4. Phase I of the Research: Application of VA/VE

In the first phase of the research, Value Analysis (VA)/Value Engineering (VE) principles and practices have been systematically applied to reduce the cost of the manual-mechanical 'tyre-changer' equipment. This chapter describes the application of VA/VE and fabrication of low cost 'tyre-changer' (LCMTC).

4.1 Existing Manual - Mechanical 'Tyre-changer' (MTC)

The 'tyre-changer' is the equipment/machine used for demounting and mounting of tyre from and/or on to the rim/disc of wheel of light motor vehicles (LMVs) to carry out vulcanising work or replacement of tyre or tube. The usage of the 'tyre-changer' equipment in India is not popular due to high cost but it is used in most of the western countries.

The design of 'tyre-changer' will mainly depend on its capacity. Generally, heavy tyres require more power as much as 2 tonnes, for demounting and mounting. The design of 'tyre-changer' varies from the simple tools required for a bicycle to the very complicated operation for a car, truck and tractor front wheel tyres etc.

The manual-mechanical 'tyre-changer' equipment has been considered for the research which is used for tyre changing of light motor vehicles (LMVs) i.e., car, jeep and tractor front wheel etc. The people who use 'tyre-changer' are the retailers of new tyres, tyre retreading works, vulcanising shops and servicing stations.

In the manual-mechanical method of tyre-changing, people use spanner(s)/chisel(s)/hammer(s) and a lot of manpower for demounting and mounting of tyres. But this is a cumbersome job requiring a minimum two workers and the physical effort required for the job is very high. In the conventional method, the edge of the tyre (called 'bead') usually gets spoiled due to rough handling of spanner(s)/chisel(s) with repeated hammering. By using the manual 'tyre-changer' equipment/machine, the above mentioned difficulties associated with conventional method of tyre-changing can be eliminated and the entire vulcanising job(s) can be completed with a single person using a minimum of physical effort in less time compared to the conventional manual method.
There are a number of ‘tyre-changer’ equipment/machines of different designs with different capacities available all over the world. But in India, there are a very few to manufacture the ‘tyre-changer’ equipment/machines. M/s Pneu Pack Equipment, Madras has been engaged in the fabrication of ‘tyre-changer’ equipment/machine. The manufacturer was only fabricating automatic ‘tyre-changer’ with electrically operated motors costing approximately Rs 25,000/- to Rs 40,000/-, a piece. Another manufacturer, M/s Kattukaran Industries, Kerala fabricates only manually operated ‘tyre-changer’ of two basic varieties, i.e., pneumatic and mechanical. It is reported that the Kerala based manufacturer has discontinued to fabricate these machines due to various reasons.

The cost of the manual-mechanical and manual-pneumatic ‘tyre-changer’ machines was ranging from Rs 6,000/- to Rs 8,000/- per machine, long ago. Both these manual ‘tyre-changer’ machines are found to be used by only two local vulcanising shops at Bhimavaram (M/s Safeena Vulcanising Works and M/s Maqbool Vulcanising Works). Due to high cost of ‘tyre-changer’ equipment, most of the self-employed vulcanising shops/units are not able to afford the same. The manual-mechanical ‘tyre-changer’ equipment is considered for the (redesign) research (Ref Fig. 4.1 Photograph of the existing manual-mechanical ‘tyre-changer’).

The major parts of the existing mechanical (manual) ‘tyre-changer’ equipment/machine are as follows:

1. Table
2. Column
3. Base
4. Edge Press
5. Hand Tools
6. Tyre-fixing Mechanism

The existing mechanical (manual) ‘tyre-changer’ is heavy with separate Edge Presses (bead breaking mechanism) and Tyre-fixing (arrangement) mechanism.
PHOTOGRAPH OF THE EXISTING MANUAL-MECHANICAL TYRE CHANGER (MTC)

FIG: 4.1
4.1.1 Tyre-changing Operation

Tyre-changing operation consists of three main stages as described below:

1. First stage is 'bead' breaking. This operation is necessary because the edge of the tyre will adhere very tightly to the wheel rim/disc and hard due to high tension/pressure of air and heat produced while running of the automobile. This operation requires a lot of force to release the contact between the edge of the tyre and the wheel disc/rim. The method of application of force is different with different types of 'tyre-changer' machines from manual-pneumatic to manual-mechanical types. In automatic models electrical power is used for the same. In the existing manual-mechanical 'tyre-changer', two edge-presses are used, one in the bottom and other on the top to carry out the 'bead' breaking operations.

