Fabrication of 1300 T Mixer for Steel Plant

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Introduction :

Mixer is a storage vessel for molten iron from the blast furnace wherefrom it is taken to open hearth furnace, convertors etc. for making steel. In fact it serves as a reservoir and ensures a continuous supply of molten iron irrespective of any irregularity in production from the blast furnaces. Mixer also maintains a homogenity in composition and temperature of iron from different blast furnaces and charges. It supplies molten iron at a predetermined temperature of 1250 °C which is helpful in subsequent operations of steel making.

In our country, the maximum size of mixer having a capacity of 1300 T of molten iron is commissioned and working at Bokaro Steel Ltd., Bhilai Ispat plant etc. These mixers of rivetted construction have been supplied by the Soviet Union. Rourkela steel plant has a mixer of 1100 T capacity which is fully welded construction supplied by W. Germany. Recently a mixer of 1300 T capacity, designed and fabricated by Heavy Machine Building Plant, Ranchi has been supplied to Bhilai Ispat Ltd., which is now undei erection. This is a completely welded construction.

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Welded & Rivetted Design—Advantages & Disadvantages : (1300 T Mixer)

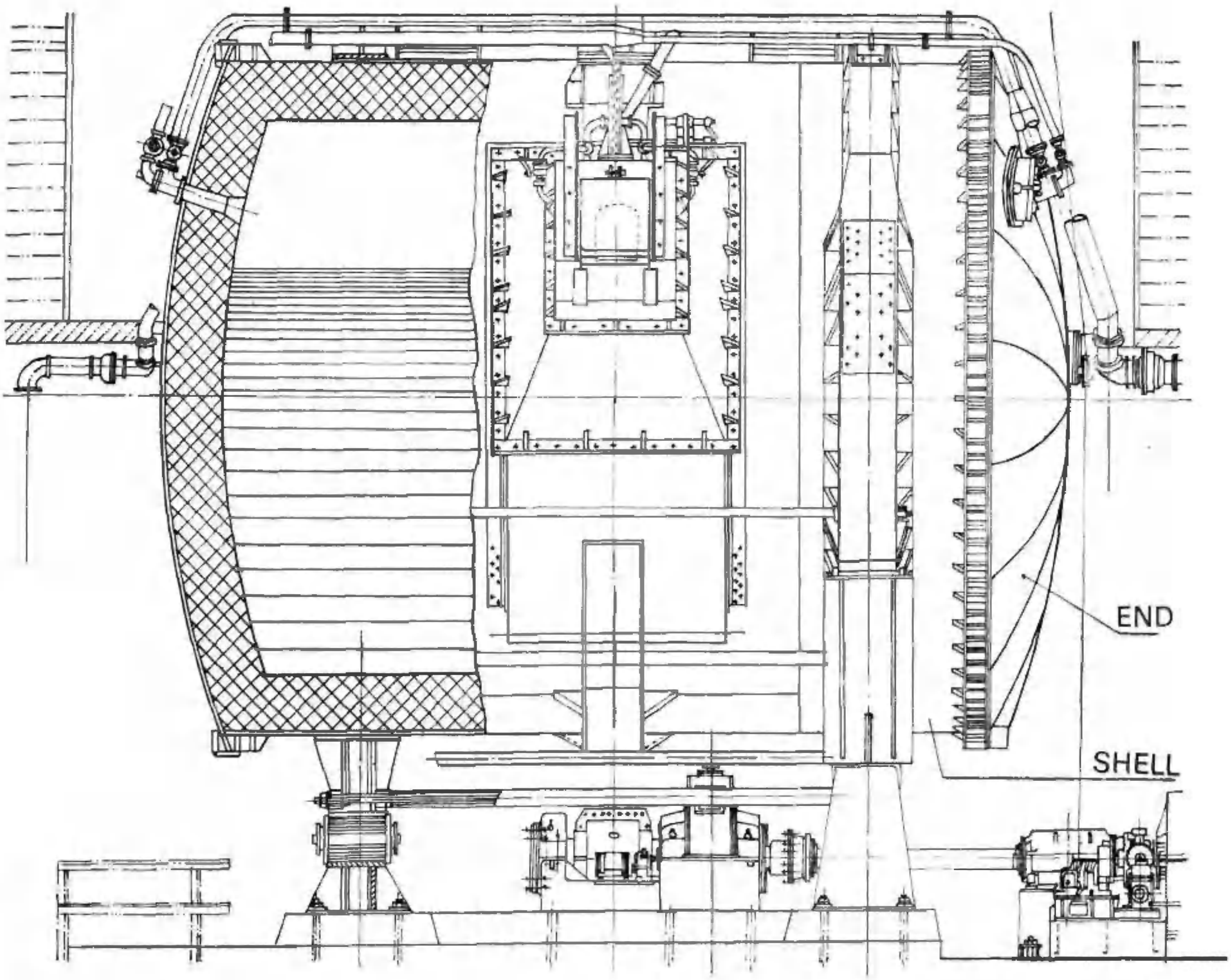
1. Rivetted construction requires nearly 5350 rivets and 4800 holes of ϕ 32 mm, with a pack thickness of about 70-80 mm for connection of different parts. In a welded construction, this laborious process of drilling a large number of holes and later rivetting at site is completely avoided.

