Steelwork Design for Power Units

Hans H. Faatz

1 Introduction

A hydraulic power unit comprises an unpressurized fluid tank, a motor-driven pump, control gear, accessories and interconnecting pipework. The various sub-assemblies of the unit can be arranged either separately or together It is common practice to mount the motor-driven pump, control gear and accessories such as coolers, filters and accumulators on top of the tank or on its sides. The supporting structures required are generally made of weldable materials, usually steel, more seldom aluminium. Plastics have not yet come into use for the supporting structures of hydraulic power units. Although it might not actually be made of steel, the supporting structure made of weldable materials is usually known as the "steelwork". The same basic principles that are applicable to the construction of ordinary steelwork are also applicable to the steelwork for hydraulic power units so generalities have been avoided in this chapter.

Instead, close attention is given to the design of steelwork suitable for welding because of the considerable importance of this subject in connection with hydraulic power units. The special aspects of the design of steelwork for hydraulic power units referring to the individual sub-assemblies which form the unit are also dealt with.

2 Design of steelwork suitable for welding

Suitability for welding is an important factor even at the initial design stage of steelwork. This also includes the selection of steels suitable for the type of welding to be employed. Form, dimensions, manufacturing conditions and operating conditions of the steelwork must also be taken into account.

2.1 Welding instructions on the drawings

Drawings should show clearly the nature of the finished structure. The standardized symbols listed in DIN 1910 to 1912 allow the designer to impart the necessary information in a form of shorthand. Due to the strain on the weld seams the design must specify in each case the form of joint, the method of welding and, if necessary, the filler metal to be used. In the case of fillet welds, the thickness must also be stated.

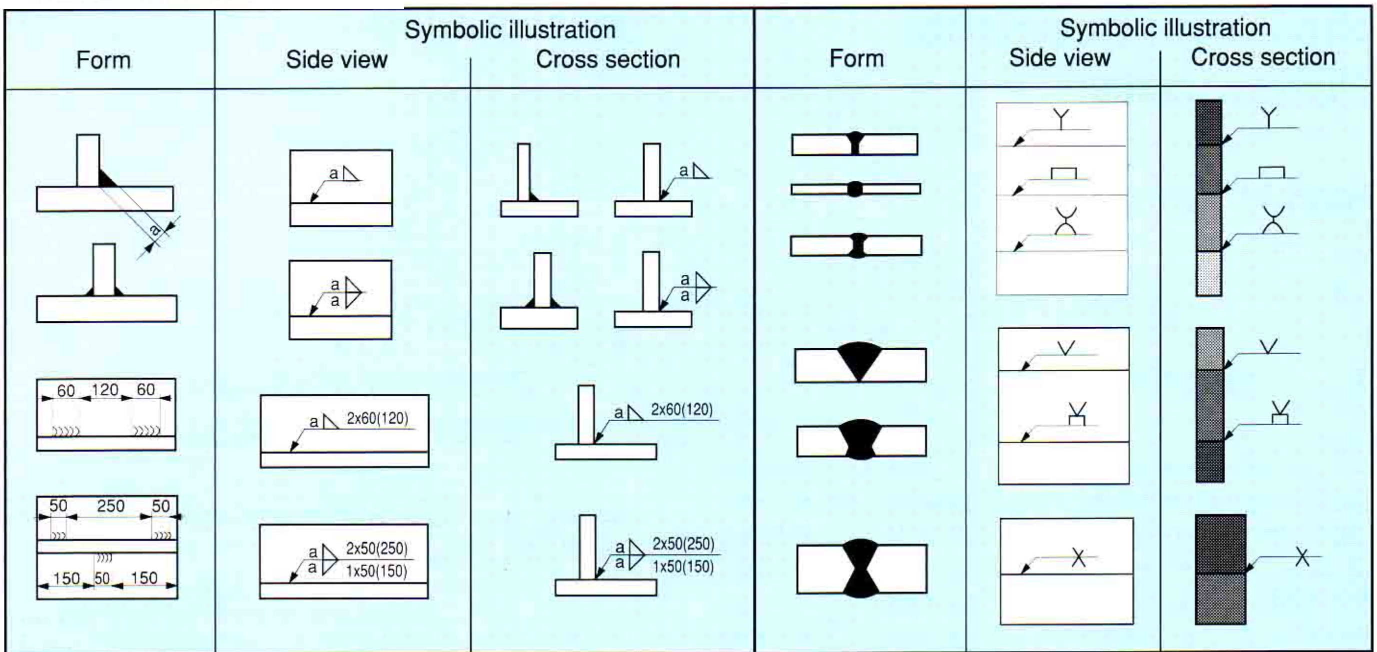
The symbols for the weld must be entered against each seam. The thickness of fillet welds must also be shown. Methods and soundness for welds and also the classes of weld quality can be tabulated on the drawings.

2.2 Weldability

The materials that are to be welded must be suitable for welding. Most steelwork for hydraulic power units is fabricated from steels of quality RST 37.2 to DIN 17100.

Stainless steel tanks are made of X5CRNI189 or X10RNITI189, Material Nos. 1.4301 or 1.4541 to DIN 17440.

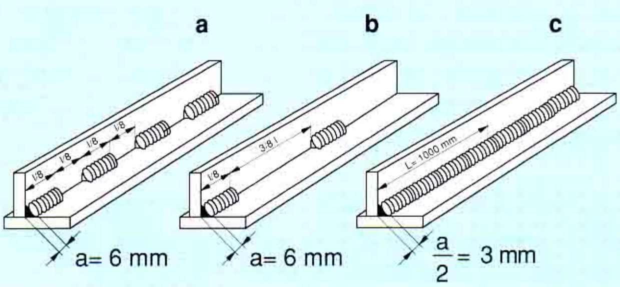
When special acceptance of materials is necessary the procedures must be agreed between contractor and principal.



Fillet welds
Assembly welds on site are identified by a small flag on the symbol

Butt welds
U-welds and other special forms are drawn to full scale

Fig. 98: *Symbols for workshop drawings for the principal forms of welds (further details will be found in DIN 1912)*



	Area under stress	Amount of weld material
a	$\frac{a\,l}{2} = 3000\ mm^2$	$\frac{a^2\,l}{2} = 18000\ mm^2$
b	$\frac{a\,l}{4} = 1500\ mm^2$	$\frac{a^2\,l}{4} = 9000\ mm^2$
c	$\frac{a\,l}{2} = 3000\ mm^2$	$\frac{a^2\,l}{4} = 9000\ mm^2$

Fig. 99: *Comparison of intermittent and continuous fillet welds*

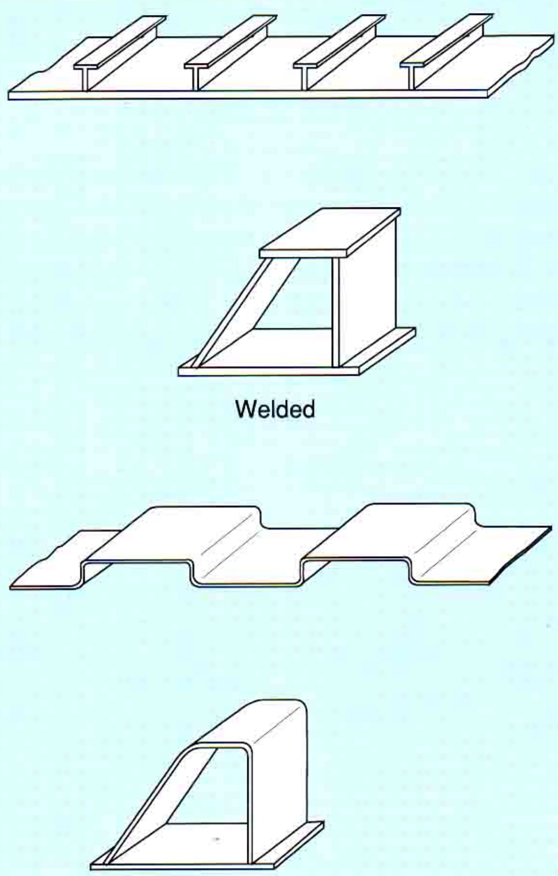
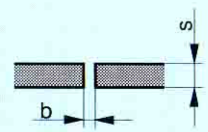
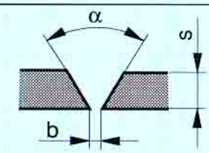
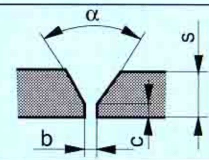
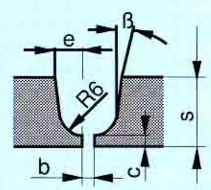
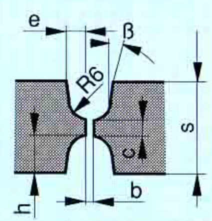


Fig. 100: *Bending can save on welds*

Thickness of workpiece	Form	Description	Symbol 1)	Section through groove	Dimensions: Degrees 2) α, β	Dimensions: Gap 3) b	Dimensions: Root face c	Dimensions: Throat depth h	Welding method 4)	Remarks
< 4	one side	Plain butt weld	||		—	≈ s	—	—	G, E, TIG 5)	—
					—	0 < s	—	—	MIG, MAG	Up to 8 mm with backing-up.
< 8	both sides 6)				—	≈ s/2	—	—	E, TIG 5)	—
					—	0 < s/2	—	—	MIG, MAG	—
3 < 10	one side or both sides	Single-V butt weld	V		≈ 60	0 < 3	—	—	G	With back-up seam and larger gap if necessary.
3 < 40					≈ 60				E, TIG 5)	
					40 < 60				MIG, MAG	
10 <	both sides 6)	Single-V butt weld with root faces	Y		≈ 60	0 < 3	2 < 4	—	E, TIG 5)	Also for thinner work and G in special cases.
					40 < 60				MIG, MAG	
12 <	one side or both sides 6)	Single-U butt weld			≈ 8	0 < 3	≈ 3	—	E, TIG 5) MIG, MAG	Root also with e= 4.6 + 0.14 s, when c= 4 mm and β= 8°.
30 <	both sides 6)	Double-U butt weld			≈ 8	0 < 3	≈ 3	≈ s/2	E, TIG 5) MIG, MAG	This type of groove can also have different throat thicknesses like the 2/3 double-V butt weld. e= 5 + 0.1 s, when c= 3 mm and β= 8°.

1) For any supplementary symbols see DIN 1912, Part 5
2) For welding in position q (horizontal in vertical plane) also larger and/or asymmetrical welds
3) The given dimensions refer to the tacked state. The best gap depends on the welding position and method of welding
4) E = Manual arc welding, G = Gas welding, MIG = Shielded-arc welding, MAG = Metal active gas welding, TIG = Inert-gas tungsten arc welding
5) With TIG welding, protection against oxidation and backing-up with an inert gas such as anti-slag gas may be necessary (see DIN 32 526 in preparation)
6) Root cut-out and backing run deposited if necessary

Table 36: *Types of grooves and chamfers for butt welds in steelwork (extract from DIN 8551, Part 1)*

2.3 Economy in the use of welding

Designers should always attempt to keep the number of seams, the seam cross section and seam length to a minimum in order to save unnecessary welding work. Cutting away corners in places where there are no forces to be transmitted can also save work and, therefore, money.