2. The second stage of operation is fixing the tyre rim/disc on the table. This is done by a cone and fixing mechanism in the existing 'tyre-changer'. Tyre rim is placed on the table and hooked with the fixed mechanism and tightened with the cone on the top. Thus, the tyre is firmly fixed on the table.

3. The third stage of operation is demounting or mounting of tyre from and/or on to the wheel disc/rim as necessary. This is done by inserting a hand tool in between tyre edge and rim and rotating it pressing at the edge. This operation (demounting or mounting) requires operator's skill and effort. Similarly, mounting is also performed with another hand tool requiring operator's skill and effort. To perform this operation, tyre rim/disc must be firmly fixed on the table and the tool has to be rotated pressing against rim by the operator.

4.2 Limitations of the Existing Manual-Mechanical 'Tyre-changer' (MTC)

The existing manual-mechanical 'tyre-changer' under consideration is very heavy and consists of main 'tyre-changer' (work table with tyre-fixing arrangement),
separate edge-presses (bead breaking mechanism) and two hand tools for separating tyre edge from the wheel rim/disc

The cost of the equipment is high and most of the self-employed vulcanising shops/units can not afford to purchase the equipment. The cost is the major reason why the equipment is not popular among vulcanising shops/units in India. Pneumatic manual ‘tyre-changer’ is much costlier than mechanical-manual type ‘tyre-changer’. The sophisticated automatic models of ‘tyre-changer’ are prohibitively costly. Due to the high cost of existing ‘tyre-changer’ equipment, most of the self-employed vulcanising shops employ child labour in vulcanising jobs.

The other limitation of existing ‘tyre-changer’ equipment available in the market is that it can not be fabricated locally due to complicated design. Self-employment could not be developed in vulcanising works/jobs due to high cost of existing ‘tyre-changer’ equipment inspite of opportunities available particularly in urban, semi-urban and rural areas due to rapid usage of light motor vehicles in the recent past.

4.3 Application of Value Analysis/Value Engineering on MTC

In this chapter, the application of Value Analysis/Value Engineering on Manual (Mechanical) ‘Tyre-changer’ is described in detailed part by part. The design details of the proposed parts of LCMTC are also discussed.

4.3.1 Application of Basic VA/VE on MTC

The application of VA/VE on manual-mechanical ‘tyre-changer’ part by part is discussed. The function(s) of the part, disadvantages of existing part of ‘tyre-changer’, alternatives considered and recommendations are also discussed for the main parts of manual-mechanical ‘tyre-changer’ equipment (Ref. Fig.4.2) such as (i) Table, (ii) Base, (iii) Fixing arrangement, (iv) Hand tool and (v) Edge Press. The existing and proposed designs are discussed for these main parts as given below.
EXISTING TYRE CHANGER

1. Table
2. Column
3. Base
4. Edge Press
5. Hand Tool
6. Tyre
7. Rim / Disc
8. Cone
9. Tyre Fixing Mechanism

Not to Scale.

FIG: 4.2
(i) Table

a) **Function**: Table is used to provide support for tyre. The existing table is in round shape. It is a 6 mm thickness plate. A flat is welded along with the edge of the table for reinforcement. The table is welded on to the hollow pipe (column). The tyre along with the disc/rim is placed on the table for carrying out demounting and mounting operation(s) after firmly fixing it with fixing mechanism.

b) **Disadvantages of the existing design**: The following disadvantages have been observed during the analysis of the existing design of the table:

(i) The machining cost for obtaining round shape is high.

(ii) The area of the table is more so the weight is high which resulted in more cost.

c) **Alternatives considered**: The various alternatives emerged in the analysis phase for this part during the “brain-storming” session(s) are as given below:

i) The round shape of the table is modified to square shape. The area of the table is also reduced in such a way that the total area of the rim is rested on the table and the tyre is also rested on the four corners of the square plate.

ii) Keep the round table as it is and removing the flat around the edge of the table.

iii) Replacing the round table by square shape.

d) **Recommendation**: The round shape of the table is modified to square shape. The reinforcement is done by four angular flats at each of the four corners under the table. The present and proposed Table is shown in Fig. 4.3.

