PIPEWORK

SYSTEMS

PIPING SYSTEMS

Dimensions of Welded & Seamless Pipe
Schedule

Carbon and Alloy Steel Pip to ASA B36.10

Nominal Wall Thickness

Pipe Size	Outside Diameter	Sched. 20	Sched. 30	Std Weight	Sched. 40	Sched. 60	Extra Strong	Sched. 80	Shecd. 100	Sched. 120	Sched. 140	Sched. 160	XX Strong
1/8	0.405	.....	.....	0.068	0.068	.....	0.095	0.095	.....	.....	.....	.....	.....
1/4	0.540	.....	.....	0.088	0.088	.....	0.119	0.119	.....	.....	.....	.....	.....
3/8	0.675	.....	.....	0.091	0.091	.....	0.126	0.126	.....	.....	.....	.....	.....
1/2	0.840			0.109	0.109		0.147	0.147				0.187	0.294
3/4	1.050	.....	.....	0.113	0.113	.....	0.154	0.154	.....	.....	.....	0.218	0.308
1	1.315			0.133	0.133		0.179	0.179				0.250	0.358
1 1/4	1.660	.....	.....	0.140	0.140	.....	0.191	0.191	.....	.....	.....	0.250	0.322
1 1/2	1.900			0.145	0.145		0.200	0.200				0.281	0.400
2	2.375	.....	.....	0.154	0.154	.....	0.218	0.218	.....	.....	.....	0.343	0.346
2 1/2	2.875			0.203	0.203		0.276	0.276				0.375	0.552
3	3.500	.....	.....	0.216	0.216	.....	0.300	0.300	.....	.....	.....	0.438	0.600
3 1/2	4.000			0.226	0.226		0.318	0.318				.....	0.636
4	4.500	.....	.....	0.237	0.237	.....	0.337	0.337	.....	0.438	.....	.0531	0.674
5	5.563			0.258	0.258	.....	0.375	0.375	.....	0.500	.....	0.625	0.750
6	6.625	.....	.....	0.280	0.280	.....	0.432	0.432	.....	0.562	.....	0.781	0.864
8	8.625	0.250	0.277	0.322	0.322	0.406	0.500	0.500	0.593	0.718	0.812	0.906	0.875
10	10.750	0.250	0.307	0.365	0.365	0.500	0.500	0.593	0.718	0.843	1.000	1.125	.....
12	12.750	0.250	0.330	0.375	0.406	0.562	0.500	0.687	0.843	1.000	1.125	1.312	
14	14.000	0.312	0.375	0.375	0.438	0.593	0.500	0.750	0.937	1.093	1.250	1.406	.....
16	16.000	0.312	0.375	0.375	0.500	0.656	0.500	0.843	1.031	1.218	1.438	1.593	
18	18.000	0.312	0.438	0.375	0.562	0.750	0.500	0.937	1.156	1.375	1.562	1.781	.....
20	20.000	0.375	0.500	0.375	0.593	0.812	0.500	10.31	1.281	1.500	1.750	1.968	
24	24.000	0.375	0.562	0.375	0.687	0.968	0.500	1.218	1.531	1.812	2.062	2.343	.....
30	30.000	0.500	0.625	0.375	.....	.....	0.500	.....	.....	.....	.....	.....	

Basic Components of a Pipe System

Basically, a pipe system consists of straight pip runs and fittings, assembled according to a design and connected to points of discharge or intake.

For making the required deviations, branches, changes in diameter and connections in a pipe system, a wide range of pipe fittings is available.

The most commonly used pipe fittings and their functions in a pipe system are:

- Elbows and Bends – To arrange deviations at 90^{o} or 45^{o} angles
- Tees – With an equal diameter – or a reducing branch, for branching a pipe line at 90^{o}
- Reducers – To be fitted wherever a change in pipe diameter is required
- Unions – To make detachable connections in small diameter pipelines
- Couplings – To make permanent connections
- Flanges – Attached to pipe ends or branches or as fixed part of a fitting to make dependable connections between the components of a pipe system

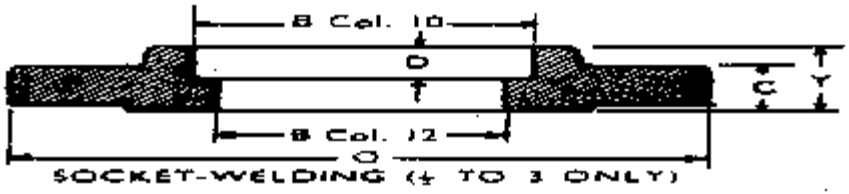
In addition, there are a number of fittings such as Bosses and Weldolets, the application of which, however, do not require important workshop calculations, since their position in a pipe plan is always clearly indicated on the drawings.

Typical Flange Applications

FLANGE TYPE	TYPICAL APPLICATION
Welding neck	All applications including sever service conditions of pressure, temperature and cycling
Slip-on welding	Moderate service conditions. Hazardous substances, proving the flange is double welded to the pipe, i.e. both back and front welds
Socket welding	Small bore piping where the crevice is not detrimental. High pressures, moderate temperatures
Lapped	Used with lap-joint stubs where easy alignment of bolt holes is required. Also for expensive piping materials e.g. nickle alloys where the flange can be of a less expensive material
Threaded	Moderate service conditions where the threaded joint is not detrimental. Generally non-hazardous fluids in small bore piping at low to high pressures and ambient temperature
Blind (blank)	Blanking ends of piping, valves etc… For severe duty consider welding caps

PIPING SYSTEMS

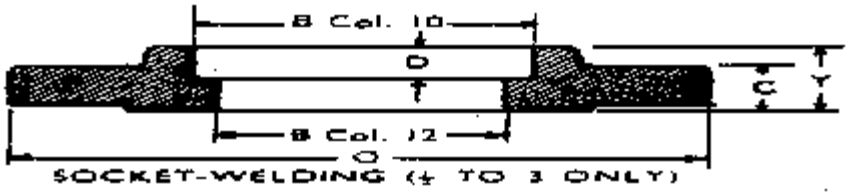
Pipe Flange Dimensions ASA
150 L.B. Rating



Nominal Pipe Size	Outside Diameter of Flange	Thickness of Flange Min	Drilling			Length Through Hub			Bore			Corner Radius of Bore of Lapped Flange and Pipe	Depth of Socket
			Diam. Of Bolt Circle	No. of Bolts	Diam of Bolts	Slip-On Socket Welding	Lapped	Welding Neck	Slip-On Socket Welding Min	Lapped Min	Welding Neck Socket Welding		
½	3 ½ / 89	7/16 / 11	2 3/8 / 60	4	1/2 / 13	5/8 / 16	5/8 / 16	1 7/8 / 48	.88 / 23	.90 / 23	.62 / 16	1/8 / 3	3/8 / 9
¾	3 7/8 / 98	½ / 13	2 ¾ / 70	4	1/2 / 13	5/8 / 16	5/8 / 16	2 1/16 / 52	1.09 / 28	1.11 / 28	.82 / 21	1/8 / 3	7/16 / 11
1	4 ¼ / 108	9/16 / 14	3 1/8 / 79	4	1/2 / 13	11/16 / 17	11/16 / 17	2 3/16 / 56	1.38 / 35	1.40 / 36	1.05 / 27	1/8 / 3	1/2 / 13
1 ½	5 / 127	11/16 / 17	3 7/8 / 98	4	1/2 / 13	7/8 / 22	7/8 / 22	2 7/16 / 62	1.95 / 50	1.97 / 50	1.61 / 41	1/4 / 6	5/8 / 16
2	6 / 152	¾ / 19	4 ¾ / 121	4	5/8 / 16	1 / 25	1 / 25	2 1/2 / 63	2.44 / 62	2.46 / 62	2.07 / 53	5/16 / 8	11/16 / 17
2 ½	7 / 178	7/8 / 22	5 ½ / 140	4	5/8 / 16	1 1/8 / 29	1 1/8 / 29	2 3/4 / 70	2.94 / 75	2.97 / 75	2.47 / 63	5/16 / 8	3/4 / 19
3	7 1/2 / 191	15/16 / 24	6 / 152	4	5/8 / 16	1 3/16 / 30	1 3/16 / 30	2 3/4 / 70	3.57 / 91	3.60 / 92	3.07 / 78	3//8 / 8	13/16 / 21
4	9 / 229	15/16 / 24	7 1/2 / 190	8	5/8 / 16	1 5/16 / 33	1 5/16 / 33	3 / 76	4.57 / 116	4.60 / 116	4.03 / 102	7/16 / 11	
6	11 / 279	1 / 25	9 1/2 / 241	8	3/4 / 19	1 9/16 / 40	1 9/16 / 40	3 1/2 / 89	6.72 / 171	6.75 / 171	6.07 / 154	1/2 / 13	
8	13 1/2 / 343	1 1/8 / 29	11 3/4 / 298	8	3/4 / 19	1 3/4 / 44	1 3/4 / 44	4 / 102	8.72 / 221	8.75 / 222	7.98 / 203	1/2 / 13	
10	16 / 406	1 3/16 / 30	14 1/2 / 362	12	7/8 / 22	1 15/16 / 49	1 15/16 / 49	4 / 102	10.88 / 276	10.92 / 276	10.02 / 254	1/2 / 13	
12	19 / 483	1 1/4 / 32	17 / 432	12	7/8 / 22	2 3/16 / 56	2 3/16 / 56	4 1/2 / 114	12.88 / 327	12.92 / 327	12.00 / 305	1/2 / 13	
14	21 / 533	1 3/8 / 35	18 3/4 / 478	12	1 / 25	2 1/4 / 57	3 1/8 / 79	5 / 127	14.14 / 359	14.18 / 360	To be Specified by Purchaser	1/2 / 13	
16	23 1/2 / 597	1 7/16 / 36	21 3/4 / 540	16	1 / 25	2 1/2 / 63	3 7/16 / 87	5 / 127	16.16 / 410	16.19 / 410		1/2 / 13	
18	25 / 635	1 9/16 / 40	22 3/4 / 578	16	1 1/8 / 29	2 11/16 / 68	3 13/16 / 97	5 1/2 / 140	18.18 / 462	18.20 / 462		1/2 / 13	
20	27 1/2 / 698	1 11/16 / 43	25 / 635	20	1 1/8 / 29	2 7/8 / 73	4 1/16 / 103	5 11/16 / 144	20.25 / 513	20.35 / 514		1/2 / 13	
24	32 / 813	1 7/8 / 48	29 1/2 / 749	20	1 1/4 / 32	3 1/4 / 82	4 3/8 / 111	6 / 152	24.25 / 616	24.25 / 616		½ / 13	

PIPING SYSTEMS

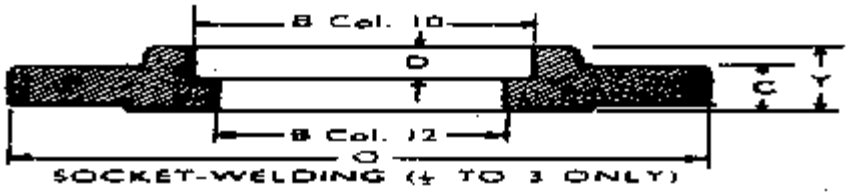
Pipe Flange Dimensions ASA
300 L.B. Rating



Nominal Pipe Size	Outside Diameter of Flange	Thickness of Flange Min	Drilling			Length Through Hub			Bore			Corner Radius of Bore of Lapped Flange and Pipe	Depth of Socket
			Diam. Of Bolt Circle	No. of Bolts	Diam of Bolts	Slip-On Socket Welding	Lapped	Welding Neck	Slip-On Socket Welding Min	Lapped Min	Welding Neck Socket Welding		
½	3 3/4 95	9/16 14	2 5/8 67	4	1/2 13	7/8 22	7/8 22	2 1/16 52	.88 23	.90 23	.62 16	1/8 3	3/8 9
¾	4 5/8 117	3/8 16	3 1/4 82	4	5/8 16	1 25	1 25	2 1/4 57	1.09 28	1.11 28	.82 21	1/8 3	7/16 11
1	4 7/8 124	11/16 17	3 1/2 89	4	5/8 16	1 1/16 27	1 1/16 27	2 7/16 62	1.36 34	1.38 35	1.05 27	1/8 3	1/2 13
1 ½	6 1/8 156	13/16 21	4 1/2 114	4	3/4 19	1 3/16 30	1 3/16 30	2 11/16 68	1.95 50	1.97 50	1.61 41	1/4 6	5/8 16
2	6 ½ 165	7/8 22	5 127	8	5/8 16	1 5/16 33	1 5/16 33	2 3/4 70	2.44 62	2.46 62	2.07 53	5/16 8	11/16 17
3	8 1/4 209	1 1/8 29	6 5/8 168	8	3/4 19	1 11/16 43	1 11/16 43	3 1/8 79	3.57 91	3.60 92	3.07 78	3/8 8	13/16 21
4	10 254	1 1/4 32	7 7/8 200	8	3/4 19	1 7/8 48	1 7/8 48	3 3/8 86	4.57 116	4.60 116	4.03 102	7/16 11	
6	12 1/2 317	1 7/16 36	10 5/8 270	12	3/4 19	2 1/16 52	2 1/16 52	3 7/8 98	6.72 171	6.75 171	6.07 154	1/2 13	
8	15 381	1 5/8 41	13 330	12	7/8 22	2 7/16 62	2 7/16 62	4 3/8 111	8.72 221	8.75 222	7.98 203	1/2 13	
10	17 1/2 444	1 7/8 48	15 1/4 387	16	1 25	2 3/8 67	3 3/4 95	4 5/8 117	10.88 276	10.92 276	10.02 254	1/2 13	
12	20 1/2 521	2 51	17 3/4 451	16	1 1/8 29	2 7/8 73	4 102	5 1/8 130	12.88 327	12.92 327	12.00 305	1/2 13	
14	23 584	2 1/8 54	20 1/4 514	20	1 1/8 29	3 76	4 3/8 111	5 5/8 143	14.14 359	14.18 360	To be Specified by Purchaser	1/2 13	
16	25 1/2 648	2 1/4 54	22 1/2 571	20	1 1/4 32	3 1/4 82	4 3/4 121	5 3/4 146	16.16 410	16.19 410		1/2 13	
18	28 711	2 3/8 60	24 3/4 629	24	1 1/4 32	3 1/2 89	5 1/8 130	6 1/4 159	18.18 462	18.20 462		1/2 13	
20	30 1/2 775	2 1/2 63	27 686	24	1 1/4 32	3 3/4 95	5 1/2 140	6 3/8 162	20.20 518	20.25 514		1/2 13	
24	36 914	2 3/4 70	32 813	24	1 1/2 38	4 3/16 106	6 152	6 5/8 168	24.25 616	24.25 616		1/2 13	

