilian status immediately after war caused few problems to the Airlines, since it had already acquired considerable operating experience. To stress on its new civilian status and role as public utility, Tata Airlines was converted into Public Limited Company on July 29, 1946 and renamed AIR-INDIA. Around this time the Airline moved its operating base from Juhu to its present location at Mumbai Airport.[3]

The early fifties saw the financial condition of the Airlines deteriorate to such an extent that the Government decide to step in and nationalize the air transport industry and accordingly two autonomous corporations were created on August 1, 1953. INDIAN AIRLINES was formed with the merger of eight airlines to operate the domestic services, while AIR-INDIA International was to operate over seas services. Nationalization opened a new chapter in the airline history, which was marked by the expansion of its fleet and route. By mid fifties, AIR INDIA busted forth on the world on the air transports scene with a refreshingly different publicity campaign. The little MAHARAJA who has first made his appearance as a symbol all over the world. No other airlines matched AIR-INDIA's panache and subtle humour in promoting its services. AIR-INDIA became one of the most talked about airlines in the world.[3]

Air-India keeping a sharp eye on the latest developments and decided to order the Boeing 707 in the late fifties. The first Boeing was received in February 1960.

As sixties closed, AIR-INDIA in keeping its tradition of ordering the latest and the best planes available placed an order for Boeing 747-200s, the first of which was delivered in April 1971. Over the next nine years AIR-INDIA received nine more planes at regular intervals thus, achieving the biggest ever expansion of its fleet and its capacity in history, with simultaneous expansion of all other facilities.[3]

AIR-INDIA started the eighties with the program of fleet renewal. In the first phase, AIR-INDIA purchased 3 Airbus A300-B4s in 1932. In the second phase, six A310-300s were inducted into the fleet. The airline acquired two more Boeing 747-300 Combi aircraft in October 1988 and two Airbus A310s in August 1990. Four Boeing 747-400s were been inducted on dry lease in the fleet. Three more are due for induction by early 2003.[3]

From its inception AIR INDIA has followed the policy of self-sufficiency. This has meant, of course a considerable investment in building extensive, but the major advantage of this policy has been that the airline now posses one of the most modern and up-to-date engineering bases in the world, capable of handling complete work on its fleet of six Boeing 747-400s, four Boeing 747-200s, two Boeing 747-300s, three Airbus A300-B4s and 13 Airbus A310-300s.[3]

The engineering base located in Mumbai is approved by the Directorate General of Civil Aviation, the Indian regulating authority, and meets the stringent requirements of the manufacturers and regulatory agencies. AIR-INDIA Engineering has been certified by the Federal Aviation Administration of USA as a “FAR 145 Repair Station” for overhaul of engines and Auxiliary Power Units (APUs) including their accessories.[3]

2.6.2 About The Workshop In Santacruz:

The workshop in santacruz is very close to international airport in santacruz and domestic airport in Andheri, inside a radius of 5 km. This workshop is the major maintenance workshop in India. All the maintenance work has been undertaken in this workshop. As AIR INDIA does not manufacture any aircraft, it obviously has the workshop in maintenance as said earlier any major maintenance takes place only in santacruz. The workshop is divided in to different sections or divisions.[3]

1. LMD : LIGHT MAINTENANCE DIVISION.
2. MMD : MAJOR MAINTENANCE DIVISION.
3. EOD : ELECTRONICS OVERHAUL DIVISION.
4. AOD : ACCESSORIES OVERHAUL DIVISION.
5. IOD : INSTRUMENT OVERHAUL DIVISION.
6. COD : COMPONENT OVERHAUL DIVISION.
7. EAOD : ELECTRICAL ACCESSORIES OVERHAUL DIVISION.
8. PPOD : POWER PLANT OVERHAUL DIVISION.
9. IE : INDUSTRIAL ENGINEERING.
10. QCS : QUALITY CONTROL & TECHNICAL SERVICES.

2.6.3 Air India –Range Of Service:

AIR INDIA is responsible for the major transport of man and material quickly and efficiently all over India and countries around the world. AIR INDIA gives service even in the most remote places inside India.

Even with the presence of other domestic airlines the dominance of AIR INDIA is quite evident in the range and quality of service.

In case of international service there are new routes being established which enables travelers to reach their destination with ease and less time.

AIR INDIA also gives service to other airways for the maintenance and overhaul of their aircraft's. These include jet airways, Sahara airlines, etc.

Air-India became the first company in the Asian region to order for Jet Aircrafts in the late 1950's. It received its first Boeing 707 aircraft just two years after it was introduced into international service. Today it covers 44 destinations throughout the world by operating services through its own aircraft and code-shared flights. Since then Air-India has expanded its fleet by including 21 aircrafts consisting of B 777, B 747-400 and A 310.

In its ever growing quest for providing direct services from various points in India it has started operating flights from 12 other India cities. Significant improvements introduced in all areas of Air-India operations on an ongoing basis, reinforces the airline'scommitment to quality and high standards. Besides acquiring the latest aircrafts, Air-India has one of the best ground support staff for maintenance and repair of these aircrafts. The Engineering base is located at Kalina in Santa Cruz, close to old Bombay airport. It has 18 dept's looking after various activities with work force strength of 18000 employees. The dept undertakes the following services:

1. Maintenance of Airframes
2. Repair and Overhaul
3. Engine and Accessories
4. Providing certification of Aircraft
5. Line maintenance support
6. Component Repair and Overhaul to airlines.[3]

2.6.4 Component Overhaul Division

"C.O.D." or "Component Overhaul Division" is responsible for carrying out detailed overhauling of the aircraft and also parts which are related to aircraft performance and safety. C.O.D has different sections like the under-carriage section, control system etc, which basically deals with overhauling of parts like the landing gear, brakes, wheel, air-spoilers, etc. In the under-carriage section wheel maintenance, brake testing as well as paint removal from the wheel half takes place. Eddy current testing as well as Non-Destructive testing to check the reusability of the wheels is also done in this division. Hydraulics and Pneumatics come under the control system section. Here testing and maintenance of hydraulics used in the aircraft are done. [3]

2.7 Theory On Jib Crane

A crane is a mechanical lifting device equipped with hoists, wire ropes and sheaves that can be used both to lift and lower materials and to move them horizontally. It uses one or more simple machines to create mechanical advantage and thus move loads beyond the normal capability of a human.

There are several types of cranes and one of them is JIB CRANE. Jib crane is a revolving type crane. It has a horizontal jib which has the appearance of an arm has extended over the work area. A hoist is attached to the arm to provide lifting capability. The arm can rotate and hoist can move along the arm to achieve a wide coverage. It may be projected from a wall, attached to self supporting pillar or mounted on a column as shown below.

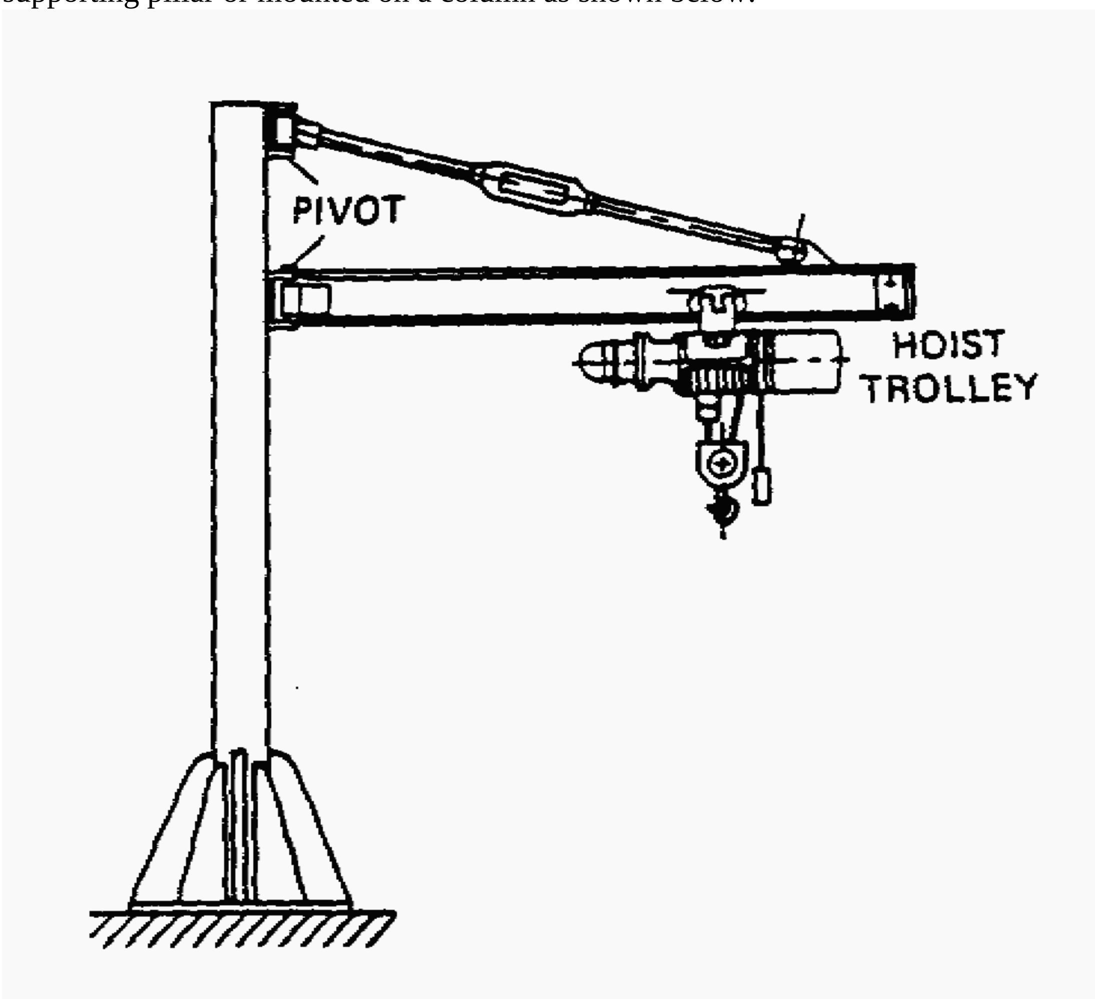

Figure 23.JIB CRANE

2.7.1 Automation In The Jib Crane:

The Automation in the Jib Crane can be done with the help of the PLC (Programmable Logic Controller). The Jib Crane will move the objects from one place to another with the help of Push Buttons easily because of the Program stored in the PLC. This will remove the Human effort required for lifting the Heavy objects like Tires, Hubs etc.