(ii) Base

a) **Function**: Base is used for rigid (stable) fixing of the machine and this is fixed on the ground with the help of nuts and bolts. The existing 'base' is in round shape with 6 mm thickness. A flat is welded along with the edge of
PRESENT TABLE

PROPOSED TABLE

FIG: 4. 3

Not to Scale.
All Dimensions are in mm.
the top plate. This plate is fixed on to the another square plate with the help of four bolts.

b) Disadvantages of the existing design

(i) There is no need of two plates and a flat (along with the edge of one of the plates).

(ii) The square plate is extra. It leads to more weight and machining cost is also high.

c) Alternatives considered

(i) Since there is no need of two plates, one plate may be eliminated. The flat along with the edge of the plate may also be eliminated.

(ii) The weight may be reduced by decreasing the area of the plate. Instead of bolts and nuts, foundation (fixing) bolts of higher size (1.25 cm dia x 10 cm long) may be used for greater stability and firm fixing.

d) Recommendation A square plate (300 x 300 x 6 mm) is recommended for base with four foundation bolts (1.25 cm dia x 10 cm length) at four corners. Another square plate (150 x 150 x 6 mm) is recommended for fixing column with the base plate. The present and proposed Base is shown in Fig 4.4.

iii) Fixing Mechanism

a) Function This fixing mechanism is used for fixing the tyre on the table to carry out demounting and mounting operations. The present fixing mechanism consists of many parts such as (1) Cone, (2) Locking hook, (3) Foot pedal, (4) Brake fixture, (5) Brake supporter and Spring. Fixing of tyre rim on the table is done first by placing the tyre on the table. Cone is put on the rim, pulling the brake pedal down with leg and kept in the (brake) supporter up to proper fixing position. Then the locking hook pulls the cone, thus causing the cone to fix the rim rigidly on the table. The material used for locking hook (rod) is mild steel. One end is fixed on the column and hook end is free for positioning and it can oscillate for fixing the required diameter of the rim.
PRESENT BASE

PROPOSED BASE

FIG: 4.4

Not to Scale.
All Dimensions are in mm.
b) **Disadvantages of the existing design**

(i) Number of parts are more in the fixing mechanism (6 parts).

(ii) Making a slot on both sides of the column is difficult and costly.

(iii) Machining cost of all parts is high.

c) **Alternatives considered**

(i) Parts such as locking hook, foot pedal, brake fixture, brake supporter and spring etc. can be totally eliminated.

(ii) Fixing arrangement can be done by making the external square threading on the central pilot rod and with internal square threading in the cone.

(iii) The present cone is made with casting. So the weight is more. Instead, cone can be made alternatively with a hallow pipe, welding four (angular) plates on the outer surface for grip.

(iv) A positioning pin may also be used for extra support for fixing the tyre on the table.

d) **Recommendation**

Entire fixing mechanism is thus simplified reducing the number of parts from 6 to 2 only. A Cone and a Positioning Pin are used for fixing tyre on the table in the proposed design. The present and proposed Fixing Arrangement (part-wise) is shown in Fig 4.5. EN-24 material is recommended for high strength for the ‘Positioning Pin’. A spring system controls position and tension of the ‘Positioning Pin’ while holding the tyre on the table.

iv) **Hand tool**

a) **Function**

It is used for demounting and mounting operations of the tyre from and/or on to the wheel disc/rim. In the existing ‘tyre-changer’ equipment, two solid rods are used as hand tools (Ref. Fig 4.6). One is used for demounting and another for mounting operation. Each tool contains two rollers at one end. These rollers are used for free rotation of the hand tool around the wheel rim/disc.

b) **Disadvantages of the existing design**

i) There is no need of two solid lever rods.
PRESENT PARTS OF FIXING MECHANISM

PROPOSED PARTS OF FIXING MECHANISM

Fig: 4.5
PRESENT HAND TOOL (For mouting)

PRESENT HAND TOOL (For demouting)

FIG: 4.6

Not to Scale.
All Dimensions are in mm.
ii) The diameter of rod is large hence the weight of each rod (hand tool) is high.

c) **Alternatives considered:**

i) One rod (hand tool) can be eliminated

ii) Both demounting and mounting operations can be done by only one hand tool (rod) with rollers at one end of the hand tool. Diameter of the hand tool (rod) can be reduced

d) **Recommendation:** A single hand tool (rod) is recommended with two types of rollers (big and small) fixed at one end of the hand tool. The other end of the hand tool is sharpened.

v) **Edge Press**

a) **Function:** It is used for 'bead' breaking of the tyre from the rim/disc of the wheel. In the existing machine two edge-presses are used, for 'bead' breaking on the top by keeping on the Central Pivot Rod. Another is used for bottom 'bead' breaking. This is fixed on the column.