2. In a rivetted construction, the number of units to be transported are much more and therefore the chances of deformation and damage during transportation is moie, whereas in a weided design, many parts are welded together at shop level and the units transported are rigid.

3. The rivetted design involves difficult machining for connection between shell and the end, whereas in welded construction it has been avoided altogether.

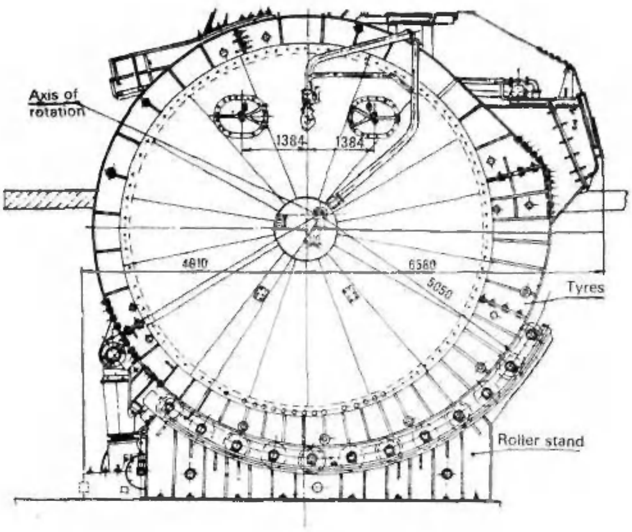
4. Welded design calls for good and reliable workmanship both at shop and at site.

5. Heat treatment of various parts after welding for stress relieving is required in case of a welded construction.



GENERAL VIEW OF 1300T MIXER (ELEVATION)

Fig. 1.



CENTRAL VIEW OF BOOT MIXER (END VIEW)

Fig. 2.

Specifications :

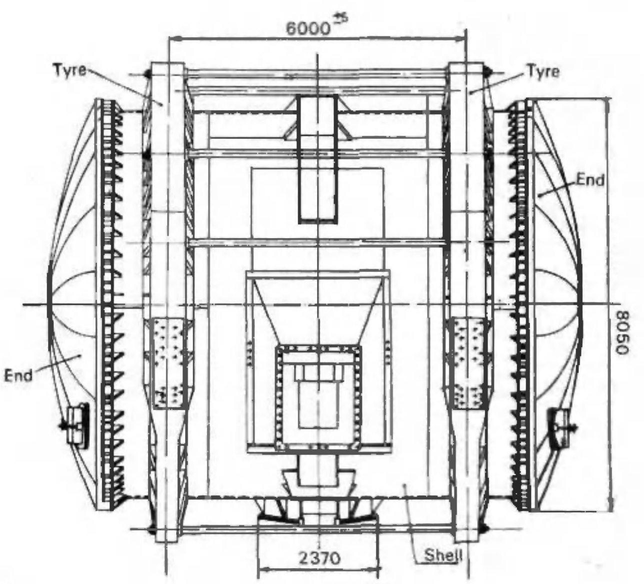
This paper deals with the fabrication of a 1300 T mixer, a fully welded construction. The main units of such a mixer are

(i) Shell assembly including.
  a. Shell
  b. Tyres
  c. Ends
(ii) Roller support
(iii) Tilting mechanism
(iv) Hand brake mechanism
(v) Charging hole cover winch
(vi) Charging hole platform
(vii) Spout door opening mechanism
(viii) Gas and air distribution system
(ix) Lubrication system
(x) Electrical system.

Capacity	1300 Tonnes.
Length	10750 mm
Diameter	7640 mm
Weight	340 Tonnes
Nominal temperature of iron in mixer	1250°C
Fuel used	Coke oven gas
Capacity of burners at ends	250 M^3/Hr.
Capacity of burners at spout	150 M^3/Hr.
Maximum angle of tilt during emptying	45°
Maximum angle of tilt during operation.	30°
Working motor for tilting mechanism	68 KW
Blower (centrifugal) capacity	5000 M^3/Hr.
Pressure	350 mm w.g.

A general view of a 1300 T mixer is shown in *figures 1 & 2*

The main fabrication in a mixer is shell assembly consisting of a shell, two tyres and two ends. These parts are shown in *fig. 3*. This paper is devoted only to the fabrication of shell, tyres and ends of a 1300 T mixer, which requires heavy welding by MAG, submerged arc automatic and electro-slag welding processes.



SHELL ASSEMBLY

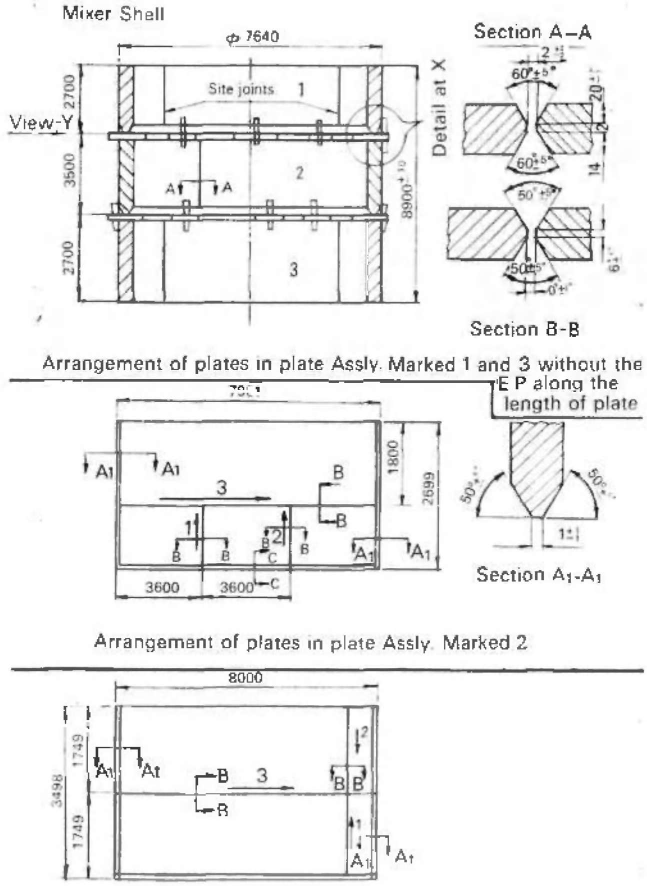
Fig. 3.

