



INDIAN RAILWAYS

TRACK MACHINES DIGEST

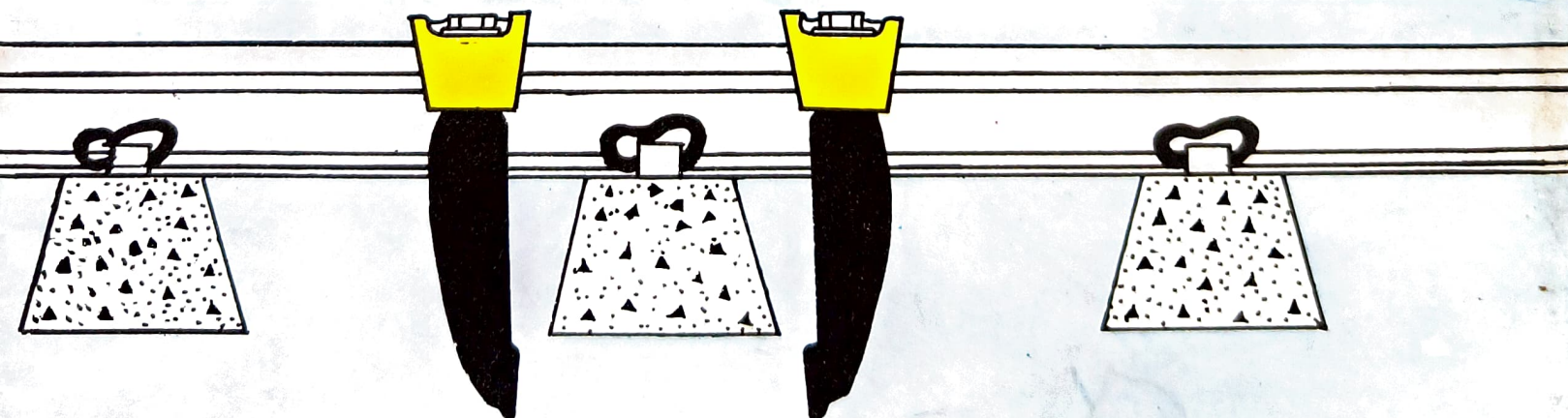
भारतीय रेलपथ मशीन डायजेस्ट

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THEORY AND OPERATION OF DIESEL ENGINES

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Principal/IRTMT/C/ALD

1.0 Diesel Engine Systems:–

All diesel engines have, in one form or another, following four systems that are necessary to sustain rotary motion and useful engine life:

- (i) Air System
- (ii) Fuel System
- (iii) Cooling System
- (iv) Lubricating System
- (v) Cut Models figures of (1) PT Fuel pump & Governor (ii) NT-743 Engine (iii) Turbo-charger is placed at S.No. (2)

2.0 Air System:–

The main functions of Air System of a diesel engine are as under:–

- (a) to supply oxygen to the cylinders so that fuel may burn and
- (b) to carry away the spent gases left from combustion.

Dry air is composed of approximately 78% nitrogen and 21% oxygen by volume. Nitrogen is an inactive element and serves no useful purpose except that it gets hot from compression along with the oxygen. To get air into the cylinders, the air system consists of piping from a source of fresh air to (1) the intake manifold on 4-stroke cycle engines, (2) the scavenging blower inlet on 2-stroke cycle engines, or (3) the turbocharger or or scavenger inlet on turbo and supercharged engines. The air system should have a cleaner to remove dust and other harmful particles. This filter is usually located where the air enters the piping and must be serviced periodically to keep restriction to a minimum. On the discharge side of the air system, there should be provisions for muffling the noise produced by

the high velocity exhaust gas. All piping in the complete air system should be as smooth and free of bends as possible. Sharp right angles are definitely a bad practice. Bends add restriction to the free flow of air and the higher the velocity of air, the more restriction there is. Restriction on the exhaust side is called back pressure. A large percentage of the engines produced today are turbocharged. Turbochargers, which are part of the air system, are centrifugal blowers driven by exhaust gas. Thus they run on power that otherwise is wasted. The purposes of a turbocharger are (1) to stuff more air into the cylinder so more fuel can be burnt thus boosting power or (2) to compensate for less air pressure at higher altitudes so the engine does not lose power as quickly. The turbocharger substantially increases volumetric efficiency. However turbochargers are not mechanically driven by engine. Controls for turbocharger speed, air quantity, and pressure follow changes in engine speed and load conditions. Superchargers charge the cylinder with more air but are mechanically driven and significantly increase the engines parasitic load. Scavenging blowers are used on 2-stroke cycle engines to rid the cylinder of exhaust gas.

3.0 Fuel System:–

The main functions of Fuel system of a diesel engine are as under:–

- (a) Supplying clean fuel to the rest of the system where it will be regulated;
- (b) Metering the right amount of fuel injected at all speed & load conditions;
- (c) Timing fuel injection so that fuel is burnt at the optimum period in the cycle;
- (d) Injecting, atomizing, and distributing fuel in the combustion chamber and;

- (c) Controlling engine speed by means of a governor;

3.1.1 Supplying Fuel:–

In most of the diesel fuel systems, fuel is supplied by a positive displacement gear type pump. Fuel is pumped around the outside of the two meshing gears and is then under sufficient pressure to reach other parts of the system.

3.1.2 Metering Fuel:–

The amount of fuel metered in a diesel engine depends upon the time fuel has to flow into the injector cup and the amount of pressure the fuel is under. Since the time the metering orifice is open is inversely proportional to and wholly dependent on engine speed, power output is regulated by changing the pressure of the fuel.

3.1.3 Timing Fuel Injection:–

The exact period of time injection takes place in the engine cycle is a function of the cam lobe on the cam shaft. Camshaft rotary motion is changed into reciprocating motion by a follower riding on the eccentric cam. Thus, grinding the cam lobe properly during manufacture is of prime importance. Tolerances are held extremely close so fuel injection takes place at an optimum time in the engine cycle and uniformly in all cylinders.

3.1.4 Injecting Fuel:–

Fuel injection in a diesel engine is accomplished by the descent of the injector plunger. Since the plunger fits into the injector barrel very closely, fuel is put under tremendous hydraulic pressure and is sprayed out the extremely small drillings into the cylinder. Fuel is atomized by the small drillings it is forced out through and is distributed uniformly in the hot compressed air because the drillings are spaced all around the bottom of the cup.

3.1.5 Controlling Engine Speed:–

Since diesel engines have a top speed at which they may safely run, provisions must be made to limit the amount of fuel going to the injectors. Maximum speed control is accomplished by means of a governor. When the engine reaches a pre-determined speed, a plunger moves to close a fuel port and tends to restrict fuel to the injectors. Governors also maintain a minimum or idle speed.

- 3.2 Although all fuel systems in all makes of diesel engines have the 5 foregoing functions, the manner in which the functions are effected vary considerably. Broadly speaking, Fuel system of a diesel engine can be categorised in following two systems:

3.1.2 Multiple Pump System:

In this system, fuel is supplied to a housing that incorporates a group of high pressure pumps. Each cylinder has its own individual pump and high-strength steel lines carry fuel to each cylinder injector. In this system, the injector is not operated by the engine camshaft. The supply function is usually done by a gear type pump. Metering, timing, and control are done within the housing of the individual pump. Injection into the cylinder is done by the spray nozzle.

3.2.2 Unit Injector System:–

In this system, all functions except the fuel supply from the tank and governing are incorporated in one injector. Each cylinder has one unit injector and is engine cam operated. A gear-type pump supplies fuel and a governor and throttle are connected by mechanical linkage to each injector. Metering is accomplished by positioning the injector plunger.

4.0 Cooling System:–

As fuel burns within the cylinders of a diesel engine, about 1/3rd of the fuel's heat energy is used in actually doing work on the pistons. The rest of the

heat that is generated either goes out the exhaust system or is transferred to a liquid or air medium and then to the atmosphere. Transferring excess heat from the engine to the atmosphere is the job of the cooling system. Removing heat prevents:

- (i) the resulting breakdown of the lubricating oil film that separates rubbing parts and
- (ii) the resulting loss of strength of the metal itself.

Very few diesel engines made today are air cooled. That is, cooled by transferring heat directly to the atmosphere. The vast majority are liquid cooled and have coolant passages cast into the block, heads, and sometimes-exhaust manifolds.

Pistons transfer some of the heat of combustion to cylinder walls and some of it to the lubricating oil. The coolant circulating in the water jackets absorbs most of this heat and carries it away to the radiator where it is transferred to the atmosphere. Most diesel engines use a special oil cooler to reduce the temperature of the lubricating oil. The oil cooler is a tube-and-shell type heat exchanger with coolant passing through the tubes and picking up heat from the oil that passes through the shell. The coolant is circulated throughout the system by the water pump that works by centrifugal force. The pump gets its power from the engine crankshaft and may be either gear driven or belt driven. In addition to the water pump, controls are necessary to regulate coolant flow and coolant temperature. These are essential if the engine is to work at peak performance and have a long useful life.

Proper engine cooling depends upon following four factors:—

- (i) the amount the coolant temperature rises in the passages as it circulates,
- (ii) the temperature of the coolant when it leaves the engine
- (iii) how pure the coolant is, and
- (iv) minimal entrained air in the coolant.