PIPING SYSTEMS

Pipe Flange Dimensions ASA
600 L.B. Rating



Nominal Pipe Size	Outside Diameter of Flange	Thickness of Flange Min	Drilling			Length Through Hub			Bore			Corner Radius of Bore of Lapped Flange and Pipe	Depth of Socket
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½	Xxxx / xxx	Xxxx / xxx	Xxxx / xxx	4	Xxxx / xxx	Xxxx / xxx	Xxxx / xxx	Xxxx / xxx	Xxxx / xxx	Xxxx / xxx	To be Specified by Purchaser	Xxxx / xxx	Xxxx / xxx
¾	Xxxx / xxx	Xxxx / xxx	Xxxx / xxx	4	Xxxx / xxx	Xxxx / xxx	Xxxx / xxx	Xxxx / xxx	Xxxx / xxx	Xxxx / xxx		Xxxx / xxx	Xxxx / xxx
1	Xxxx / xxx	Xxxx / xxx	Xxxx / xxx	4	Xxxx / xxx	Xxxx / xxx	Xxxx / xxx	Xxxx / xxx	Xxxx / xxx	Xxxx / xxx		Xxxx / xxx	Xxxx / xxx
1 ½	Xxxx / xxx	Xxxx / xxx	Xxxx / xxx	4	Xxxx / xxx	Xxxx / xxx	Xxxx / xxx	Xxxx / xxx	Xxxx / xxx	Xxxx / xxx		Xxxx / xxx	Xxxx / xxx
2	Xxxx / xxx	Xxxx / xxx	Xxxx / xxx	8	Xxxx / xxx	Xxxx / xxx	Xxxx / xxx	Xxxx / xxx	Xxxx / xxx	Xxxx / xxx		Xxxx / xxx	Xxxx / xxx
3	Xxxx / xxx	Xxxx / xxx	Xxxx / xxx	8	Xxxx / xxx	Xxxx / xxx	Xxxx / xxx	Xxxx / xxx	Xxxx / xxx	Xxxx / xxx		Xxxx / xxx	Xxxx / xxx
4	Xxxx / xxx	Xxxx / xxx	Xxxx / xxx	8	Xxxx / xxx	Xxxx / xxx	Xxxx / xxx	Xxxx / xxx	Xxxx / xxx	Xxxx / xxx		Xxxx / xxx	Xxxx / xxx
6	Xxxx / xxx	Xxxx / xxx	Xxxx / xxx	12	Xxxx / xxx	Xxxx / xxx	Xxxx / xxx	Xxxx / xxx	Xxxx / xxx	Xxxx / xxx		Xxxx / xxx	Xxxx / xxx
8	Xxxx / xxx	Xxxx / xxx	Xxxx / xxx	12	Xxxx / xxx	Xxxx / xxx	Xxxx / xxx	Xxxx / xxx	Xxxx / xxx	Xxxx / xxx		Xxxx / xxx	Xxxx / xxx
10	Xxxx / xxx	Xxxx / xxx	Xxxx / xxx	16	Xxxx / xxx	Xxxx / xxx	Xxxx / xxx	Xxxx / xxx	Xxxx / xxx	Xxxx / xxx		Xxxx / xxx	Xxxx / xxx
12	Xxxx / xxx	Xxxx / xxx	Xxxx / xxx	20	Xxxx / xxx	Xxxx / xxx	Xxxx / xxx	Xxxx / xxx	Xxxx / xxx	Xxxx / xxx		Xxxx / xxx	Xxxx / xxx
14	Xxxx / xxx	Xxxx / xxx	Xxxx / xxx	20	Xxxx / xxx	Xxxx / xxx	Xxxx / xxx	Xxxx / xxx	Xxxx / xxx	Xxxx / xxx		Xxxx / xxx	Xxxx / xxx
16	Xxxx / xxx	Xxxx / xxx	Xxxx / xxx	20	Xxxx / xxx	Xxxx / xxx	Xxxx / xxx	Xxxx / xxx	Xxxx / xxx	Xxxx / xxx		Xxxx / xxx	Xxxx / xxx
18	Xxxx / xxx	Xxxx / xxx	Xxxx / xxx	20	Xxxx / xxx	Xxxx / xxx	Xxxx / xxx	Xxxx / xxx	Xxxx / xxx	Xxxx / xxx		Xxxx / xxx	Xxxx / xxx
20	Xxxx / xxx	Xxxx / xxx	Xxxx / xxx	24	Xxxx / xxx	Xxxx / xxx	Xxxx / xxx	Xxxx / xxx	Xxxx / xxx	Xxxx / xxx		Xxxx / xxx	Xxxx / xxx
24	Xxxx / xxx	Xxxx / xxx	Xxxx / xxx	24	Xxxx / xxx	Xxxx / xxx	Xxxx / xxx	Xxxx / xxx	Xxxx / xxx	Xxxx / xxx		Xxxx / xxx	Xxxx / xxx

Appendix 1

Pipe Joint Considerations

Typical considerations include:

a) Material(s) of construction of the piping

b) Metallic, metallic with for example, glass lining, fluorocarbons linking or rubber lining

c) Normal pipe size

d) Design conditions including start-up, shut-down, etc…Thermal movement of piping

e) Fluid properties/characteristics

f) Fabrication/construction requirements

g) Operational requirements

h) Maintenance requirements

i) Inspection requirements

a) Can site erection be carried out by welding? What are the normal methods of jointing?

b) What nominal sizes are available? What limitations are imposed by the piping code?

c) Pressure, pressure cycles, temperature, temperature cycles/transients

d) Flammability, toxicity, corrosive, erosive, malodorous, potential for blockage

e) Area classification. Likely size of leak, effect on environment. Electrical continuity

f) Can site welding, heat treatment be carried out?

g) Does the piping require frequent dismantling for cleaning?

h) Is cutting, site welding, post-weld heat treatment etc. permitted? Will valves, in-line instruments etc. need to be removed for repair/replacement? Will the piping require frequent replacement or dismantling for access to pressure vessels etc?

i) Will piping need to be dismantled in order to carry out pressure vessel inspection? Will visual inspection of the piping bore be required?

Reformable Joints

Reformable joints provide a ready means for connecting or disconnecting piping components, equipment etc… This if often necessary:

a) For joining piping etc… that cannot be joined by welding or where insitu welding is impracticable
b) For connections to pressure vessels, pumps, valves, in-line instruments etc…
c) For piping frequently dismantled
d) For inspection and maintenance of piping equipment

Of the different types of reformable joints available the flange joint is the type most commonly used. It is a joint that has extensive use over wide ranges of pressure, temperature, materials and nominal pipe sizes.

Gaskets

Composite gasket material such as compressed fibre is frequently used in addition to materials such as rubber, copper, steel and aluminium. IN certain countries there may be restrictions on the use of certain gasket materials.

Where gasket blow out is a cause for concern, non-blow out gaskets, such as serrated or spiral wound gaskets should be specified.

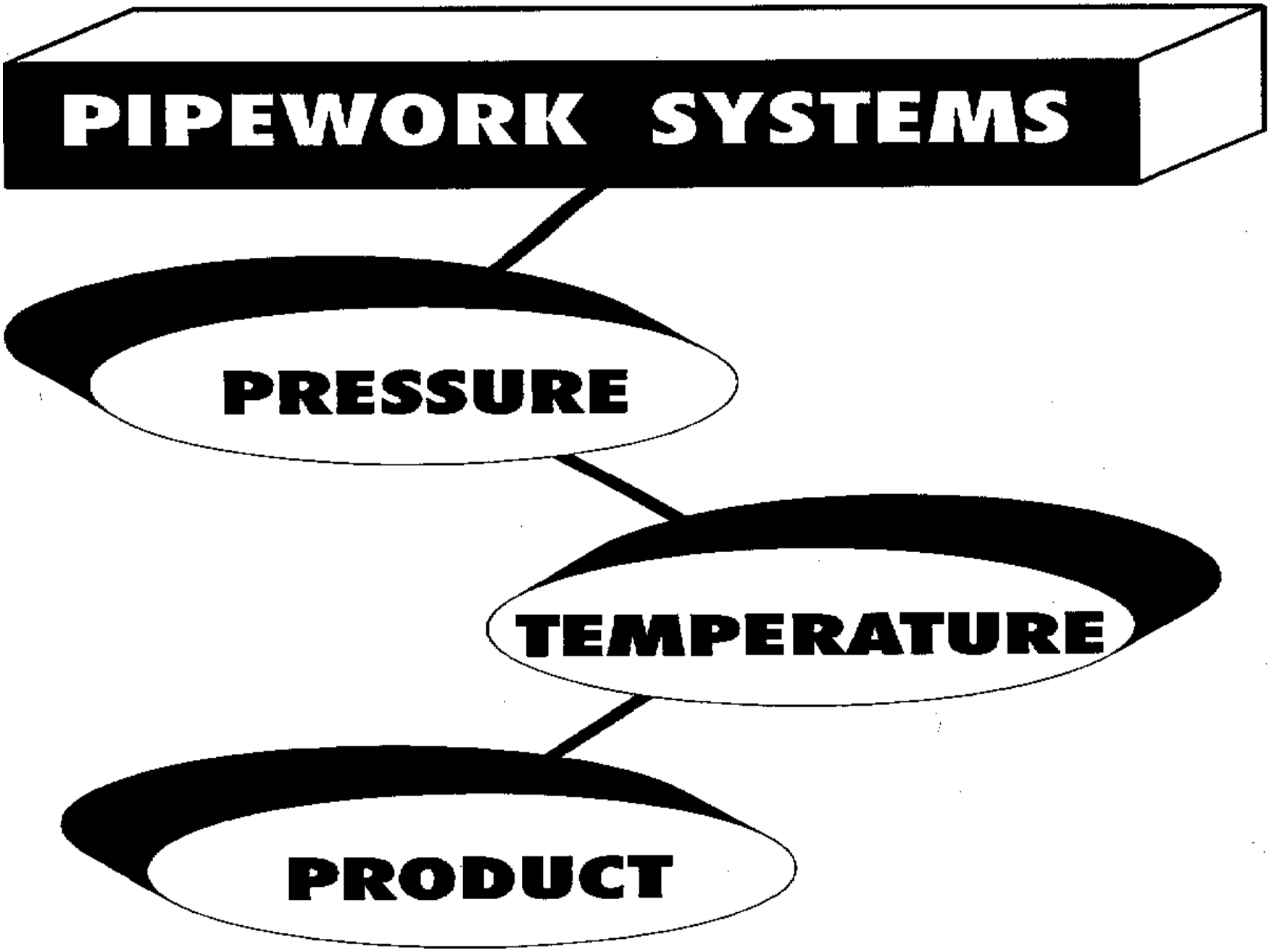
The internal diameter of the gasket should generally coincide with the bore of the flange.

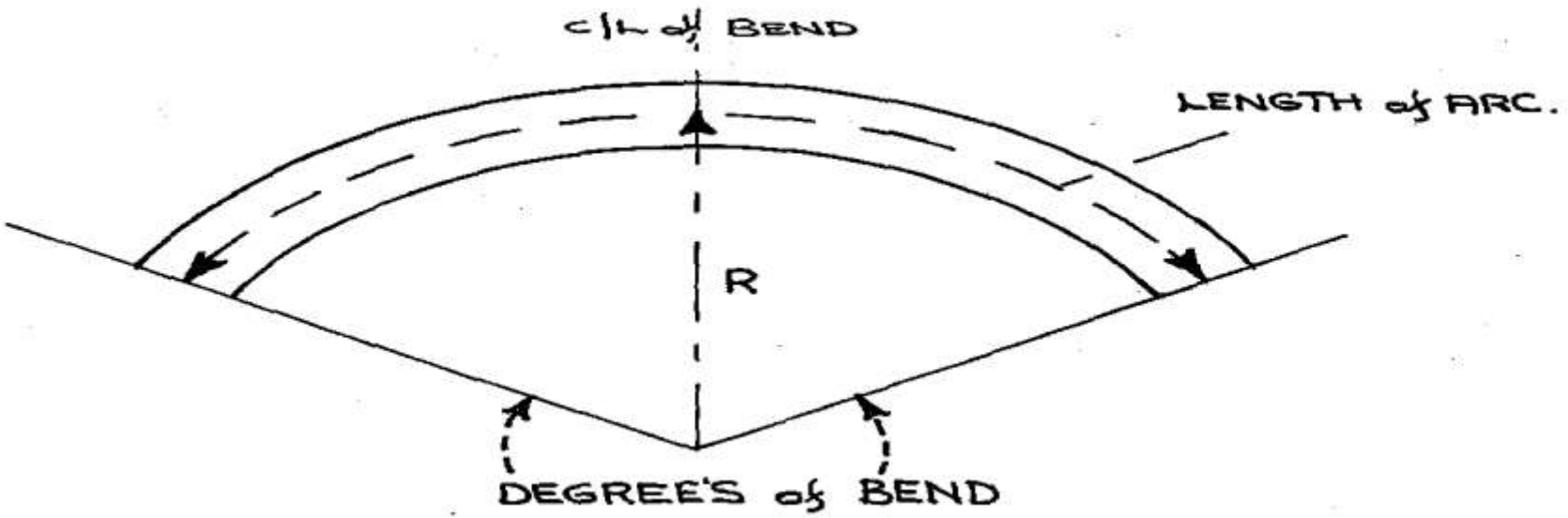
Selection criteria for gasket material are:

a) Process conditions, such as operating pressure and operating temperature
b) Admissibility of leakage, depending on line fluid and process conditions
c) Durability of the gasket material for the line fluid and its operating conditions

FlangeFacings

Whilst the nature of the fluid may dictate the gasket material to be used, the design of the flange facing depends solely on the operating temperature and pressure.


PIPEWORK SYSTEMS
PRESSURE
TEMPERATURE
PRODUCT



FORMULA

$$= \text{LENGTH of ARC} = \left(\text{N° of DEGREE'S} \times .01745 \times R\right)$$

EXAMPLE. FOR 45° BEND

$= 45° @ 3.5\ R.$

$= 45 \times .01745 \times 3.5$

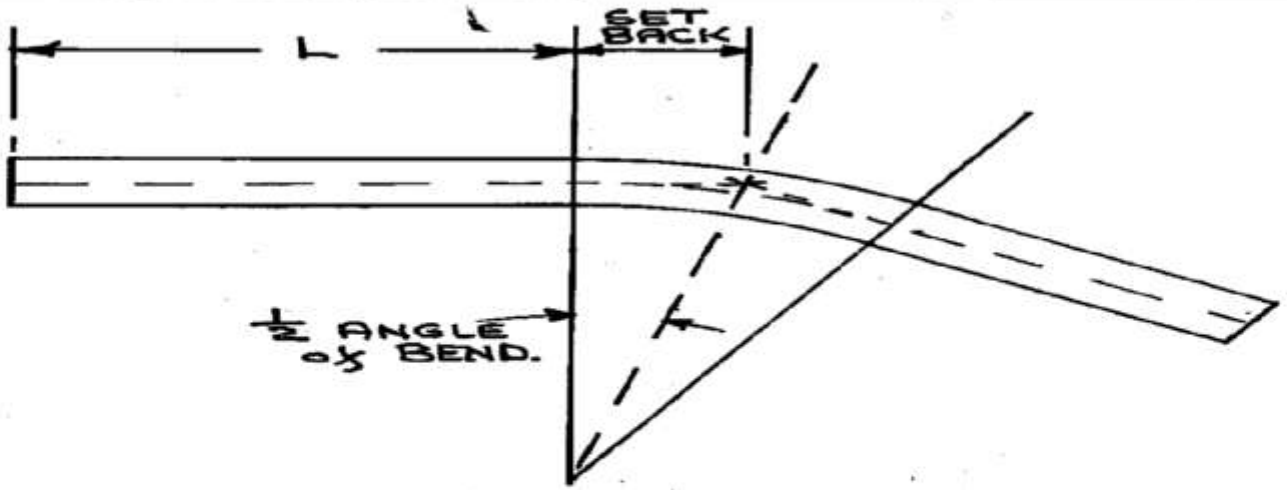
$= 2.748$

$= \boxed{2\ \frac{3}{4}"}$

SET - BACK

USED TO LOCATE THE BEGINNING of A BEND IN A PIECE OF PIPE

MEASUREMENTS CAN BE OBTAINED FOR ALL ANGLES | RADIUS.