Shell :

Shell is a cylindrical construction consisting of three courses 2700 mm, 3500 mm & 2700 mm in length, thus making a total length of 8900 mm.

Length of shell	8900 mm
Diameter of shell	7640 mm
Plate thickness	36 mm
Material	ST 42W as per IS 2062-62.

Each course consists of three sections rolled to an external diameter of 7640 mm. Each section is a fabricated plate with overall dimension 8000×36×3500 mm maximum. A typical fabricated plate with spliced joints and sequence of welding is shown in *fig. 4*. The joints are double vee-butt welded by submerged arc automatic welding process. In order to achieve good penetration, flux cushion was provided at the joint and a gap of 3 mm was maintained. While welding from the other side, carbon air arc gouging was done to get radiographic quality weld joint. Typical regimes of welding are given below.



Note Arrows with numerals show the sequence of welding.
FIG. 4

	Wire dia.	Flux type	Current	Voltage	Wire feed	Welding speed
1st side	4.0 mm	Fused	900	38	105 M/Hr	28 M/Hr.
2nd side	4.0 mm	Fused	950	40	105 M/Hr	32 M/Hr.

Welded seams are tested 100% of its length by ultrasonic testing. 10% of welded length, especially at teesections is radiographed with a portable Gamma-ray unit using Iridum—192 source.

Before rolling the plates on a 4-roll plate bending machine, the butt welded reinforcements are ground off because of the following reasons.

a. The joint will meet the specifications for a 100% strength butt weld.

b. It will avoid dents on the bending roll.

c. It will ensure maximum contact of the plates with the bending rolls thus avoiding unevenness in the plates.

During the operation of rolling, the diameter of bending is checked by means of a metallic template and after completion, the curvature is checked by putting it on a layout. Also the verticality of the plates are checked to ensure uniform diameter throughout. Erection cleats are then put on these individual plates to facilitate control assembly of shell.

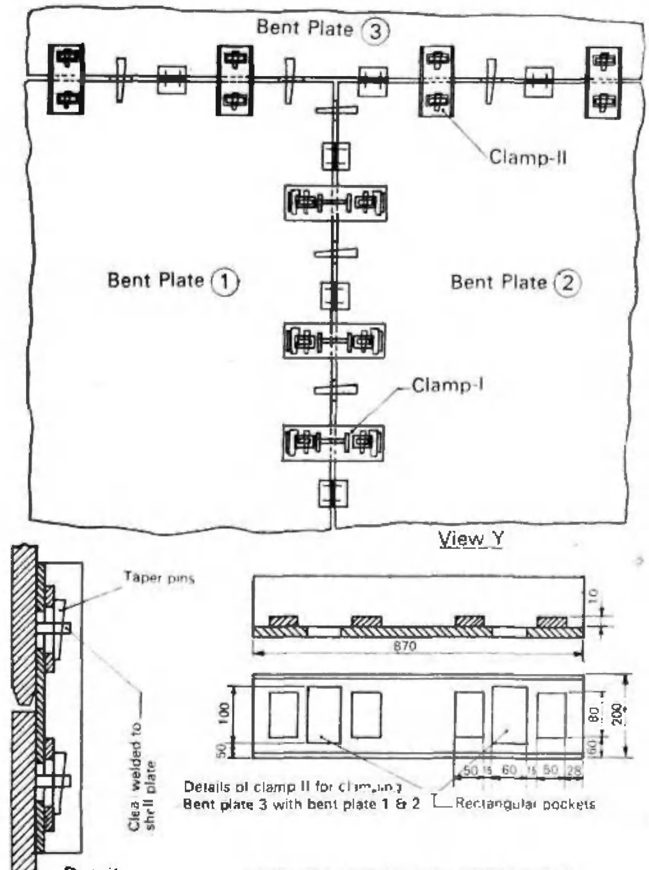
Assembly of Shell :

For control assembly of shell, a layout is drawn on level bed. First course consisting of three bent plates are placed as per layout. Diameters at top and at bottom and gap in between the plates is adjusted by means of a fixture as shown in *fig.* 5 & 6. The fixture for control assembly though very simple in design is extremely convenient and easy during working.

After first course is assembled, subsequent courses are assembled one over the other using the same assembly fixtures. Control assembly of shell being over, the axes of charging hole, spout opening, tyres for tilting the shell, and position of ends with respect to these openings etc. are marked for proper alignment of connecting details. Match marks on three courses in different bands are given to ease erection at site *Photograph I* shows control assembly of shell in progress.