For butt weld preparation the type of groove must be shown on the drawing. The actual shape of the groove depends on the type and size of the workpiece, the welding process, the number of passes and the equipment. Shielded-arc welding (MIG, MAG) and manual arc welding are most common in the manufacture of steelwork for hydraulic power units.

In the case of fillet welds it can often be sensible to employ intermittent seams, although the operating conditions of the finished item must be taken into account. Intermittent fillet welds are not allowed on hydraulic power units used in civil engineering or inside tanks. In order to give an intermittent fillet weld the same fracture area as a continuous weld, the seam must be twice as thick if the interruptions are as long as the bead. But this is not an economical solution to the problem. Therefore, intermittent seams should only be used where there are no large forces to be transmitted, such as with stiffeners. In this case the intermittent welding has the advantage that shrinkage and distortion is less.

As calculations for strength of steelwork are seldom carried out for hydraulic power units, the designer must specify the minimum weld thickness from experience. Weld seams should always be easily accessible. Special care must be taken at the design stage when welding together bent plate.

Weld seams should also always be positioned at points of minimum stress and variations in cross section between the parts should be avoided.

Box sections are to be preferred over flat sections because of their greater static and dynamic stiffness. In the case of hydraulic power units, however, it is important for the box to remain totally closed so that no corrosion can occur inside.

The designer must see whether welds can be saved through bending or folding *(Fig. 100)*. Bending is generally cheaper and stronger than welding.

2.4 Ensuring soundness of welding

The soundness of welds can be assessed according to DIN 8563, Part 3. This DIN standard divides butt welds and fillet welds into qualification classes, giving details of how permissible external and internal faults are to be assessed. Qualification classes DS and CK are sufficient for hydraulic steelwork.

3 Design of hydraulic power units

The design of hydraulic power units must take into account the special needs of fluid technology. The arrangement of the equipment must promote easy maintenance and there must be good accessibility to threaded pipe fittings. The relevant standards such as DIN 24 346, special company specifications and component manufacturers' maintenance instructions must also be adhered to.

In order to allow economic manufacture, sub-assemblies or parts or parts of sub-assemblies should be standardized in company specifications.

Hydraulic power unit design should be based on the model hydraulic circuit diagram and parts lists to DIN 24 347 .

The hydraulic circuit diagram to DIN 24 347 indicates:

- the energy flow of the hydraulic fluid
- the pressure settings
- the pipe sizes.

The parts list must contain all the components in the hydraulic circuit diagram with precise details of type, supplier or manufacturer.

3.1 Procedure

The basic guidelines of design theory also apply to hydraulic power units. The method described in VDI 2221 can therefore, for example, also be applied *(Fig. 101)*.

There are often numerous aids available to the designer such as stick-on symbols for pumps, motors and valves and template drawings for tanks and motor/pump units. The gradual spread of CAD systems is also proving of great benefit to hydraulics designers, especially systems that will run on medium-size computers or personal computers.

3.2 Special aspects of hydraulic power unit design

In addition to the standard rules of design theory there are also a number of special aspects to be taken into account in the design of hydraulic power units. They vary according to the application and type of equipment and are dealt with separately in each case.

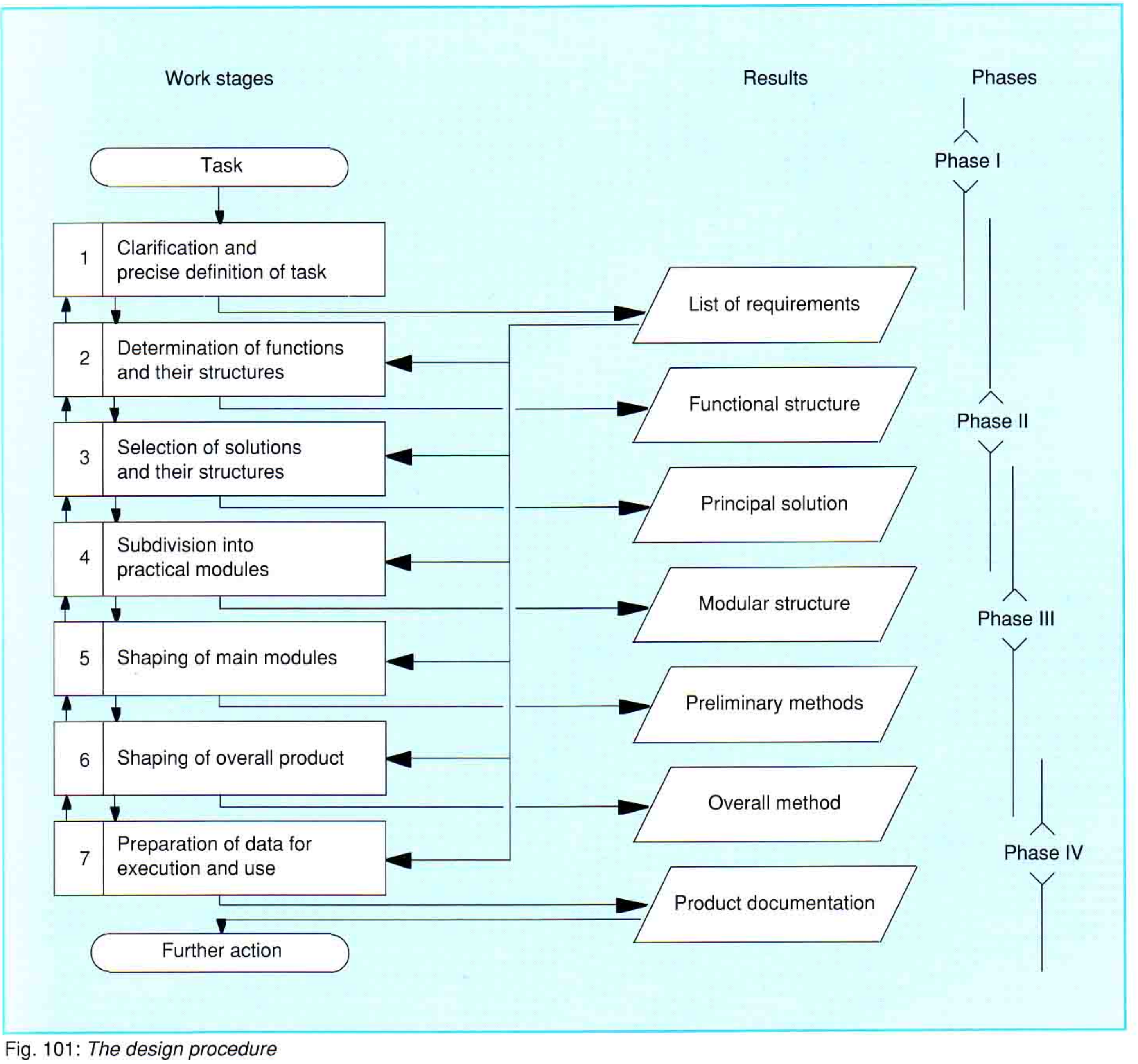


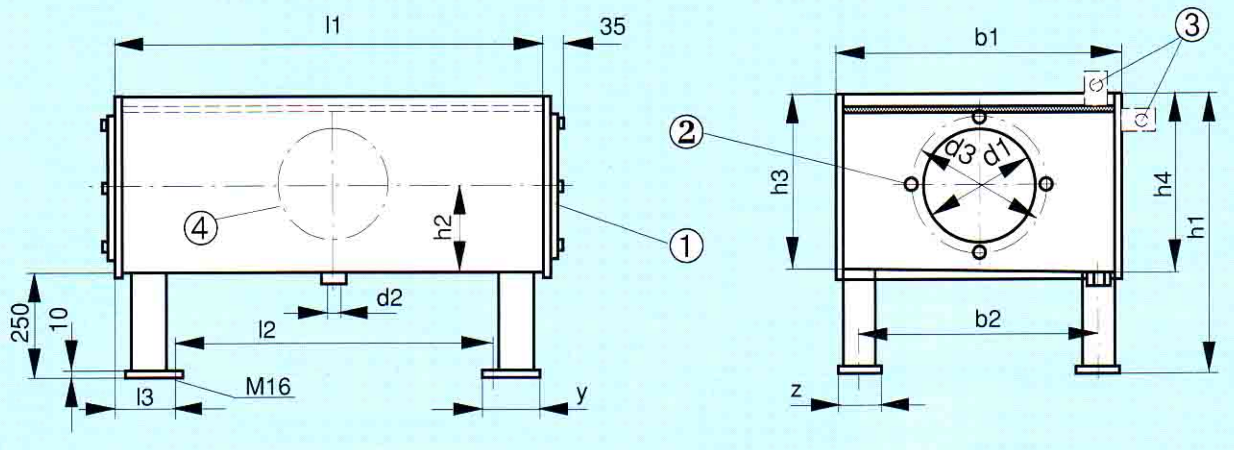
Fig. 101: *The design procedure*

4 Sub-assemblies

4.1 Oil tanks

Unpressurized oil tanks (generally termed oil tanks although often containing other operating fluids) are normally used in hydraulic systems. They should be of sufficient size to accommodate all the fluid in the system when there are no devices in the circuit, such as automatic check valves, which prevent back-flow of the fluid to the tank. The tank volume should be at least equal to or greater than three times the delivery/minute of the hydraulic pumps. This applies to systems operated with mineral oil-based fluids. If a different type of fluid is being used, such as a fire-resistant fluid, the tank volume must be 5 to 8 times the flow/minute of the hydraulic pump, depending on the air-separation and dirt-settling characteristics.

Aluminium is normally used for tanks of up to about 63 L capacity. Above that size they are made of steel plate. For machine tools the steel tanks are rectangular and comply to DIN 24 339 which also standardizes the tank connections. Rectangular tanks with flat reinforced or corrugated sides are used on presses and foundry machinery. Steelworks and rolling mill installations normally use cylindrical tanks.