Temperature rise of the coolant is very important. The greater the amount of temperature difference, the more parts are prone to distort. Cylinder liners are especially likely to suffer from this condition if the difference is excessive. To reduce the chances of this, temperature rise is kept within a minimum range of 8 to 12 degree centigrade—primarily by boosting the rate of coolant flow.

Higher rates of coolant flow reduce the chance of vapor pockets and localized hot spots. Thus, if there are no hot areas which cause distortion, the temperature of the coolant leaving the engine can be safely raised. This is the method most high speed diesels use today.

The purity of the coolant is also of prime importance if the engine is to be cooled efficiently. Water is the main ingredient in coolants and usually carries scale forming impurities. At the temperatures found around internal surfaces, these impurities separate and coat passage surfaces. Results are poorer heat transfer to the coolant. A corrosion inhibitor should be incorporated in the system and changed regularly.

Also, steps should be taken to keep the coolant at the correct level. Air in the form of bubbles will burst against cylinder liners from high natural vibrations and foster a pitting known as cavitation. Keeping the entire system sealed and corrosion checked will help guard against this condition.

5.0 Lubricating System:—

The fourth system essential to all diesel engines is the Lubricating system. Lubricating oil is pumped through passages and drillings by a gear-type pump and performs basically four functions. It lubricates, seals, cleans and cools those parts in which it comes into contact.

One of the worst enemies of the diesel engine is damaging heat resulting from friction. If oil is to fulfil its job of keeping rolling and sliding surfaces from metal-to-metal contact, it must possess certain

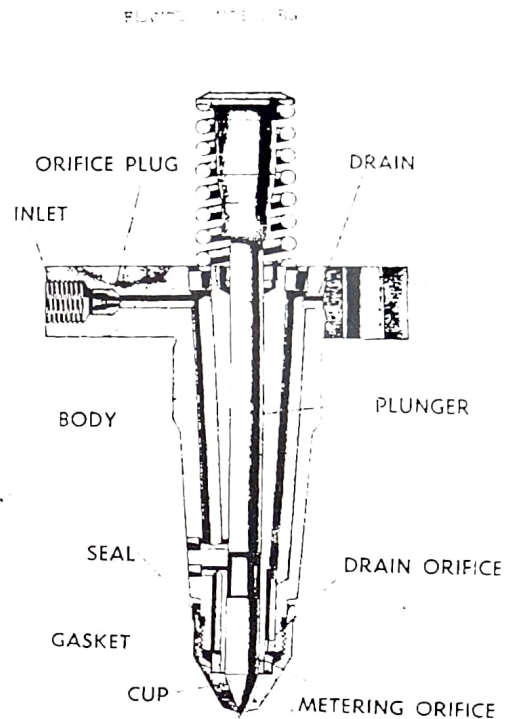
properties. It must be able to withstand extremes in temperatures and loads without breaking down. Also, the proper thickness or viscosity of the oil will in part determine how effectively the thin oil film separates rubbing surfaces.

Oil must form a gas tight seal between sliding surfaces if peak performance from the engine is to be realised. The film between the rings and cylinder wall must be kept thick enough for proper sealing yet thin enough so that the piston moves with a minimum of fluid friction. To perform the cleaning function, oil must be able to hold solid particles in suspension so that the oil filter can remove the largest of them. This, of course, is an on-going process that results in the need for oil filter maintenance. Smaller particles that the filter does not trap should be dispersed in the oil and will drain out when the oil is changed. Because all parts of the lube system are under pressure once the oil leaves the gear pump, cooler oil is constantly taking the place of hotter oil. This is one of the benefits of pressurized system. Cooling the oil in the oil cooler keeps the oil in the correct temperature range.

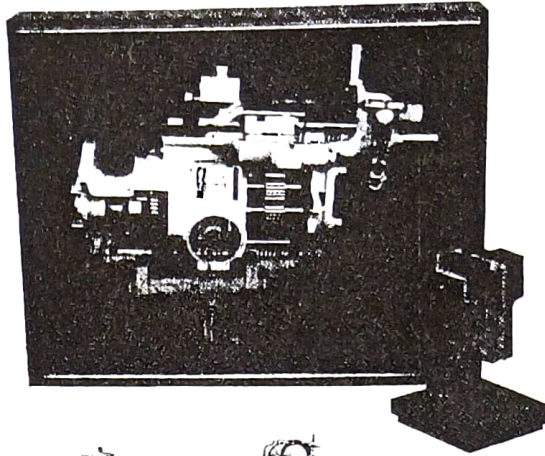
6.0 Conclusion:-

All these four systems of a diesel engine, though separate, affect each other as functions are carried out. Consider for example, a leak in the air intake system. Enough dirt particles can eventually enter the cylinder to make small grooves in the cylinder wall. Thus the seal is broken and water vapor from combustion will blow down and mix with the oil-forming corrosive acids. In addition, effective cylinder pressure is lost and fuel consumption increases. As a further consequence, the hotter exhaust gas creates a greater load on the cooling system. It is for the reasons like this that it is recommended to perform **REGULAR MAINTENANCE** on all engine systems.

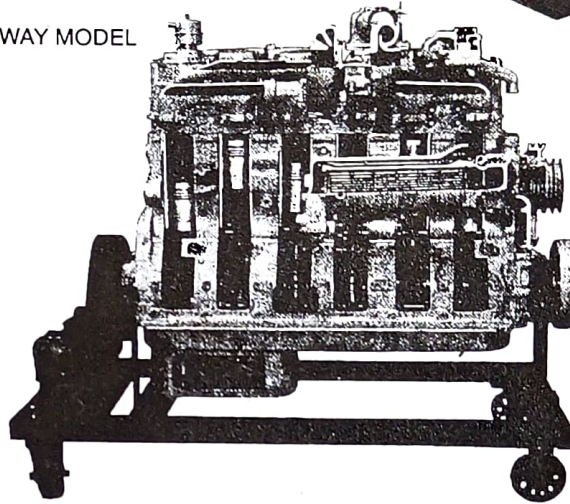
FLANGE INJECTORS



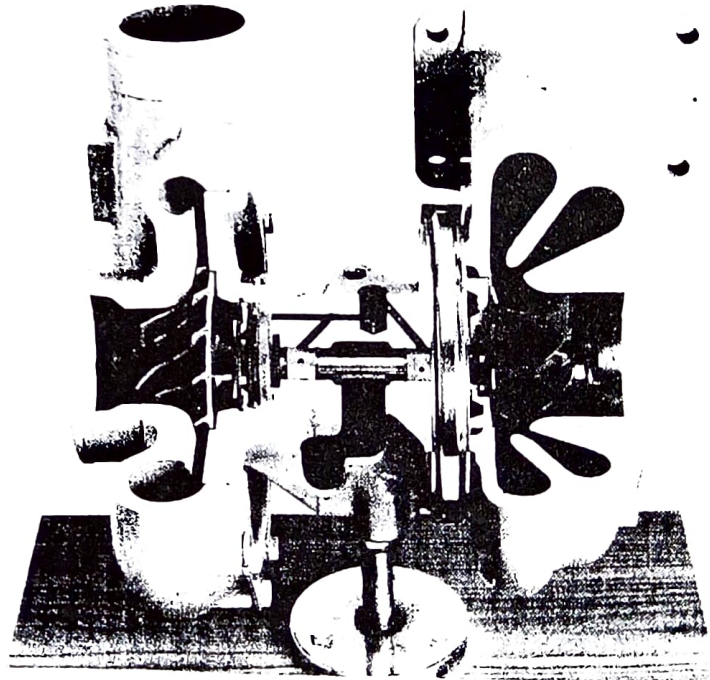
TRANS-SLIDE P.T. FUEL PUMP AND HYDRAULIC GOVERNOR



NT - 743 ENGINE CUT-AWAY MODEL



TURBOCHARGER CUT-AWAY MODEL



IMPORTANCE OF TAMPING TOOLS (TYNE) AND THEIR DIMENSIONS

By. S.M. Mitra

Vice Principal/IRTMTTC/ALD.

Indian Railways switched over from manual track maintenance in the late sixties. With the introduction of machine maintenance in permanent way, not only the quality of track maintenance improved greatly but also cost of track maintenance has been reduced drastically. Initially slow speed and low output track machines with 16 number of tools (Tyne) such as SLC, UT's had been inducted. With the passage of times, high output machines such as Duomatic, CSM, UNIMAT have been inducted w.e.f. mid of eighties, with 32 Nos. tamping tools (see Fig. No. 22)

Main aim of any machine is that machine should achieve maximum output with great accuracy with minimum down time and less maintenance charges.

Shape and size of tamping tool (Tyne) play a very vital role for achieving good quality of packing as well as less damage to tamping arms. In order to, therefore, minimise the failure of tamping banks, it is very much essential that the specification/dimension of tamping tools (tyne) must be as per the OEM specification.

During procurement of tamping tools (Tyne) the procurement authority must incorporate the dimension/specification issued by OEM.

There exist instructions for correctly fixing and extracting the tamping tools (Tyne), we must follow those

instructions for achieving greater life of tamping tool (Tyne) and its Arm.