b) **Disadvantages of the existing design:**

i) There is no need of two edge-presses

ii) the 'bead' breaking operation requires more labour and difficult with the existing two edge-presses system.

iii) Fixing of bottom Edge Press on the column is cumbersome

c) **Alternatives considered:**

i) One edge-press can be eliminated.

ii) Edge-press may be fixed on the column at the appropriate place. 'Bead' breaking operation can be done by hand by putting an extension rod in edge-press pipe for better grip and lever action. The present and proposed Edge Press is shown in Fig. 4 7

### 4.3.2 Design Details of LCMTC

The dimensions of each part of the proposed low cost manual-mechanical 'tyre-changer' are fixed by considering various factors. Some of the factors are the required
PRESENT EDGE PRESS
(for top bead breaking)

PRESENT EDGE PRESS
(for bottom bead breaking)

PROPOSED EDGE PRESS
(for top and bottom bead breaking)

FIG: 4.7
Not to Scale
All Dimensions are in mm
strength to withstand loads, availability of standard sizes in market, manufacturing or fabrication difficulties and cost of the materials etc. The load(s) applied is assumed approximately for maximum conditions wherever required. Factor of safety is used according to the load(s) assumed during design.

The material for all parts except 'Positioning Pin' is taken as mild steel (M.S.). The allowable stresses assumed for mild steel during design are as given below.

\[
\begin{align*}
ft &= 2450 \text{ kg/cm}^2 \text{ (Tensile stress)} \\
f_c &= 2450 \text{ kg/cm}^2 \text{ (Compressive stress)} \\
f_s &= 1470 \text{ kg/cm}^2 \text{ (Shear stress)} \\
E &= 2100 \times 10^3 \text{ kg/cm}^2 \text{ (Modulus of elasticity)}
\end{align*}
\]

Engineering will succeed only if the equipment is designed for strength combined with elegant look. The surface finish is an important operation which needs a great art. The part-wise design details of the proposed low cost 'tyre-changer' are presented below:

i) **Table**

The dimensions for the proposed Table are taken as shown in Fig. 4.8. The only dimension to be calculated is the thickness of the plate considering the design aspects. We have to check for deflection. The load acting on the Table is assumed to be uniform load. It acts only on the strip which has contact on the area of rim edge. The magnitude of the total load acting is the sum of the weight of rim and tyre, load due to tool operation, and load due to fixing of cone. The other load acting is the weight of the Central Pivot Rod at the centre of the Table.

The maximum load, we may assume acting on the Table is 173 Kg, i.e.,

- Maximum weight of the tyre, assumed = 40 Kg
- Weight of Cone and Central Pivot Rod (approximately) = 13 Kg.
- Load when tool is manually operated = 120 Kg
  (A healthy man can apply a torque of 120 Kg.)

The formula for thickness is taken as below for plates whose edges freely supported with distributed load.
PROPOSED TABLE

FIG: 4.8

Not to Scale.
All Dimensions are in mm
\[ t = \frac{3F(3 + \mu)}{8 \Pi (ft/fs)} \] (Shigley, 1983)

\[ = \frac{3 \times 173 \times (3 + 0.3)}{8 \times \Pi \times (2450)} \]
\[ \text{where } \mu = 0.3 \text{ for Mild Steel, } \]
\[ F = \text{load applied} = 173 \text{ Kg, and} \]
\[ \text{fs} = \text{Factor of Safety} = 8 \]

\[ = 0.472 \text{ Cm } \equiv 5 \text{ mm} \]

The available market size is 6 mm plate. Hence a 6 mm square plate of 450 x 450 mm is taken for Table which also enhances strength. To avoid bending, ribs are provided at four corners of the plate under the Table supporting with column to give extra strength (Ref Fig. 4.8).

ii) Column

Column is a M.S Pipe of 107 mm external diameter of 650 mm length (height). This is based on the existing manual-mechanical 'tyre-changer'. The thickness of pipe has to be calculated considering it as a column fixed at the bottom and a load is applied on upper edge to avoid buckling. The maximum load acting assumed is 173 kg as explained earlier. The following Euler's formula may be applied to calculate internal diameter of the pipe (column):

\[ \text{Critical load, } F_\alpha = \frac{Ct^2EA}{(I/k)^2} \] (Sadhu Singh, 1995)