1 Two for sizes 160 to 1000
2 6 Fixing bolts from size 630
3 Lifting lugs, 50 dia.
4 One only for sizes 63 and 100

Size	b1	b2	d1	d2	d3	h1	h2	h3	h4	l1	l2	l3	y	z	Effective capacity in L
63	365	285	248	G 1	324	660	205	397	409	508	308	100	115	80	60
100	460	360	248	G 1	324	660	205	397	409	633	393	120	135	100	95
160	590	490	248	G 1	324	660	205	397	409	810	570	120	135	100	156
250	690	590	248	G 1	324	680	215	417	429	1010	770	120	135	100	241
400	735	635	248	G 1	324	680	215	417	429	1514	1274	120	135	100	387
630	945	845	383	G 1	449	770	265	502	519	1514	1274	120	135	100	622
800	900	800	383	G 1	449	770	265	502	519	2014	1774	120	135	100	790
1000	1065	965	383	G 1	449	800	285	527	549	2014	1774	120	135	100	993

Fig. 102: *Principal dimensions of rectangular oil tanks in steel similar to DIN 24 339*

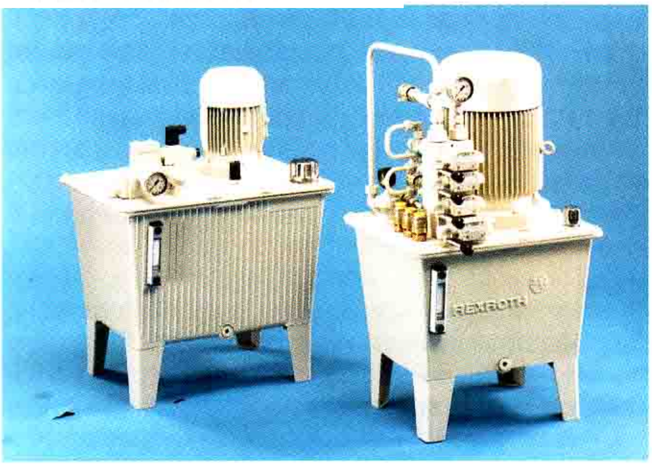


Fig. 103: *Aluminium tanks*

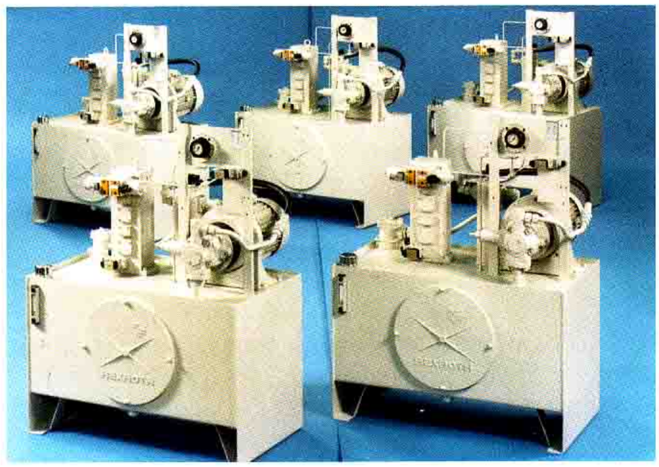


Fig. 104: *Steel tanks*

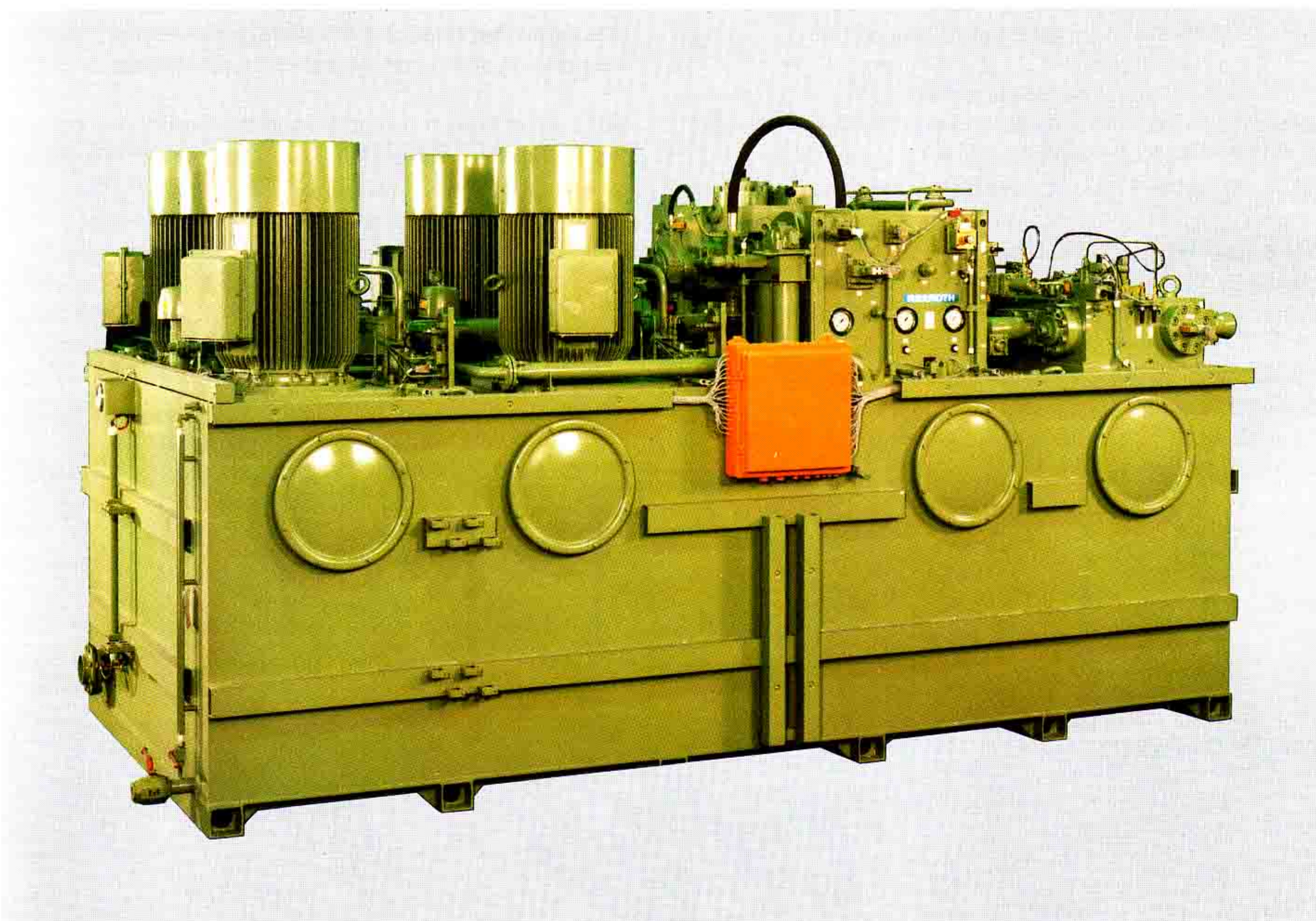


Fig. 105: *16 000 litre tank*

Any air entrained in the hydraulic fluid should be able to escape from it within the tank. Suction and return lines should therefore be kept as far apart as possible. The flow velocity in the tank itself should be as low as possible to allow any dirt suspended in the fluid to settle out. Access holes of adequate size must therefore also be provided, so that the inside of the tank can be inspected and cleaned from time to time.

In the case of tanks with a capacity over 1000 L it is a good idea to have a fully welded separator plate with an overflow between the suction and return chambers. In such cases, of course, the two chambers would have to be drained and cleaned separately.

Instead of this type of separator plate it is also possible to have a permeable separator which can be made of expanded metal. Placing this type of separator at an angle improves the air separation. Even with this design there should at least be a fully welded separator plate in the lower part of the tank in order to prevent dirt being carried from the return chamber along to the suction chamber.

The tank itself is often used as the supporting structure for other components such as the complete motor-driven pump set and/or the control gear. This sometimes makes it necessary to stiffen the sides of the tank. The simplest way of doing this is by means of pressed corrugations which have the advantage of needing no welding.

Sometimes it is necessary to weld in stiffening plates. In their simplest form they are flat plates welded to the tank sides at each end with continuous fillet seams.

If flat plates provide insufficient stiffening the usual alternative is to use welded U-sections. Here too the U-section must be seal-welded to the tank so that any dirt inside the section cannot get into the hydraulic fluid.

When welding in stiffening ribs take care to avoid accumulations of seams and dirt traps in corners. The interior of the tank must always be easy to clean thoroughly.

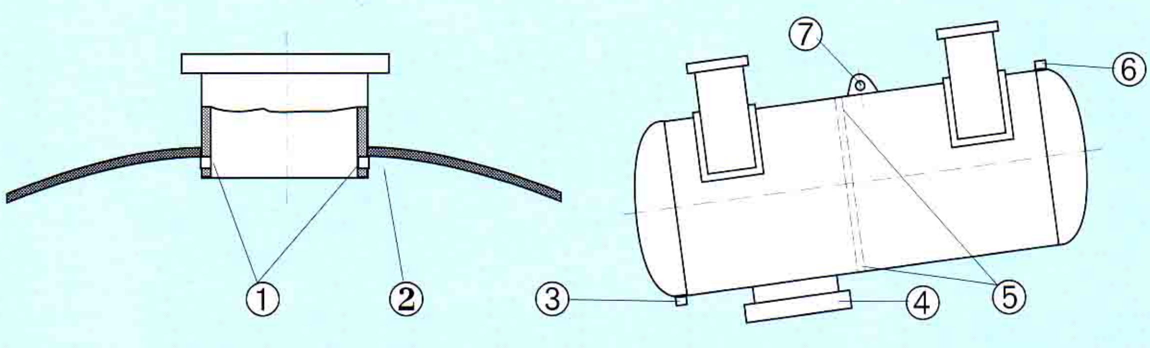
If tanks are to be hot-galvanized, good accessibility to the interior is essential. The interior must be ventilated during the process so vent holes and drain holes must be provided in the various parts.

Spray-galvanizing has only limited application to hydraulic tanks. Its advantage is that tanks can still be galvanized although they will not fit into a galvanizing bath. However, the zinc can only be sprayed on to bright metal surfaces which means that parts to which access is poor will generally receive insufficient galvanizing and, at the other end of the scale, the zinc peels off easily if it is applied too thickly.

When galvanizing hydraulic tanks in a bath ensure that the bath temperature is approximately 480°C because this will relieve any welding stresses in the steel plate which could otherwise cause distortion of the tank. For this reason alone it can sometimes be necessary to stiffen the tank sides. The zinc in the tank and in other voids must be able to run away quickly and without any major drop in temperature. The size of galvanizing bath available and the method of dipping must be taken into account when finalizing the design. Additional points of suspension should be provided for this purpose.

Steel tanks are sand-blasted and the interior primed with zinc-rich paint before the cover is welded on. This paint is resistant to most hydraulic fluids and also offers adequate protection against corrosion.

For systems containing servo valves the tanks are often specified in stainless steel. The same design principles apply to these tanks as to those made of carbon steel. A careful check should be made to see whether the thickness of the sides can be reduced. Welds between austenitic steels and carbon steels should be avoided.
Tanks made of stainless materials should be pickled after manufacture and no painting is necessary.



1 Drain holes
2 Critical zone
3 Extra drain
4 Main drain
5 Apertures in separator plate
6 Vent
7 Lifting lug

Fig. 106: *Additional features for galvanizing a cylindrical fluid tank in a bath*

With larger tanks the design must also take into account the fact that their length will change with variations in temperature. Therefore, cylindrical tanks must have one fixed support and one sliding support *(see Fig. 107)*.

Hydraulic tanks must not only allow none of their contents to escape outwards, they must also prevent any dirt gaining access to them. This is particularly important in the case of rectangular tanks having the top part in the form of a drip tray. Any necessary openings through the tank, e.g. pipe connections, filter connections and pump connections, must be carefully sealed and tightened. Rubber-cork compounds are suitable as sealing materials. They must be flexible and/or thick enough to compensate for any small unevenness in the structure and must be resistant to the particular fluid being used. Sealing surfaces must be flat and clean and the pitch of the fixing bolts must be close enough to ensure a good seal.