I. PLC (PROGRAMMABLE LOGIC CONTROLLER)

A programmable logic controller, PLC or programmable controller is a digital computer used for automation of typically industrial electromechanical processes, such as control of machinery on factory assembly lines, amusement rides, or light fixtures. PLCs are used in many industries and machines. PLCs are designed for multiple analogue and digital inputs and output arrangements, extended temperature ranges, immunity to electrical noise, and resistance to vibration and impact. Programs to control machine operation are typically stored in battery-backed-up or non-volatile memory. A PLC is an example of a "hard" real-time system since output results must be produced in response to input conditions within a limited time, otherwise unintended operation will result.[4]

II. PROGRAMMING IN PLC:

Early PLCs, up to the mid-1990s, were programmed using proprietary programming panels or special-purpose programming terminals, which often had dedicated function keys representing the various logical elements of PLC programs.[2] Some proprietary programming terminals displayed the elements of PLC programs as graphic symbols, but plain ASCII character representations of contacts, coils, and wires were common. Programs were stored on cassette tape cartridges. Facilities for printing and documentation were minimal due to lack of memory capacity. The very oldest PLCs used non-volatile magnetic core memory.[4]

More recently, PLCs are programmed using application software on personal computers, which now represent the logic in graphic form instead of character symbols. The computer is connected to the PLC through Ethernet, RS-232, RS-485 or RS-422 cabling. The programming software allows entry and editing of the ladder-style logic. Generally the software provides functions for debugging and troubleshooting the PLC software, for example, by highlighting portions of the logic to show current status during operation or via simulation. The software will upload and download the PLC program, for backup and restoration purposes. In some models of programmable controller, the program is transferred from a personal computer to the PLC through a programming board which writes the program into a removable chip such as an EEPROM or EPROM.[4]

III. FEATURES OF PLC:

The main difference from other computers is that PLCs are armored for severe conditions (such as dust, moisture, heat, cold) and have the facility for extensive input/output (I/O) arrangements. These connect the PLC to sensors and actuators. PLCs read limit switches, analog process variables (such as temperature and pressure), and the positions of complex positioning systems. Some use machine vision.[4] On the actuator side, PLCs operate electric motors, pneumatic or hydraulic cylinders, magnetic relays, solenoids, or analog outputs. The input/output arrangements may be built into a simple PLC, or the PLC may have external I/O modules attached to a computer network that plugs into the PLC.[5]

2.8 Design

Design is the creation of a plan or convention for the construction of an object or a system (as in architectural blueprints, engineering drawings, business processes, circuit diagrams and sewing patterns). Design has different connotations in different fields (see design disciplines below). In some cases the direct construction of an object (as in pottery, engineering, management, cowboy coding and graphic design) is also considered to be design.

2.8.1 Design Requirements:

- Define Requirements
- Gather/Analyse Information
- Develop Several Options
- Choose the Best Options
- Implement the Design

2.8.2 Software That Can Used In 3d Modelling:

Following is a list of commercially available **3D modeling software**, computer programs used for developing a mathematical representation of any three-dimensional surface of objects, also called 3D modeling.

CAD Design Softwares:

- Solid Works
- Unigraphics
- CATIA
- PRO-E
- AUTODESK

Analysis Softwares:

- ANSYS
- NASTRAN

2.9 Finite Element Analysis

Finite Element Analysis is a powerful mathematical tool for numerical solution (approximate solution) of engineering problems. These problems are expressed in the form of a differential equation. These differential equations relate various quantities of interest. These quantities are classified as "field variables" (e.g. displacement, temperature, pressure head, etc.) and "geometric variable" (i.e. length).

The essence of FEA is to break a large geometrically complex domain into smaller interconnected geometrically simple subdomains called as "Finite Elements". This process is known as "discretization". Each element is connected to the other element through "nodes".

The differential equations are solved by taking an approximate solution (Trial function) over each element in "Weighted Integral" sense. This trial function which is usually an algebraic polynomial is known as element level "Interpolation Function". These functions are used to interpolate the value of field variable at an interior point within the element from its value at the nodes of the element.

The term **Finite Element** was first coined by Clough in 1960. During this period, methods of approximation were usually used to solve problems on stress analysis, fluid flow, heat transfer, etc. basic concepts regarding **F.E.M** were developed even prior to that.

However, as the technology pertaining to computers and software developed, particularly from seventies onwards, the use of finite element procedures got momentum and as of now, this technique is used extensively to analyse practically any engineering problem. The first book on F.E.M was written by Zienkiewicz and Chung, published in 1967.

2.9.1 FEA Introduction

The Finite Element Analysis (FEA) is a numerical method for solving problems of engineering and mathematical physics. Useful for problems with complicated geometries, loadings, and material properties where analytical solutions cannot be obtained

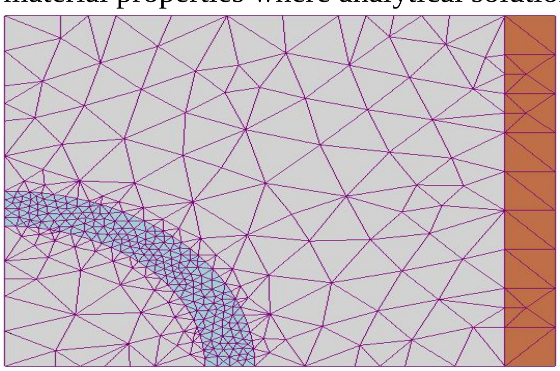

Figure 24.FEM Mesh

FEM mesh created by an analyst prior to finding a solution to a magnetic problem using FEM software. Colors indicate that the analyst has set material properties for each zone, in this case a conducting wire coil in orange; a ferromagnetic component (perhaps iron) in light blue; and air in grey. Although the geometry may seem simple, it would be very challenging to calculate the magnetic field for this setup without FEM software, using equations alone.[8]

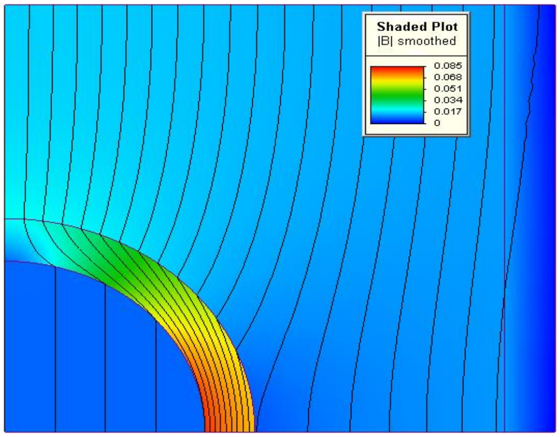

Figure 25.FEM Analyzed

FEM solution to the problem at left, involving a cylindrically shaped magnetic shield. The ferromagnetic cylindrical part is shielding the area inside the cylinder by diverting the magnetic field created by the coil (rectangular area on the right). The color represents the amplitude of the magnetic flux density, as indicated by the scale in the inset legend, red being high amplitude. The area inside the cylinder is low amplitude (dark blue, with widely spaced lines of magnetic flux), which suggests that the shield is performing as it was designed to.[8]

2.9.2 The Purpose of FEA:

Analytical Solution

Stress analysis for trusses, beams, and other simple structures are carried out based on dramatic simplification and idealization:

- mass concentrated at the center of gravity
- beam simplified as a line segment (same cross-section)
- Design is based on the calculation results of the idealized

structure& a large *safety factor* (1.5-3) given.[8]

FEA

- Design geometry is a lot more complex; and the accuracy requirement is a lot higher. We need
- To understand the physical behaviors of a complex object (strength, heat transfer capability, fluid flow, etc.)
- To predict the performance and behavior of the design; to calculate the safety margin; and to identify the weakness of the design accurately; and
- To identify the optimal design with confidence[8]

2.9.3 Common FEA Applications:

- Mechanical/Aerospace/Civil/Automotive
- Engineering
- Structural/Stress Analysis
    - Static/Dynamic

- Linear/Nonlinear

- Fluid Flow
- Heat Transfer
- Electromagnetic Fields
- Soil Mechanics
- Acoustics
- Biomechanics[8]

2.9.4finite Element Analysis Method:

- Mixed finite element method
- hp-FEM
- hpk-FEM
- XFEM
- S-FEM
- Fiber Beam Method
- Spectral methods
- Meshfree methods
- Discontinuous Galerkin methods
- Finite element limit analysis
- Stretched grid method[8]