Where
- \( C = \text{Constant} = 0.25 \) for the above condition
- \( E = \text{Modulus of Elasticity} = 2100 \times 10^3 \frac{\text{kg}}{\text{cm}^2} \)
- \( A = \text{Cross sectional area of the column (pipe)} \)
- \( I = \text{length of the column} = 65 \text{ Cm} \)
- \( k = \text{least radius of gyration of the cross section} \)

Here Factor of Safety assumed for the load = 8

\[ F_\alpha = \text{factor of safety} \times \text{maximum load (acting)} = 8 \times 173 = 1384 \text{ kg} \]
\[
F_d = \frac{C \pi^2 EA}{(l/k)^2} = \frac{C \pi^2 EAK^2}{l^2}
\]

\[
= \frac{C \pi^2 EI}{l^2} \quad \text{(because } AK^2 = I, \text{ moment of inertia)}
\]

\[
I = AK^2 = \frac{\pi}{64} (d_o^2 - d_i^2) \text{ where } d_o = \text{outer diameter of column (pipe)} \quad d_i = \text{inner diameter of column (pipe)}
\]

Substituting all the values, we have

\[
1384 = 0.25 \times \pi^2 \times 2100 \times 10^3 \times \pi/64 \times (10.70)^2 - (d_i)^2
\]

Solving the above equation, we get \(d_i = 9.56 \text{ cm} = 96 \text{ mm}\)

Hence for the column, a M.S. pipe of 107 mm outer diameter and 96 mm inner diameter is taken. The length of the column is 650 mm (height). The proposed column dimensions are shown in Fig. 4.9

**iii) Central Pivot Rod**

This is designed by analysing it as a power screw. Central Pivot Rod must withstand the bending load due to load applied by the lever and also the pressure of cone. Its diameter is calculated by considering it as a cantilever having a length of 50 cm working under a load of 120 kg (torque that can be applied by a healthy man while operating the hand tool) (Ref. Fig. 4.10).

Maximum bending moment, \(M_e = 120 \times 50 = 6000 \text{ kg - cm}\)

But \(M_e = \frac{\pi \times f_o \times D_1^3}{32}\) (Shigley, 1983)

Where \(f_o = \text{bending stress, in this case assume } f_o = f_t\)

\(D_1\) is the nominal diameter of the Central Pivot Rod.

\[
6000 = \frac{\pi}{32} \times 2450 \times D_1^3 \quad \text{(Factor of Safety } = 4)\]

\[
\therefore D_1 = 4.639 \times 5 \text{ cm} = 50 \text{ mm}.\]
PROPOSED COLUMN

FIG: 4.9

Not to Scale
All Dimensions are in mm,
Central Pivot Rod is assumed as a Cantilever having a length of 50cm working under a load of 120 kg. (A Healthy man's torque)

FIG: 4.10

Not to Scale.
All Dimensions are in mm.
From Tables for Normal series according to IS. 4694 - 1968, the following dimensions are taken for square thread of double start on Central Pivot Rod

- Nominal diameter = 50 mm
- Major diameter for bolts = 50 mm
- Major diameter for nut = 50.5 mm
- Minor diameter for nut = 42 mm
- Depth of thread for bolt = 4.25 mm
- Area of the core = 1385 mm²
- Pitch = 8 mm

The proposed Central Pivot Rod dimensions are shown in Fig 4.11. In the proposed Fixing Mechanism, Cone is used as a Nut for fixing the tyre on the table, having internal square threading. The dimensions of Cone are taken as given above as per standard Nut. Cone is provided with four angular plates welded on the outer surface for grip while screwing on the Central Pivot Rod to fix the tyre on the Table. The design details of the proposed Cone is shown in Fig 4.12.

iv) Hand Tool

Tool is an important part of the 'tyre-changer' equipment which requires careful attention. It consists of solid rod of 1015 mm total length. Instead of two hand tools as in the existing 'tyre-changer' only one hand tool is suggested. The diameter of the solid rod is 25 mm. One end of the hand tool is sharpened like a chisel-end to insert in between tyre edge and rim. The other end is fitted with two types of rollers, one big and the other small for demounting and mounting operations. The material suggested for hand tool is hardened steel. The hand tool design is adopted from a local vulcanising shop where it is employed along with the manual-pneumatic 'tyre-changer' equipment (Ref Fig 4.13).

\[
\frac{L_2}{L_1} = \frac{880}{135} = 6.5
\]