FORMULA. = (RADIUS x TANGENT ½ ANGLE of BEND)

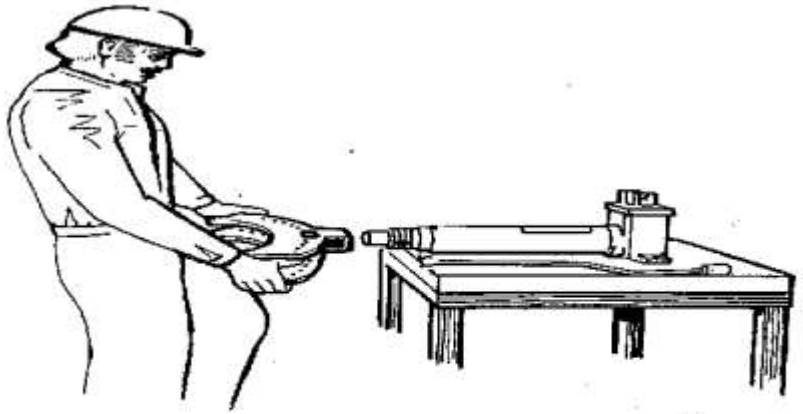
EXAMPLE = $45^\circ = (3.5 \times .414) = 1.449$

$= 1\frac{1}{2}"$

B		T		R		SET- BACK
$22\frac{1}{2}^\circ$		.199		3.5		.70 — ¾"
30°		.268		3.5		.95 — 1"
45°		.414		3.5		1.54 — 1½"
60°		.577		3.5		2.00 — 2"
90°		1.00		3.5		3.5 — 3½

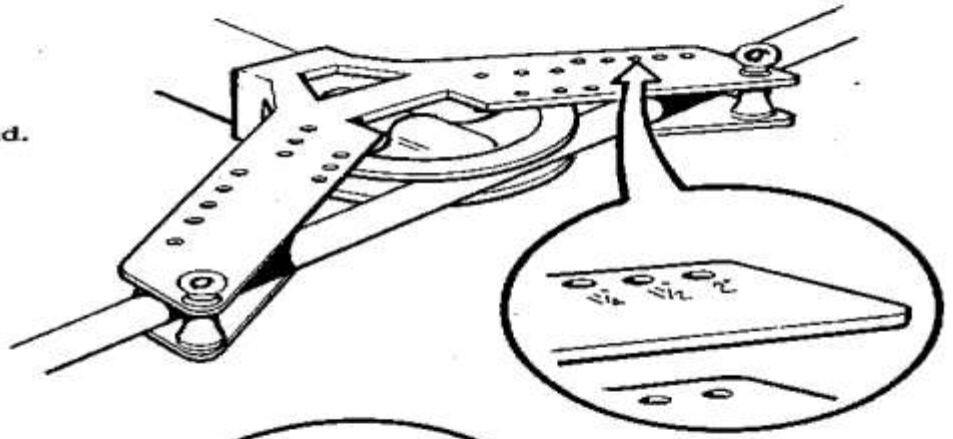
The setting up and operation of a manually operated Hydraulic Bending Machine

1. Screw the forming head on to the hydraulic cylinder.



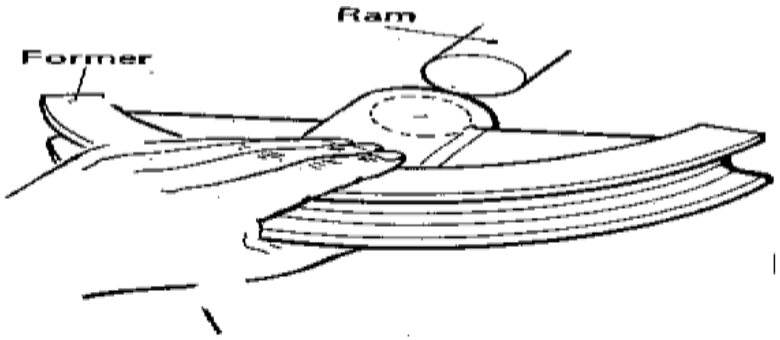
2. Place the machine on the ground.

Note:
Holes are drilled in the forming head. These are usually marked to show the nominal bore sizes of pipes.

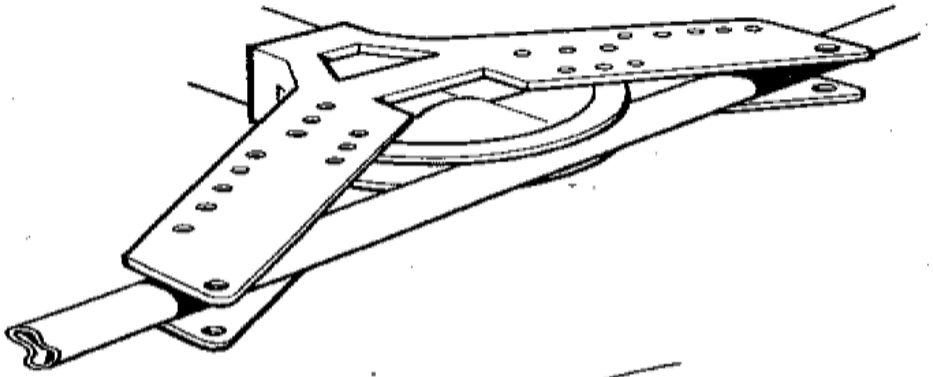


3. Select the correct former to fit the outside diameter of the pipe. Formers are available for standard sizes of pipe from 12 mm (½ in.) to 50 mm (2 in.) bore.

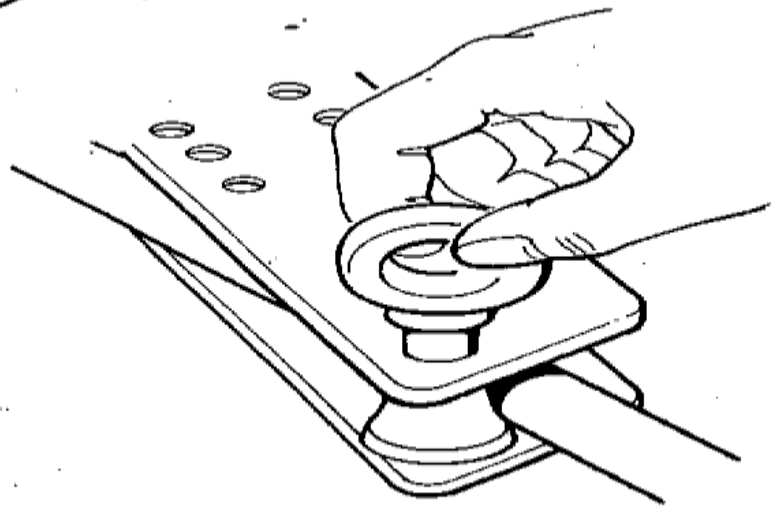
4. Fit the pipe former on to the cylinder ram.



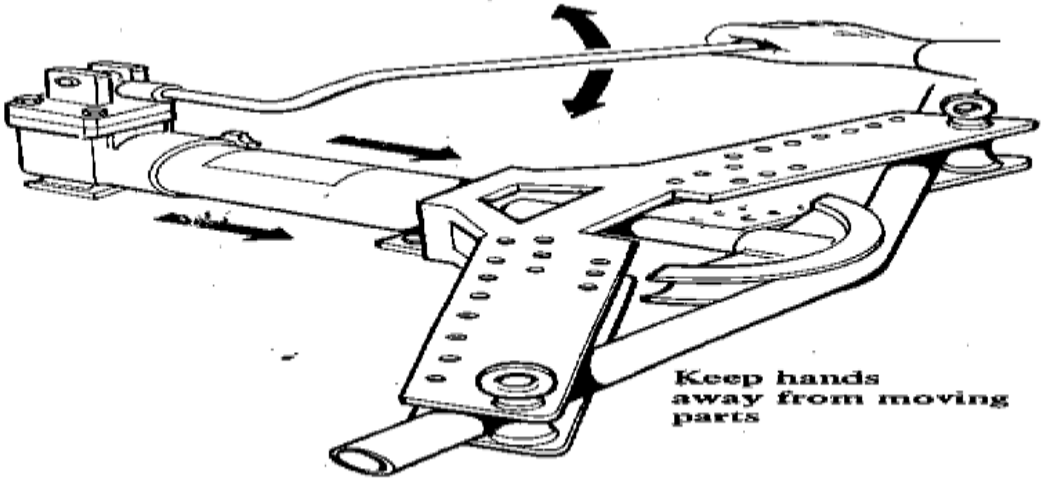
5. Place the pipe between the forming head plates and against the former.



6. Support the pipe and fit dollies (or rollers) between the upper and lower plates of the forming head; secure them in position by passing pins through the plates and the dollies. The dollies should be fitted in the holes marked to suit the size of pipe being bent.

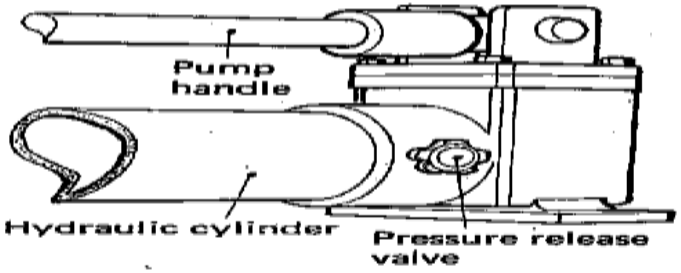


7. Close the pressure release valve on the pump body then start pumping to push the former against the pipe.

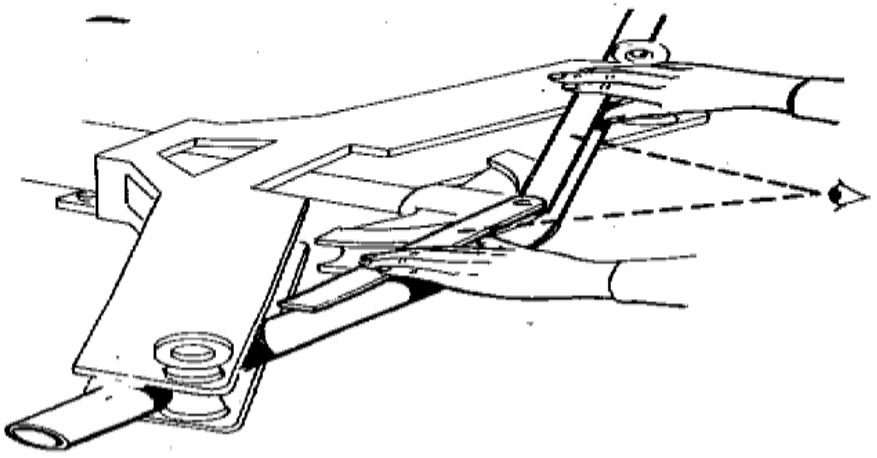


8. Stop pumping when the desired bend has been achieved.

9. Turn the pressure release valve anticlockwise to release the pressure in the hydraulic cylinder. When the ram has moved back about 6 mm (¼ in.) to 10 mm (⅜in.) close the pressure release valve to hold the ram steady.



10. Check the accuracy of the bend with a bevel stick.

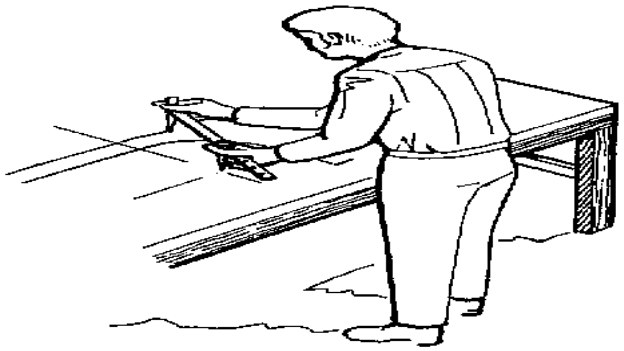


11. Open the pressure release valve and allow the ram to return to the start position. Remove the dollies and the bent pipe from the machine.

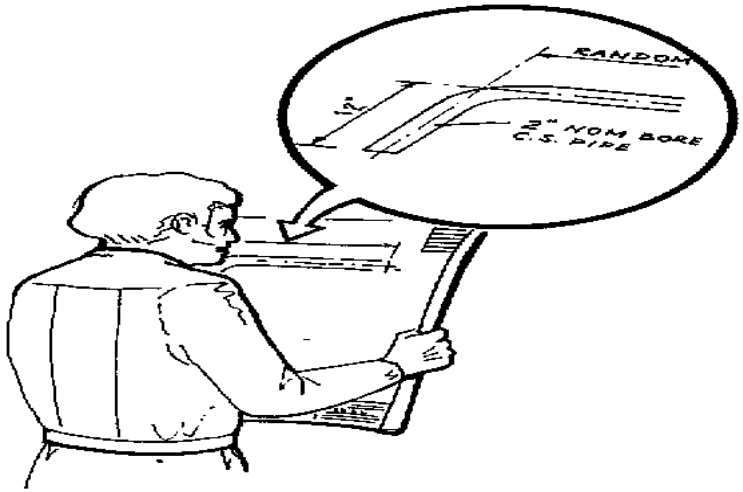
Making a 90° bend using a manually operated Hydraulic Bending Machine

1. Make a full size drawing of the bend on the bench or floor. Mark on the drawing the centre line and double lines representing the outside of the pipe and the radius.

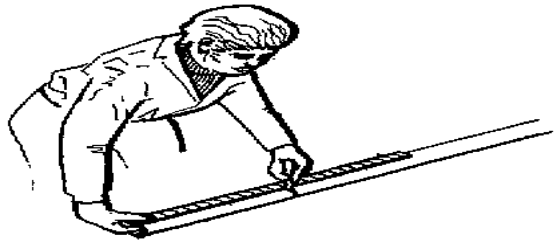
   Keep the drawing clean as it will be needed to check dimensions after the bend has been formed.



2. Collect the pipe and check against the drawing that it is of the correct bore, length and wall thickness before starting work.
3. Determine the position of the centre of the bend by subtracting the nominal bore of the pipe from the leg length of the pipe. For example, in the drawing shown the leg length is 300 mm (12 in.) and the nominal bore is 50 mm (2 in.). Therefore the centre of the bend will be 250 mm (10 in.) from the end of the pipe i.e. 300 mm (12 in.) leg length minus 50 mm (2 in.) bore.