The tamping machine can give the satisfactory output and quality maximum up to 20% wear of Tyne Blades of the original size. After that tamping tools (Tyne) must be taken out and blade should be rewelded with specified method and electrodes.

The methods and precautions for fixing and extracting the tamping tools (Tyne), instruction of welding of wear out tools with specified Electrodes and the dimensions of tyne are given below:-

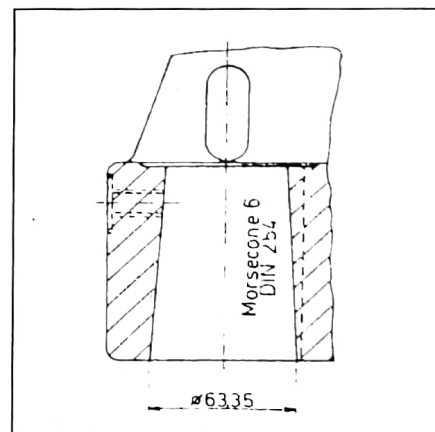
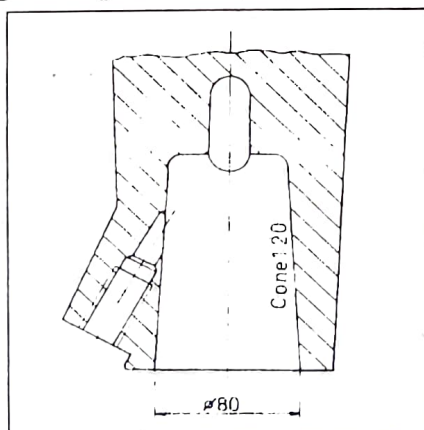
TYNE ASSEMBLY:

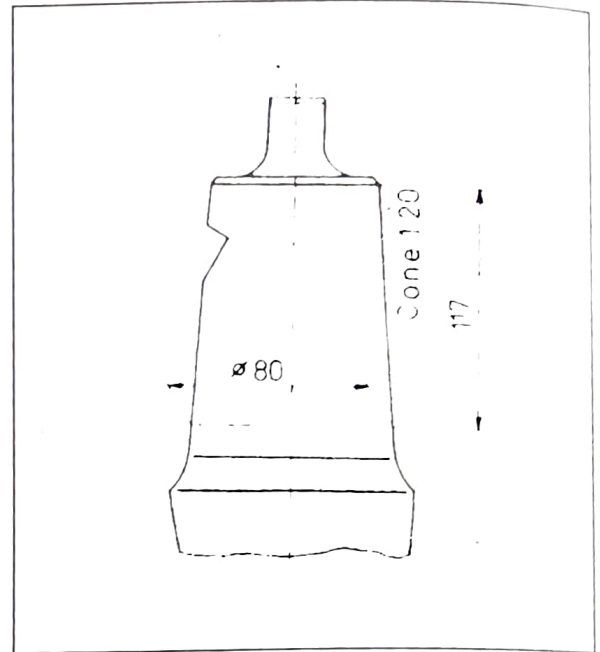
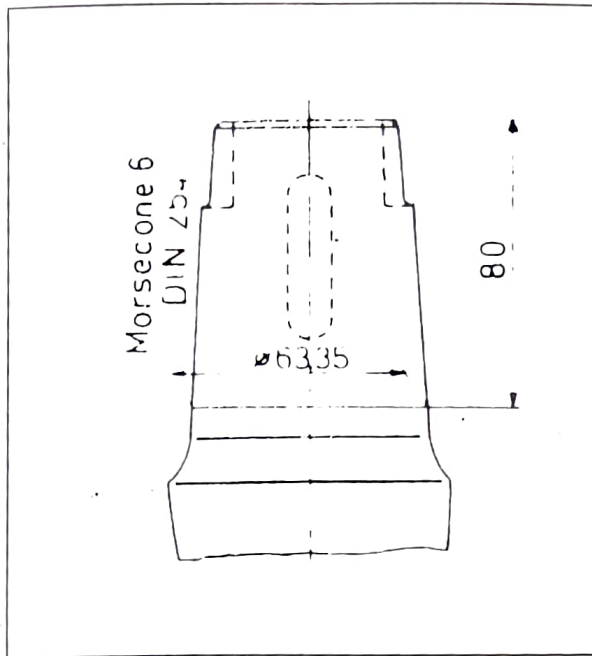
Before inserting new tynes, clean cone in the tyne arm and tyne. Check for damages (dents, fins notches etc.)

IMPORTANT:

Do not use tynes with damaged or deformed cones, since a fast fit is not ensured and subsequently will create ovality in the tyne arm cone and finally cracks will occur.

Oval tynes or tyne arms have to be changed.





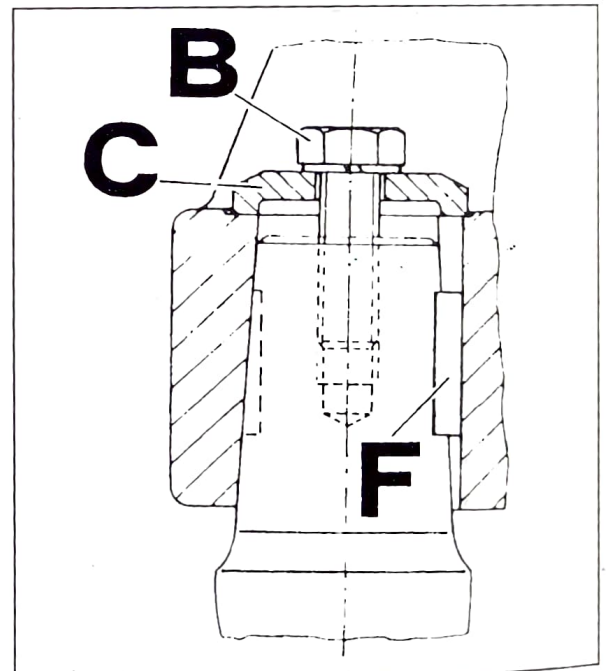
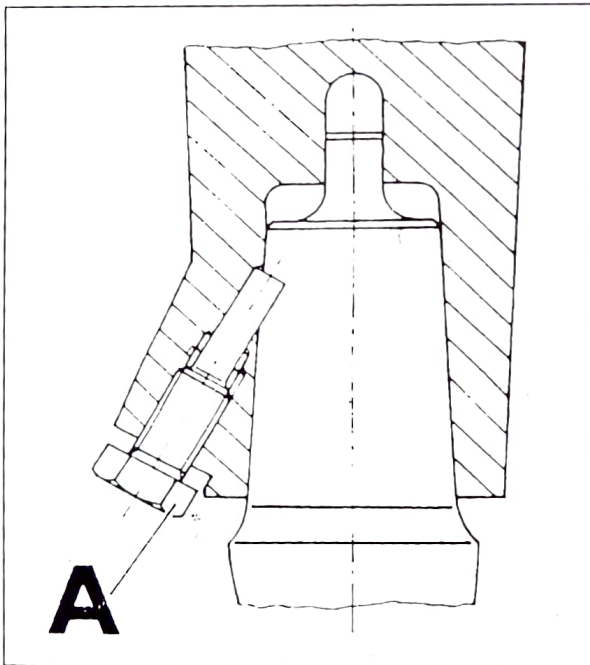
Before mounting Tynes degrease Cones of tynes and tyne-arms

Points and Crossing Tynes

Insert points and Crossing tynes right reading, with force into the tyne arm and tighten bolt "A".

Ke-type tyne

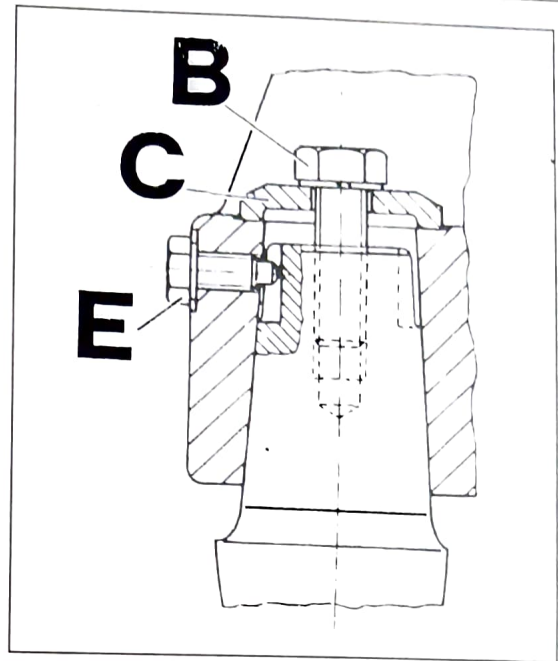
Insert tyne according tyne arrangement into tyne arm. Put disc "C" on top of tyne and fasten with screw "B".



Tyne-type with fitting screw

Insert tyne according tyne-arrangement.

Place tyne disc "C" and fasten with screw "B".



IMPORTANT:

Tighten screws "A, B and E" after tamping of 200-300 meters. From time to time check for tightness of screws respect tynes.