The procedure involved in using the hand tool for demounting and mounting operations is as explained below:
PROPOSED CENTRAL PIVOT ROD

FIG 4.11

Not to Scale.
All Dimensions are in mm.
PROPOSED CONE
(PHASE - I)

FIG: 4.12

Not to Scale.
All Dimensions are in mm
HAND TOOL (PROPOSED)
(FOR DEMOUNTING AND MOUNTING)

FIG: 4.13

Not to Scale.
All Dimensions are in mm.
Demounting. First, the sharp edge of the hand tool is inserted in between the tyre edge and disc/rim of the wheel after 'bead' breaking operation has been carried out. After insertion of the sharp edge, the tool is rotated in clock-wise direction till the tyre got separated from the wheel disc/rim.

Mounting. The other end of the tool with rollers is used for mounting tyre on to the wheel disc/rim. Two rollers, one small and another big, freely rotate while performing mounting operation. The friction is prevented due to rollers during the operation.

First, insert the small roller of the tool between tyre and disc. The roller is engaged on the outer periphery of the disc. Pressing down the tyre 'bead' behind roller with left hand, rotate tool with right hand as before. It will be seen that bigger roller is pressing the 'bead' and as rotation progresses, the 'bead' is getting inserted (mounted) on the disc. After rotation is completed, lift the tool out. This will cause the remaining portion of the 'bead' also gets inserted. The tool will also then becomes free to take it out.

4.3.3 Development of Low Cost Manual-Mechanical 'Tyre-changer' (LCMTC) Model

The low cost manual 'tyre-changer' (LCMTC) model is fabricated by using various machine tools such as Lathe, Drilling machine, Grinding machine and employing fabrication processes such as welding etc.

The salient features of fabrication of the low cost 'tyre-changer' equipment are discussed part wise. The various parts comprising of the 'tyre-changer' (LCMTC) are (I) Table, (II) Column, (III) Central Pivot Rod, (IV) Cone, (V) Base, (VI) Positioning Pin, (VII) Edge Press and (VIII) Hand Tool

(I) Table

First, 450 x 450 x 6 mm M S plate is taken. Make a central hole of 50 mm diameter and a slot by using gas welding. This central hole is used for fixing the Central Pivot Rod and the slot for positioning pin. For reinforcement, four 250 x 50 x 6 mm M.S. flats are welded by means of arc welding to the bottom of the plate along
with the four corners of the table. The corners of the table are grounded off by grinding machines (Ref. Fig. 4.8).

(II) **Column**

A M.S. pipe of 107 outer diameter having a thickness of 6 mm and a length of 650 mm is taken. The Table along with the Central Pivot Rod is placed on the top end of the Column and welded. Reinforcement is provided to the Table along with the column for better support. All sides are grounded for accurate alignment (Ref. Fig 4.9).

(III) **Central Pivot Rod**

A 50 mm diameter M.S. rod of 500 mm length is taken. Multi-start Double square thread with pitch of 8 mm arc made on the rod from bottom end up to 300 mm length. The plain portion of the central Pivot rod is having 200 mm length and the top end rounded-off. The bottom end of the rod is welded with 100 x 100 x 6 mm M.S plate and this plate is welded on the top centre portion of the table (Ref. Fig 4.11).

(IV) **Cone**

A M.S. pipe of 60 mm diameter, 80 mm length with 9 mm thickness is taken. Internal multi-start (double) threads with 8 mm pitch are made to the pipe with the help of lathe. A 350 x 40 x 6 mm M.S. flat is cut into four right angle triangular pieces. These four pieces are welded on the pipe by forming the cone shape (Ref. Fig 4.13).

(V) **Base**

A 300 x 300 x 6 mm size M.S. plate is taken. A central hole of 107 mm diameter is made by using gas welding and four 12.5 mm diameter holes are made at four corners of the base plate by using drilling machine. Column is inserted into the 107 mm hole. Another 150 x 150 x 6 mm M.S. plate is welded to this column pipe for reinforcement. Again this plate along with the column is welded with the main base plate of 300 x 300 x 6 mm size. The whole 'tyre-changer' equipment is fixed with the help of four standard foundation bolts (100 x 12 mm) (Ref. Fig. 4.14).
PROPOSED BASE

FIG : 4.14

Not to Scale.
All Dimensions are in mm.
(VI) Positioning Pin

A 250 mm EN-24 rod with 36 mm diameter is taken as material for positioning pin. At one end remove the metal up to 18 mm diameter for a length of 113 mm by using lathe. Remove the metal up to 25 mm square for a length of 115 mm by using slotting machine. Taper is made at the other end for length of 22 mm on lathe (Ref Fig 4.15). This Positioning Pin is fixed at the bottom of the Table using flats, spring and cotter. The proposed Positioning Pin assembly under the Table is shown in Fig 4.16.