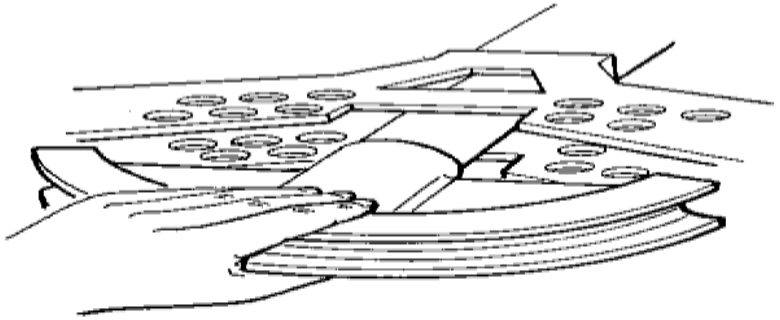


4. Measure from one end of the pipe and mark the centre of the bend with chalk.

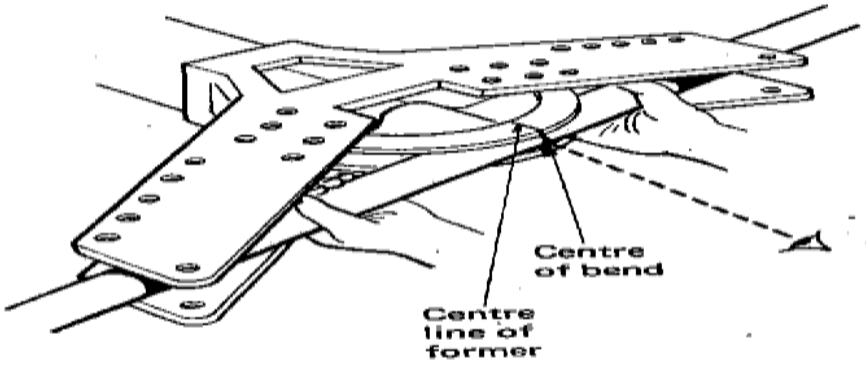


5. Select the correct size of former. Make sure that it is free from dirt and dust and then fit it over the end of the ram.

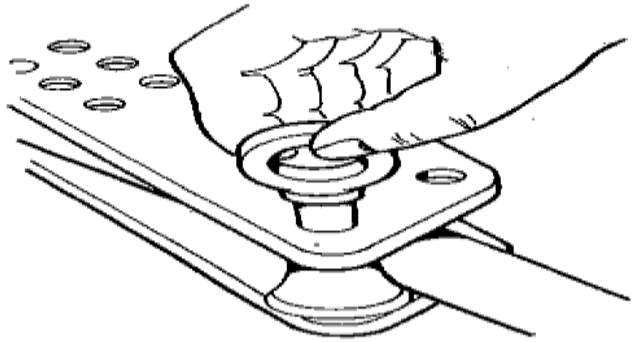
   Ensure that the former is a good fit and push it firmly on to the ram.



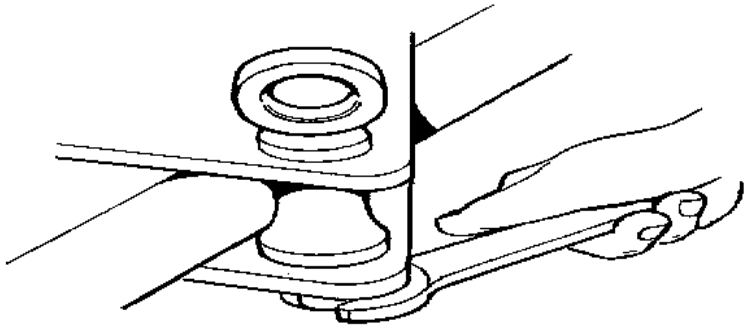
6. Place the pipe in the machine between the forming head plates with the centre of bend of the pipe in line with the centre line of the former.



7. Position the dollies in the forming head to suit the size of the pipe.



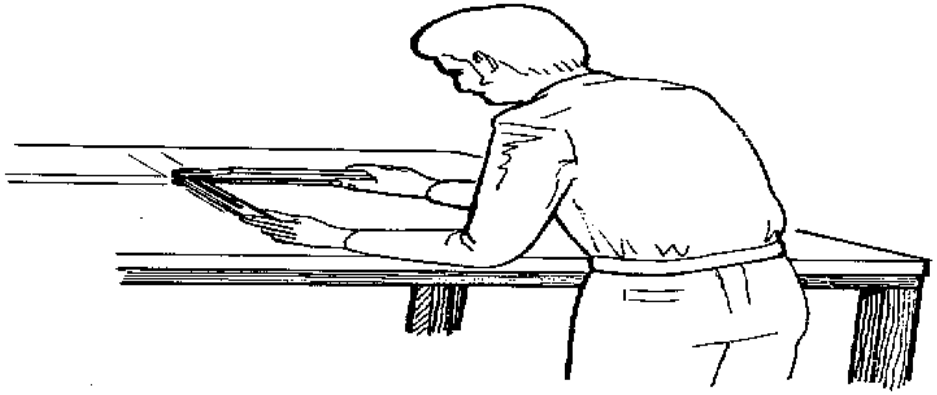
8. Ensure the dollies are correctly secured in position.



9. Close the pressure release valve on the pump body.
10. Hold the pipe against the dollies. Make sure that the centre of the bend corresponds to the centre line marked on the former.
11. Pump steadily.
12. Stop pumping when the pipe is held firmly between the former and the dollies.

Keep the hands away from moving parts.

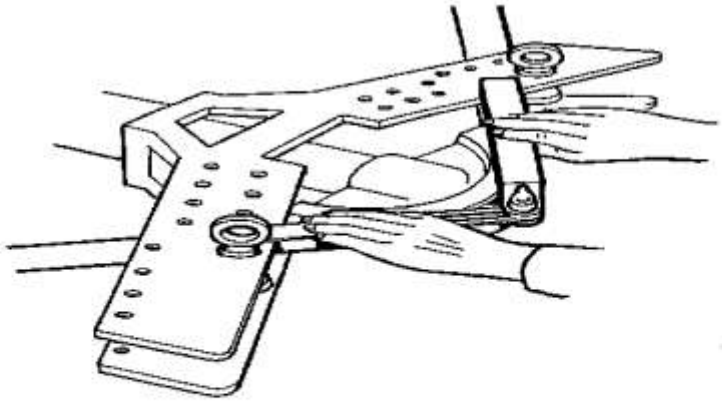
13. Place a bevel stick on the centre line of the bench drawing and lift the angle of the bend.



14. Place the bevel stick on top of the forming head then pump until the pipe is bent slightly more than the angle of the bevel stick.

15. Measure from the front centre of the forming head to a chalk or other position on the pump body. Make a note of the measurement then open the pressure release valve and allow the ram to retract about 6 mm (¼ in.). Close the valve.

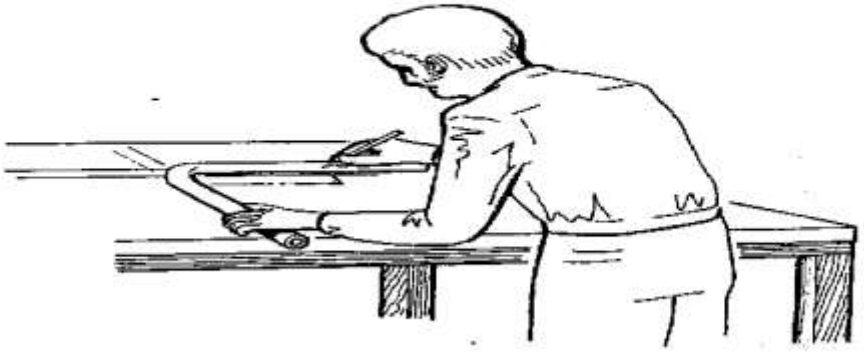
Note:
When released from the bending pressure, the pipe will spring back slightly, altering the degree of bend. By trial and error the trainee will learn how much the pipe should be over-bent to obtain a specified angle.



16. Re-check the bend by placing the bevel stick on the pipe and sighting its edges against the edge of the pipe.

Note:
The pipe can be bent further by more pumping. Ensure that the centre of the bend of the pipe remains in line with the centre line of the former. Before increasing the bend, pump until the distance between the former and the mark on the pump body agree with the measurement taken and recorded earlier.

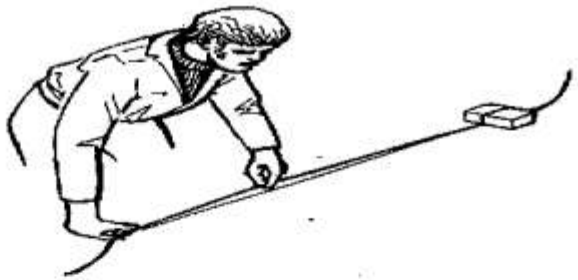
17. Open the pressure release valve to slacken off the ram, remove the dollies and take the pipe out of the machine.
    Keep a firm grip on the pipe to stop it falling when the pins and dollies are removed.
18. Check the bend for accuracy by placing it on the full scale chalk drawing.
19. Place the pipe on the drawing and mark required cutting length.
20. Cut to size.



Note:
The procedure for bending any angle using this type of machine is similar to that described above.

Making a double 90° bend in the same plane using a manually operated Hydraulic Bending Machine

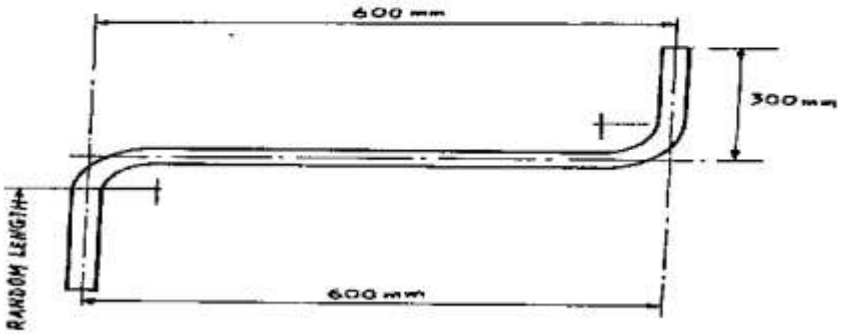
1. Draw the pipe on the bench floor full size, with double 90° bends.



2. Calculate, measure and mark off the position of the centre of the first bend.
3. Bend the first 90° bend and check it against the drawing.

4. Determine the centre of the second bond. Subtract the nominal bore of the pipe from the centre distance between the two parallel legs. In the drawing shown the 2nd leg length = 600 mm (24 in.) and the bore of the pipe = 50 mm (2 in.).

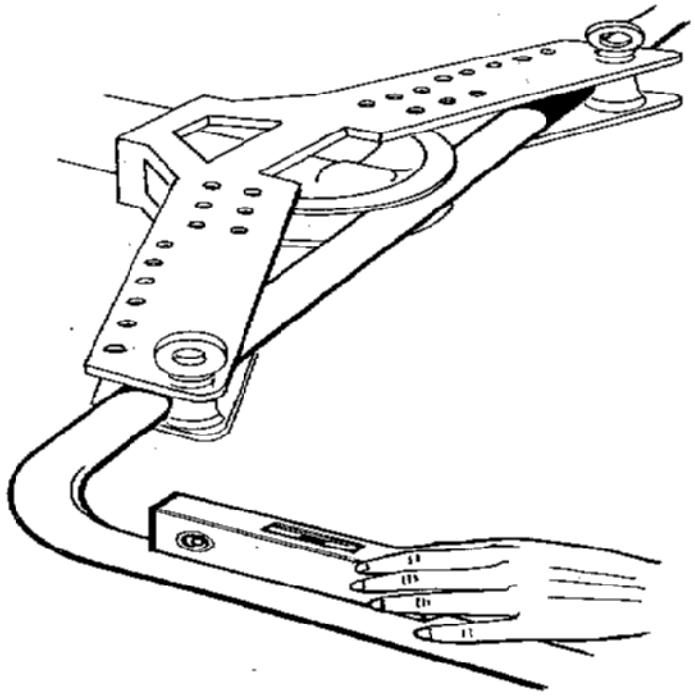
   Measure from the centre line of the last leg 600 mm (24 in.) less 50 mm (2 in.) (i.e. 550 mm (22 in.)) to give the position of the 2nd bend centre. Mark the pipe.



5. Replace the pipe in the bending machine and secure it by pumping until the former holds the pipe firmly against the dollies. Avoid bending the pipe as an error made before it is positioned correctly cannot be remedied.

6. Use a spirit level to check that the former and the first leg of the pipe are both level.

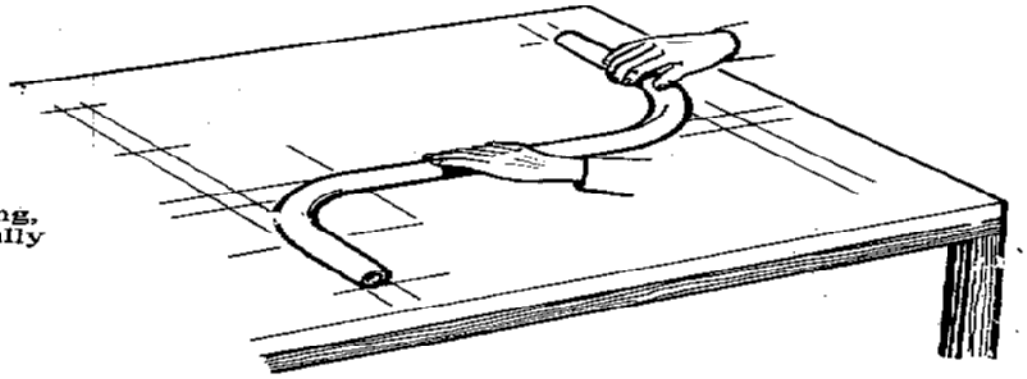
Keep the hands away from moving parts.

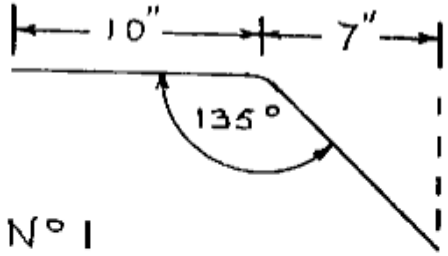


7. Bend the second 90° bend and remove the pipe from the machine.

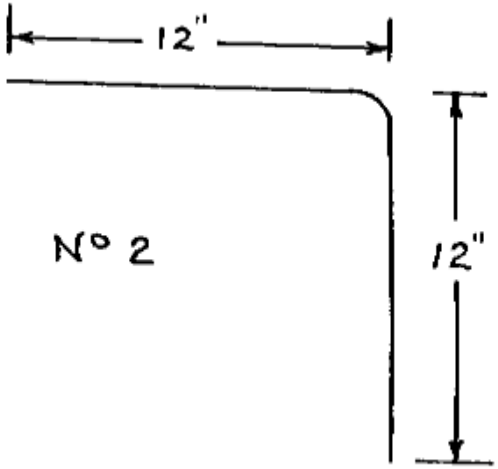
8. Place the pipe on the drawing, check the bends dimensionally and mark off the pipe for cutting to length.