DISASSEMBLY OF TYNE

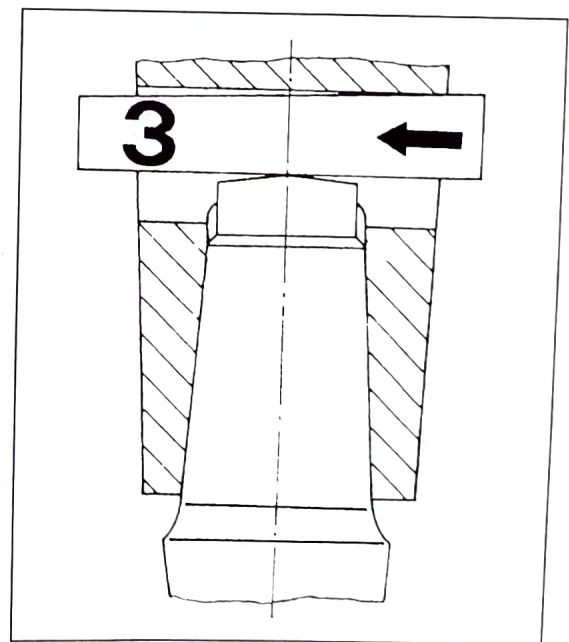
Points and Crossing tynes

Loosen screw "A". Insert wedge "3" with the rounded side upwards and remove the tyne.

ATTENTION:

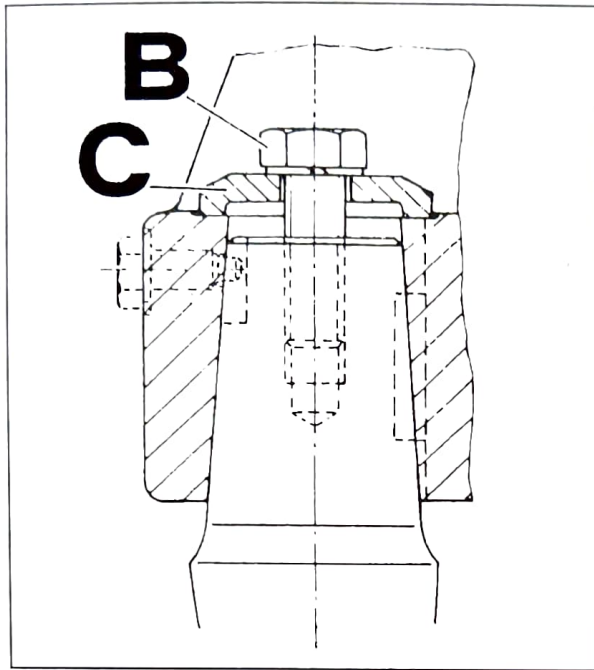
Beware of dropping tynes.

- danger of hurt.
- cone might be damaged.



Tyne-type tyne and fitting-screw type tyne.

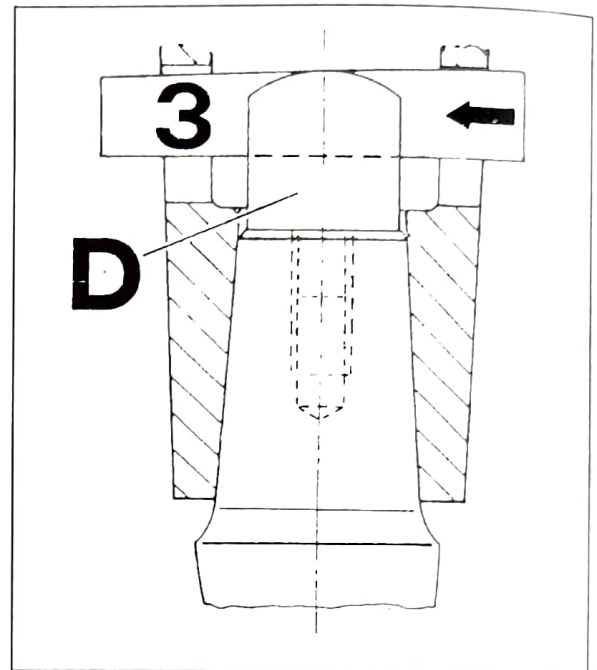
Loosen screw "B" and disc "C". Put in throust piece "D", insert wedge "3" with the rounded side upwards and remove the tyne.



ATTENTION :

Beware of dropping tynes.

- danger of hurt.
- cone might be damaged.



REGENERATION OF WORN OUT TYNES:

The faces and edges of the tamping tyne are subject to heavy strain. The rate of wear depends on type of ballast, size and compaction of the ballast bed.

For easier building up and retention of good tamping quality the wear should be 20% of the original size at most.

Worn out tynes may be regenerated by hard facing with highly wear resistant electrodes.

The attached drawings show the actual size of the various tyne plates. Those areas which are subject to most wear are shaded.

Armoring of new tamping tynes is made in the plant with BOHLER DUR 650-IG combined with inert gas

CORGON. The armor is applied with a charge (Approximately 5mm thick) to the areas which are subject to most wear.

OPERATING SEQUENCE

1. Pre-heating to 200°-300°C (392°-572°F) is recommended, but not essential.
2. The first layer should be made with BOHLER FOX A7; 3,25mm order 4mm Ø order 4mm Ø with D.C. POSITIVE, POLE. short arc.

Current: 3,25mm Ø 80 - 100 A
4,00mm Ø 110 - 130 A

3. Subsequent layers with BOHLER FOX DUE 600 or FOX DUR 600A, 4mm Ø

FOX DUR 600: with D.C. POSITIVE POLE
FOX DUE 600A: with D.C. POSITIVE POLE or A.C.
Current: 140 - 170 A

ATTENTION:

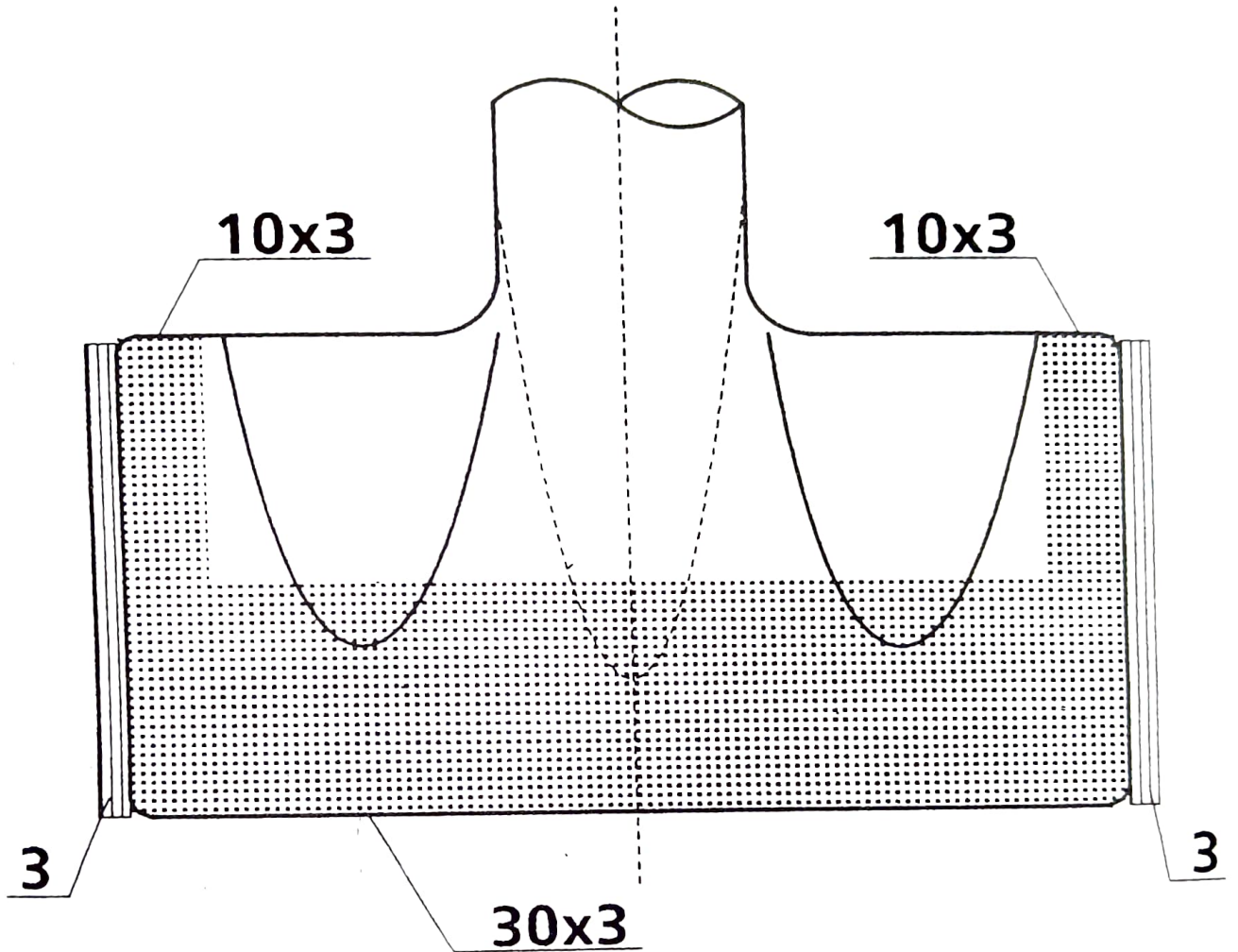
Take care to weld transitions, particular in the area of the tyne shaft, exactly. If necessary grind transitions.