Capacity L	d	l1	l2	b1	b2	a1	a2
1000	1000	1510	765	200	150	750	600
1500	1000	2050	1400	200	150	750	600
2000	1250	1830	1100	200	150	950	800
3000	1250	2740	1920	200	150	950	800
4000	1250	3490	2740	200	150	950	800
4000	1600	2230	1280	350	300	1200	1050
5000	1600	2820	1770	350	300	1200	1050
6000	1600	3260	2250	350	300	1200	1050
7000	1600	3740	2770	350	300	1200	1050
10000	1600	5350	4290	350	300	1200	1050
13000	1600	6960	5625	525	475	1150	1000
16000	2000	5550	4210	600	550	1750	1600
20000	2000	6960	5395	600	550	1750	1600

1 Fluid level gauge
2 Filler and breather
3 Overflow
4 Lifting lug
5 Inside diameter 500
6 Drain cock G2
7 Fixed support
8 Sliding support

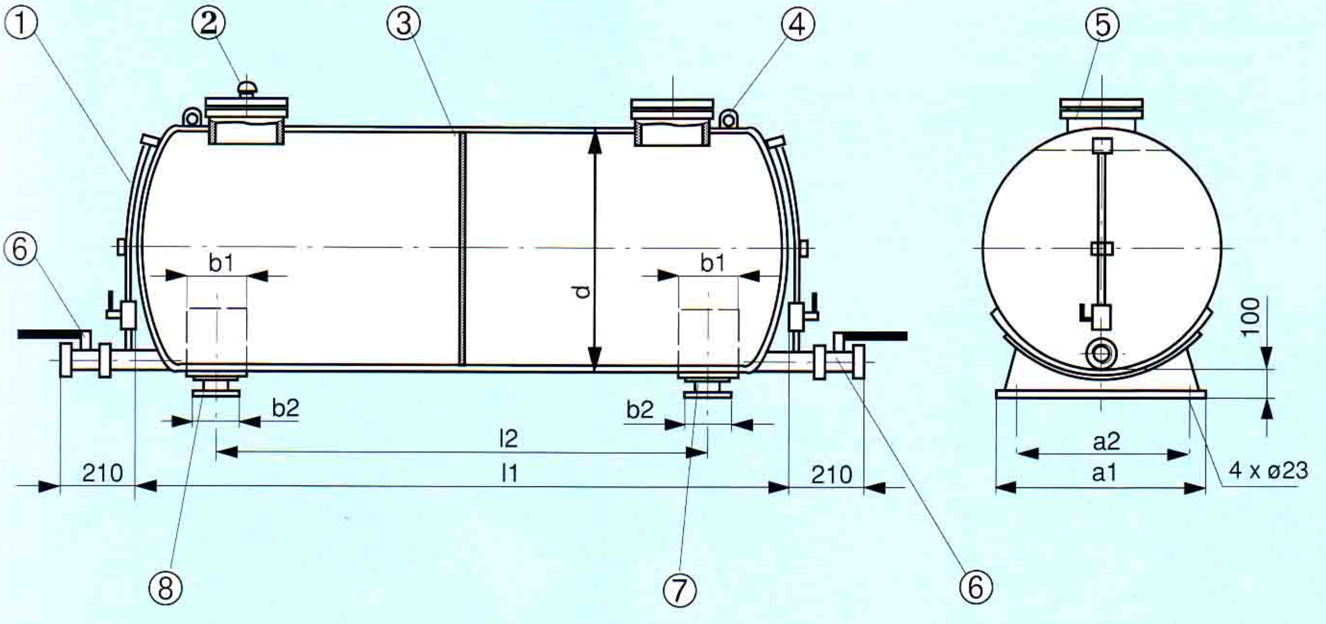


Fig. 107: *Principal dimensions of steel cylindrical fluid tanks*

4.2 Motor-pump sets

The motor-pump set of a hydraulic power unit converts electrical energy into hydraulic energy. Other common names for motor-pump sets are pump unit, pump set, motor-pump unit and others.

The designations for the mounting arrangement of the electric motor is also used for the motor-pump set itself, e.g. V1, B3, B5 or B3/B5.

In the case of types of mounting arrangements V1, B5 and B3/B5 the torque is taken by the bellhousing, which means that the torque forces are kept as short as possible.

Structure-borne noise is isolated by damping rings immediately behind the pump. The rings must be specifically designed for particular pumps.

The various components such as bellhousings with or without damping ring, foot brackets, couplings and mounting plates are normal commercial items.

Types of construction V1, B5 and B3/B5 are preferred because the inherent alignment of pump and motor shaft prevents any misalignment at the coupling and the tedious process of coupling alignment is eliminated.

The coupling manufacturer provides a small screw in the feather key to prevent the couplings sliding along the shaft. This is adequate for motor-pump assemblies of ratings up to about 15 kW. With more powerful motors both half-couplings should be secured with a retaining disc. This type of attachment is always sensible with the V1 type of construction, at least for the upper half-coupling.

Ensure that the gap between the half-couplings is correct when assembling the unit.

In the case of mounting arrangement B3, motor and pump are mounted on a common chassis. The pump is usually attached to a bracket. The common chassis transmits torque and transmission forces and so must be designed to prevent the forces causing any relative movement between motor and pump.

A simple frame made of flat steel plate is sufficient for electric motors up to Size 180. The mounting bracket can be welded to the frame.

For motor Sizes 200 to 315 the simple construction will have to be stiffened by additional welded angle sections or flat sections.

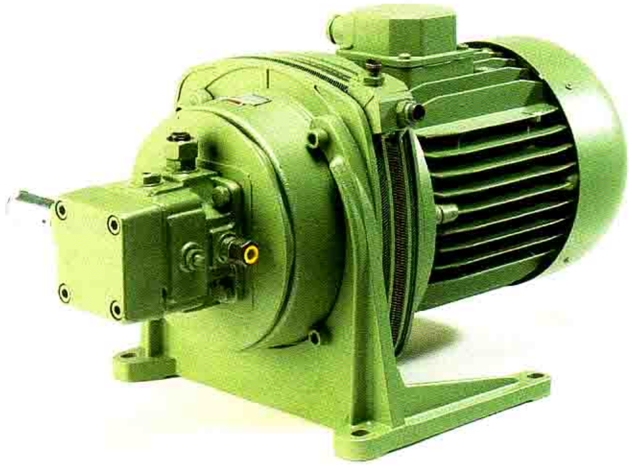


Fig. 108: *Motor-pump set*

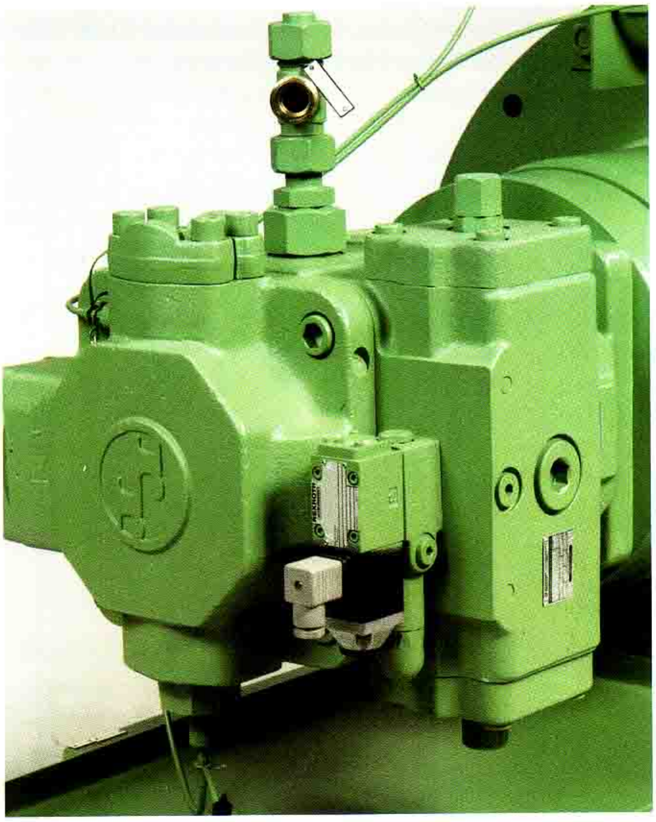


Fig. 109: *Motor-pump set*

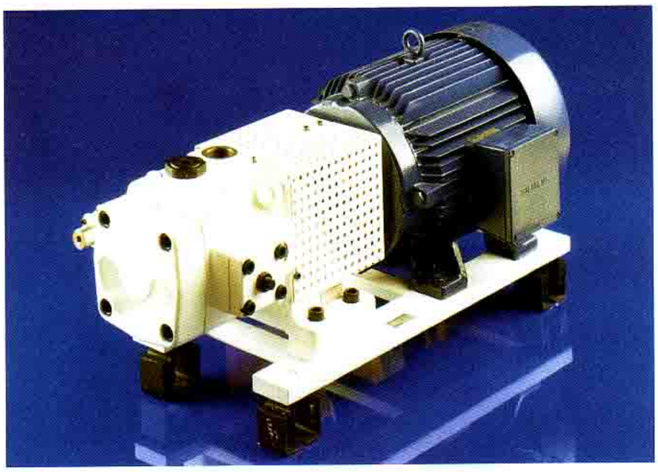


Fig. 110: *Motor-pump set*

Motors of Size 355 and larger need rigid base-frames fabricated from flat steel plate and U-sections. In this case it is better to bolt the mounting bracket for the pump on to the base-frame and not to weld it.

Shims can be used under the motor to adjust the height. Suitable lugs should be provided on the base-frame to prevent any lateral movement, at least over Size 200. The motor-pump sets often carry the pump control devices and/or pressure relief valves.

With the B5 and B3/B5 mounting arrangements, a mounting plate for attaching these devices can be secured to the motor fixing bolts.

With the V1 type of construction the devices can be placed on the mounting plate.