9. Cut to size.

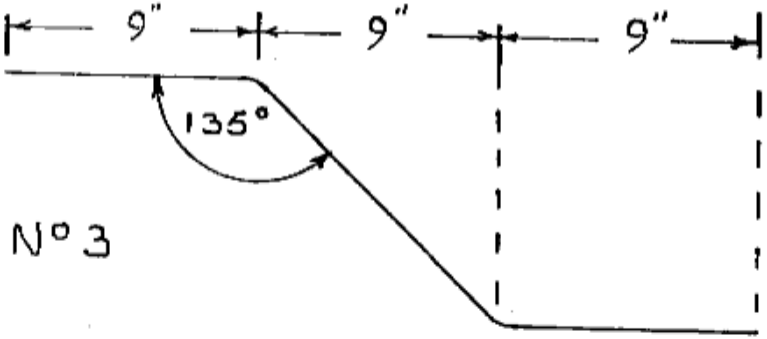




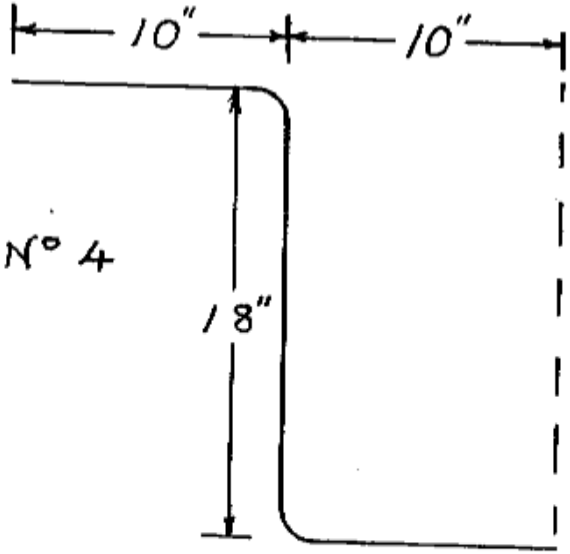
N° 1



N° 2

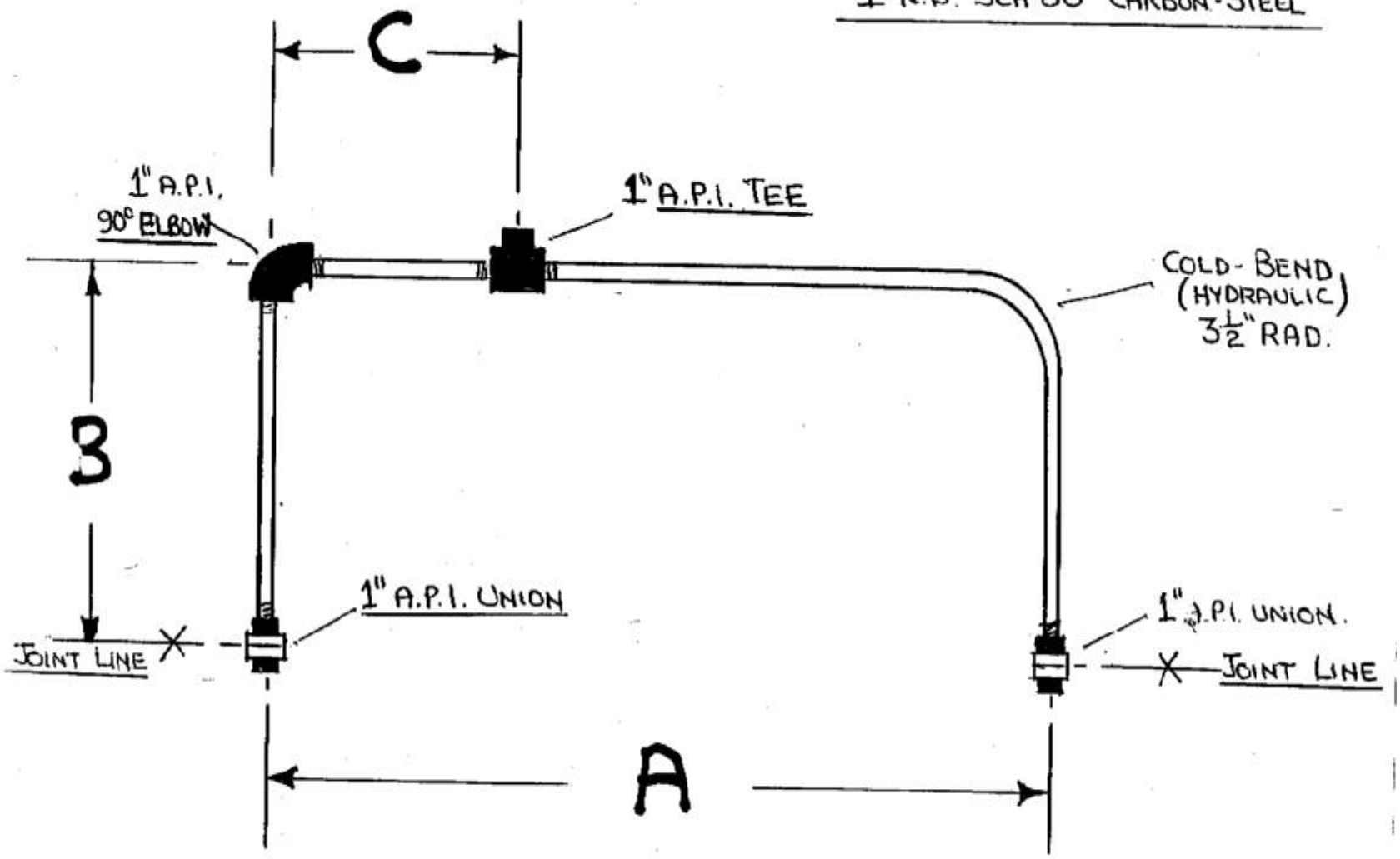


N° 3



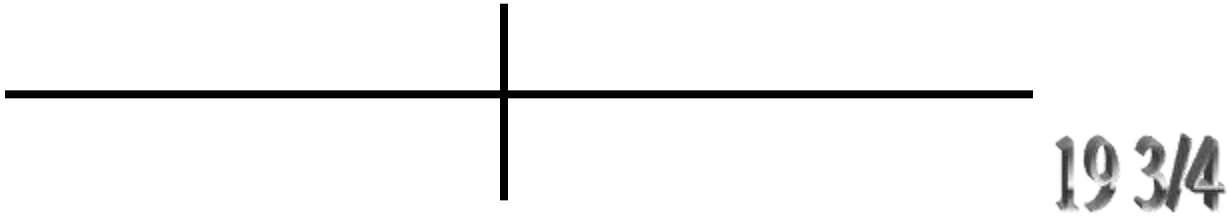
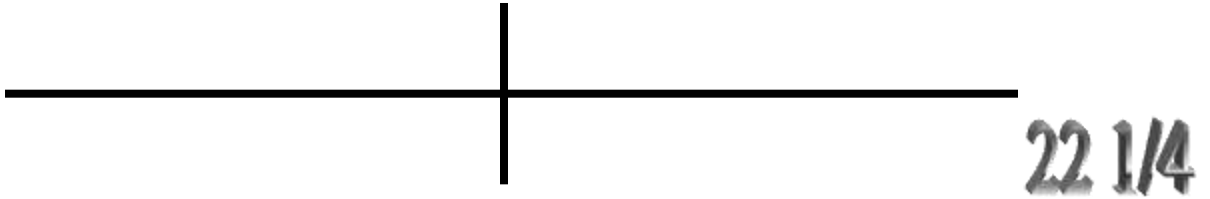
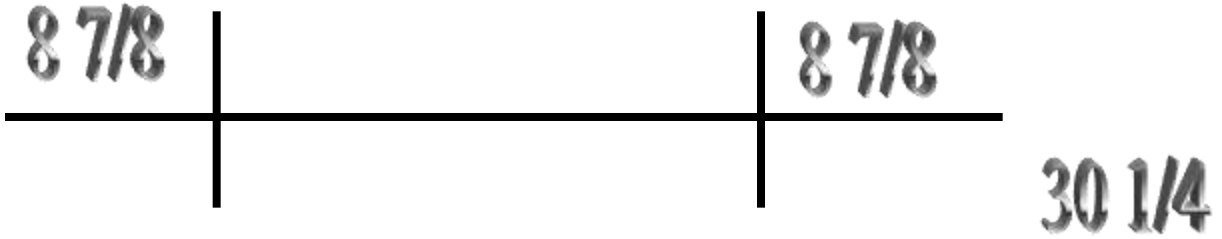
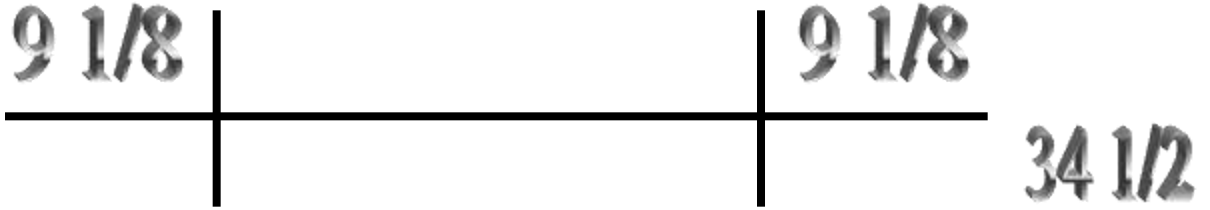
N° 4

	PF 2A	BENDING METALLIC PIPE USING	MATERIAL	1" N.B SCHEDULE 80

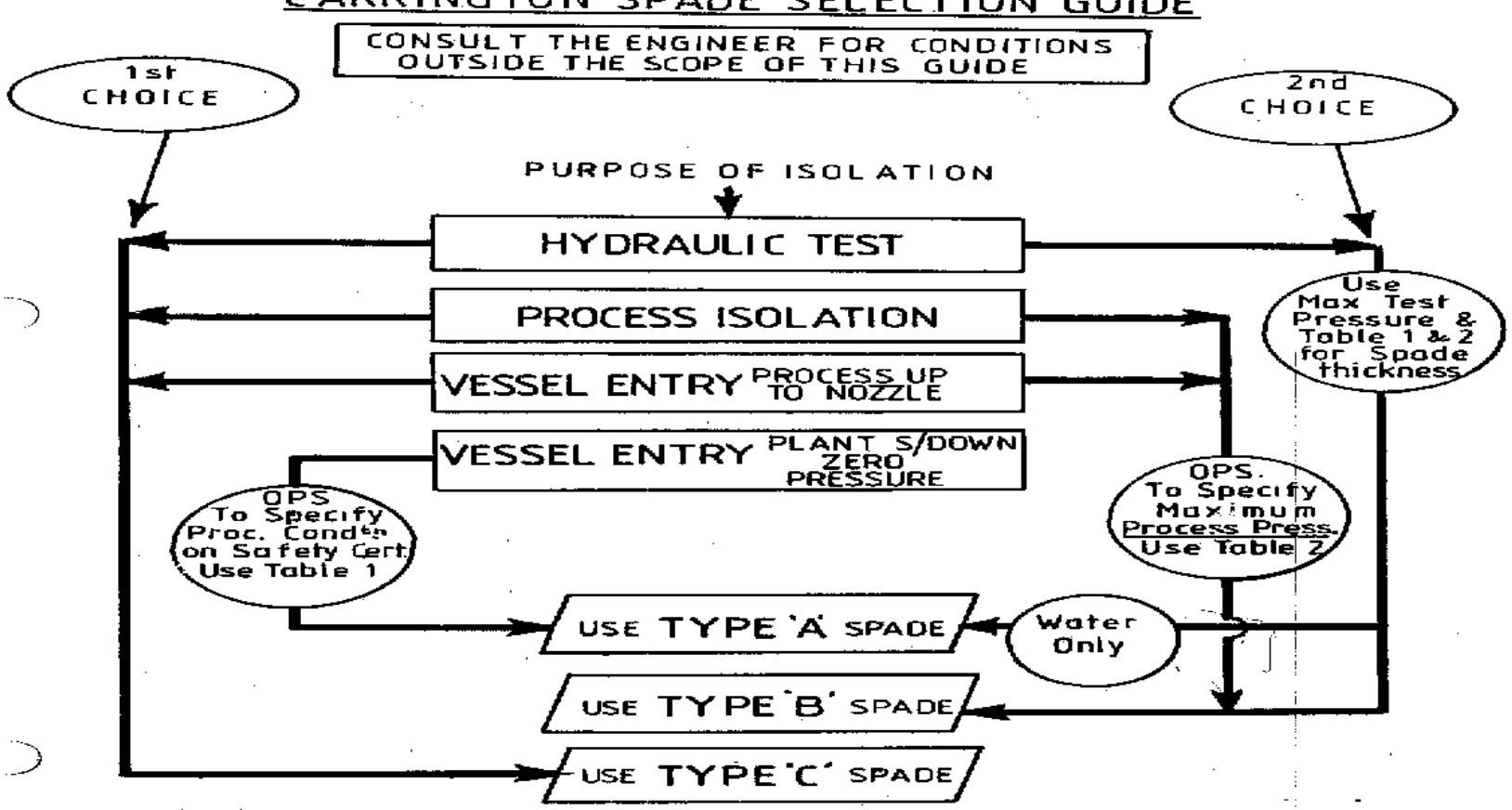

1" N.B. SCH 80 CARBON-STEEL
C
1" A.P.I. 90° ELBOW
1" A.P.I. TEE
COLD-BEND (HYDRAULIC) 3½" RAD.
B
1" A.P.I. UNION
1" A.P.I. UNION.
JOINT LINE
JOINT LINE
A
HYDRAULIC-TEST-PRESSURE

Item 7 - Draft

Day One - Session 1	Day 2 – Session 1	Day 3 – Session 1
Intro Piping Systems Line Pipe Jointing/Change Manufacture & Fabrication Standards	Practical Session Thread Cutting Exercises	Practical Session Flange Joining and Identification
Lunch	Lunch	Lunch
Day 1 - Session 2	Day 2 - Session 2	Day 3 - Session 2
Practical Session Bending, Cutting, Forming	Practical Session Thread Cutting Exercises continued	Test. Practice and Application

1	
2	
3	
4	

LARRINGTON SPADE SELECTION GUIDE



DEFINITIONS

TYPE 'A' SPADE Low pressure spade cut from flat plate, Gasket contact surface may be left unmachined but must be free of rust, mill scale, burrs and other damage.

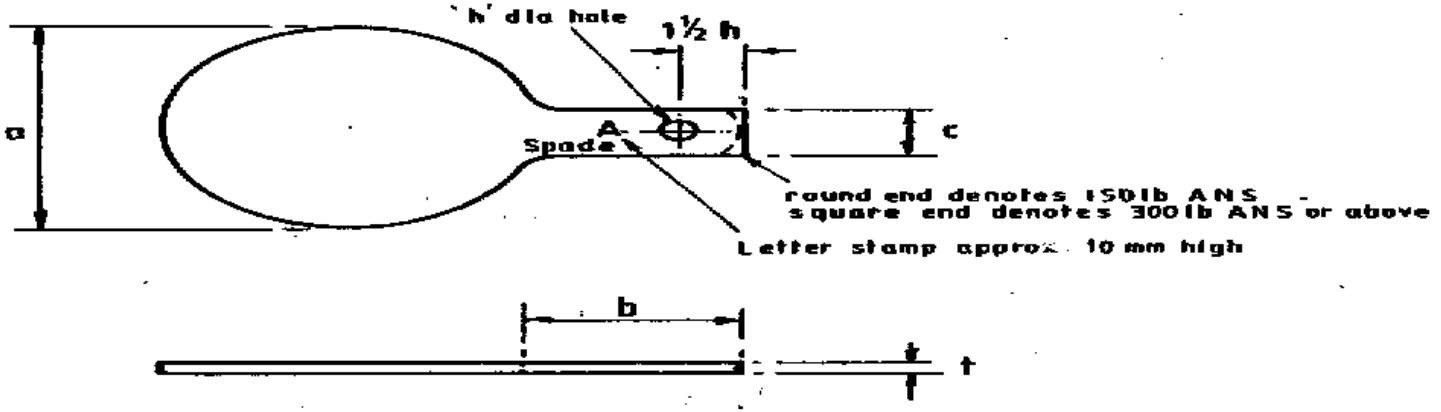
TYPE 'B' SPADE Medium pressure spade (not to full pipe flange specification). Gasket contact area to be machined finish per specification.