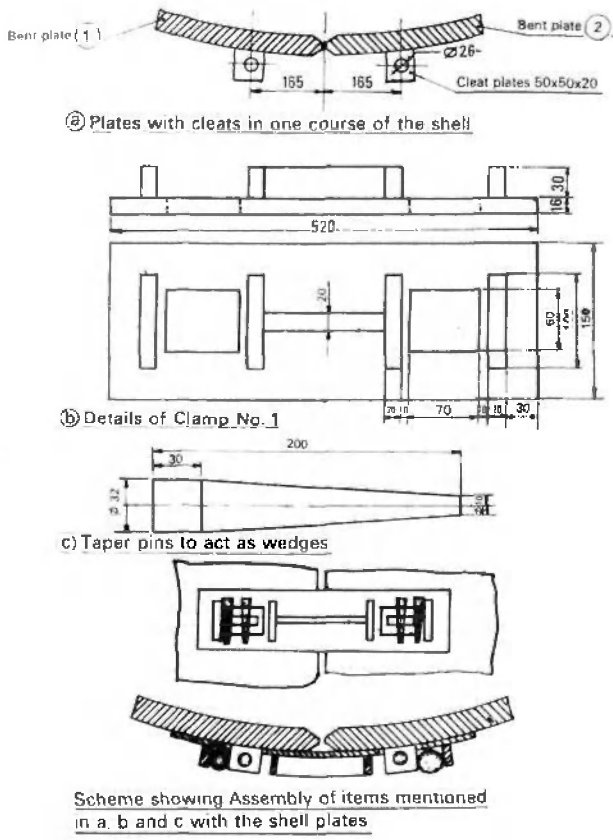
Assembly of spout, Charging hole pipe, Bracket for tilting etc with Shell.

After control assembly, the shell is dismantled in 3 parts i.e. 3 courses separately. Top and bottom courses