2.10 Simulation

Simulation is the imitation of the operation of a real-world process or system over time. The act of simulating something first requires that a model be developed; this model represents the key characteristics or behaviors/functions of the selected physical or abstract system or process. The model represents the system itself, whereas the simulation represents the operation of the system over time.[6]

Simulation is used in many contexts, such as simulation of technology for performance optimization, safety engineering, testing, training,education, and video games. Often, computer experiments are used to study simulation models. Simulation is also used with scientific modelling of natural systems or human systems to gain insight into their functioning.Simulation can be used to show the eventual real effects of alternative conditions and courses of action. Simulation is also used when the real system cannot be engaged, because it may not be accessible, or it may be dangerous or unacceptable to engage, or it is being designed but not yet built, or it may simply not exist.[6]

2.10.1 Computer Simulation:

A computer simulation (or "sim") is an attempt to model a real-life or hypothetical situation on a computer so that it can be studied to see how the system works. By changing variables in the simulation, predictions may be made about the behavior of the system. It is a tool to virtually investigate the behavior of the system under study.[6]

Computer simulation has become a useful part of modeling many natural systems in physics, chemistry and biology, and human systems in economics and social science (thecomputational sociology) as well as in engineering to gain insight into the operation of those systems. A good example of the usefulness of using computers to simulate can be found in the field of network traffic simulation. In such simulations, the model behavior will change each simulation according to the set of initial parameters assumed for the environment.[6]

Traditionally, the formal modeling of systems has been via a mathematical model, which attempts to find analytical solutions enabling the prediction of the behaviour of the system from a set of parameters and initial conditions. Computer simulation is often used as an adjunct to, or substitution for, modeling systems for which simple closed form analytic solutions are not possible. There are many different types of computer simulation; the common feature they all share is the attempt to generate a sample of representativescenarios for a model in which a complete enumeration of all possible states would be prohibitive or impossible.[6]

Several software packages exist for running computer-based simulation modeling (e.g.Monte Carlo simulation, stochastic modeling, multimethod modeling) that makes all the modeling almost effortless.[6]

Modern usage of the term "computer simulation" may encompass virtually any computer-based representation.[6]

2.11 Materials:

- Chromium-vanadium steel:

Chromium-vanadium steel refers to steel alloys incorporating carbon, manganese, phosphorus, sulphur, silicon, chromium, and vanadium. Some forms can be used as high speed steel.[1] Chromium and vanadium both make the steel more hardenable. Chromium also helps resist abrasion, oxidation, and corrosion.[2] Chromium and carbon can both improve elasticity.[3]

Vanadium is a chemical element with symbol V and atomic number 23. It is a hard, silvery gray, ductile and malleable transition metal. The element is found only in chemically combined form in nature, but once isolated artificially, the formation of an oxide layer stabilizes the free metal somewhat against further oxidation.

Large amounts of vanadium ions are found in a few organisms, possibly as a toxin. The oxide and some other salts of vanadium have moderate toxicity. Particularly in the ocean, vanadium is used by some life forms as an active center of enzymes, such as the vanadium bromoperoxidase of some ocean algae. Vanadium is probably a micronutrient in mammals, including humans, but its precise role in this regard is unknown.

Characteristics:

Vanadium is a medium-hard, ductile, steel-blue metal. Some sources describe vanadium as "soft", perhaps because it is ductile, malleable and not brittle.[10][11] Vanadium is harder than most metals and steels (see Hardnesses of the elements (data page) and iron). It has good resistance to corrosion and it is stable against alkalis and sulfuric and hydrochloric acids.[12] It is oxidized in air at about 933 K (660 °C, 1220 °F), although an oxide layer forms even at room temperature.

- High Carbon Steel Properties & Uses: (C 65):

High-carbon steel has 0.8 to 1.99% carbon content. MinimumTensile strength is 750 N/mm^2.

Advantages:

Depending on the specific needs of the person using it, high carbon steel can have many advantages over other options. This type of steel is excellent for making cutting tools or masonry nails. The hardness levels and metal wear resistance of high carbon steel is also rated very highly. High carbon steel is also preferred by many manufacturers who create metal cutting tools or press machinery that must bend and form metal.

Disadvantages:

Many disadvantages also come with the use of high carbon steel. This type of steel is not recommended for any type of welding or welding work. Out of the commonly used types of steel, this one is the most likely to fracture or break because of extra brittleness. This style of steel doesn't necessarily hold up to wear as well as other types of specialty steel.

Properties of high carbon steel:

High carbon steel will be any type of steel that contains over 0.8% carbon but less than 2.11% carbon in its composition. The average level of carbon found in this metal usually falls right around the 1.5% mark. High carbon steel has a reputation for being especially hard, but the extra carbon also makes it more brittle than other types of steel. This type of steel is the most likely to fracture when misused.

Common Uses:

High carbon steel remains popular for a wide variety of uses. This type of steel is preferred in the manufacturing of many tools such as drill bits, knives, masonry nails, saws, metal cutting tools, and woodcutting tools.

- Medium carbon steel:(C 45):

Medium carbon steel contains between 0.30–0.59% carbon and balances ductility and strength with good wear resistance. The tensile strength is 580 to 710 N/mm^2.

Advantage:

It is a shiny metal with a very attractive finish. It can be rolled into thin sheet, bar, rod and beam, resistance to failure & having high heat transfer & electricity.

Disadvantages:

Medium carbon steels are generally use at Rails, turbine discs, gear wheels etc. but their weldability is not good. And have low tensile strength as compared to high carbon steel.

Properties of medium carbon steel:

Medium carbon is used for large parts, forging and automotive components. High-carbon steel is used for springs and high-strength wires. Ultra high carbon steel is used for special purposes like knives, axles or punches.

- Low carbon steel(C 07):

Low carbon steel is the most common and cost effective form. It contains around 0.05–0.320% carbon and is malleable and ductile. tensile strength is 320 to 400 N/mm^2.

Advantage:

The low – carbon steels are relatively cheap, and valves produced from carbon steels provide a cost-effective solution in environments where other factors are considered less important than cost.

Disadvantages:

Poor corrosion resistance. This can be overcome by surface protection such as paint, provided that the line media does not corrode the valve from the inside.

Properties of low carbon steel:

The most important properties of steel are great formability and durability, good tensile and yield strength and good thermal conductivity. As well as these important properties the most characteristic of the stainless steel properties is its resistance to corrosion.

Chapter 3: Methodology

3.1 Calculations

3.1.10 Time And Profit Calculations:

Table 2.Time calculation of Existing and Propose process

Step No.	Time Needed In Steps Of Existing Stand (3 Persons Required)	Time Needed In Steps Of Modelled Stands (1 Person Required)
1	12 Min (720 Sec)	6 Min (360 Sec)
2	12 Min (720 Sec)	6 Min (360 Sec)
3	12 Min (720 Sec)	12 Min (720 Sec)
4	10 Min (600 Sec)	6 Min (360 Sec)
5	12 Min (720 Sec)	6 Min (360 Sec)
6	14 Min (840 Sec)	12 Min (720 Sec)
7	20 Min (1200 Sec)	10 MIN (600 Sec)
8	10 Min (600 Sec)	-
Total	102 Min (6120 Sec)	58 Min (3480 Sec)

Man hour saving = (3x6120)-3480

= 14880 sec

= 248 min

= 4.14 hours

Percentage Man hour saving = {[(3x6120)-3480] / (3x6120)}

= 81%

On an average, 0.97 hours will be required for one assembly in modelled stand. If we consider only 261 days of working excluding Saturday and Sunday we have,

Yearly potential in hours that can be improved= yearly work hours + Improvement

= (0.97 x 261) + (4.14 x 261)

= 1333.71 hours

This above calculation is only for one assembly of aircraft wheel.

Existing Stand: In this 3 S.E are required,

- Monthly one service engineer salary on an average = Rs.75000/-
- Monthly three service engineer salary on an average = Rs.225000/-

Modelled Stand: In this one service engineer is required,

- Monthly salary of service engineer on an average = Rs.75000/-

So, cost saving in terms of S.E salary = 225000-75000

= Rs.150000/-

Percentage cost saving in terms of S.E salary = (225000-75000) / 225000

= 67%

This above cost calculation is for assembly of aircraft wheel on an assembly stand.