TYPE 'C' SPADE Full pressure spade of correct thickness and surface finish in accordance with pipe flange specification.

DJF

TYPE A SPADE

Low pressure spade cut from flat plate. Gasket contact surface may be left unmachined but must be free of rust, will scale, burrs and other damage. A suitable ring (not full face) gasket shall be used to protect the gasket contact surface of the pipe flanges.



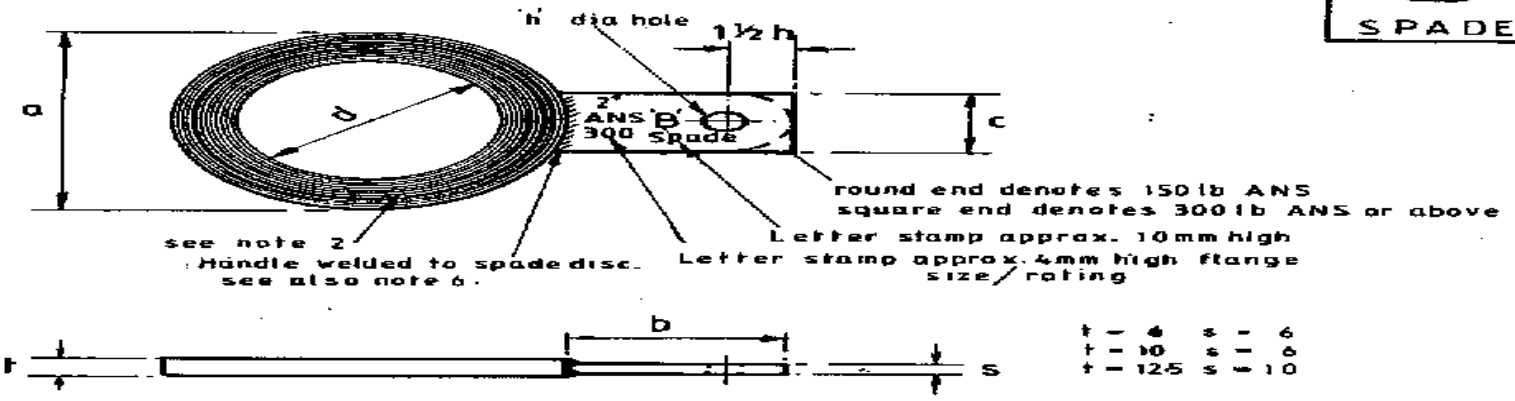
NOTES 1. All dimensions in mm
2. Material – carbon steel
3. Refer type 'C' spade for all dimensions except thickness 't'

Table 1

nominal pipe size		t	MAX. ALLOWABLE PRESS. bar. g.
in	mm		
½	15	6	210·5
¾	20	6	105·3
1	25	6	69·2
1½	40	6	26·3
2	50	6	15·7
3	80	6	7·4
4	100	6	4·1
6	150	10	9·4
8	200	10	5·7
10	250	10	3·7
12	300	12	4·2
14	350	12	3·5
16	400	12	2·7
18	450	12	2·1
20	500	12	1·7
24	600	12	1·2

Medium pressure spade (not to full pipe flange specification).

TYPE **B** SPADE



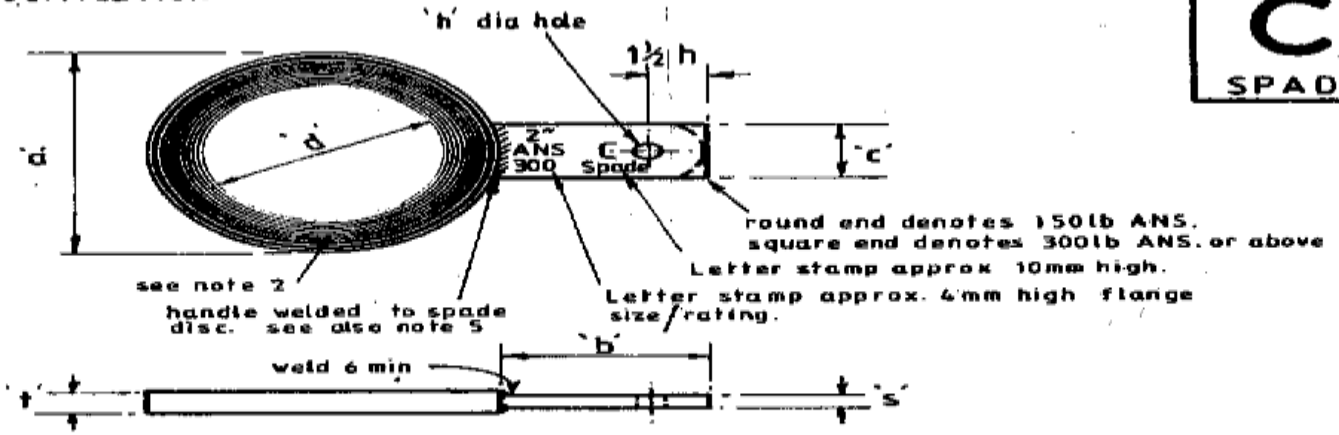
NOTES
1. All dimensions in mm
2. Gasket contact surface to be machined finish having spiral groove 125 to 250 CLA μ"
3. Maximum Allowable Working Pressure (MAWP) are applicable for temperatures up to 400° C max.
4. Thickness includes 1mm corrosion allowance on both sides.
5. Material to BS 1501-151 Gr 430 A
6. Where s-t handle may be fabricated integral with spade.
7. Refer type 'C' spade for all dimensions except thickness. t

Table 2

nominal pipe size		MAWP (bar g.) for thickness t			
in	mm	6	10	12·5	15
½	15	210·5	—	—	—
¾	20	105·3	—	—	—
1	25	69·2	277·	—	—
1½	40	26·3	105·3	181·5	—
2	50	15·7	62·9	108·3	166·0
3	80	7·4	29·8	51·3	78·6
4	100	4·8	19·0	32·8	50·3
6	150	2·3	9·4	16·2	24·8
8	200	1·4	5·7	9·8	15·1
10	250	0·9	3·7	6·7	9·8
12	300	0·7	2·7	4·6	7·0
14	350	0·6	2·2	3·8	5·9
16	400	0·4	1·7	3·0	4·5
18	450	0·3	1·4	2·3	3·6
20	500	0·3	1·1	1·9	2·9
24	600	0·2	0·8	1·3	2·0

Full pressure spade in accordance with pipe flange specification.

TYPE C SPADE



NOTES
1. All dimensions in m m.
2. Gasket contact surface to be machined finished having spiral groove 125 to 250 CLA μ".
3. Design pressure equal to test pressure of ANS flange classes. Design temp 20°C Allowable design stresses acc. to ANSI B 31-3-1976
4. Material per ASTM A285-Gr C or A515-Gr 55 except items marked * to be ASTM A515 Gr 70.
5. Where s-t handle may be fabricated integral with spade.

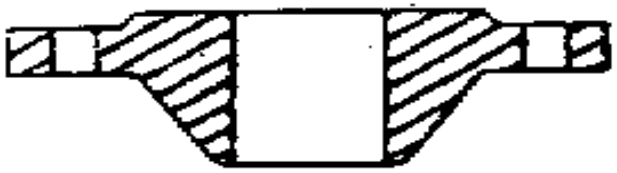
Table 3

nominal pipe size		150lb ANS							300lb ANS						
in	mm	a	b	c	d	h	t	s	a	b	c	d	h	t	s
½	15	44	90	24	15	12	4	4	50	90	24	15	12	4	4
¾	20	54	90	28	20	12	4	4	64	95	30	20	12	4	4
1	25	64	90	34	25	12	4	4	70	95	34	25	12	4	4
1½	40	82	90	40	40	12	4	4	92	100	40	40	12	5	4
2	50	102	105	50	50	20	4	4	108	110	50	50	20	7	4
3	80	132	110	50	75	20	6	4	146	115	60	75	23	10	6
4	100	172	110	50	95	20	7	4	178	120	60	95	23	12	8
6	150	218	115	60	145	23	10	6	248	115	60	145	23	17	12
8	200	276	115	60	190	23	13	8	304	120	66	190	25	21	12
10	250	336	120	66	245	26	16	10	358	130	75	245	29	26	12
12	300	406	125	66	295	26	19	12	418	135	80	295	32	31	12
14	350	444	130	75	330	29	21	12	478	140	80	330	32	33	12
16	400	506	130	75	380	29	23	12	532	165	80	380	38	38	12
18	450	542	130	80	430	32	26	12	590	165	80	430	38	43	12
20	500	598	155	80	480	32	29	12	646	170	80	480	38	47	12
24	600	710	155	80	580	38	35	12	768	180	100	580	38	51*	12

* see note 4

cont. over____

FLAT FACE

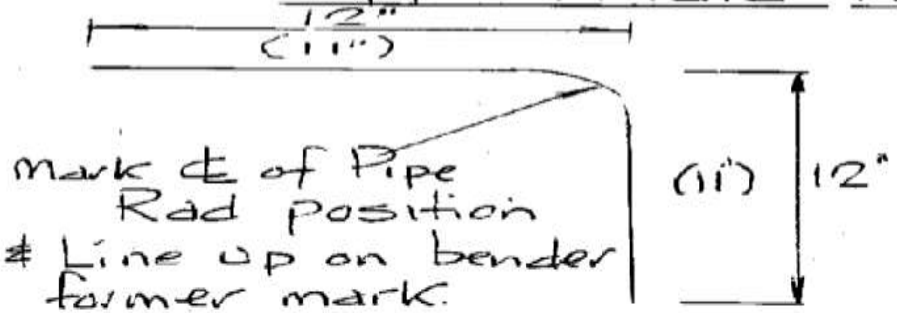


RAISED FACE

LAPPED JOINT

RING JOINT

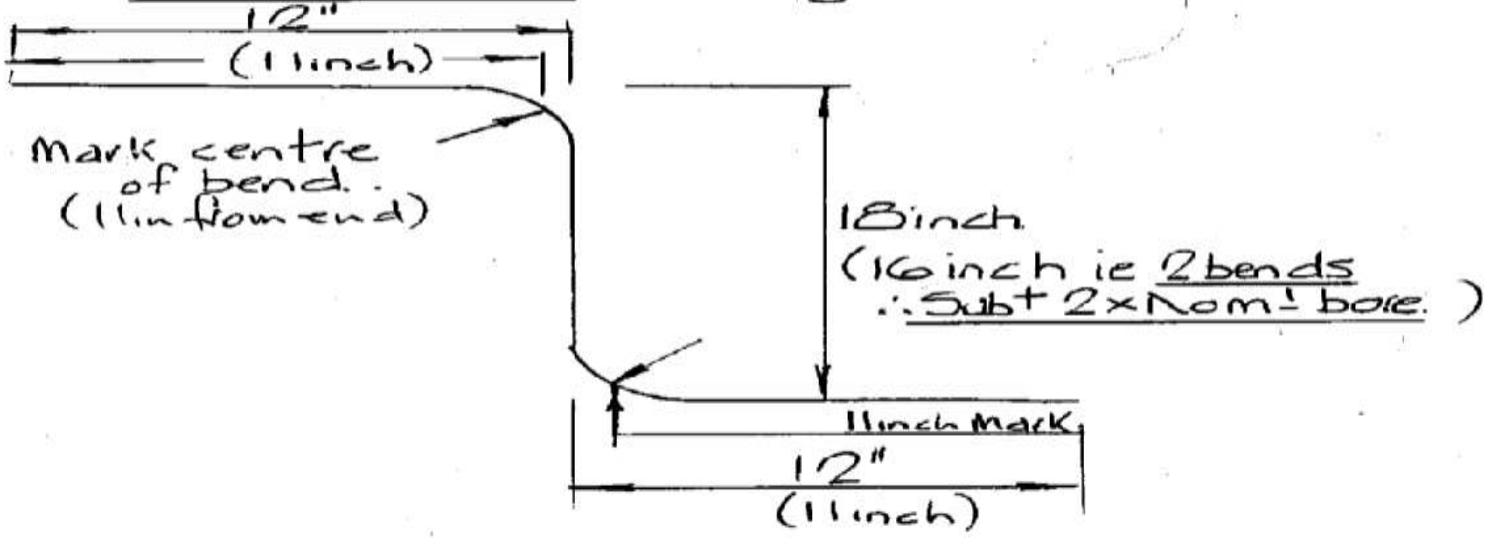
Approximate Pipe Bend

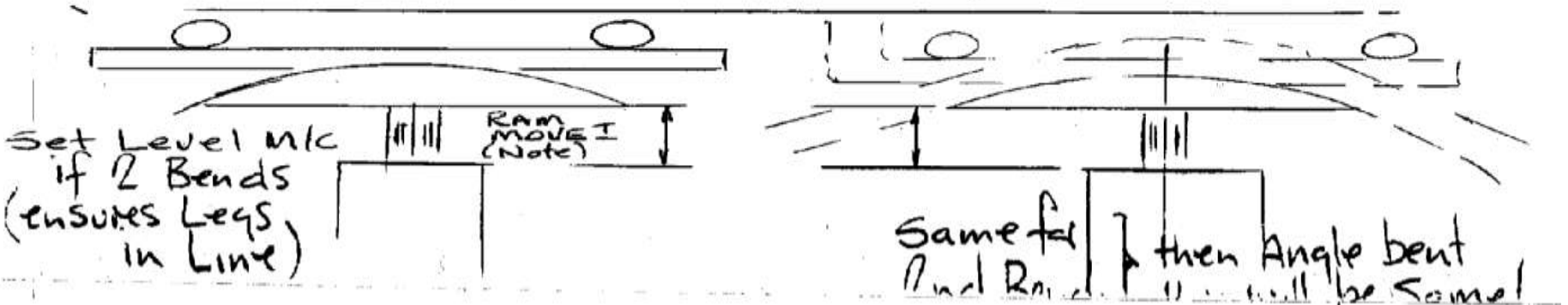


Dimns are Pipe ℄ lines
12" leg lengths req'd
Finaly.
1 inch Nom! bore Pipe
Deduct 1 inch from
Dwg leg lengths
(or 3/4 if this is pipe bore)

ONE BEND — "