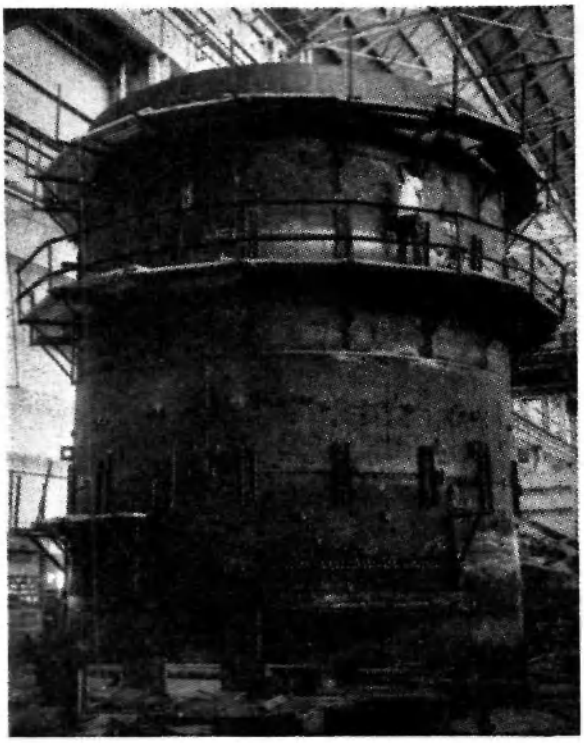
FIXTURE FOR SHELL ASSEMBLY

FIG 5

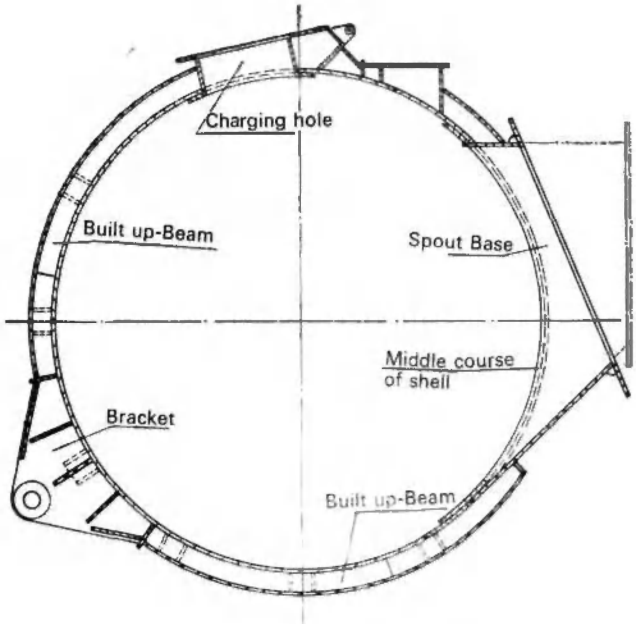


FIXTURE FOR SHELL ASSEMBLY

FIG 6

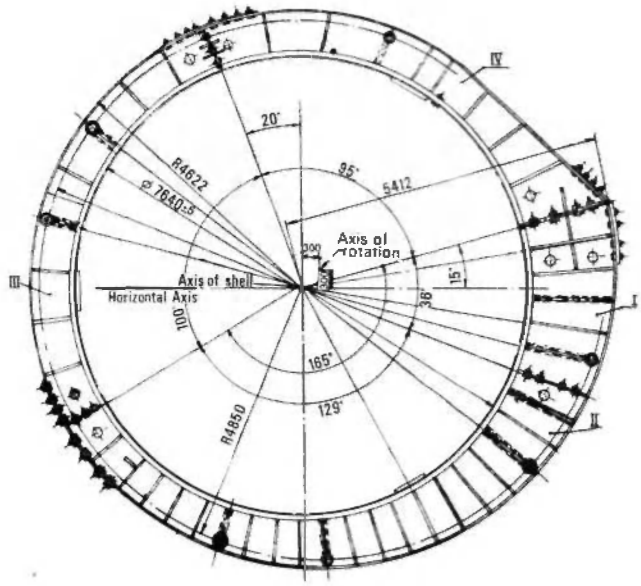


Photograph I
CONTROL ASSEMBLY OF SHELL IN PROGRESS



ASSEMBLY OF OTHER UNITS
MIDDLE COURSE OF SHELL

FIG. 7



TYRE ASSEMBLY OF MIXER

FIG. 8

are sent for control assembly with ends and the middle course is placed on a layout, predrawn on a level bed plate. The openings for spout and charging holes are hand gas cut along the markings after putting sufficient number of cross technological stiffeners to arrest any seizing of the plates. Charging cover, spout, bracket and fabricated beams are assembled round the middle course as shown in *fig.* 7. The construction and assembly of spout may be seen which is quite typical and interesting from fabrication angle.

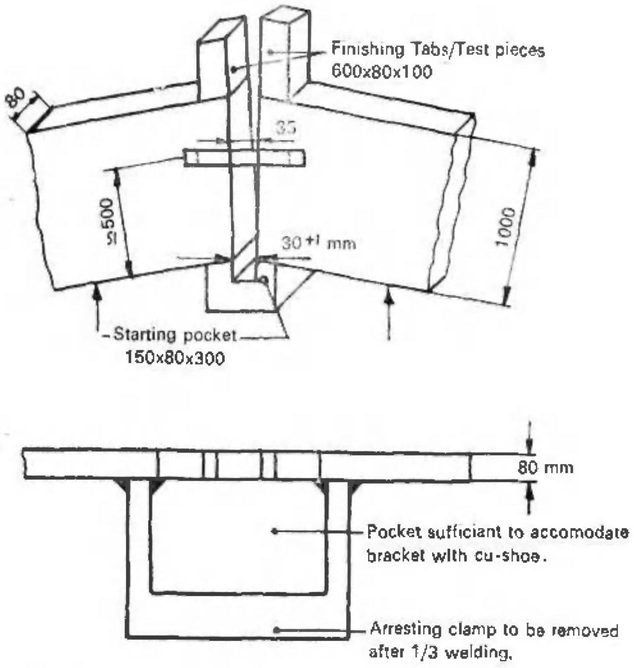
Tyres :

Tyres are fabricated circular bands which are bolted round the shell at two places 6000—5 mm apart. These tyres support the entire shell and the tilting also takes place on these tyres. Each tyre consists of four sectors as shown in *fig. 8*

Internal diameter of tyre	7640+5mm
Wt of tyre	34 Tonnes.
Maximum Wt of one sector	16.5 Tonnes.
Plate thickness	80 mm max.
Material	ST 42W, IS : 2062-62

Each sector requires rolled plates of thickness 50/80 mm. The plates are fabricated by splicing and joints welded by electro-slag welding process.

Electro-slag welding (ESW) is an extremely fast and almost defect free process of producing a butt weld which can easily pass radiographic tests. *Fig. 9* shows a typical arrangement of carrying out ESW of vertical butt joints for 80 mm plate thickness. *Photograph II* shows electro-slag welding in operation. ESW machine available with HMBP, Ranchi can weld plate thickness upto 400 mm and length 5000 mm in one setting. ESW joints require normalising for grain refinement which in

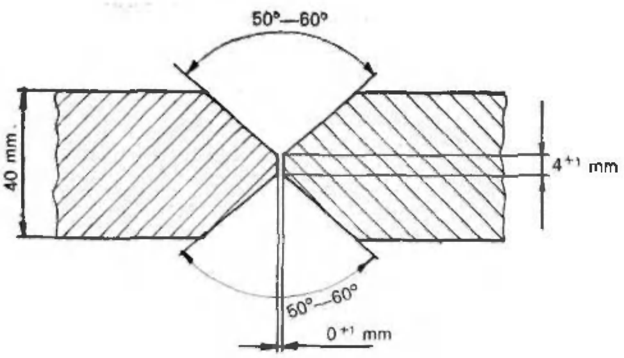


ARRANGEMENT FOR ESW OF 80mm PLATES

FIG. 9

Photograph II

ELECTROSLAG WELDING IN PROGRESS



TYPICAL JOINT CONFIGURATION FOR AUTO WELDING

FIG. 10

this case is done after the individual sectors are ready after assembly and welding.

40 mm thick plates were made to size by splicings welded by submerged arc autowelding process, the joint configuration being double-vee as shown in *sketch 10*. Table-A gives typical regimes of welding 50 mm and 80 mm thick plates by ESW process and 40 mm thick plates by submerged arc automatic welding process.

Regimes for Electro slag welding.