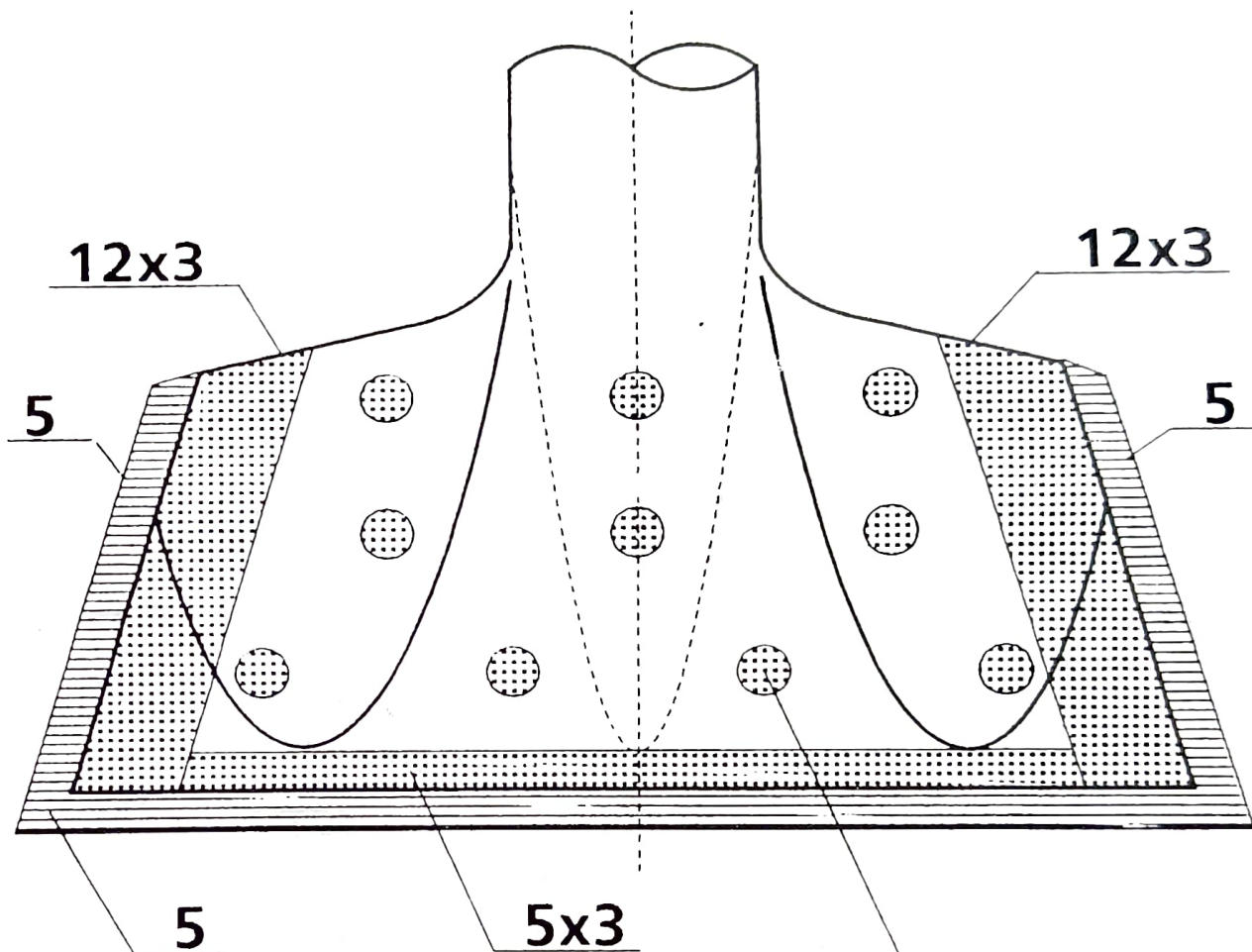
Remaining notches increase the danger of tearing and breaking.

4. To prevent tension cracks the tynes should be heat-treated subsequently. Anneal the tamping tyne at 500°C stress free for one hour. After annealing tyne, expose to ambient air-temperature.

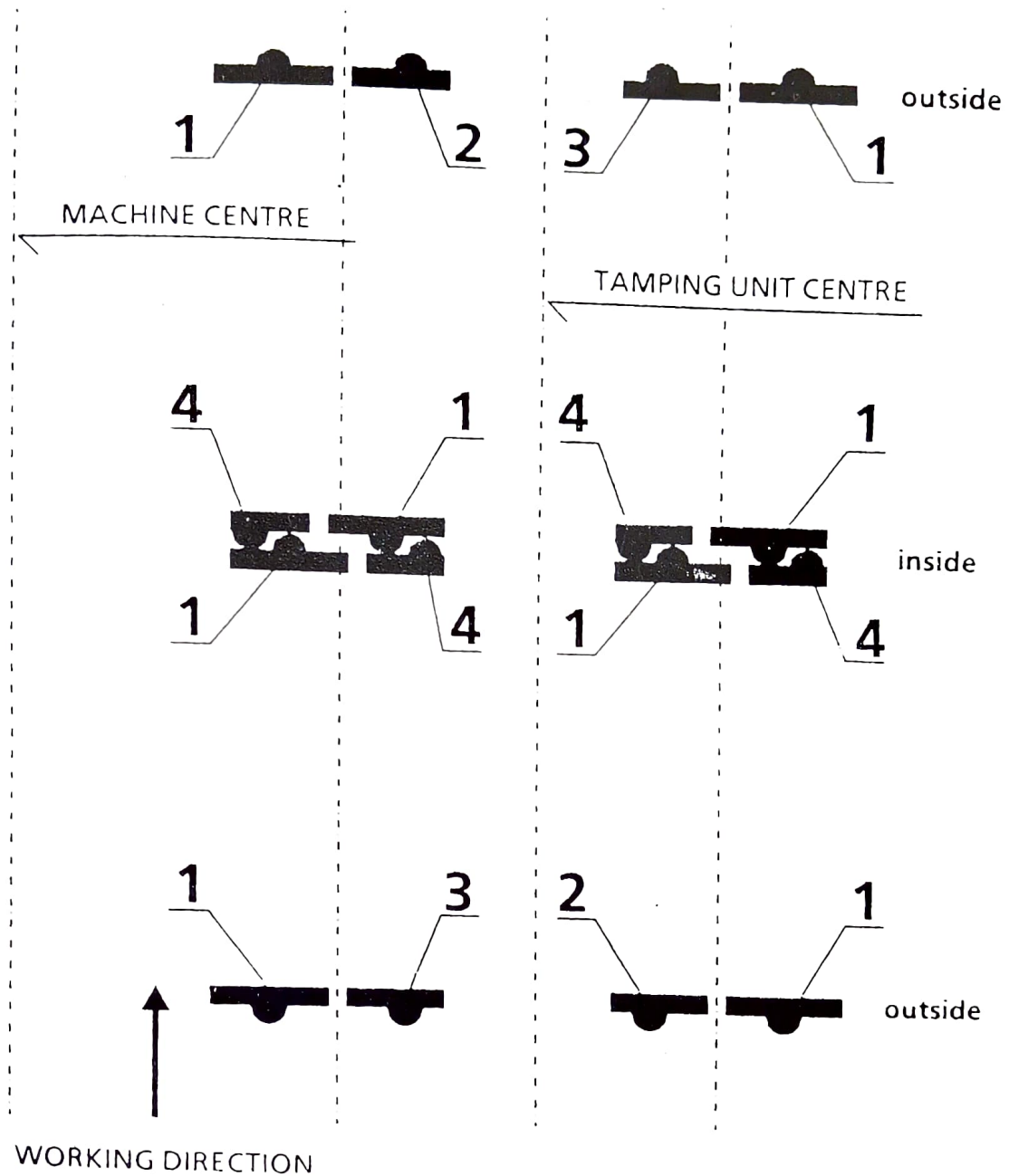
The following equivalent electrodes can be used, in case the BOHLER - electrodes are not available.

FOX A7	C	Si	Mn	Cr	Ni
Colour Code: silber	0,15	1,1	6,0	19,0	8,5%
Material No.: 4370					
DIN 8555: E-8-200 zrkn covered					
DIN 8556: E Kb 18 8 Mn 620+					
A WS-ASTM: E 307-15					
FOX DUR 600 Und DUR 600 A:	0,50	2,5	0,4	9,0	%
Colour Code: green					
Material No. 4718					
DIN 8555: E 6-60 covered					
FOX LEDURIT 60:	3,40 •	1,0	0,2	33,0	%
Colour Code L Lilac					
DIN 8555: E 10-60 recovered					
Welding wire DUR 650-IG:					
DIN 8555; SG 3 - Not covered					
Ø 1,2 mm					
Type: C 0,36: Cr 5,0; Mo 1,4 + W + V%					
Protecting gas CORGON consisting of: Argon S3, mixed gas and CO2.					