3.1.2 Cost Estimation:

Material Cost

Base Stand: v= 19.7 x 19.7 x12

v= 46578 $inch^3$

v= 72766.875 cc

m= Density x volume = 0.00784 x 72766.875

m= 570.492 kg

Cost= Rs.102688.56/-

Base Plate: v= 19.7 x 19.7 x 0.8 = 310.472 $inch^3$

v= 4851.125 cc

m= Density x volume =38.033 kg

Cost= Rs.6845.9/-

<u>Center rod:</u> $v = (\pi/4) \times (D^2 - d^2) \times L = [(\pi/4) \times (3.25^2 - 2^2)] + [2 \times 3.25^2 \times 12]$

v= 384.648 cc

m= Density x volume= 3.016 kg

Cost= Rs.542.88/-

<u>Upper Disc:</u> $v = \{[(\pi/4) \times D^2] - [\pi \times d_2^2] - [(\pi/4) \times d_1^2]\} \times h$

$v = \{[(\pi/4) \times 17.5^2] – [\pi \times 2.5^2] - [(\pi/4) \times 3.25^2]\} \times 1.5$

v= 318.89 cc

m= Density x volume= 2.5 kg

Cost= Rs.450/-

<u>Lower Disc:</u> $v = \{[(\pi/4) \times D^2] – [(\pi/4) \times d_1^2] – [\pi \times d_2^2]\} \times h$

$v = \{[(\pi/4) \times 22.5^2] – [(\pi/4) \times 3.25^2] – [\pi \times 2.5^2]\}$

v= 554.515 cc

m= Density x volume= 4.347 kg

Cost= Rs.782.46/-

<u>Fixture:</u> $v_1 = (\pi/4) \times 32.5^2 \times 8$ (Solid part of Fixture)

$v_1 = 6636.614$ cc

$v_2 = (\pi/4) \times (32.5^2 – 28.75^2) \times 12$

$v_2 = 2164.753$ cc

$v_3 = (\pi/4) \times (46.25^2 – 28.75^2) \times 2$

$v_3 = 2061.67$ cc

$v_4 = 18 \times [(\pi/4) \times 2.375^2] \times 2$

$v_4 = 159.48$ cc

$v = v_1 + v_2 + v_3 - v_4$

$v = 10703.557$ cc

m= Density x volume= 83.916 kg

Cost= Rs.15104.88/-

<u>Socket Holders:</u> (Chrome Vanadium)