Thickness	*Flux*	*Wire*	*No. of wires*	*Wire-feed*
50	AH-8 (imported)	2% Mn 3.15 mm	1	325 m Hr
80	AH-8	2% Mn 3.15 mm	2	225 m Hr

Current	*Voltage*	*Slag bath depth*	*Welding speed*
600 A	48-50 V	50-60 mm	1.4-1.5 M Hr.
450 A wire	46 V	50-55 mm	1.1-1.2 M Hr.

Assembly of Tyres :

Assembly of tyres is carried out on a layout marked on a level bed plate. All the four sectors are assembled simultaneously to achieve the required dimensions. To start with, the internal flanges with allowances on length

Regimes for Auto submerged Arc welding Thickness 40 mm

	Current amps	*Voltage*	*Wire feed*	*Welding speed*	*Wire mm*	*Flux*
1st side	900	40	112 M/Hr	30 M/Hr	40.	Fused
2nd Side	950	42	112 M/Hr	32 M/Hr	4.0	Fused

EDGE PREPARATION OF JOINTS IN TYRE FOR CO_2 WELDING

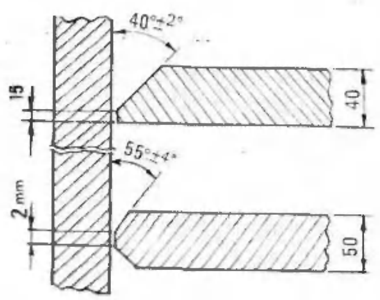
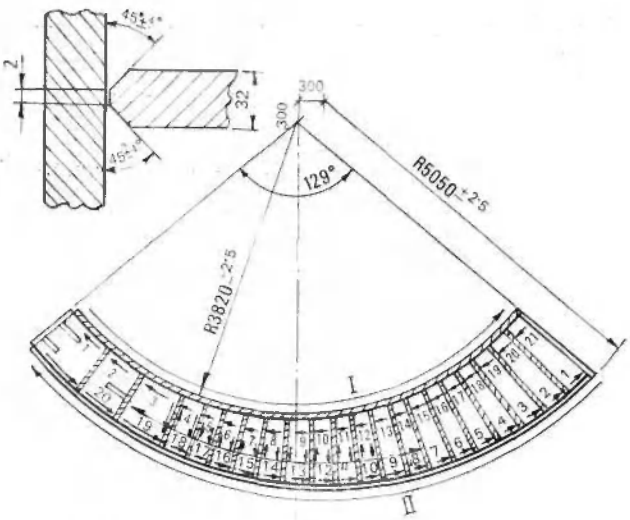


FIG. II



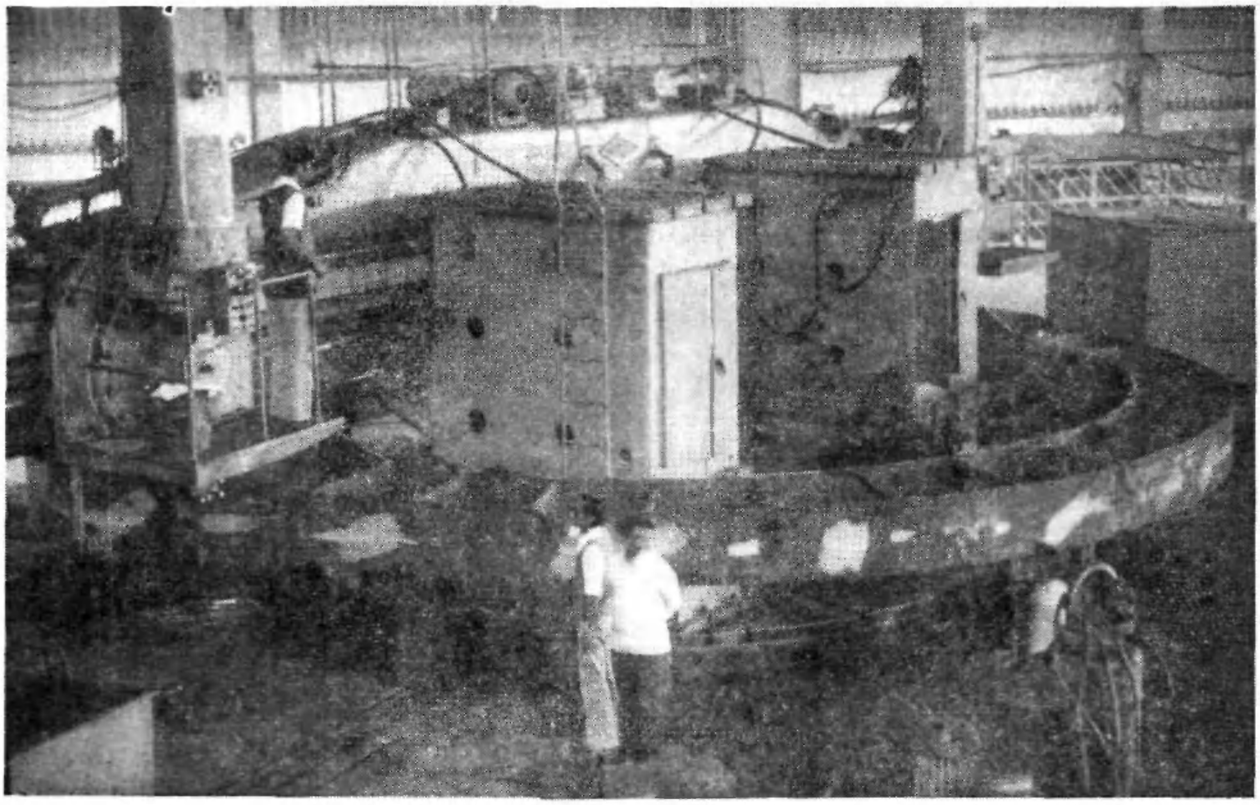
SEQUENCE OF WELDING IN ONE SECTOR OF THE TYRE