ARMOR - (FRONT and REAR)

ARMOR- FOR POINTS AND CROSSING TYNES (FRONT and REAR)

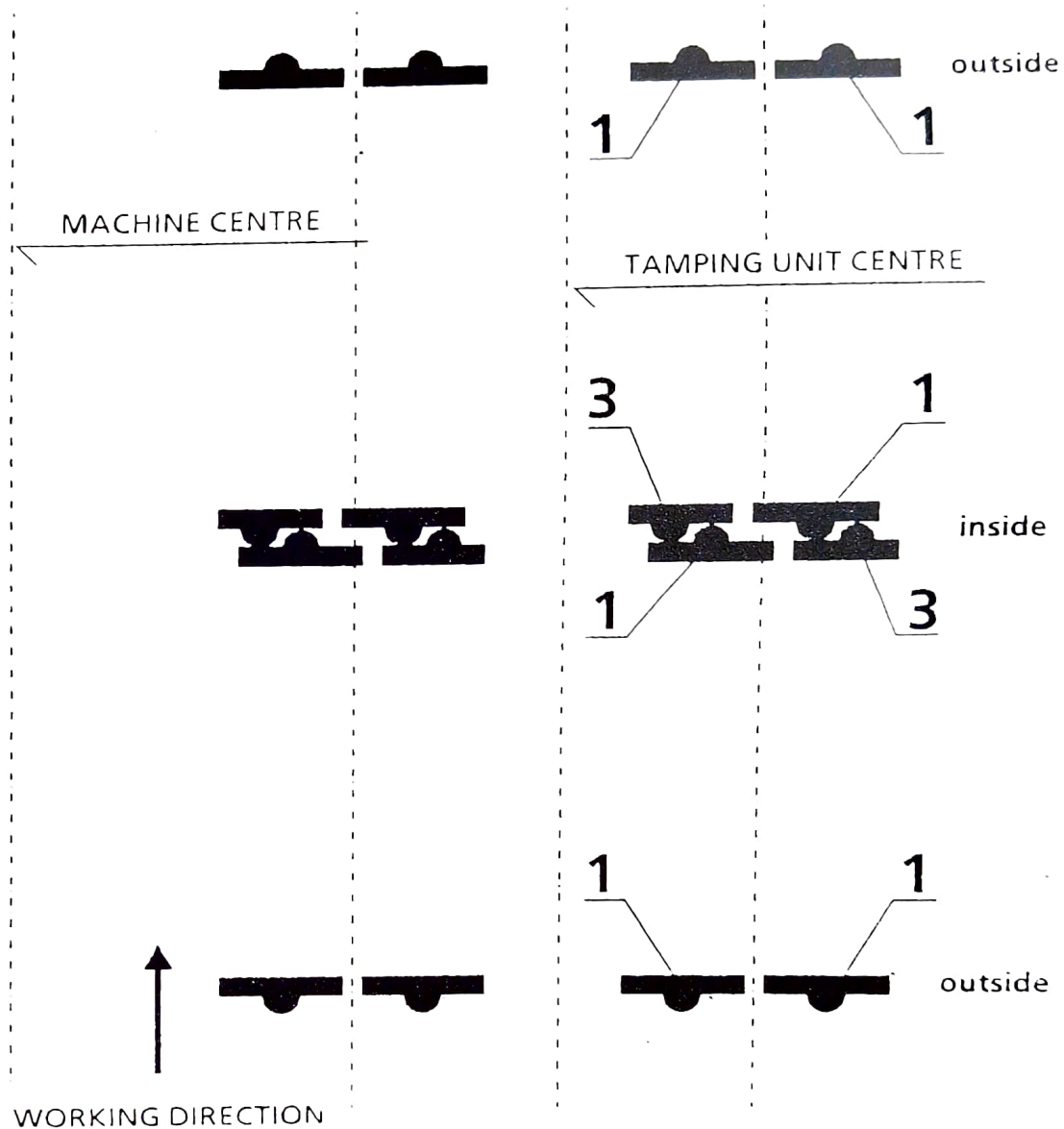
DUOMATIC - TYNE ARRANGEMENT (new)



Note:

Please take the present parts- respectively order numbers from the spare parts list.

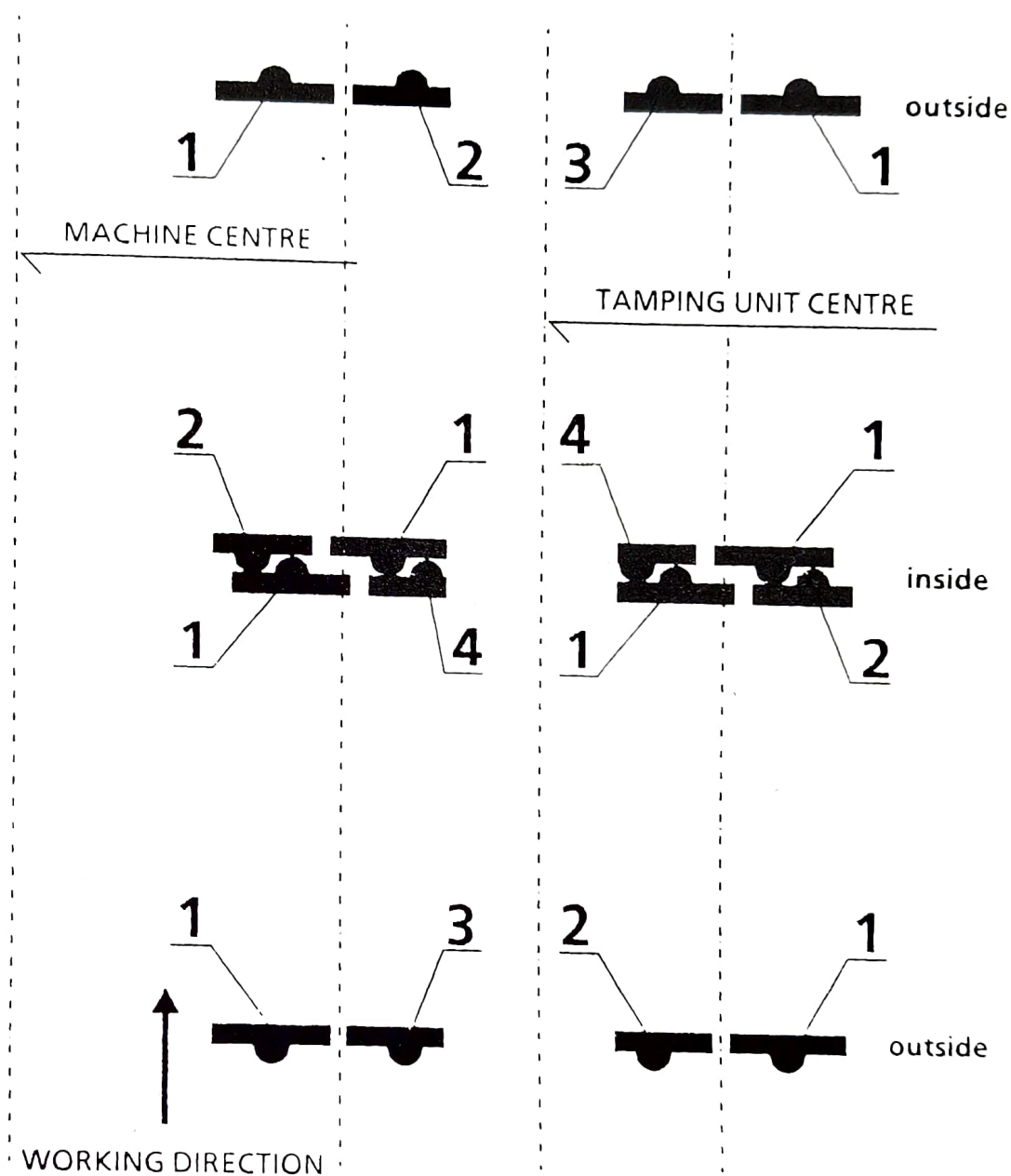
DUOMATIC - TYNE ARRANGEMENT (old)



Note:

Please take the present parts respectively order numbers from the spare parts list.