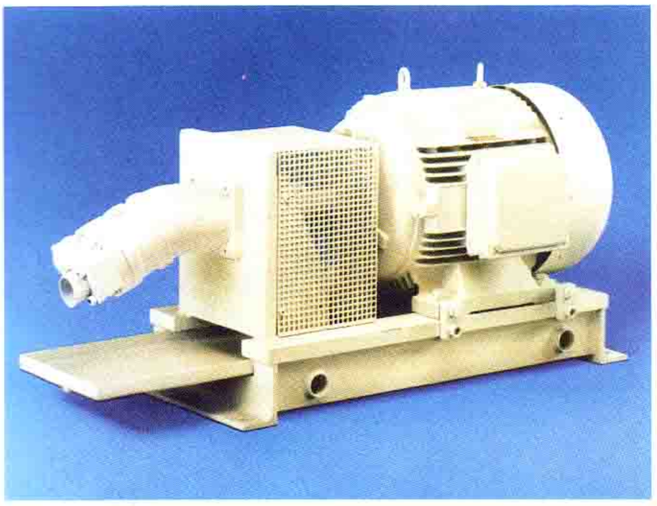


Fig. 111: *Motor-pump set*

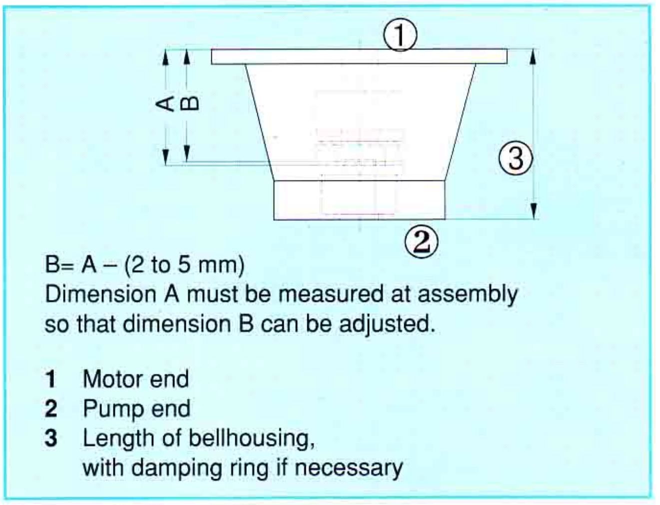


Fig. 112: *Bell housing*

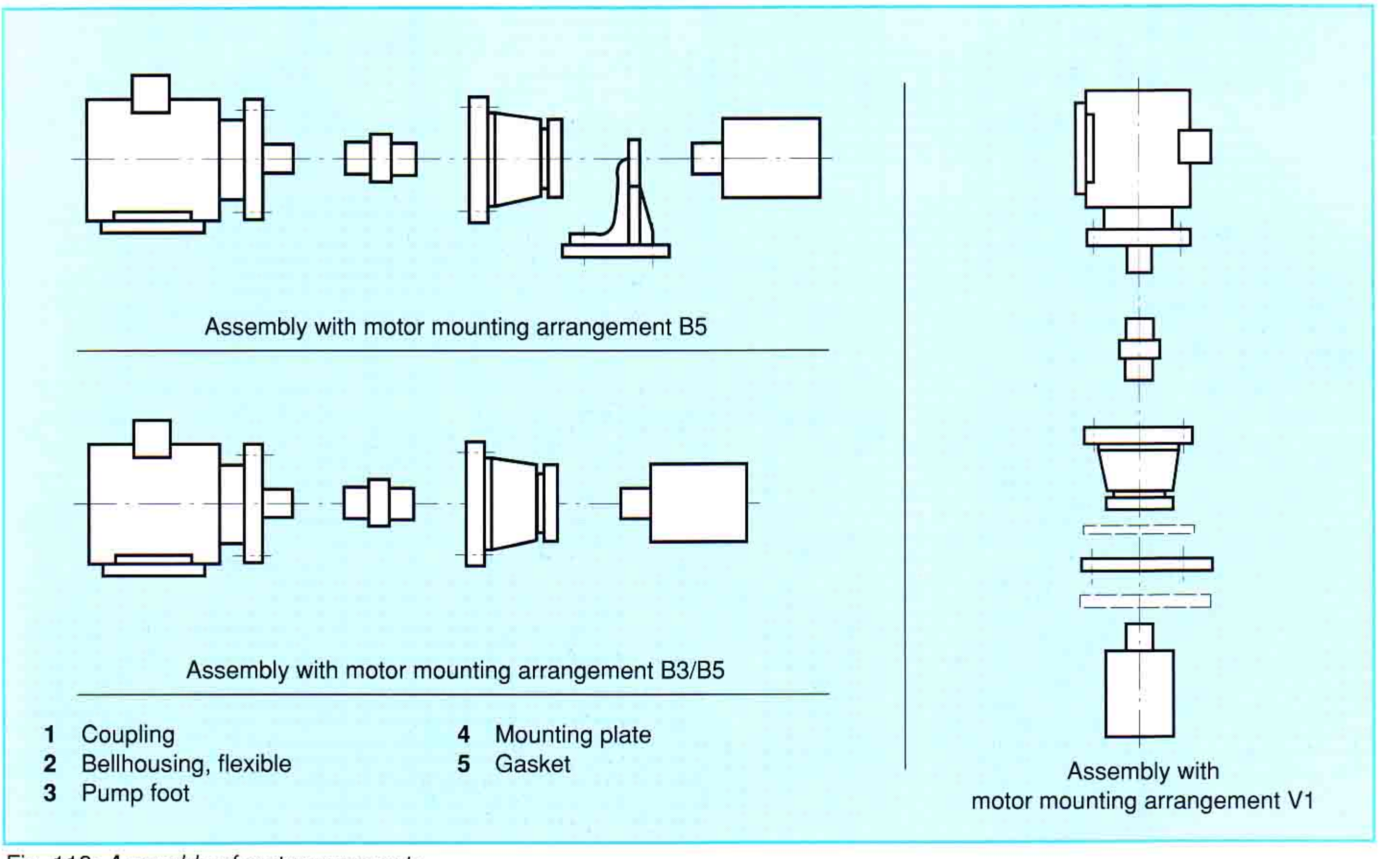
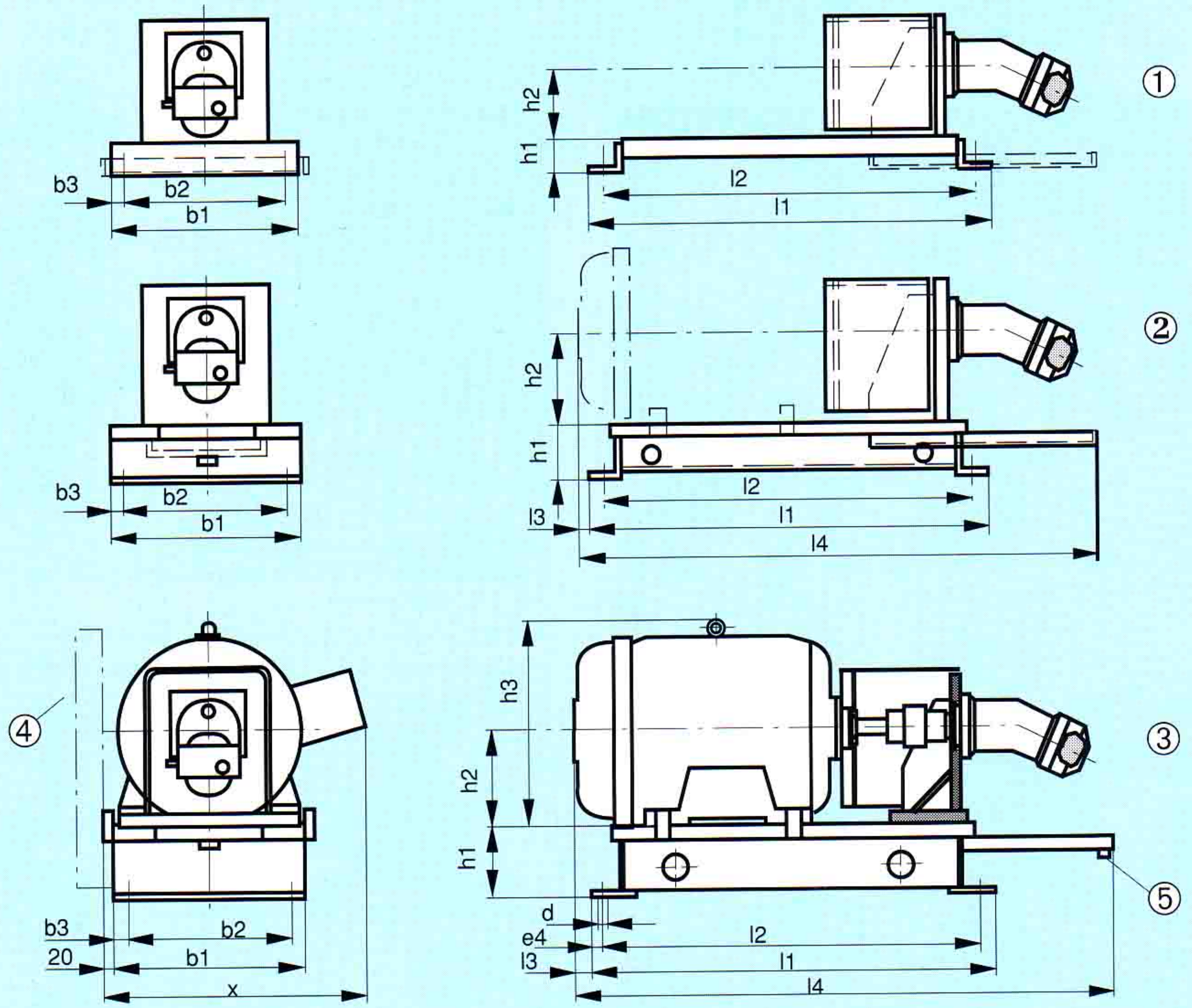


Fig. 113: *Assembly of motor-pump sets*

For mounting arrangement B3, a valve stack must be mounted on the base-frame.

Study each application individually to see whether there is any relative movement between pump and pipework which will make hoses necessary in suction and delivery lines and/or an expansion piece in the suction line.

Hoses are a good idea in the delivery and leakage-fluid lines in order to isolate any structure-borne noise. An expansion piece in the suction line is advisable.



1 Sizes 132 to 180
2 Sizes 200 to 315
3 Sizes 355 and 400

4 Valve stack
5 Fluid drain 1/4" BSP

(L3, L4 and x are only approximate dimensions since they depend on the make of motor and size of pump)

Size	b1	b2	b3	d	e	h1	h2	h3	l1	l2	l3	l4	x
132S/132M	280	200	40	18	30	55	135	308	720	660	65	900	375
160M/160L	330	250	40	23	35	55	163	368	820	750	75	1050	450
180M/180L	370	290	40	23	35	55	183	418	870	800	75	1200	520
200L	410	330	40	23	35	150	203	463	920	850	80	1350	590
225S/225M	460	380	40	23	35	150	228	520	1020	950	80	1450	630
250M	520	440	40	23	45	190	253	584	1090	1000	100	1520	730
280S/280M	620	540	40	23	45	190	283	664	1240	1150	100	1650	810
315S/315M	650	570	40	23	40	220	318	700	1360	1280	90	1800	870
355S/355M	750	650	50	23	35	255	355	795	1450	1380	140	2000	950
400S/400M	860	760	50	26	50	325	400	895	1750	1650	160	2250	1120

Fig. 114: *Principal dimensions of motor-pump sets with motor mounting arrangement type B3*

4.3 Device mounting frames and front panels

There must be facilities for the permanent and secure mounting of the devices, valves and manifold blocks used for controlling hydraulic systems.

With hydraulic systems for machine tools, the control gear is often mounted on the tank together with the motor-pump assembly. In order to keep noise emission to a minimum, the noise-emitting surface should be as small as possible. It is therefore advisable for the control gear to be incorporated into a manifold block which is better mounted straight on to the tank without an extra mounting panel.

However, space reasons often prevent this arrangement. In order, therefore, to keep the noise-emitting area as small as possible mounting frames are utilised. These are basically a standardized frame made of square tube into which standard elements to accept components can be welded.

The size of the square tube depends on the size and weight of equipment to be supported:

- Square tube of 20 x 30 x 2 is sufficient for valves of Size 6
- Square tube of 30 x 60 x 3 is used for valves of Sizes 10 to 16
- Square tube of 60 x 60 x 4 must be used for valves of Size 25 and larger.