(VII) Edge Press

A 200 x 50 x 10 mm size M S plate is taken. Bend this plate or make a curved shape with radius of 186 mm manually. Finishing of the plate is done by grinding. A M S. rod of 12 mm diameter of 375 mm length is welded at the middle of the plate and the other end is welded to the G.I. pipe of 25 mm diameter of 225 mm length at a distance of 150 mm (horizontal) from column at a height of 460 mm from the base with the help of bolt and nut. Another G.I. pipe of 1000 mm length having 18 mm in diameter is fixed to the other end of the pipe to use as an extension pipe for operating the Edge-Press. The details of the proposed Edge-Press is shown in Fig 4.17.

(VIII) Hand Tool

The hand tool design is taken from the local manual-pneumatic ‘tyre-changer’ equipment available. The Hand Tool is fabricated by following the same procedure of the Hand Tool of the manual-pneumatic ‘tyre-changer’ equipment as explained earlier.

4.3.3.1 Assembly of LCMTC

The assembly of the LCMTC is a combination of operations and operational elements such as fitting, machining and welding etc. After fabricating all necessary parts of the equipment, ‘tyre-changer’ is assembled as shown in Fig. 4.18. The Photograph of the fabricated LCMTC is shown in Fig. 4.19.

First, the Central Pivot Rod is welded to the Table, then flats for Positioning Pin are welded to the Table. Next the Table is welded to the column after a very accurate
PROPOSED POSITIONING PIN
(PHASE -1)

FIG: 4.15

Not to Scale.
All Dimensions are in mm.
POSITIONING PIN ASSEMBLY UNDER THE TABLE

FIG: 4.16

Not to Scale.
All Dimensions are in mm.
PARTS OF THE PROPOSED EDGE PRESS
(PHASE -1)

FIG: 4.17

Not to Scale.
All Dimensions are in mm
PROPOSED LOW COST TYRE CHANGER (LCMTC)
(PHASE-1)

1. Central Pivot Rod
2. Cone
3. Table
4. Column
5. Base
6. Edge Press
7. Positioning Pin
8. Hand Tool
9. Tyre

FIG: 4.18  Not to Scale.
PHOTOGRAPH OF THE FABRICATED LCMTC
(Phase-I)

FIG: 4.19
centring. After that reinforcements are welded to the Table and Column, Positioning Pin is fitted in its place by a Cotter and Spring. The column with the Table is welded to the Base. The finishing is done with grinding at all the places. Painting is done for all parts of 'tyre-changer' except Central Pivot Rod, Positioning Pin and Cone.

4.3.3.2 Cost of LCMTC

Parts list and approximate cost estimation of LCMTC are presented at Tables No 4.1 and 4.2. The prices are at the time of fabrication and may vary from time to time. The production cost is estimated and the cost per machine is compared to the cost of existing 'tyre-changer' equipment procured long ago by local vulcanising shops at Bhimavaram.

The cost of the LCMTC is estimated at Rs.3,488/- including transportation and profit. The reduction of cost from the existing 'tyre-changer' equipment may be around Rs.2,352/- per equipment assuming the cost of existing 'tyre-changer' as Rs.5,840/- (approximately).