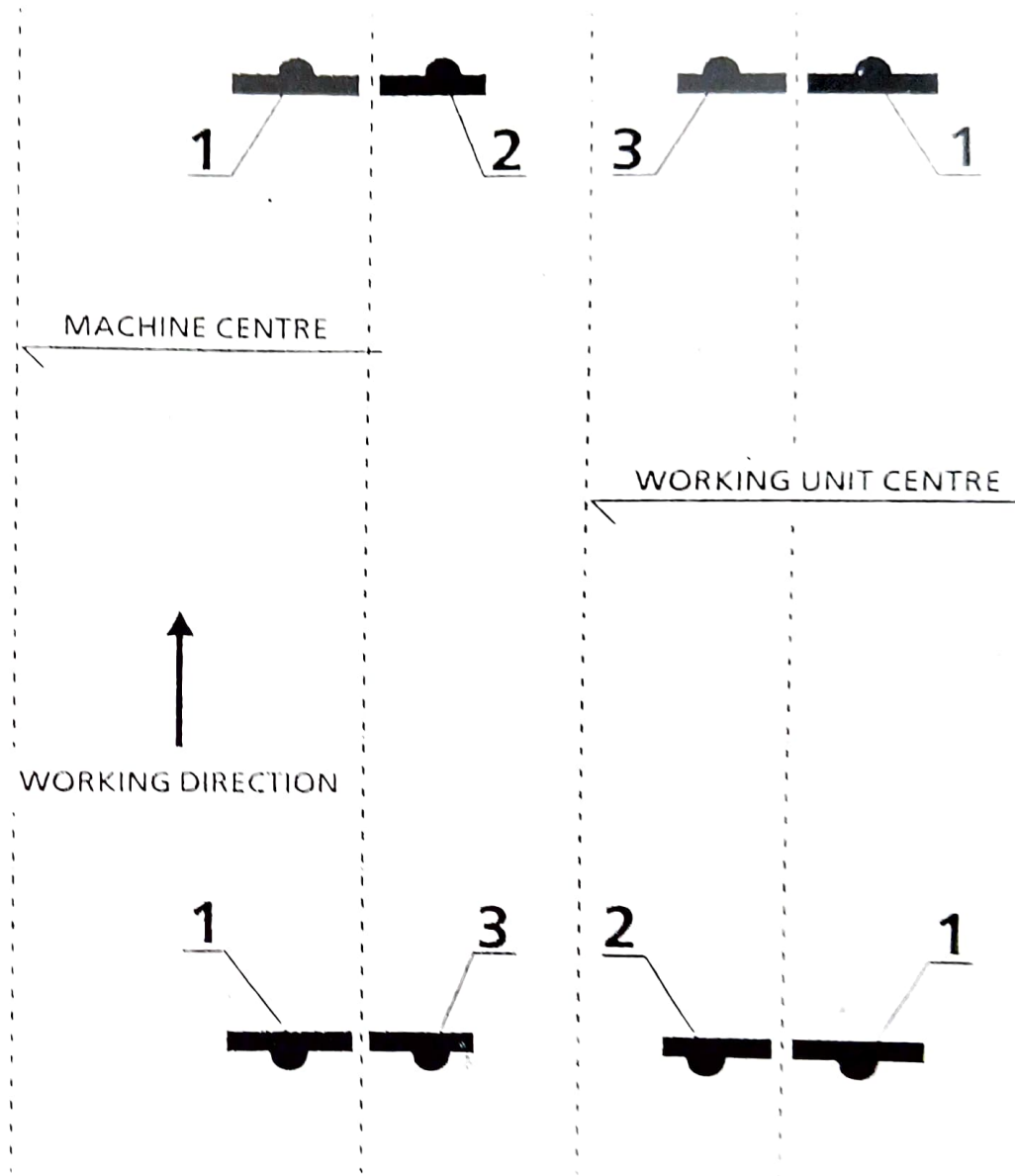
DUOMATIC - TYNE ARRANGEMENT (US-variant)



Note:

Please take the present parts respectively order numbers from the spare parts list.

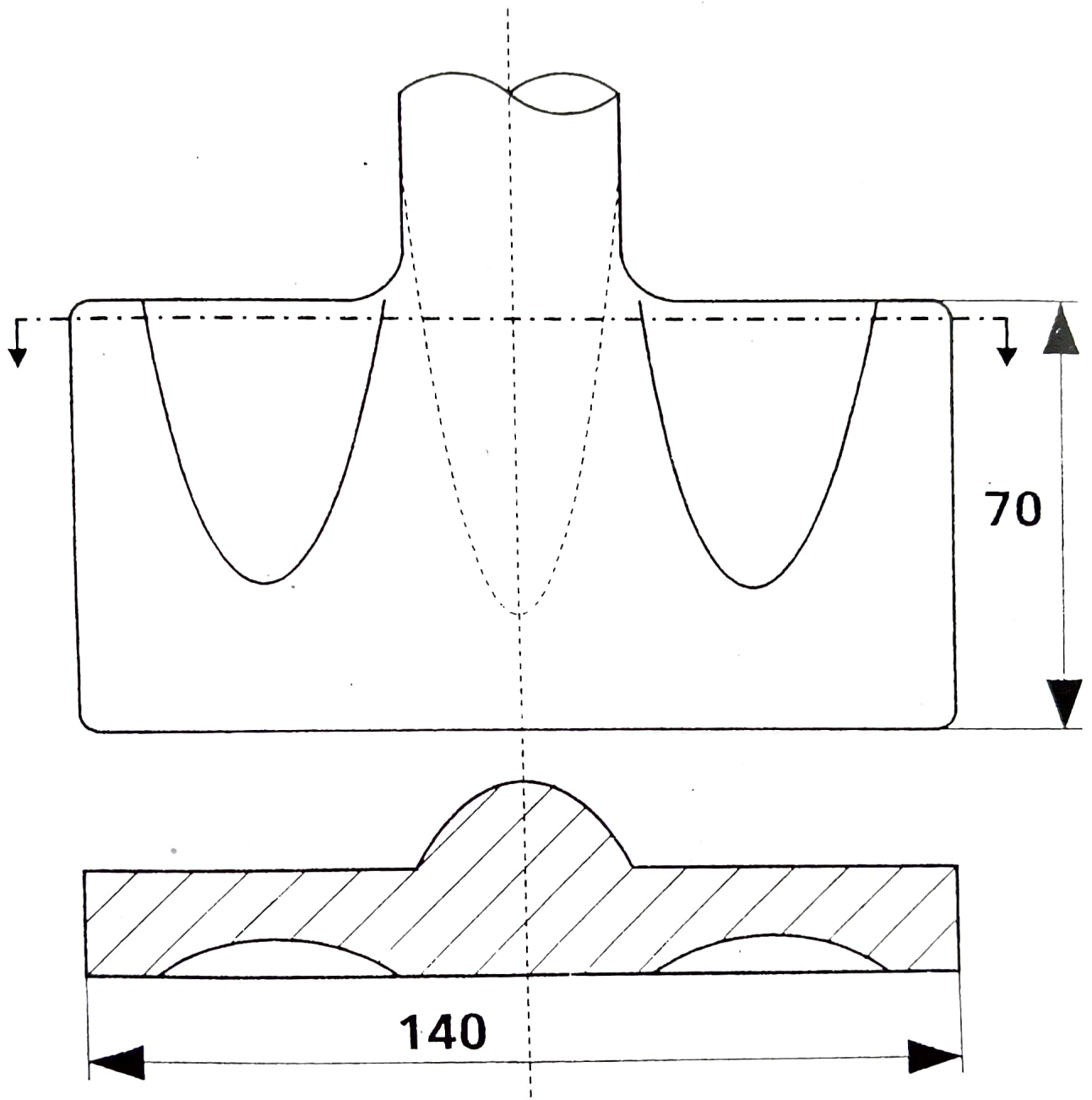
UNOMATIC - TYNE ARRANGEMENT



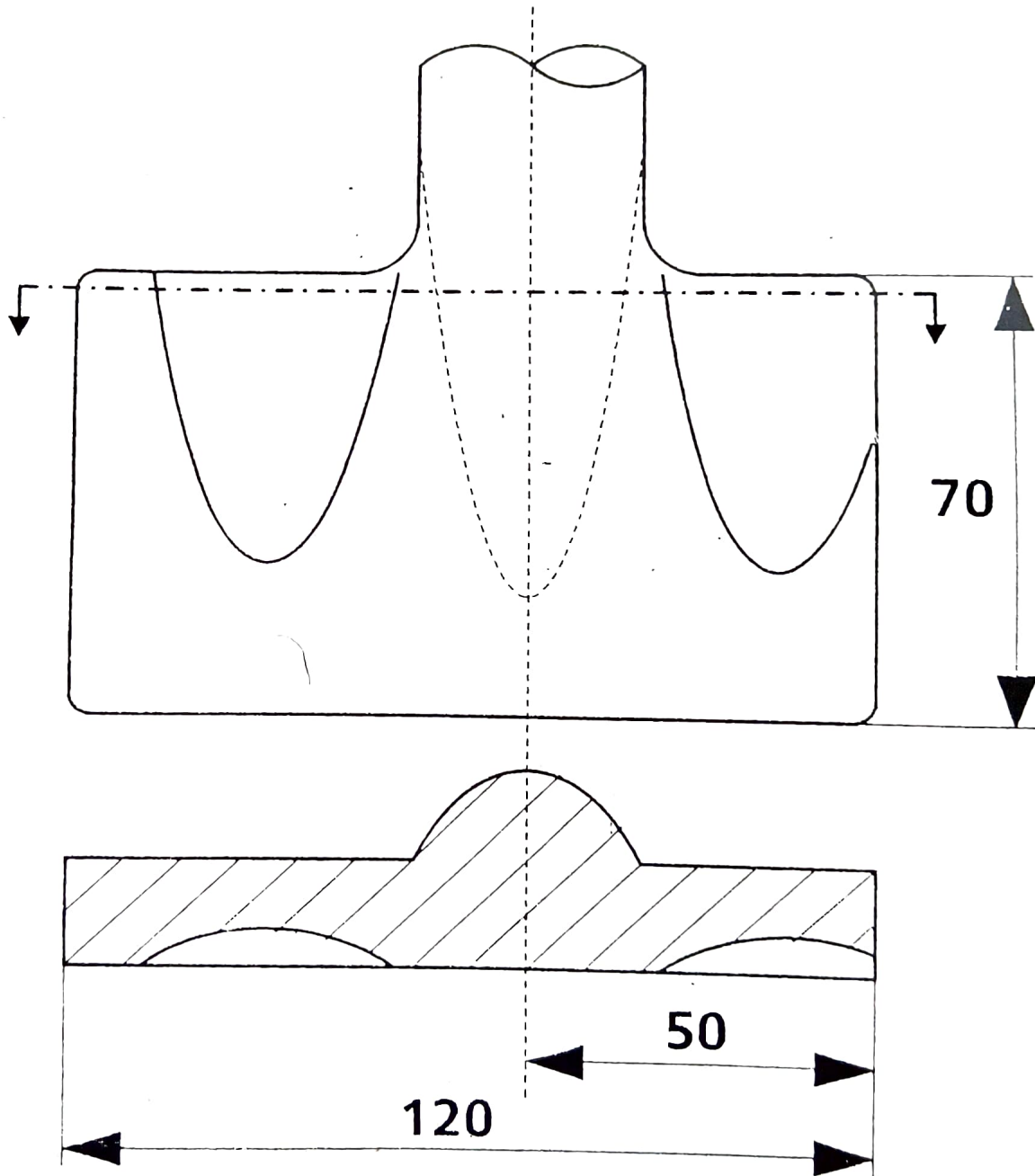
Note:

Please take the present parts respectively spare part numbers from the spare parts list.