FIG. 12

are placed on the layout to form a circle of diameter 7640±5 mm. The web plates with allowances on length are then assembled one after another. In the tyre bottom part, rolled I-beam spacers are placed and welded at the bottom web prior to placing the top web plate. Allowances on flange and web plates are then cut to make room for assembly of side plates. Technological stiffeners are put in each sector of the tyre before taking them out from the layout. The side plates with machining allowance are then assembled in each sector. Welding is done using MAG process following regimes as mentioned at page 6 last para.

The edge preparation of joints involved in tyre welding is shown in *sketch 11*. The typical sequence of welding in a tyre sector is shown in *fig. 12*

Individual tyre sectors are stress relieved in a furnace after completion of welding. *Photograph III*



Photograph III
TYRE ASSEMBLY IN MACHINING

shows a tyre assembly during machining of outside periphery after assembly, welding and stress relieving.

Ends :

Ends are fabricated dished items consisting of 18 petals and a central crown. *Fig. 13* shows the ends of a 1300 T mixer.

Overall diameter of end	8050 mm
Curvature of petals & crown	8500 mm
Plate thickness	36 mm
Material	ST 42W as per IS 2062-69
Developed dimension of petals	$3473 \times 36 \times 1390$ nun
Developed dimension of crown	ϕ 1402 mm t = 36

It may be seen that the petals and the crown have spherical contoür, which normally is possible in our country only by hot/cold pressing. The number of petals will depend on the size of press available. For hot pressing a petal of this size will require a force of 800 T and the crown will need 900 T force. In our case we have designed and used a special arrangement for spherical rolling on our existing 4-roll plate bending machine, which is not only interesting but unique in the country.

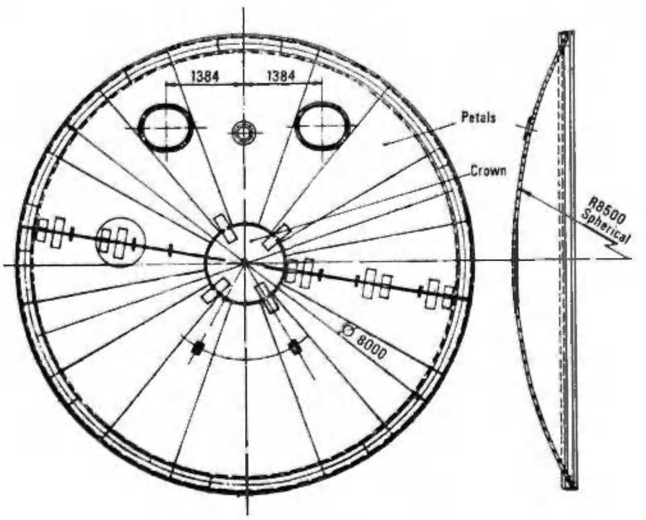
Details of spherical rolling have been discussed in details in the article "Fabrication of Horton-spheres using rolled spherical petals" written by S/Sri U. P. Chaudhary & A. Khan presented in the IIW seminar on 7th Jan., 1978 at Bombay.

Assembly of Ends :

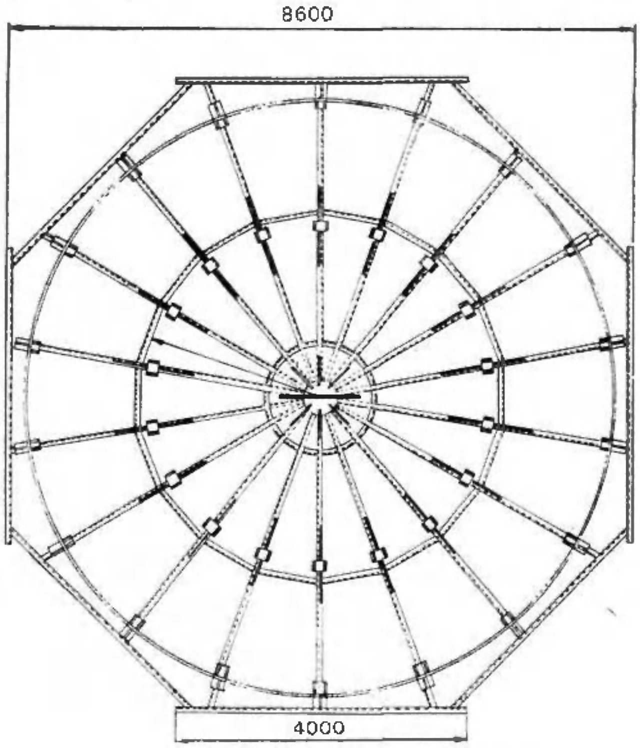
A special fixture as shown in *fig. 14* was designed and fabricated for the assembly and welding of petals and crown to form the ends. First the circular plate of ϕ 8050 mm is placed in the fixture and secured by means of clamps. The petals are then assembled one by one in the fixture. The last petal is provided with allowance on one side for proper joint fit up and the extra allowance is cut as per requirement. The crown plate is finally placed on top of the petals and assembled in position after necessary trimming by gas torch to get a good joint fit up. A typical joint preparation is shown in *fig. 15*

All the joints are then welded on this side by MAG welding using the following regimens.