TWO BENDS — Again 1in Nom! bore





SAFETY NOTICE

HYDRAULIC TEST IN PROGRESS

PANEL C-33

NORMAL THREAD ENGAGEMENT

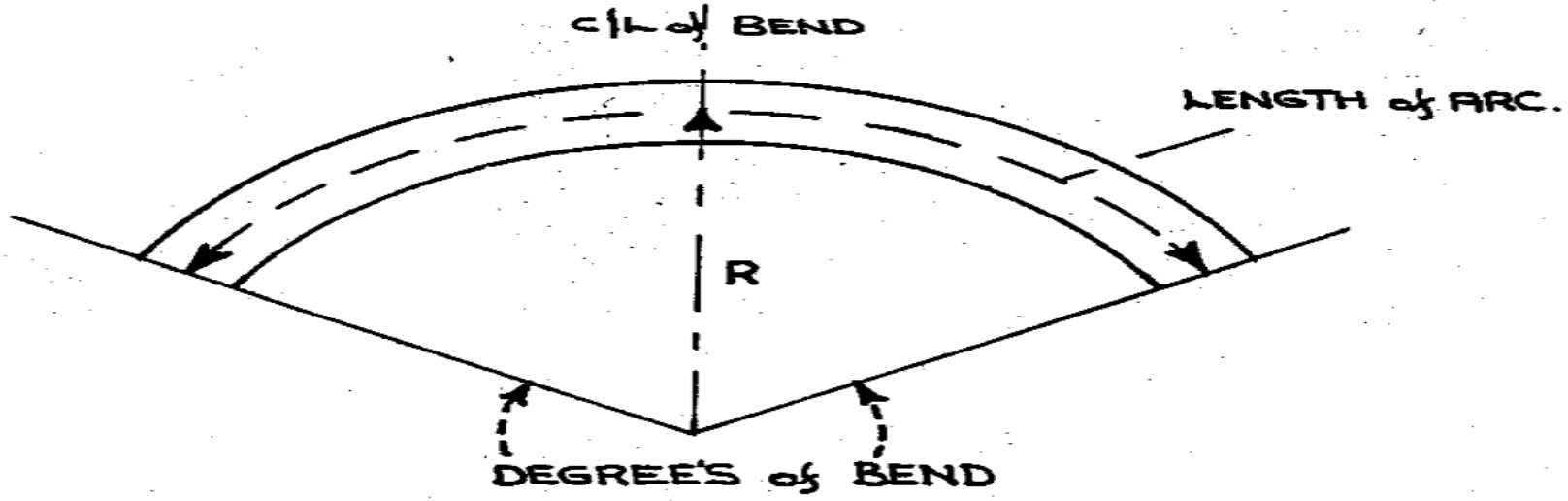
FOR

1/8" TO 12" N.P.S. SCREWED FITTINGS

TO THREADED PIPE

N.P.S. - DIMENSIONS, IN INCHES - (T) THREAD ENGAGEMENT

1/8	1/4
1/4	3/8
3/8	3/8
1/2	1/2
3/4	9/16
1	11/16
1-1/4	11/16
1-1/2	11/16
2	3/4
2-1/2	15/16
3	1
3-1/2	1-1/16
4	1-1/8
5	1-1/4
6	1- 5/16
8	1-7/16
10	1-5/8
12	1-3/4



FORMULA

= LENGTH of ARC = (N° of DEGREE'S x .01745 x R)

EXAMPLE. for 45° BEND

= 45° @ 3.5 R.

= 45 x .01745 x 3.5

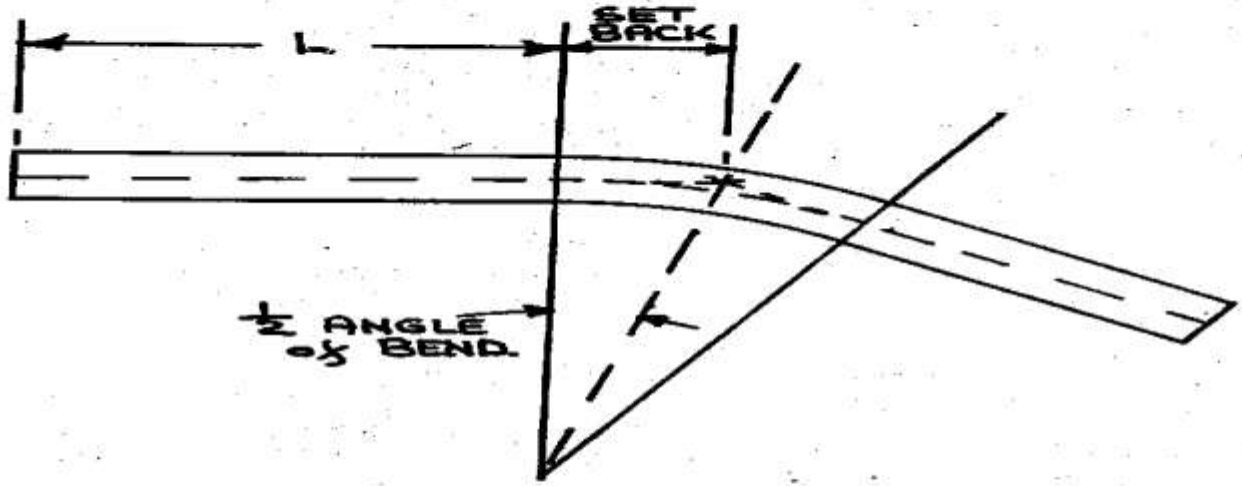
= 2.748

= $2\frac{3}{4}$"

SET-BACK

USED TO LOCATE THE BEGINNING of A BEND IN A PIECE OF PIPE

MEASUREMENTS CAN BE OBTAINED FOR ALL ANGLES | RADIU



FORMULA. = (RADIUS x TANGENT ½ ANGLE of BEND)

EXAMPLE = $45° = (3.5 \times .414) = 1.449$

$= 1\frac{1}{2}"$

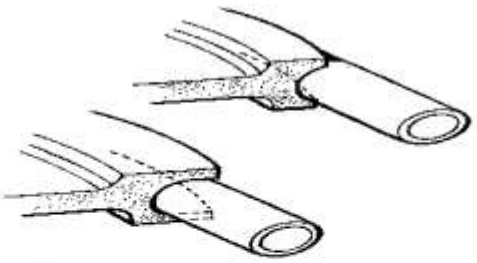
B		T		R		SET-BACK
22½°		.199		3.5		.70 — ¾"
30°		.268		3.5		.95 — 1"
45°		.414		3.5		1.54 — 1½"
60°		.577		3.5		2.00 — 2"
90°		1.00		3.5		3.5 — 3½"

The setting up and operation of a hand Compression Pipe Bending Machine

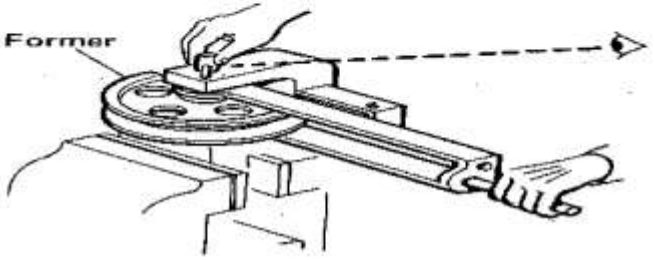
Pipes are bent round grooved formers which vary in size to suit the wall thickness and bore of the pipe.

The width of the grooves is equal to the outside diameter of the pipe whilst their depth is dependant on the type of back guide or sleeve used.

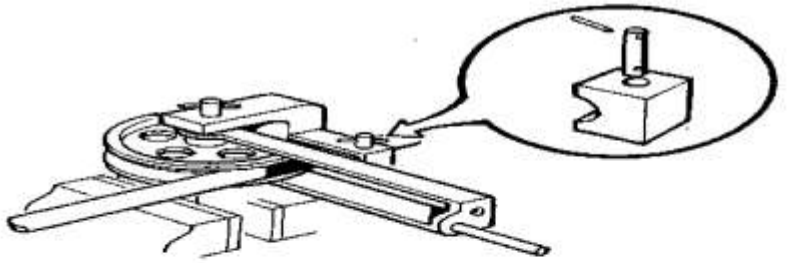
Note:
In this Training Element the procedures described utilise full depth formers and matching sleeves.



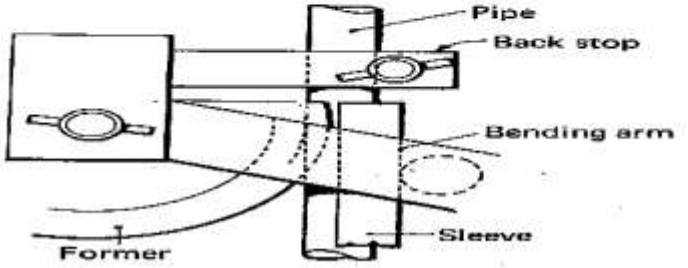
1. Lock the selected former in position by passing a pin through the bending arm and into the body of the machine.



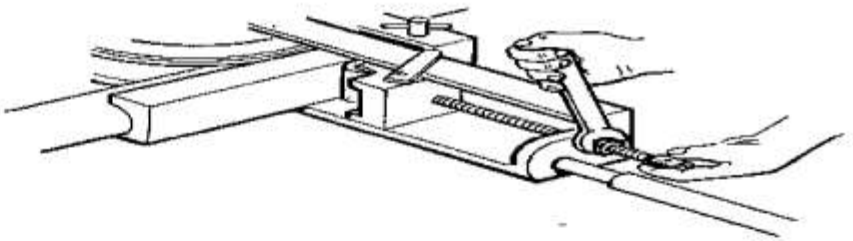
2. Fit a back stop to the stop bar of the machine to hold the pipe in position whilst it is being bent round the former.



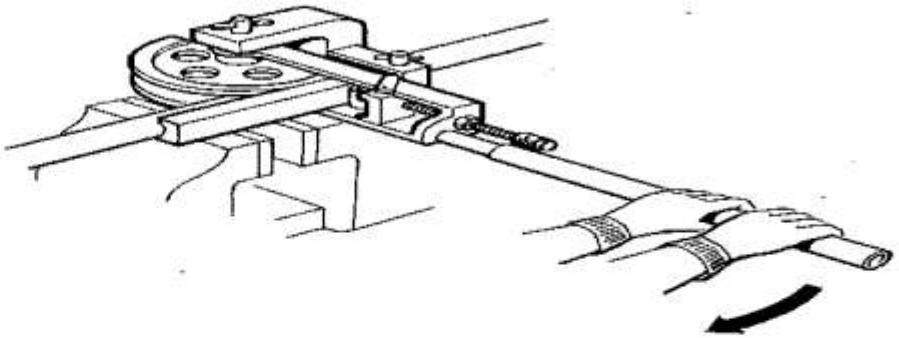
3. Place the pipe in the machine, passing it through the bending arm and ensuring that it is seated in the groove of the former and against the back stop.



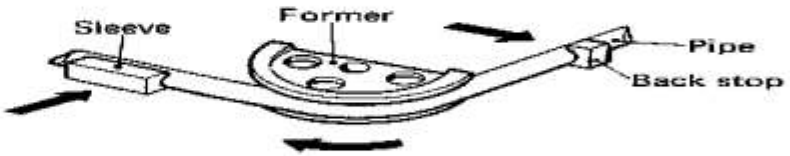
4. Fit the back guide or sleeve over the back of the pipe. Hand tighten the bending arm adjusting screw until the bending arm roller contacts the sleeve, to hold it in position. Tighten the bending arm lock nut using the correct size spanner.



5. Take up a comfortable working position with one foot in front of the other to ensure that the body is properly balanced, then bend the pipe by pulling the bending arm towards the body.

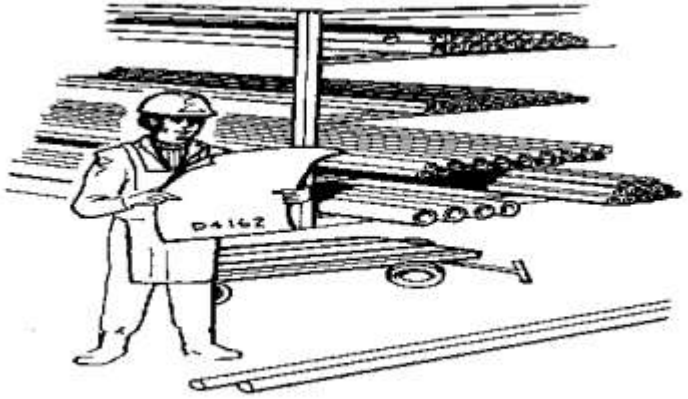


Note:
The sleeve bends the pipe round the former as the bending arm is pulled. The backstop holds the tail of the pipe in position during the bending operation.



Note:
The correct size of former and sleeve to suit the pipe dimensions must be used if faulty bends are to be avoided.

Making a 90° bend using a Hand Compression Bending Machine



1. Collect the pipe material and check against the drawing that it is of the correct bore, length and wall thickness.

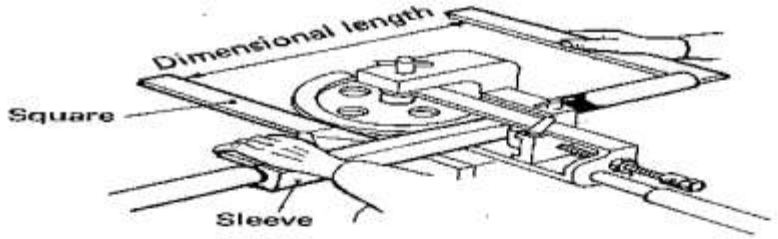
2. Secure the pipe bending machine firmly in a bench vice.

3. Select the correct size former and sleeve.

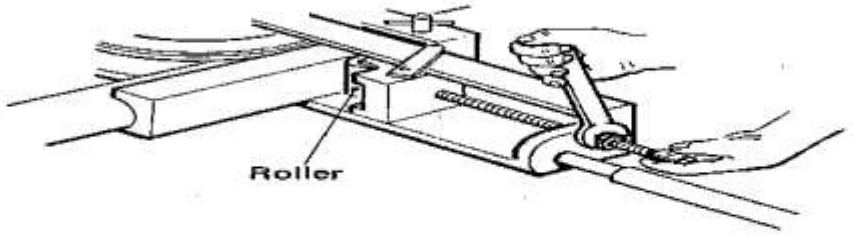
4. Assemble the former and the backstop into the machine.

5. Insert the pipe and position the sleeve against the back of the pipe.

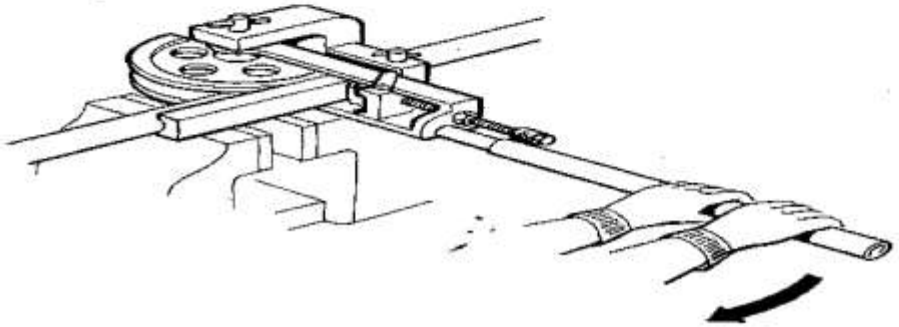
6. Place the base of an engineer's square along the edge of the sleeve with the blade touching the edge of the former.
7. Measure the distance required from the end of the pipe to the centre of the bend i.e. from the end of the pipe to the edge of the square. Adjust the pipe in the machine to the correct length.



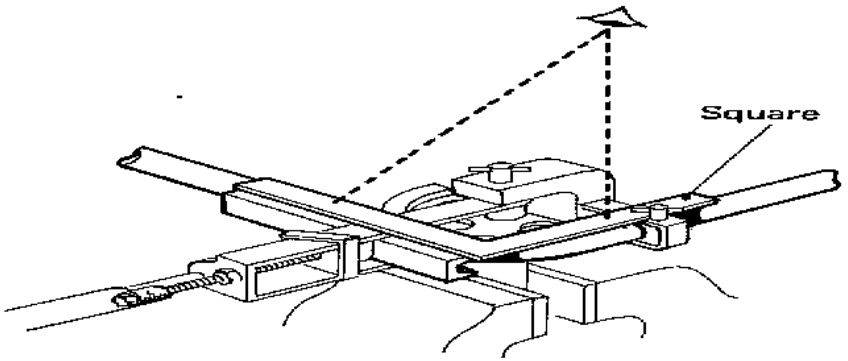
8. Hand tighten the adjusting screw until the pipe is held firmly between the former and the sleeve. Lock in position by tightening the locknut.