Angled struts must be used to brace the frame if the equipment is heavy.

If it is necessary to reduce the transmission of structure-borne noise and hence lower the noise level of the unit, the elements can be bolted to the frame with a damping material such as a rubber-cork composition between the two. The same applies to the fitting of the mounting frame on the tank.

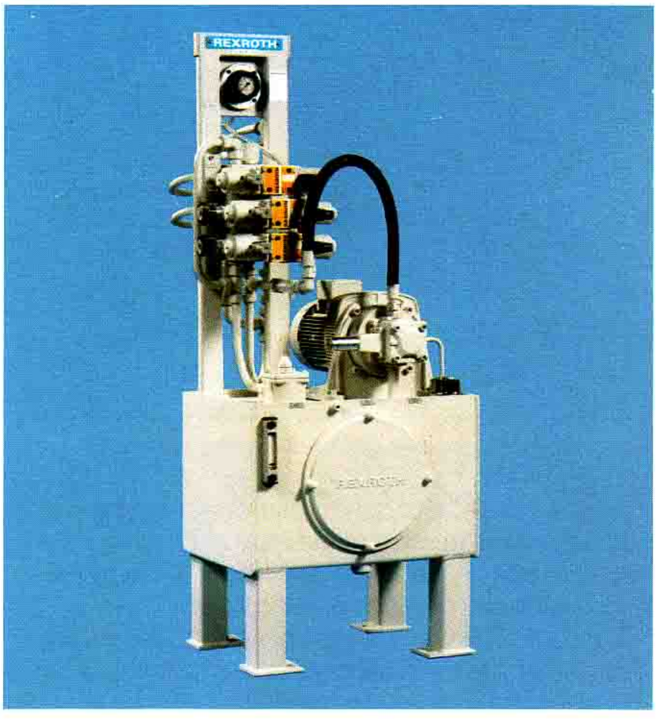
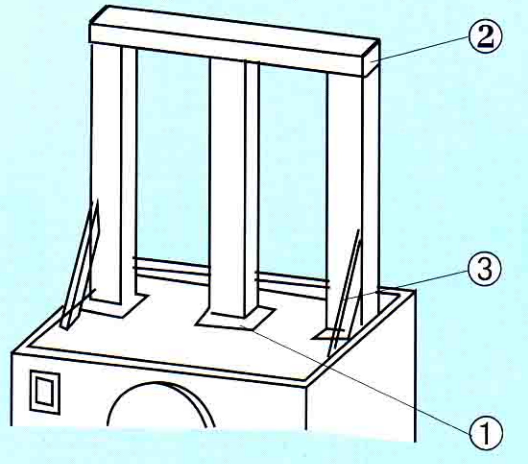


Fig. 115



1 Continuously welded round the circumference, a = 3 mm
2 Closed with plastic caps
3 Optional struts

Fig. 116: *The principle of the mounting frame*

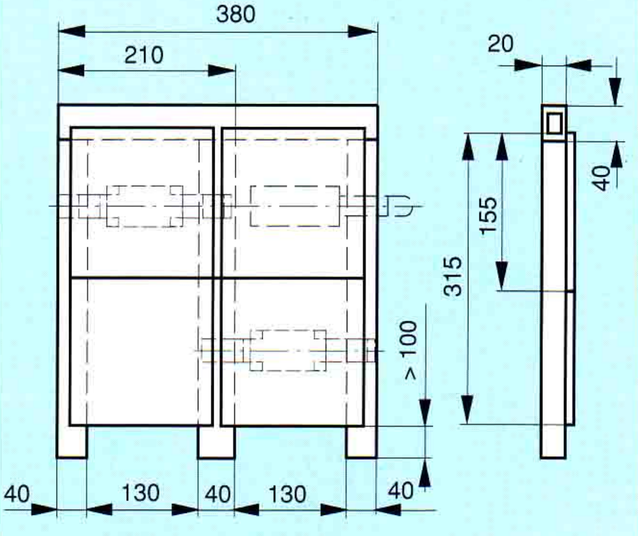


Fig. 117: *Twin-section mounting frame to accept Size 6 elements*

Access to pipe fittings is an important factor with hydraulic power units employing mounting frames. The elements should be placed behind the frame so that the devices lie between the square tubes. This can obstruct accessibility to the adjusting devices so the position of elements must be examined closely from case to case.

The mounting frame arrangement takes up more room than the front panel arrangement. The latter will have to be used if there is insufficient space to mount the equipment on a mounting frame.

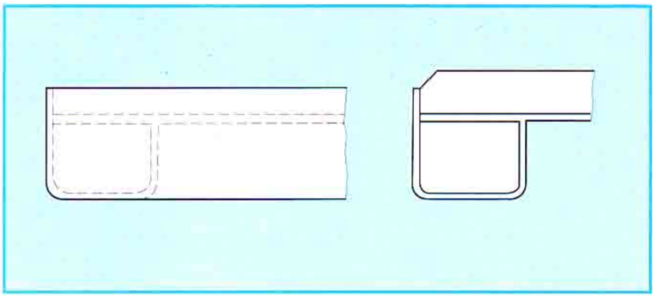


Fig. 118: *C-sections and stiffeners for front panels*

For front panels, also called mounting plates, there are company standards for cut-outs so that the designer only has to decide on the length and height of the panel and the position and direction of the cut-outs.
The rails supporting the front panel are also standardized. In this case it is sensible to use folded C-sections into which the panel can be welded.

Stiffeners may be needed for the mounting plate and braces for the tank depending on the size of front panel and weight of equipment mounted.

It is a good idea to provide lifting holes in the top part of the C-sections.

4.4 Valve stands

With hydraulic systems for large machines and installations the tanks, motor-pump sets and control gear are mounted separately because of their size. Whereas the tanks and motor-pump sets are mostly housed in specially built rooms (often basements), the control gear is best mounted as close as possible to the actuators, e.g. hydraulic motors or cylinders. In many cases the control gear is mounted and piped up on valve stands.

The size of a valve stand depends on the type and weight of the equipment to be mounted so only the supporting parts of it, such as the feet, drip tray and supporting elements can be standardized.

Once again, as with front panels, stiffeners and braces may be necessary.

Tubes welded into the side members are a good idea for lifting, as lifting from below is impossible.
The design must allow sufficient clearance between the components mounted on the stand so that they can be piped with U-bends.

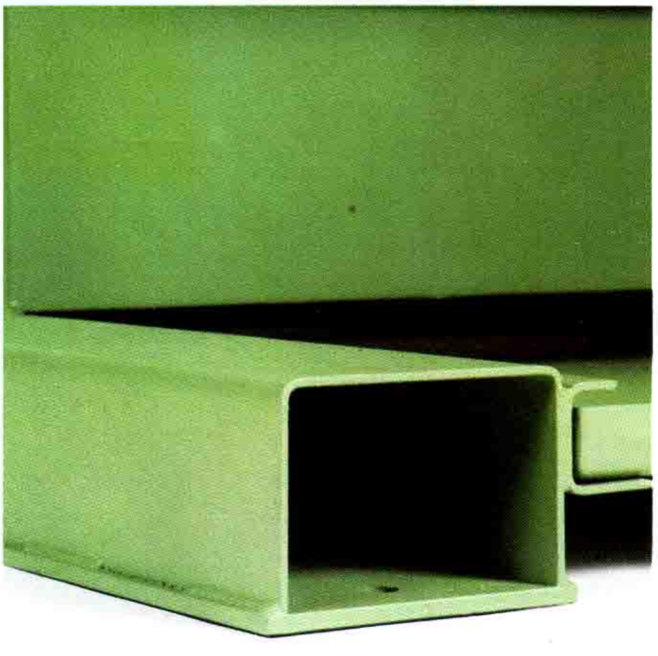


Fig. 119:

Fig. 120:

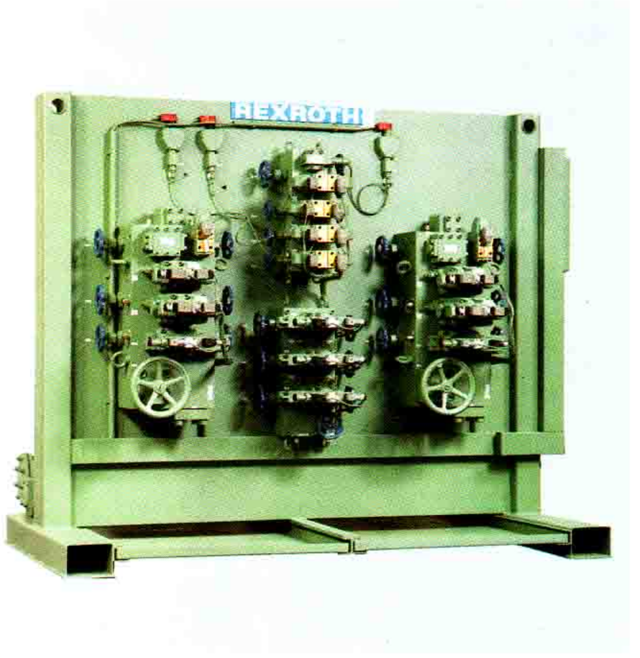
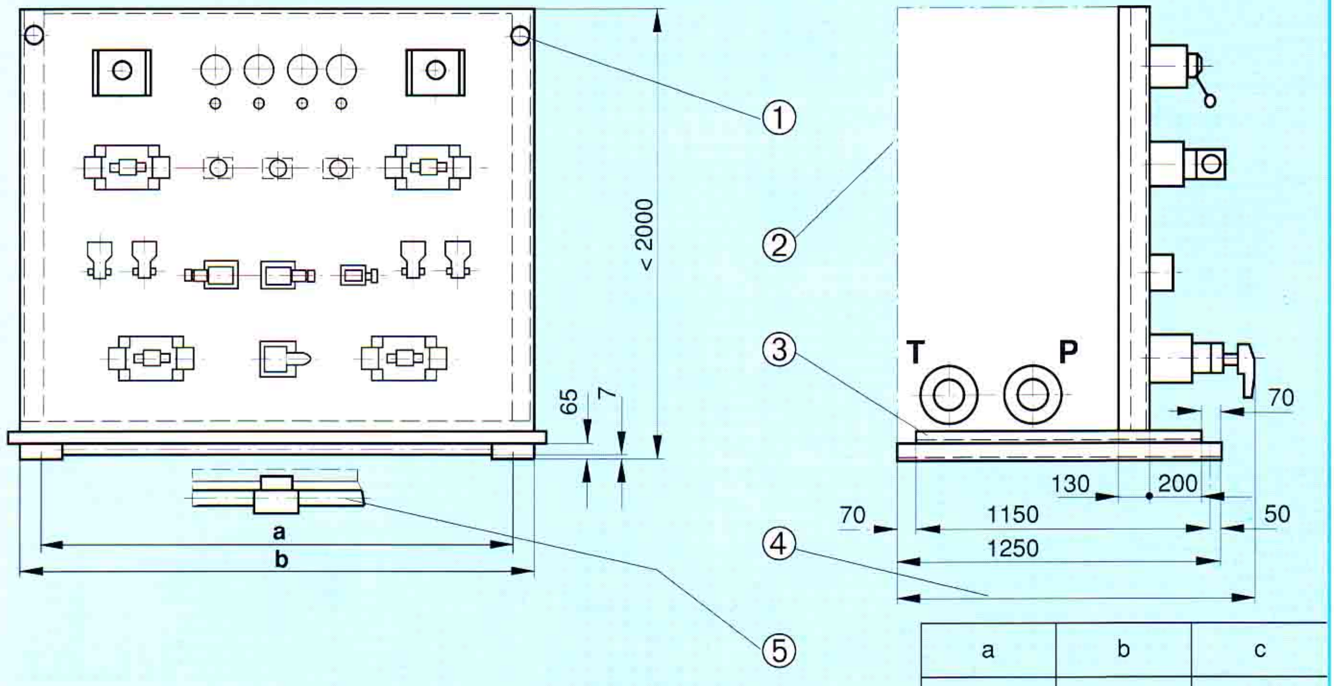
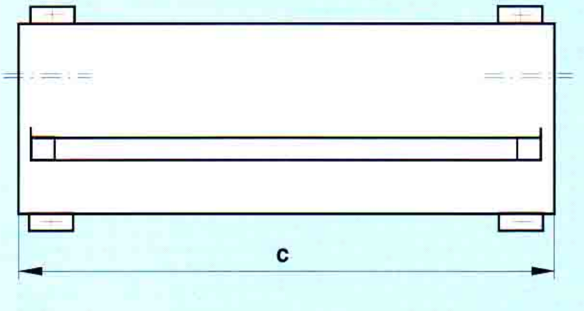