$v = (\pi/4) \times (D^2 - d^2) \times L \times n$

$v = (\pi/4) \times (3^2 - 2.4^2) \times 3.75 \times 18$

v= 171.756 cc

m= Density x volume= 0.00787 x 171.756= 1.351

For 18 Sockets, m= 1.351 x 18= 24.33 kg

Cost= 24.33 x 720

= Rs.17517/-

Total Material Cost = Rs.143932/-

Wastage Cost

Taking Wastage Cost as 25% of Material Cost

Wastage Cost = 0.25 x 143932

= Rs.35983/-

Labour Cost

Taking Labour Cost in the range of Rs.30000 to Rs.80000

Total Labour Cost = Rs.55000/-

Overall Cost

Total Cost = 143932 + 35983 + 55000

=Rs.234915/-

Therefore, our Cost Estimation of the Modelled Stand is upto Rs.2, 35, 000/-

3.2 Details Of Proposed Assembly Stand

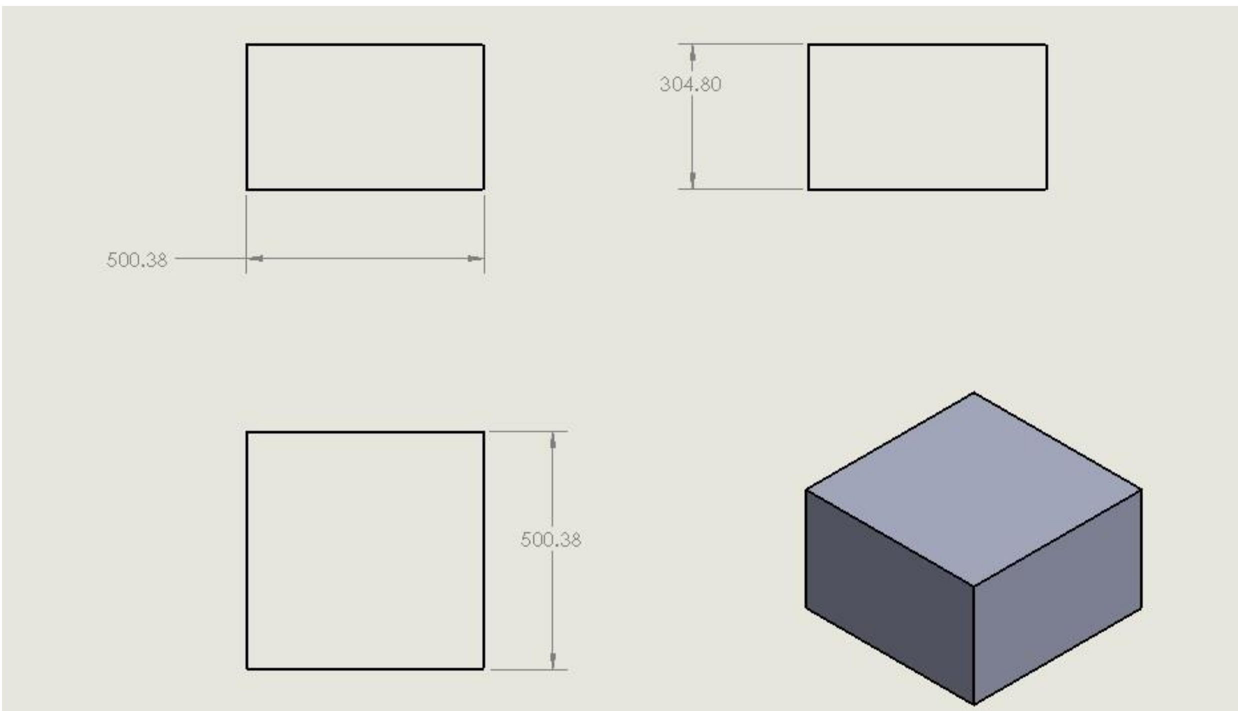

Figure 26.Base Stand

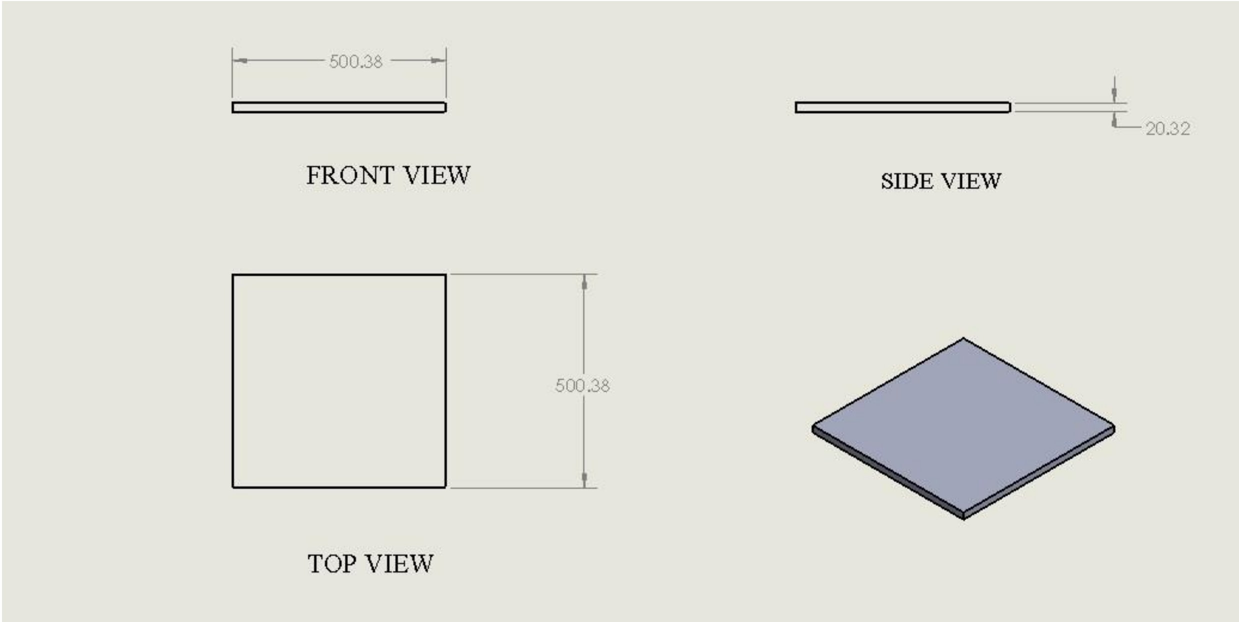

Figure 27.Base Plate

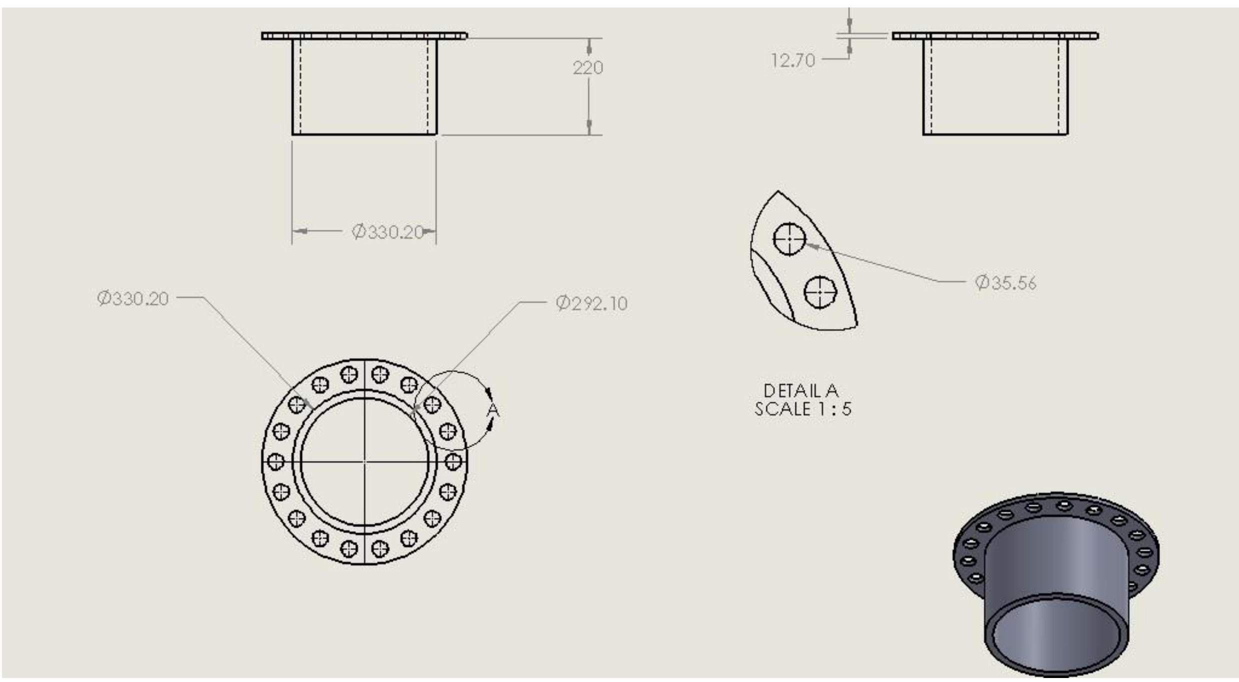

Figure 28.Fixture

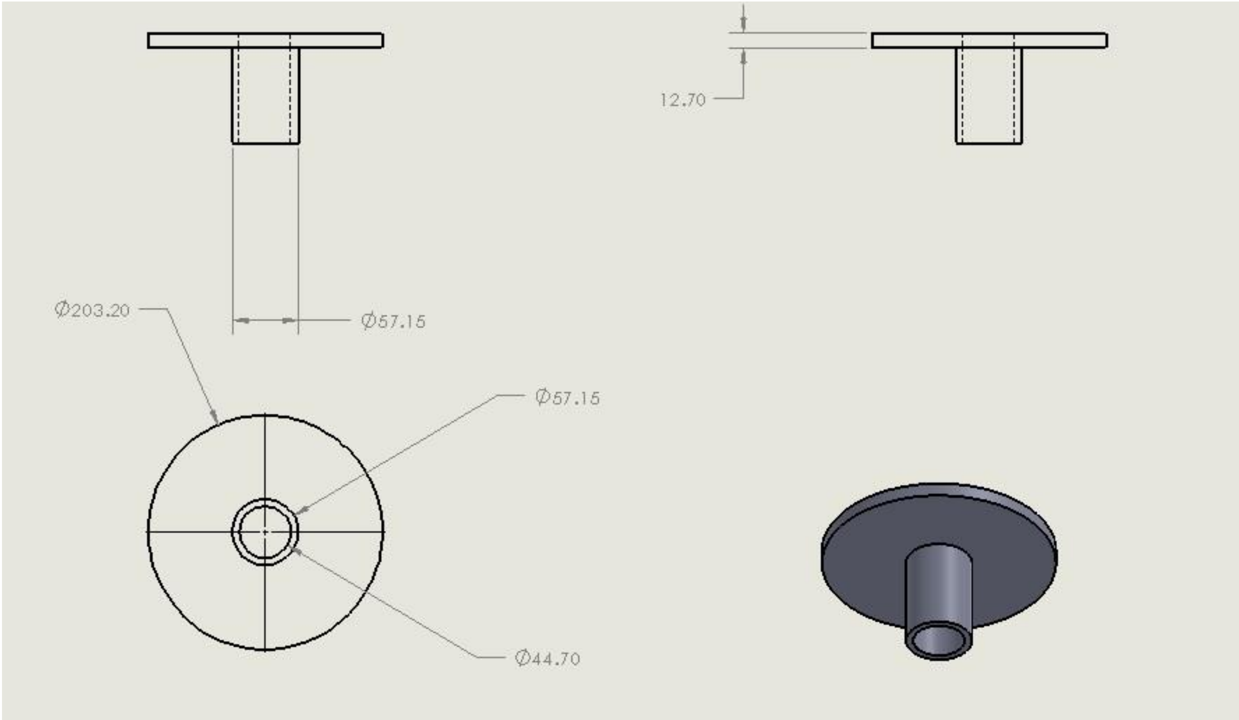

Figure 29.Clamping Plate

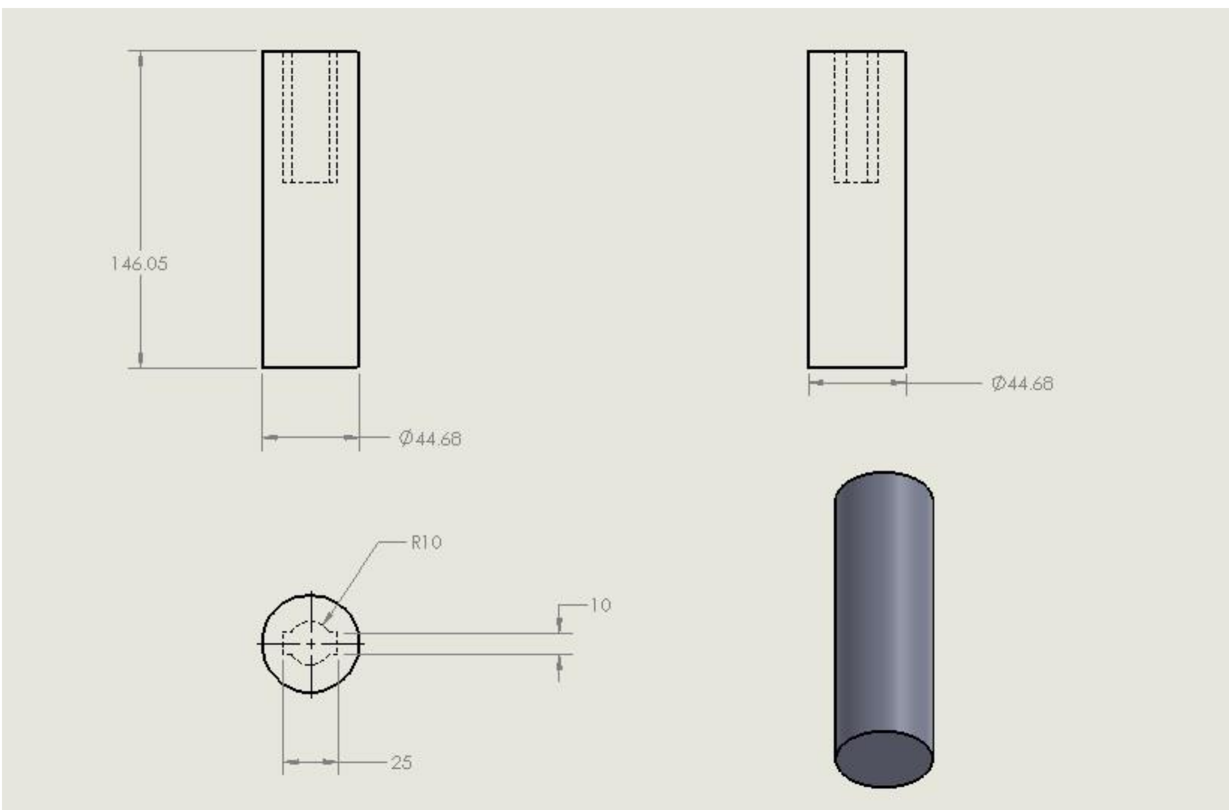

Figure 30.Piston Acquater

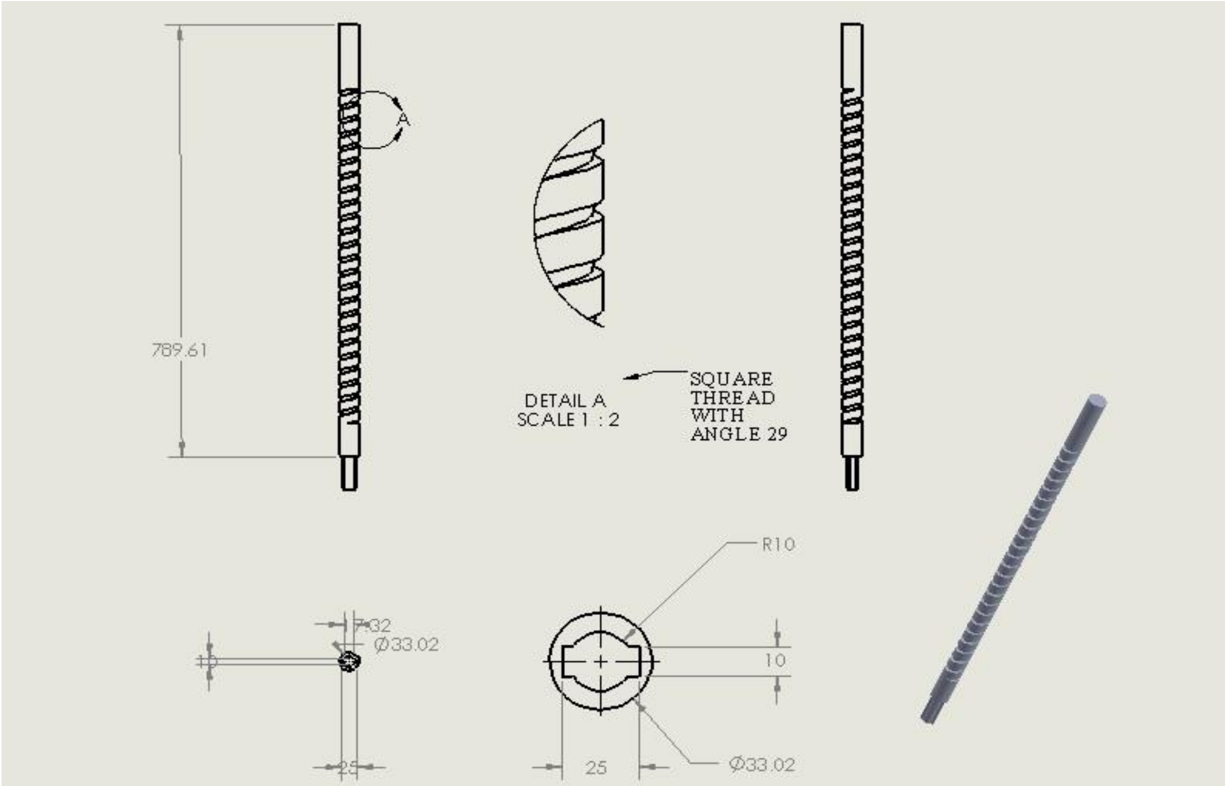

Figure 31.Centre Rod

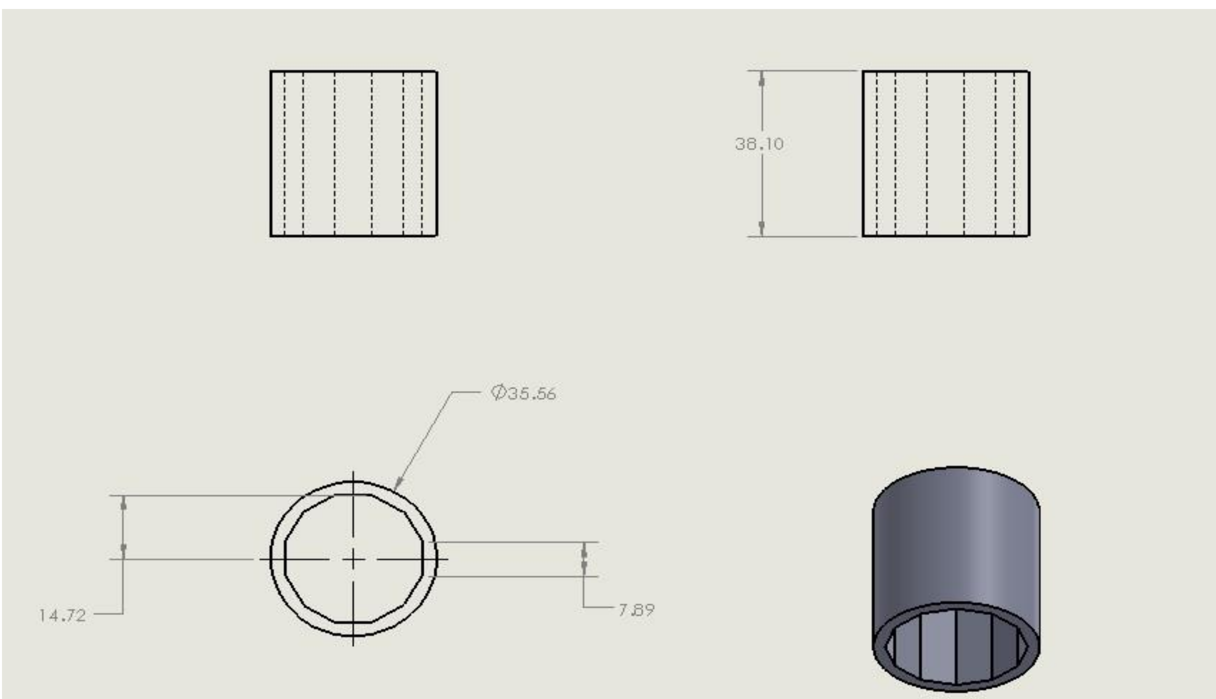

Figure 32.Socket