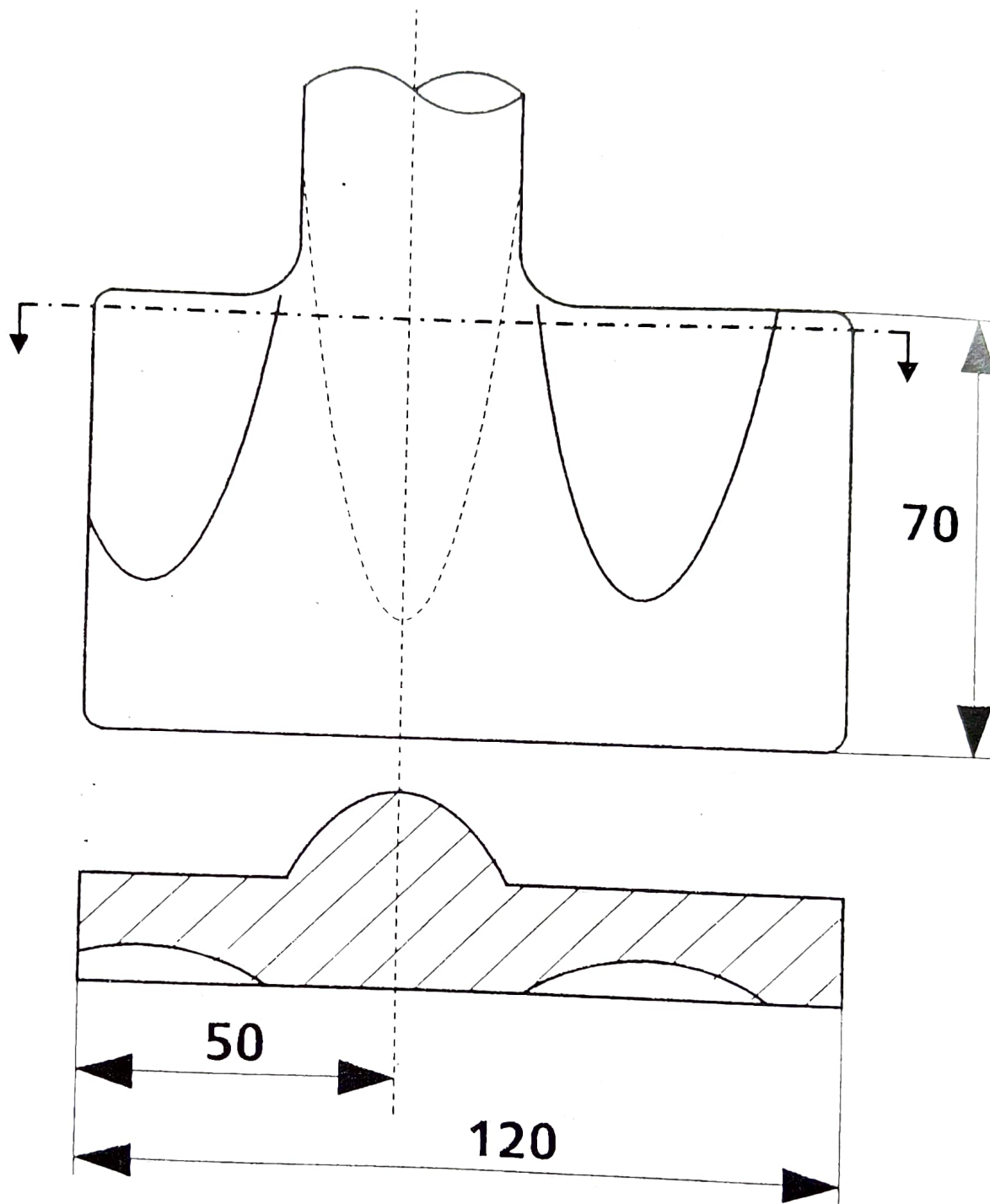
TYNE TYPE 1



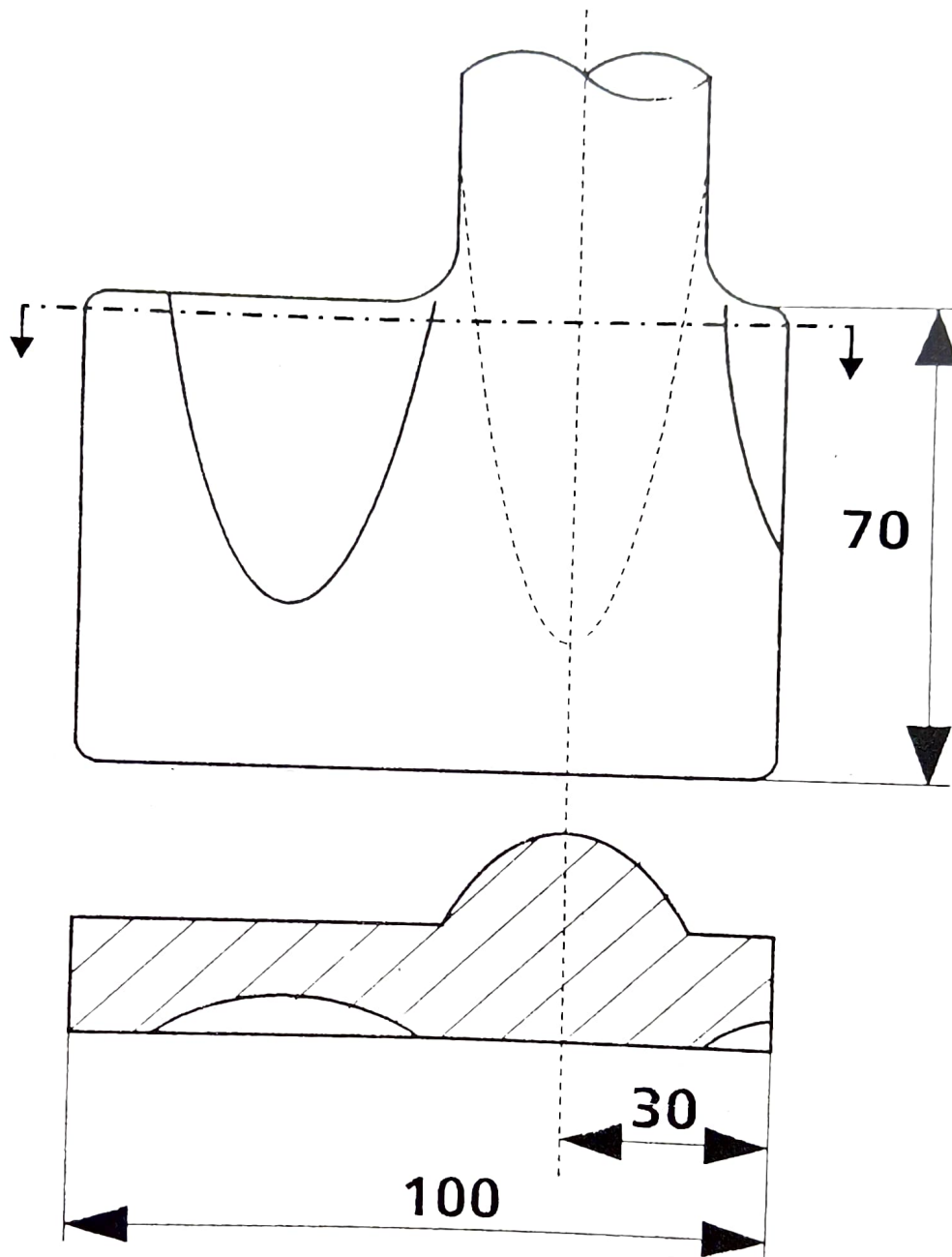
TYNE TYPE 2



TYNE TYPE 3



TYNE TYPE 4



EDITORIAL

Dear Reader,

Now 20th issue of IRTM digest is with you. It is your digest. Please contribute articles on Track Machines based on experience like improvement in operation. Maintenance overhauling & Quality Control

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Principal.



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