Fig. 121:

Fig. 122:



a	b	c
1360	1500	1600
1860	2000	2100
2360	2500	2600
2860	3000	3100



1 Lifting point
2 Space for pipework
3 Drip tray, fixed
4 Maximum dimension
5 Two drip trays and a third foot on sizes over 2500

Fig. 123: *Valve stand, lightweight type*

4.5 Valve tables

On a valve stand, the components are usually arranged so that the dividing surface between valve and plate is vertical. This is not always best for maintenance so valve tables are often used as an alternative. Most of the dividing surfaces between valves and plates can then be horizontal which makes maintenance easier.

Valve tables also come in lightweight or heavyweight versions depending on the weight to be supported. The simplest version for control plates with valves up to Size 16 uses angle sections both for the vertical feet and for the horizontal bearers. The table top can be continuous with suitable cut-outs or platforms between the horizontal bars.

For large control plates with valves over Size 16 the valve tables must be stronger and square tube can be used both for the struts and for the horizontal cross beams.

Valve stands are often designed complete with connections for outlet piping. In the case of valve tables it is better to run the outlets from the manifold blocks to common lines, so that only the common lines for pump, tank and leakage fluid have to be fitted to the valve table and be connected up later on site to the general pipework. Within the valve table the blocks are then connected to the common line for tank, pump and leakage fluid.

Due to the fact that components are mounted one above the other on valve stands the space requirement is apparently less than for valve tables in which the components are mounted side by side.

In many cases valve tables are placed against the wall in the hydraulics basement so that the pipework from the control block can run immediately on to the wall. In such cases the space requirement is no greater than that of a valve stand and the better facilities for maintenance are retained.

Fig. 124: Valve table

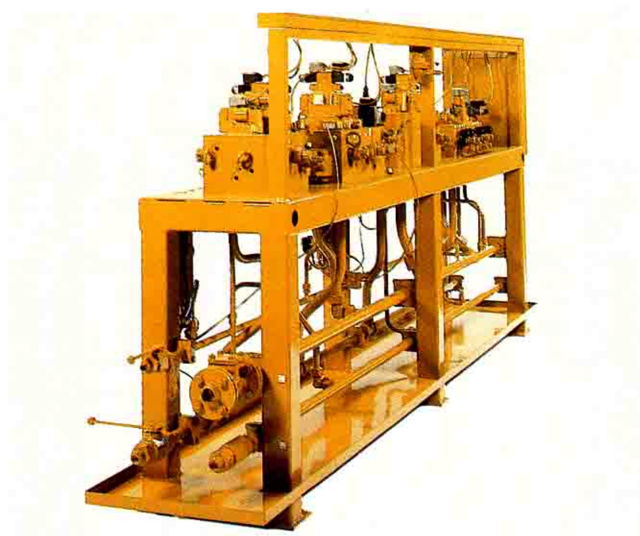


Fig. 125: Valve table

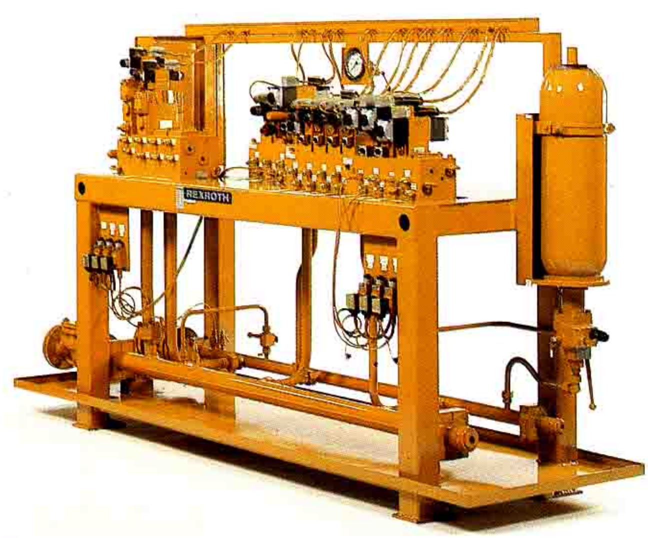
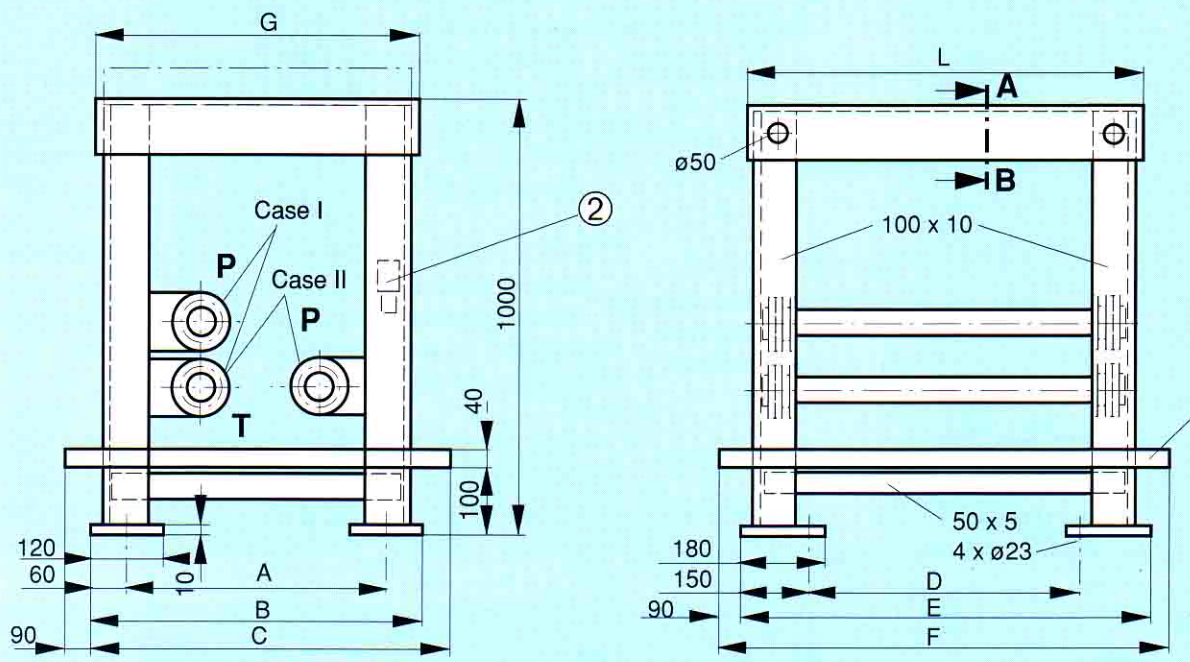


Fig. 126: Valve table



A	B	C	D	E	F	L	G
630	750	930	720	1020	1200	1000	750
630	750	930	1220	1520	1700	1500	750
630	750	930	1720	2020	2200	2000	750
630	750	930	2220	2520	2700	2500	750

1 Drip tray, 3 mm plate
2 Outlets

Section A—B

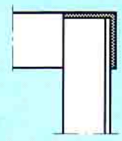
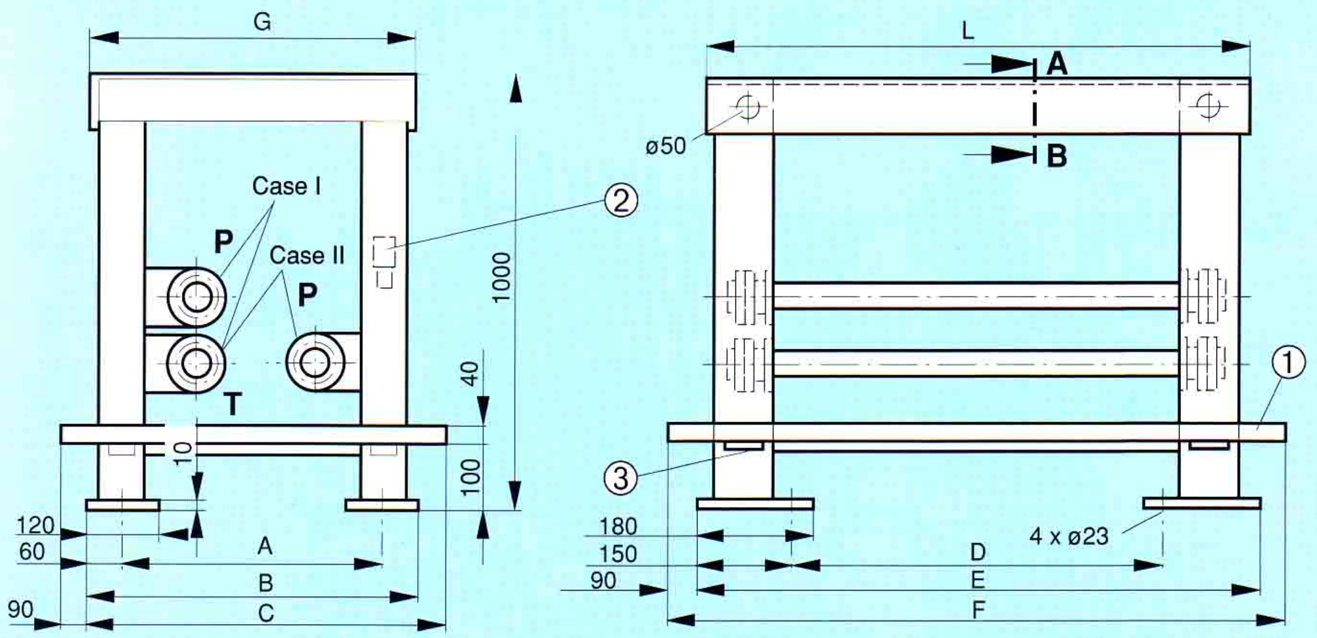


Fig. 127: *Valve table, lightweight version, for mounting single valves up to Size 22 and control plates up to Size 16*



A	B	C	D	E	F	L	G
880	1000	1180	720	1020	1200	1000	990
880	1000	1180	1220	1520	1700	1500	990
880	1000	1180	1720	2020	2200	2000	990
880	1000	1180	2220	2520	2700	2500	990

1 Drip tray
2 Outlets
3 Brace, U50x25

Section A—B

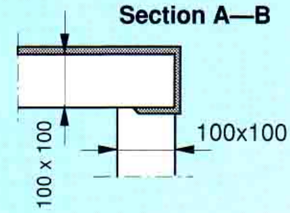


Fig. 128: *Valve table, heavyweight version*

4.6 Accumulator stands

Larger hydraulic systems often contain accumulators which, when they are providing energy storage for the control circuit, are mounted on the valve stands or valve tables. There are standard clips and brackets available to secure them in place.