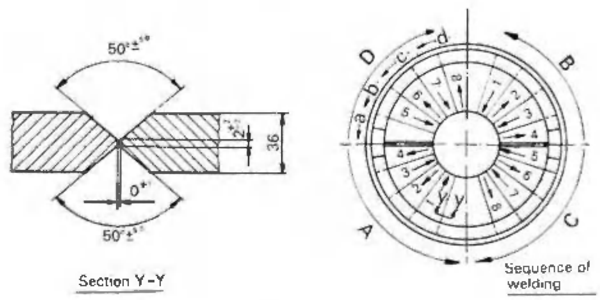
Wire dia.	*Current amps*	*Voltage*	*Wire speed*	*Welding speed*	*Shielding gas.*
ϕ 1.6 mm	280	30	190 M/Hr	15M/Hr	CO_2



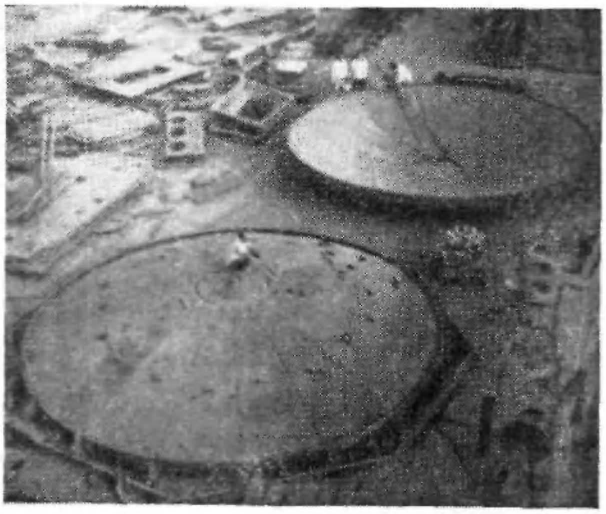
END OF A 1300T MIXER
FIG. 13



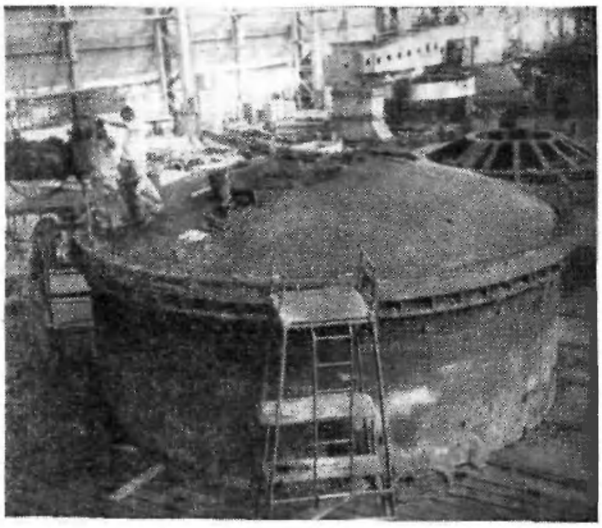
FIXTURE FOR ASSEMBLY OF ENDS (TOP VIEW)
FIG. 14



TYPICAL IN ENDS OF MIXER
FIG. 15



Photograph IV
ENDS AFTER WELDING



Photograph V
SHELL WITH END ASSEMBLY

Typical sequency of welding is shown in *fig. 15*. The end is then turned upside down and technological bracings are put on each half end. The joints are cleaned from this side, carbon arc gouging used occasionally wherever required and welding completed by CO_2 welding using the same regimes. *Photograph IV* shows one end after welding.

The joints are subjected to 100% ultrasonic test and 10% radiographic test to ensure the quality of welding. The end portions are then stress relieved in a furnace. Our furnace size available is 6000 × 3500 × 12000 mm.

Control Assembly of end with Shell :

Control assembly of ends with shell is very important in view of the following reasons.

a. After welding end portions, there might be some distortions inspite of technological stiffeners put before hand to arrest such distortions.

b. Configuration of end portions being shallow, there is every likelihood of deformation during stress relieving-operation.

For control assembly, a layout was drawn on a level bed with dimensions at the junction of first course with second course of shell (during control assembly of shell, a number of readings at ends diametrically opposite at the junctions of first with 2nd and 2nd with 3rd courses were recorded for this purpose). First course was assembled on this layout in upside down position and the end halves were placed on its top. Appreciable amount of distortion in end halves was noticed, obviously due to the reasons mentioned above. The halves were control assembled using clamps and wedges at predetermined areas. *Photograph V* shows one end control assembled with shell course. Same technology was followed for control assembly of other end with 3rd course of the shell.

Conclusion :

Using suitable welding techniques, sequence of assembly and welding and control on distortions at various stages, such a vital steel plant equipment can be conveniently fabricated and erected at site, thus reducing erection cost and time. With this background and experience, we are capable of manufacturing a 2500 T mixer a completely welded construction for future steel plants. Bokaro steel limited has imported a 2500 T mixer from Soviet Union which is a rivetted construction.

Acknowledgement :

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