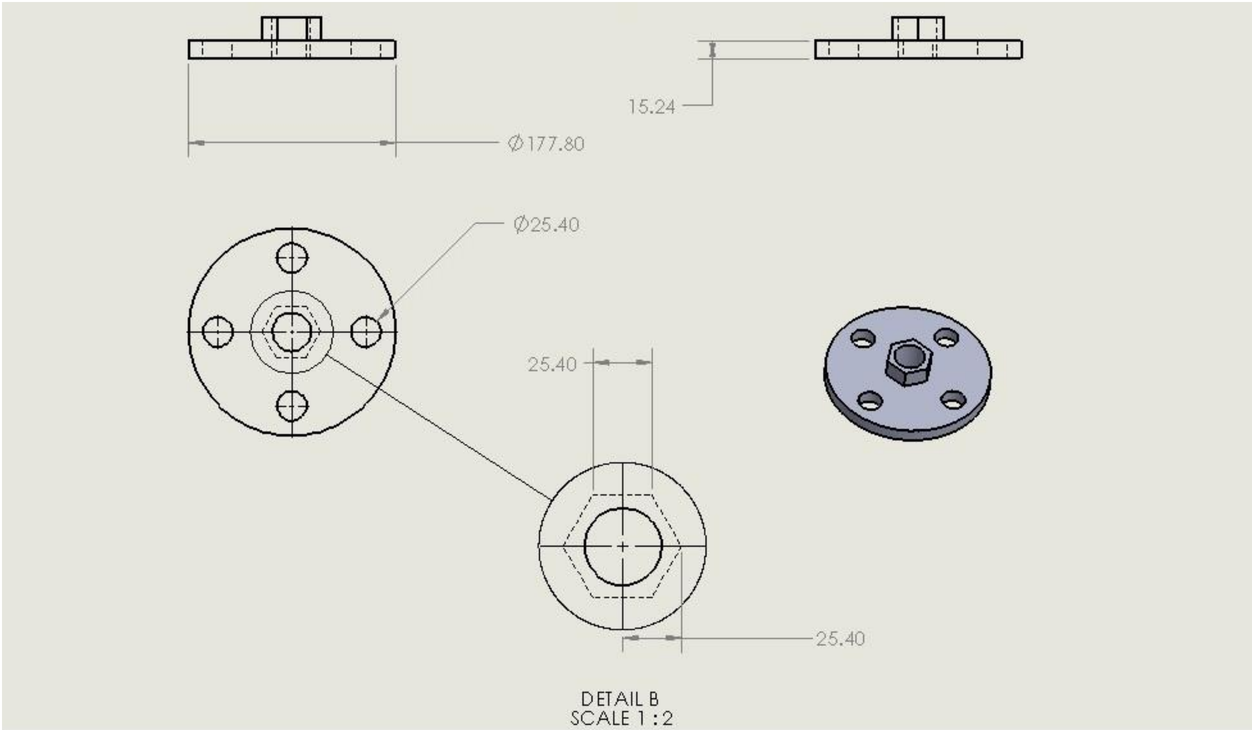

Figure 33.Upper Clamping Disc

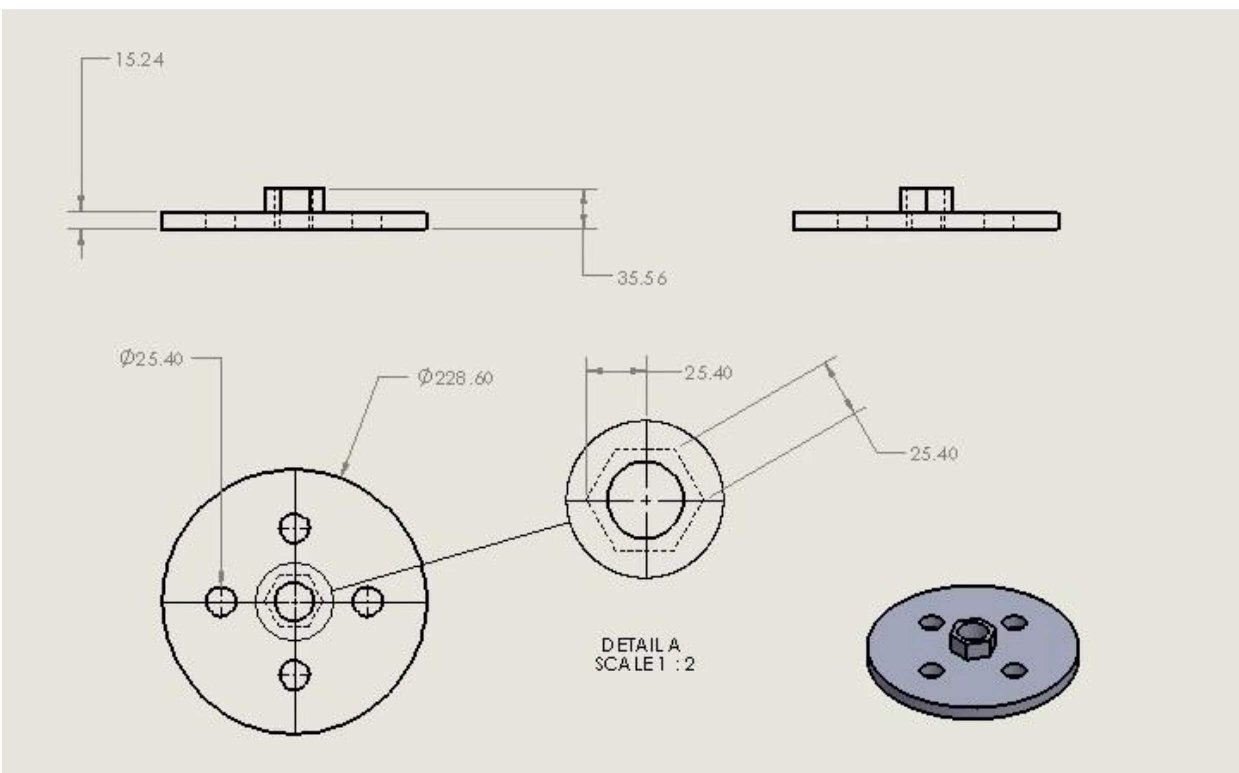

Figure 34.Lower Clamping Disc

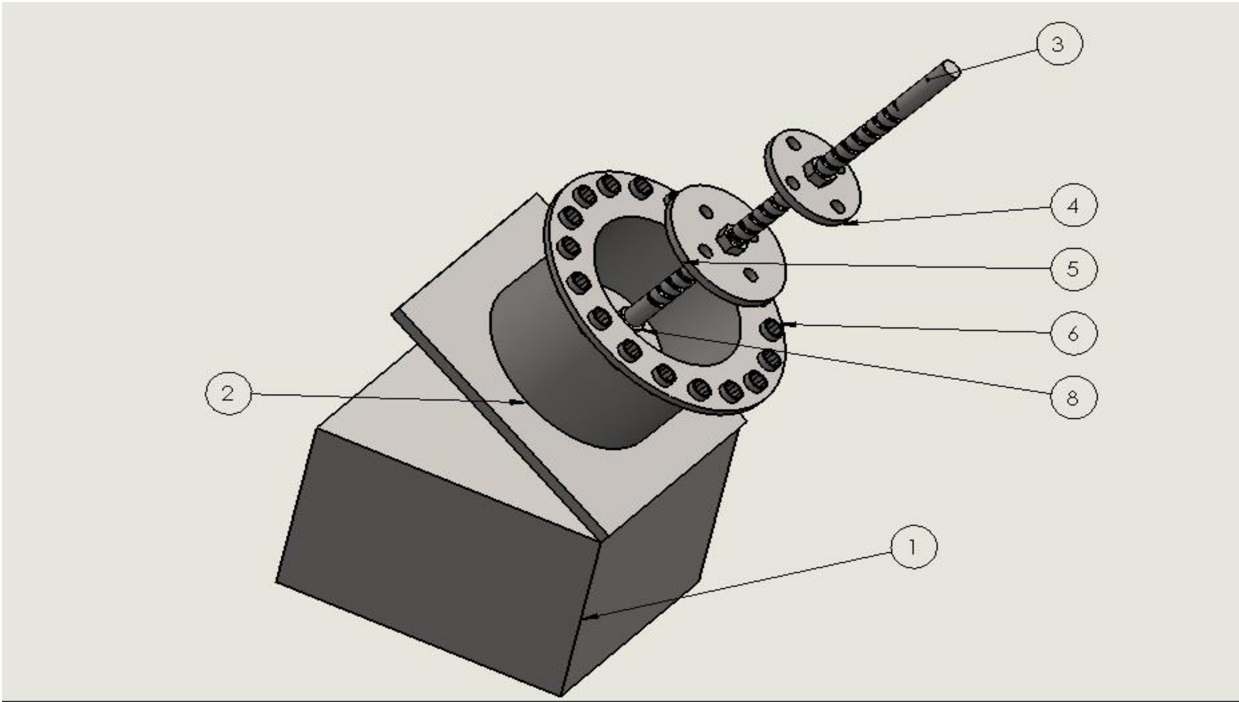

Figure 35.3D view of Proposed Wheel Assembly Stand

Table 3.BOM of the proposed stand

Part No.	Component	Material	Quantity
1	Base Stand	Medium Carbon Steel	1
2	Fixture	Medium Carbon Steel	1
3	Centre Rod	Medium Carbon Steel	1
4	Lower Clamping Disc	Medium Carbon Steel	1
5	Upper Clamping Disc	Medium Carbon Steel	1
6	Socket	Chrome Vanadium	18
8	Piston Aquater	Medium Carbon Steel	1