When hydraulic accumulators are providing energy storage for the main pumping system, however, they are mounted on separate accumulator stands. Single-row (lightweight) and double-row (heavyweight) versions are available.

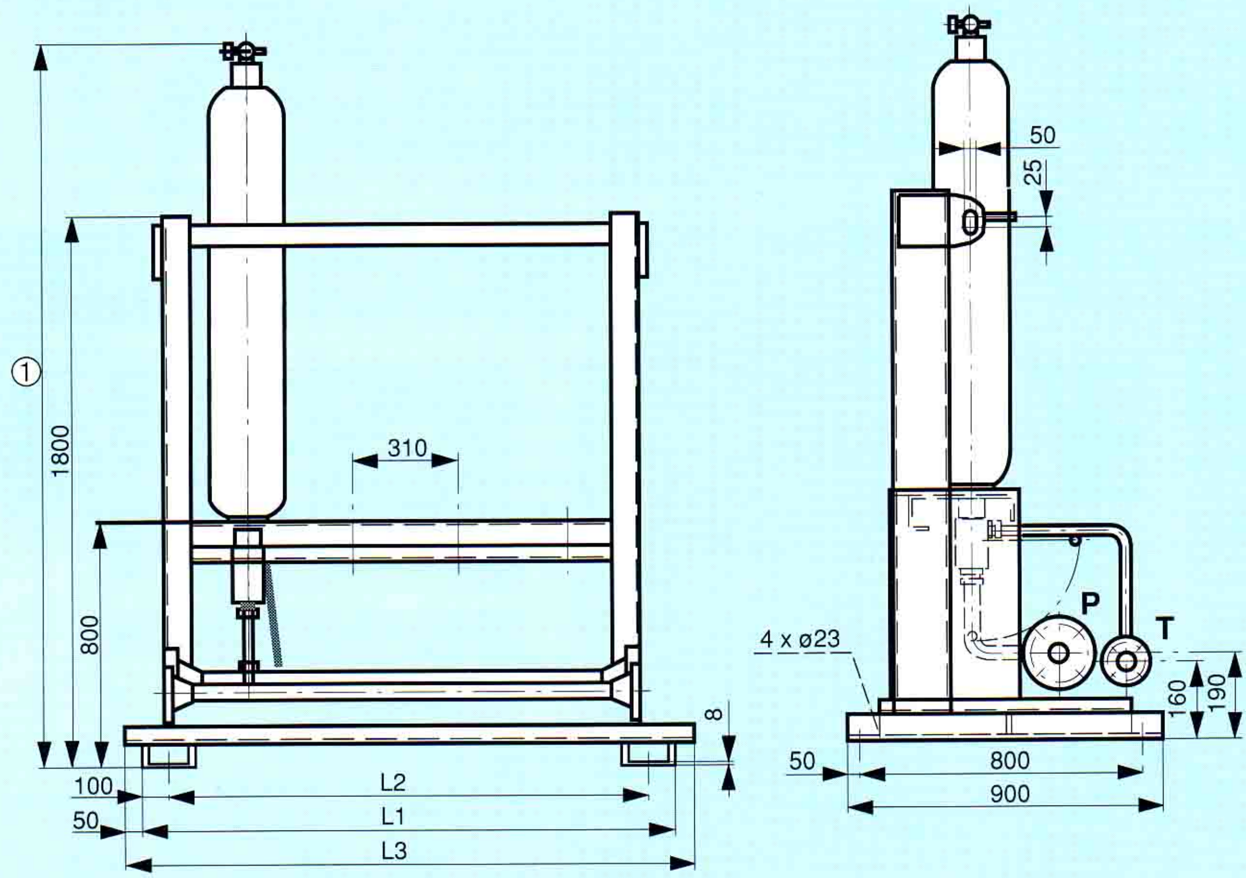
The single-row, lightweight version is usually fabricated from sectional steel.

Folded sections are used for the double-row, heavyweight version. The same standard sections used for valve stands can also be used here.

Regardless of their type, hydraulic accumulators should always be installed vertically. This means that bladder-type accumulator can rest in a rubber ring in a hole in a horizontal plate. Piston-type accumulators are also mounted on a horizontal plate; they must be secured by welded rings or other restraining devices to prevent any lateral movement.

Lifting and transportation must be considered when the stand is being designed. For example, if transportation in the upright position is impossible due to the height, bolted supports must be provided from the outset to allow the stand to be laid down.

Hydraulic accumulators must be specifically marked and secured for transportation. Details are given in the chapter "Packing and Transport".



Version	No. of accumulators		
single-row	2	3	4
L1 L2 L3	950 750 1050	1250 1050 1550	1550 1350 1650

1 approx. 2120 with 32 L accumulators, approx. 2650 with 50 L accumulators

Fig. 129: *Accumulator stand, single-row version*

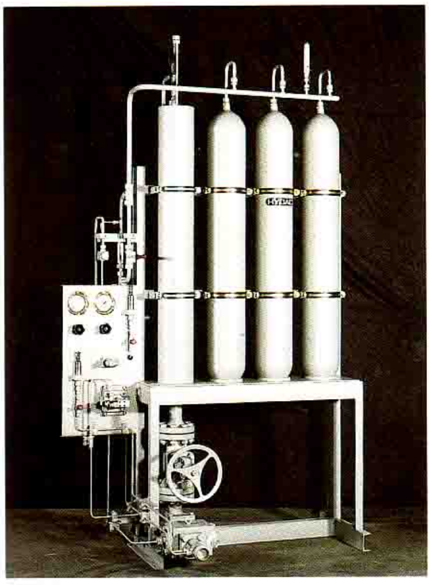
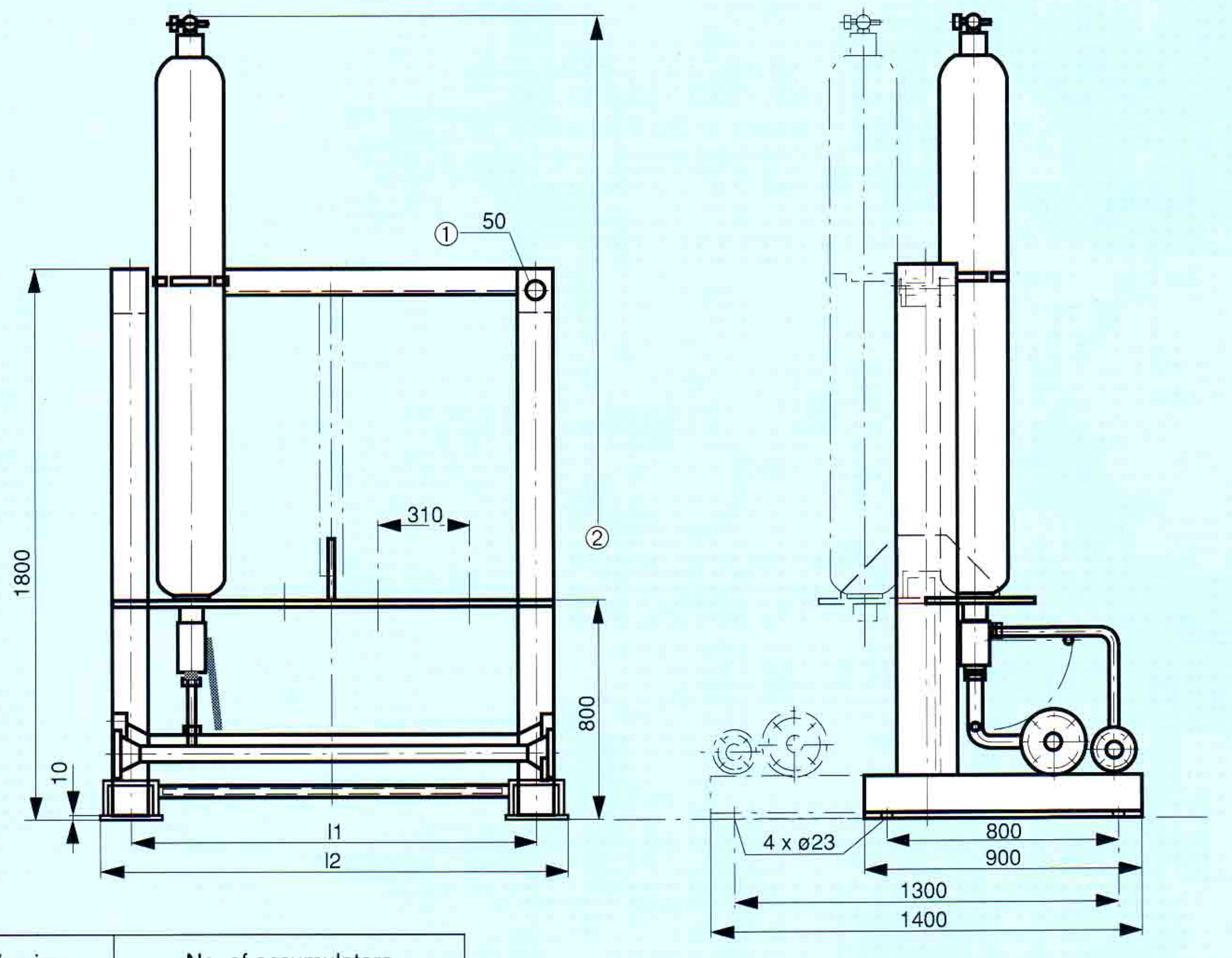


Fig. 130: (left)
Accumulator stand, single-row version

Fig. 131: (right)
Accumulator stand, double-row heavy-weight version



Version	No. of accumulators		
single-row			5
double-row	6	7 and 8	9 and 10
L1	1250	1550	1850
L2	1050	1350	1650

1 Lifting tube
2 approx. 2220 with 32 L accumulators, approx. 2750 with 50 L accumulators

Fig. 132: *Accumulator stand, double-row heavyweight version*

5 References

[1] Jahrbuch Schweißtechnik DVS

[2] Dr.-Ing. Malisius
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[3] VDI-Richtlinie VDI 2221
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