The cost of LCMTC developed is almost half of that of the existing 'tyre-changer' equipment available locally (Ref. Table 4.3). The cost can be further reduced by mass production. LCMTC can be easily fabricated with the locally available materials.
<table>
<thead>
<tr>
<th>Part Name</th>
<th>Components</th>
<th>Material</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Central Pivot Rod</td>
<td>Rod</td>
<td>Mild Steel (MS)</td>
<td>1</td>
</tr>
<tr>
<td>2 Cone</td>
<td>Pipe</td>
<td>M S</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Flat</td>
<td>M S.</td>
<td>4</td>
</tr>
<tr>
<td>3 Table</td>
<td>Plate</td>
<td>M.S.</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Flat</td>
<td>M S</td>
<td>4</td>
</tr>
<tr>
<td>4 Column</td>
<td>Pipe</td>
<td>M.S.</td>
<td>1</td>
</tr>
<tr>
<td>5 Base</td>
<td>Plate</td>
<td>M S.</td>
<td>2</td>
</tr>
<tr>
<td>6 Edge Press</td>
<td>Plate</td>
<td>M.S.</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Pipe</td>
<td>G.I.</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Rod</td>
<td>M.S.</td>
<td>3</td>
</tr>
<tr>
<td>7 Positioning Pin</td>
<td>Rod</td>
<td>EN-24</td>
<td>1</td>
</tr>
<tr>
<td>8 Spring</td>
<td>Spring</td>
<td>H.C.S</td>
<td>2</td>
</tr>
<tr>
<td>9 Cotter</td>
<td>Cotter</td>
<td>M.S.</td>
<td>1</td>
</tr>
<tr>
<td>10 Hand Tool</td>
<td>Pipe</td>
<td>G I</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Rod</td>
<td>M.S.</td>
<td>2</td>
</tr>
<tr>
<td>11 Bolts</td>
<td>Bolt</td>
<td>M.S.</td>
<td>6</td>
</tr>
<tr>
<td>12 Nuts</td>
<td>Nut</td>
<td>M.S.</td>
<td>6</td>
</tr>
</tbody>
</table>
### TABLE 4.2
COST ESTIMATION OF THE PROPOSED LCMTC

<table>
<thead>
<tr>
<th>Item No</th>
<th>Specifications</th>
<th>Cost in Rs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Plates</td>
<td>20 Kg. @ Rs 18/- per Kg</td>
<td>360</td>
</tr>
<tr>
<td>2. Flats</td>
<td>6 Kg @ Rs 16/- per Kg</td>
<td>96</td>
</tr>
<tr>
<td>3. Shaft</td>
<td>9 Kg @ Rs 16/- per Kg</td>
<td>144</td>
</tr>
<tr>
<td>4. Rods</td>
<td>4 Kg. @ Rs 15/- per Kg</td>
<td>60</td>
</tr>
<tr>
<td>5. M S Black Pipe</td>
<td>2.5 ft @ Rs 100/- per ft</td>
<td>250</td>
</tr>
<tr>
<td>6. G.I. Pipe</td>
<td>2.5 m @ Rs 50/- per meter</td>
<td>125</td>
</tr>
<tr>
<td>7. M S Pipe</td>
<td>0.5 ft @ Rs.100/- per ft</td>
<td>50</td>
</tr>
<tr>
<td>8 EN-24 Shaft</td>
<td>3 Kg @ Rs 45/- per Kg.</td>
<td>135</td>
</tr>
<tr>
<td>9. Bolts &amp; Nuts</td>
<td></td>
<td>40</td>
</tr>
<tr>
<td>10. Springs</td>
<td></td>
<td>30</td>
</tr>
<tr>
<td><strong>Material Cost</strong></td>
<td></td>
<td><strong>Rs.1290</strong></td>
</tr>
<tr>
<td>11 Machining</td>
<td></td>
<td>700</td>
</tr>
<tr>
<td>12 Finishing</td>
<td></td>
<td>500</td>
</tr>
<tr>
<td><strong>Total Machine Cost</strong></td>
<td></td>
<td><strong>Rs.2,490</strong></td>
</tr>
</tbody>
</table>
TABLE 4.3
COST COMPARISON OF THE PROPOSED LCMTC

<table>
<thead>
<tr>
<th>SI No</th>
<th>Description of Item</th>
<th>Existing cost of MTC Rs.</th>
<th>Proposed cost of LCMTC Rs (Phase-I)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Material Cost</td>
<td>2,600</td>
<td>1,290</td>
</tr>
<tr>
<td>2.</td>
<td>Machining cost</td>
<td>1,250</td>
<td>700</td>
</tr>
<tr>
<td>3</td>
<td>Finishing Cost</td>
<td>600</td>
<td>500</td>
</tr>
<tr>
<td></td>
<td>Machine Cost</td>
<td>4,450</td>
<td>2,490</td>
</tr>
<tr>
<td>4.</td>
<td>Transportation Cost</td>
<td>500</td>
<td>500</td>
</tr>
<tr>
<td>5</td>
<td>Profit (20% of 1+2+3)</td>
<td>890</td>
<td>498</td>
</tr>
<tr>
<td></td>
<td>Total cost of the machine (1+2+3+4+5)</td>
<td>5,840</td>
<td>3,488</td>
</tr>
</tbody>
</table>