Chapter 4: Results

4.1 Results:

1. The model of the existing stand and proposed stand has been created in the CAD software.

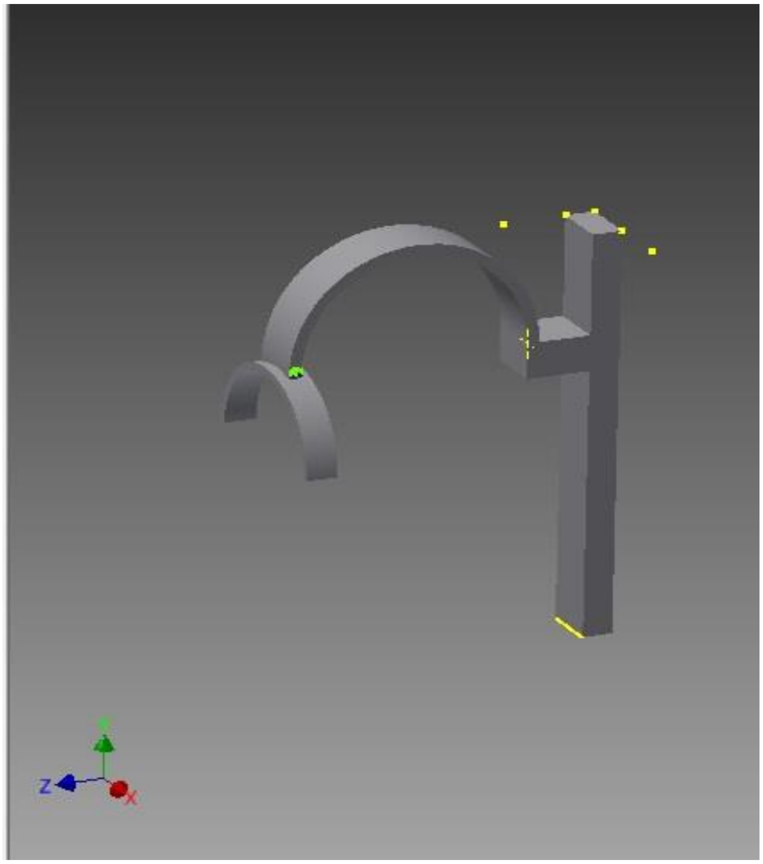

Figure 36.Model of Existing Stand

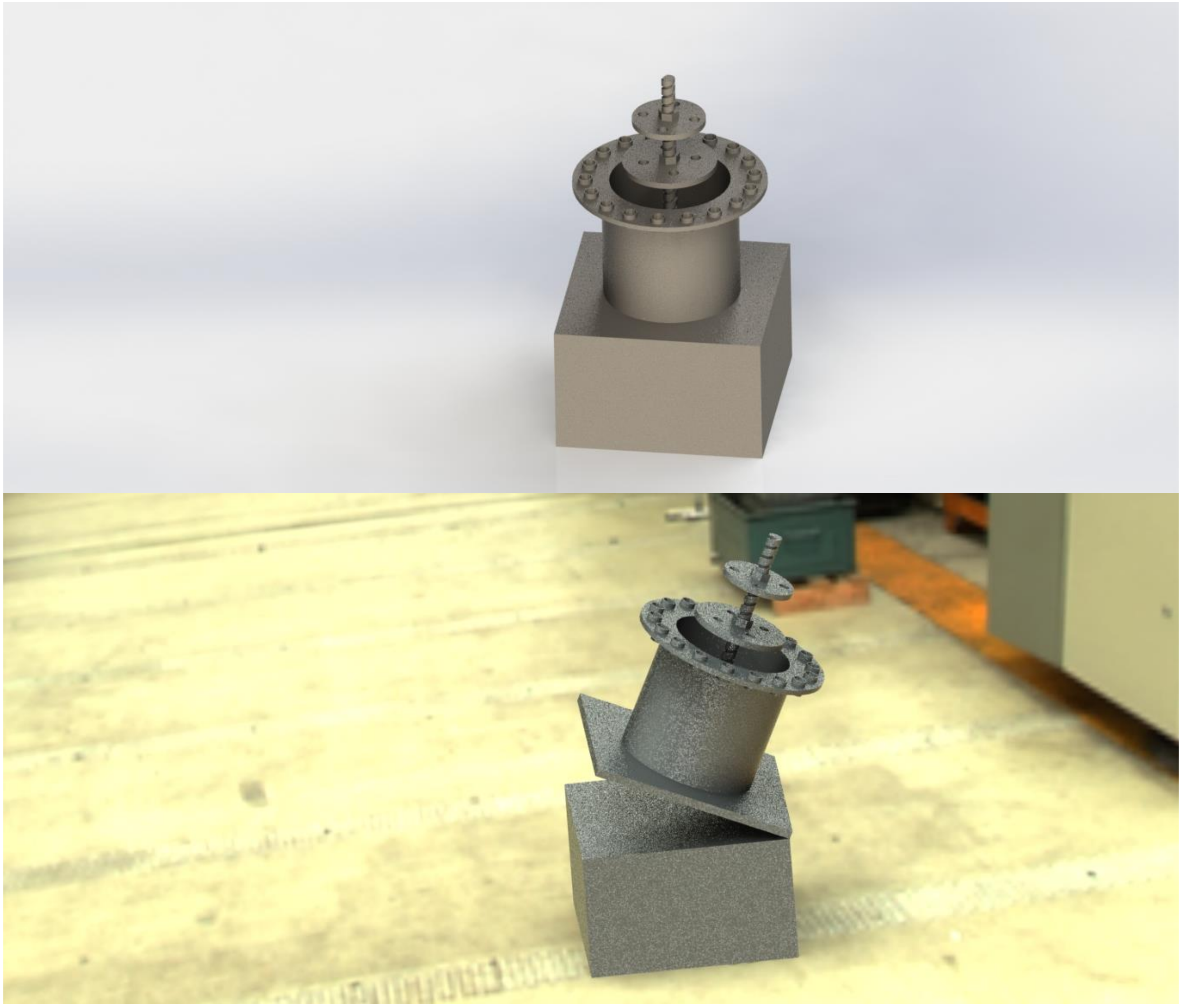

Figure 37.Model of Proposed Stand

2. The Stress Analysis has been done on the Existing stand and the proposed stand.

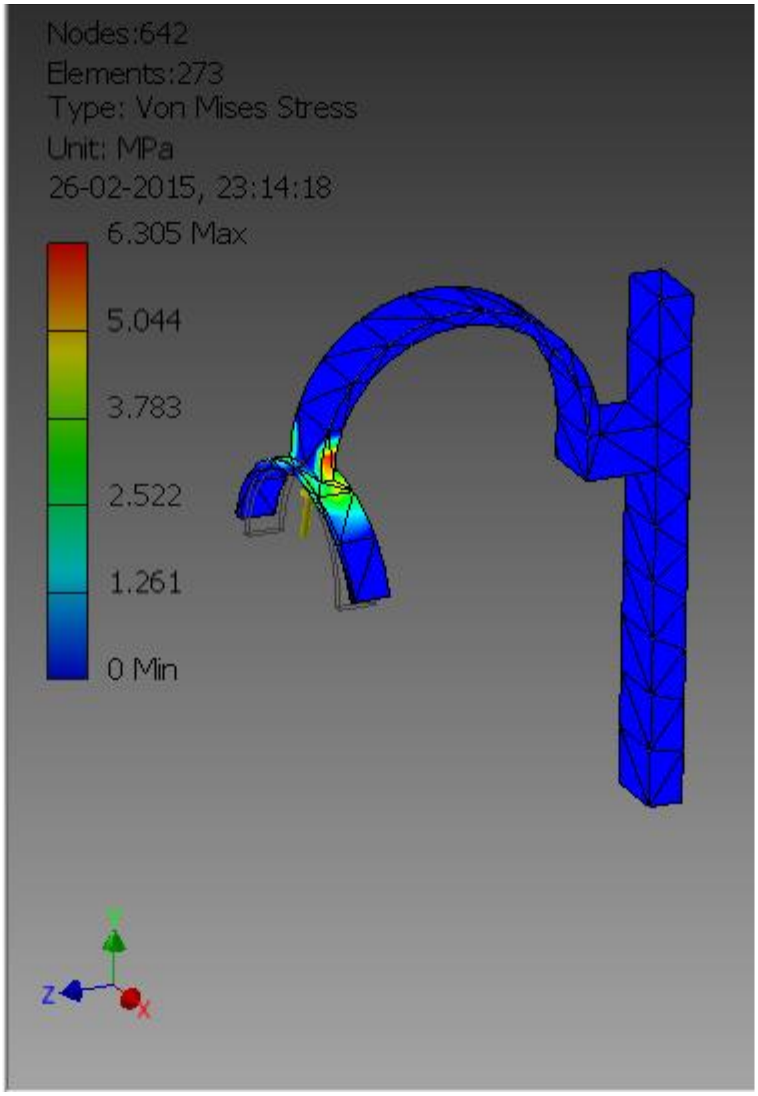

Figure 38.Analyzed Existing Stand

The above figure is showing the Analyzed Existing stand and it can be seen that Bending stress is occurring in the stand where the tyre surface contacts with the Stand.

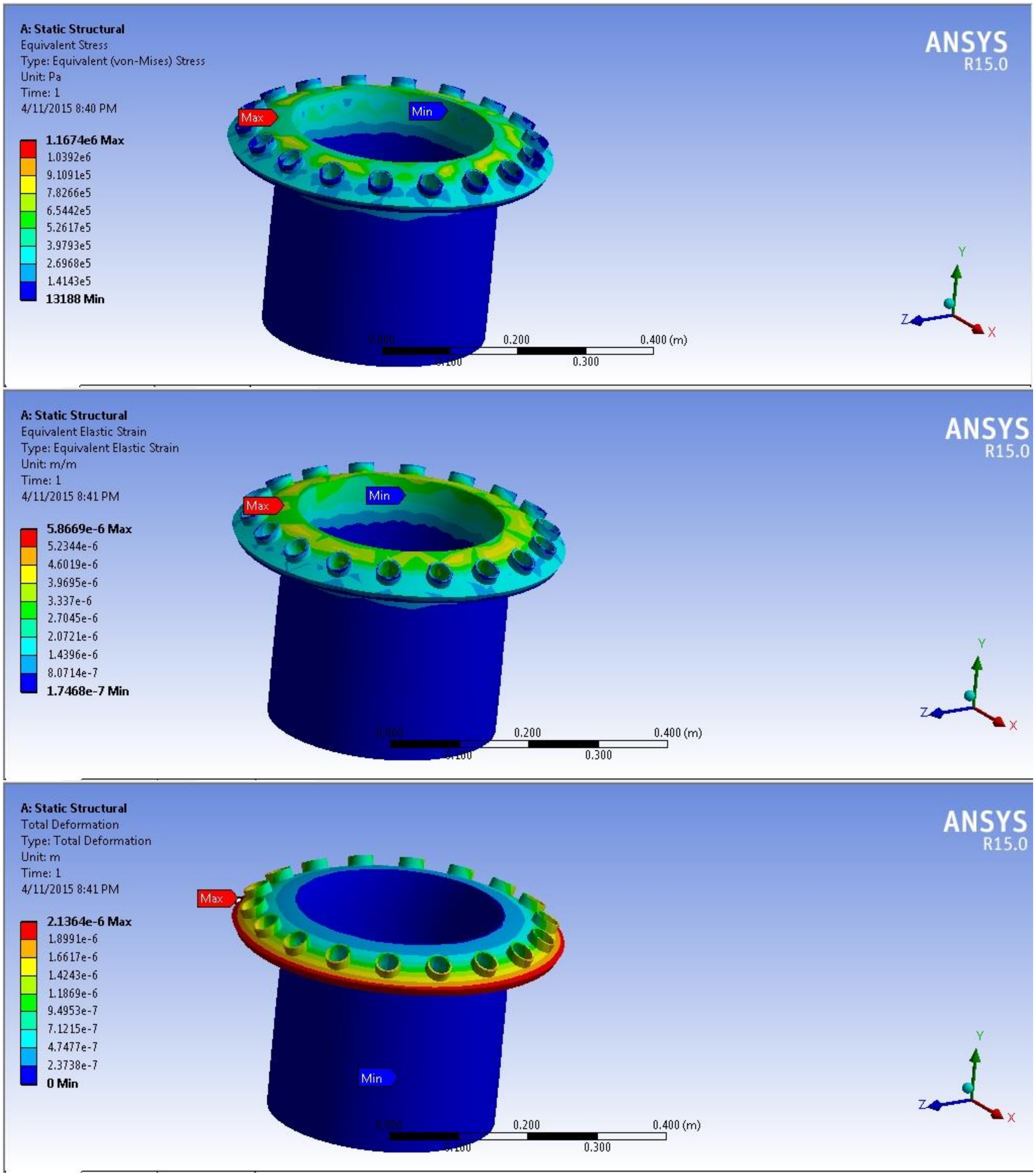

Figure 39.Analyzed Proposed Stand

Table 3.Report of Analysis of proposed stand

Type	Equivalent (von-Mises) Stress	Equivalent Elastic Strain	Total Deformation
Minimum	13188 Pa	1.7468e-007 m/m	0. m
Maximum	1.1674e+006 Pa	5.8669e-006 m/m	2.1364e-006 m

The above table shows the Equivalent stress (Von-Mises Stress), Equivalent Elastic Strain and Total Deformation produced in the Proposed Stand Fixture.

3. As per our Calculations; on an average, 4.14 hours saving which is 81% (percentage) of Man-hours saving will be done per Assembly of wheel with the use of proposed stand in comparison with the existing stand. Hence, a huge chunk of time will be saved.

4. The proposed stand will be profitable to the company as it will be a 1 person operated Assembly stand in comparison to the existing stand which is a 3 persons operated stand. Hence, 2 less persons (Service Engineers) will be required on an Assembly stand while Assembling the wheel. As per our Calculations; Monthly, 61% cost of the company will be saved in assembly of aircraft wheel on an assembly stand. Hence, it will prove beneficial for the company.

Chapter 5: Conclusion

5.1 Conclusion:

- The model of Existing stand and Proposed stand in the CAD softwares have been created successfully.

- The Stress developing in Existing stand and the fixture of proposed stand have been found out using Finite Element Analysis on CAD softwares and Bending Failure which is happening in the Existing Stand have been identified.

- The time required per assembly will get reduced to a larger extent in the proposed process with the use of proposed stand for wheel assembly in comparison to the time required on the existing stand for the same, as per our calculations.

- As per our Calculations, Reduction in the Manpower from 3 persons per assembly to 1 person per assembly by using the proposed process will in-turn reduce the cost of the company and hence will increase its profit.

Chapter 6: Bibliography

6.1 Bibliography:

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