9. Pull the lever towards the body to form the 90° bend.



10. Check the bend for squareness. Use a set square and sight both edges of the square against the pipe.



11. Loosen the locknut and adjusting screw. Remove the sleeve and backstop. Swing the arm back to its start position and remove the pipe from the machine.

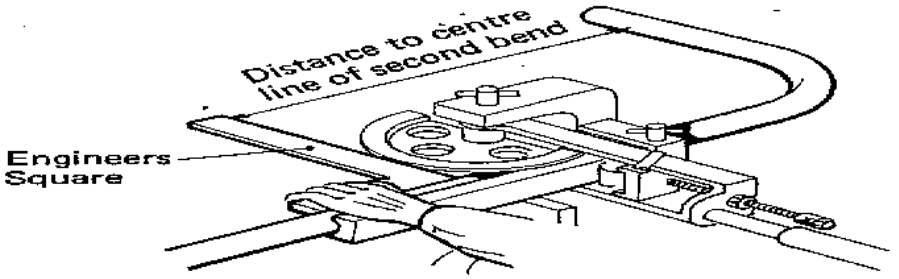
Making a double 90° bend in the same plane using a Hand Compression Bending Machine

1. Set up the machine, insert the pipe and bend the first 90° bend as previously described.

2. Replace the pipe in the machine feeding in the straight end from the back of the machine.

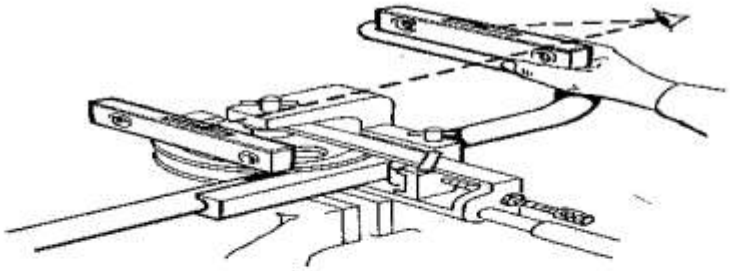
3. Secure the pipe.

4. Place the blade of an engineer's square against the edge of the former with the base along the inside of the pipe.



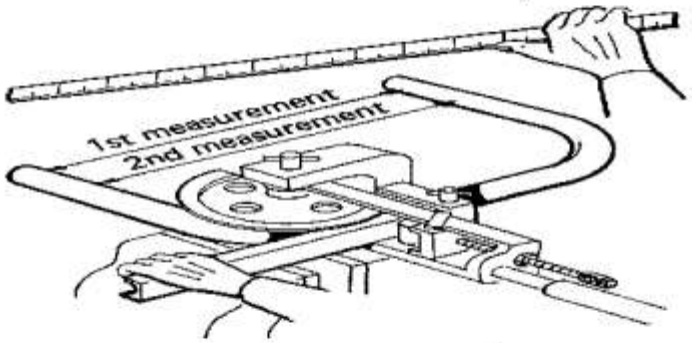
5. Measure the distance between the inside of the pipe on the first 90° bend and the edge of the square's blade and adjust the pipe to the required centre distance of the two bends.

6. Use a spirit level to check that the former and the first leg of the pipe are both level. Adjust as necessary.

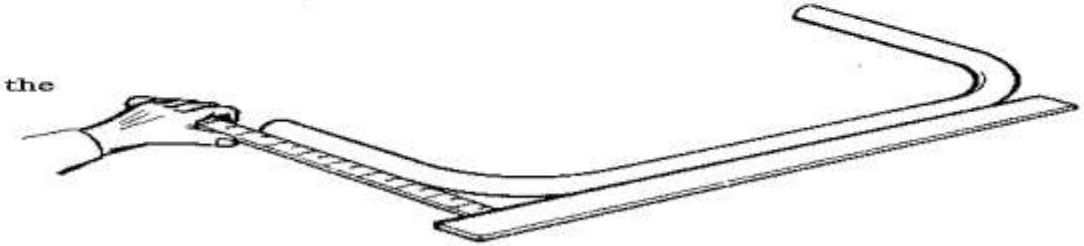


7. Tighten the locknut.
8. Bend the pipe.

9. Check the bend dimensions with a rule in two places between the pipe legs. The legs are parallel when the two measurements are equal.
10. Loosen the locknut and adjusting screw. Remove the sleeve and backstop. Swing the arm back to its start position. Remove the pipe from the machine.



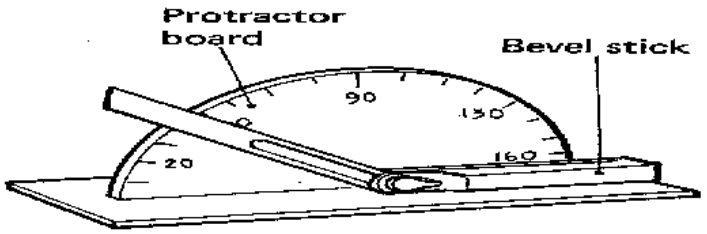
11. Measure, mark and cut the pipe to length.



Making a 45° bend using a Hand Compression Bending Machine

1. Feed the pipe into the machine and secure as previously described.

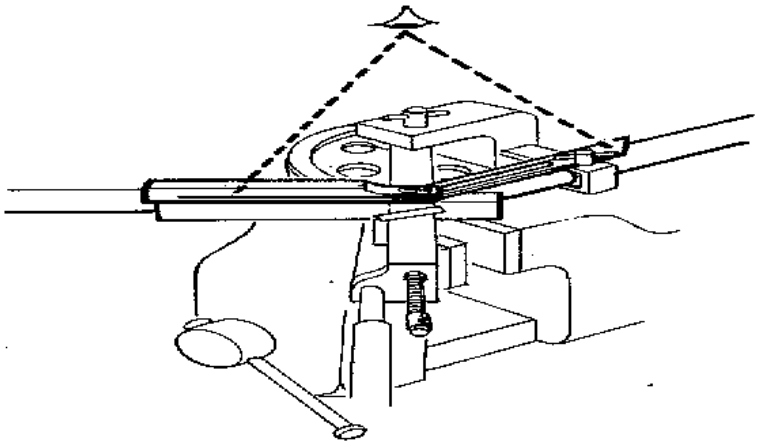
2. Set a bevel stick at 45°.



3. Bend the pipe, sighting the bevel stick along its edge until an angle of 45° is achieved.

4. Release the locknut, slacken the adjusting screw and remove the sleeve.

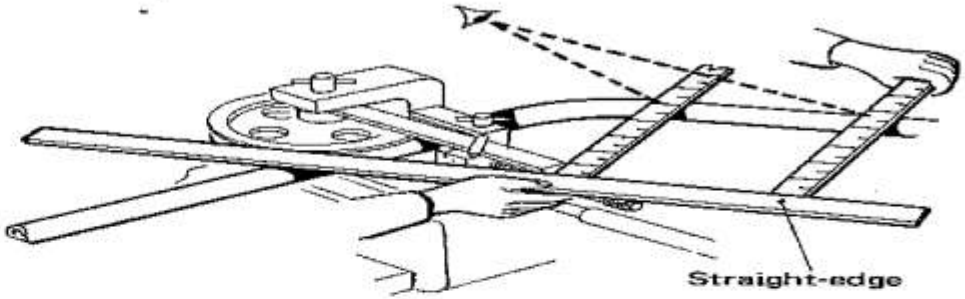
5. Remove the pipe from the machine.



Making a 45° Parallel Offset using a Hand Compression Bending Machine

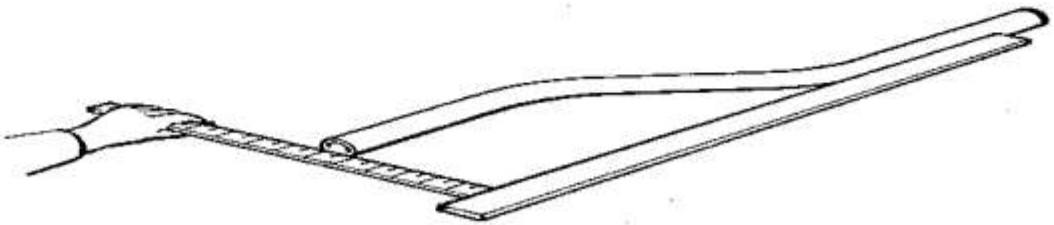
1. Make a 45° bend as previously described and leave the pipe in the machine. Slacken the adjusting screw.
2. Slide the pipe through the machine to the second bend position and re-tighten the adjusting screw.

3. Place a straight-edge on the edge of the former. Ensure that it is parallel with the first leg by taking two measurements between the straight-edge and the pipe. Both measurements will be the same when the pipe and straight-edge are parallel.



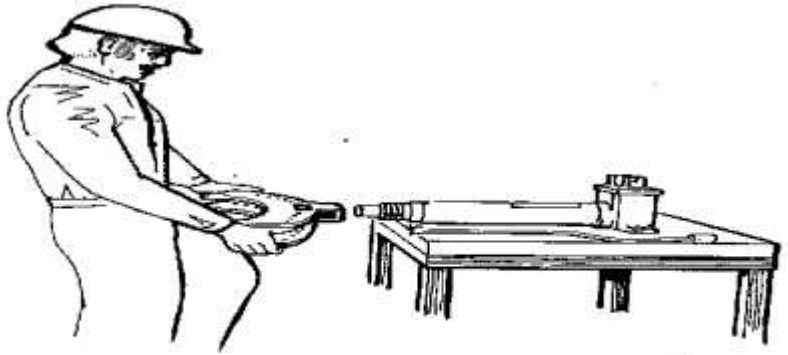
4. Use a spirit level to check that the former and the first leg of the pipe are both level.
5. Secure the pipe for bending as previously described.
6. Bend the pipe. Use the straight-edge as a guide, sighting it along the edges of the pipe.

7. Remove the pipe from the machine and check the dimensions.



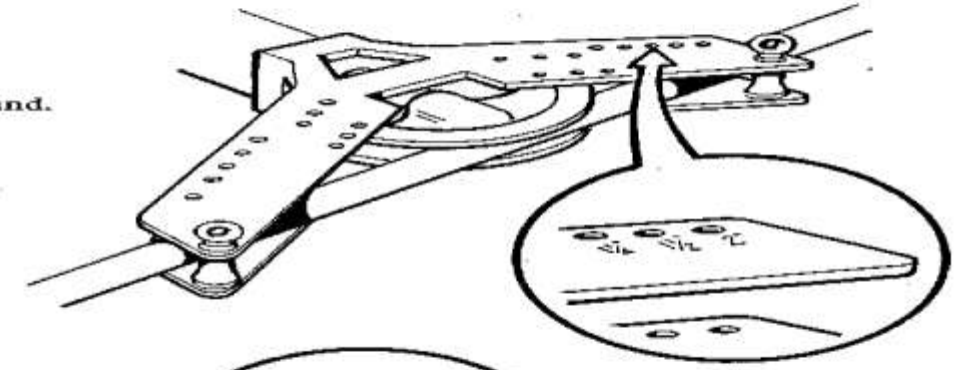
The setting up and operation of a manually operated Hydraulic Bending Machine

1. Screw the forming head on to the hydraulic cylinder.

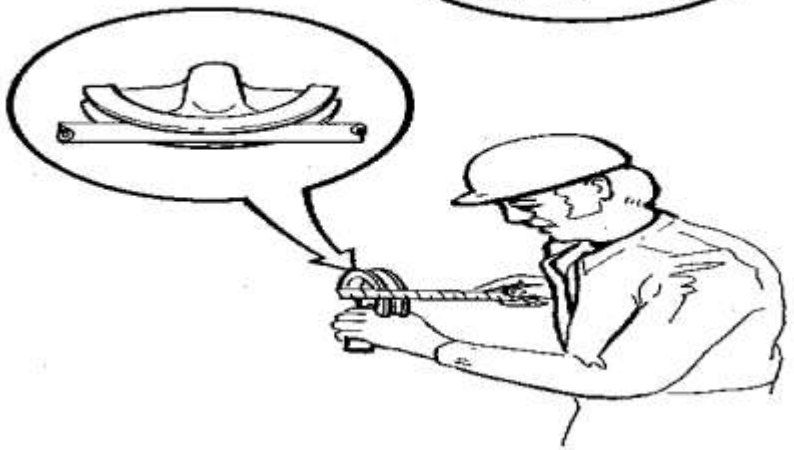


2. Place the machine on the ground.

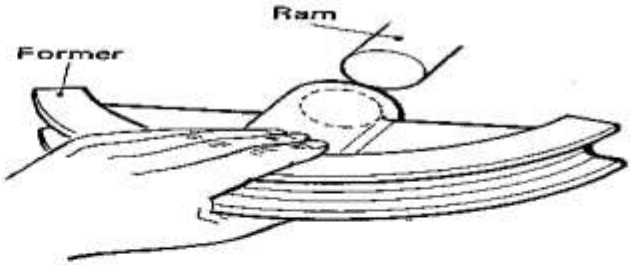
Note:
Holes are drilled in the forming head. These are usually marked to show the nominal bore sizes of pipes.



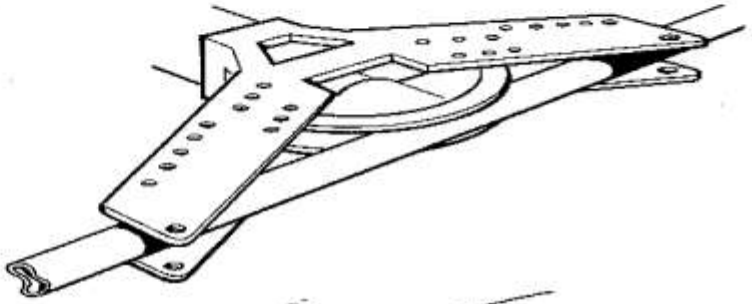
3. Select the correct former to fit the outside diameter of the pipe. Formers are available for standard sizes of pipe from 12 mm (½ in.) to 50 mm (2 in.) bore.



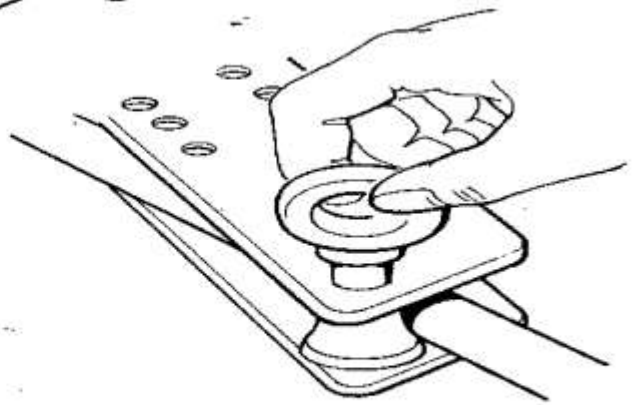
4. Fit the pipe former on to the cylinder ram.



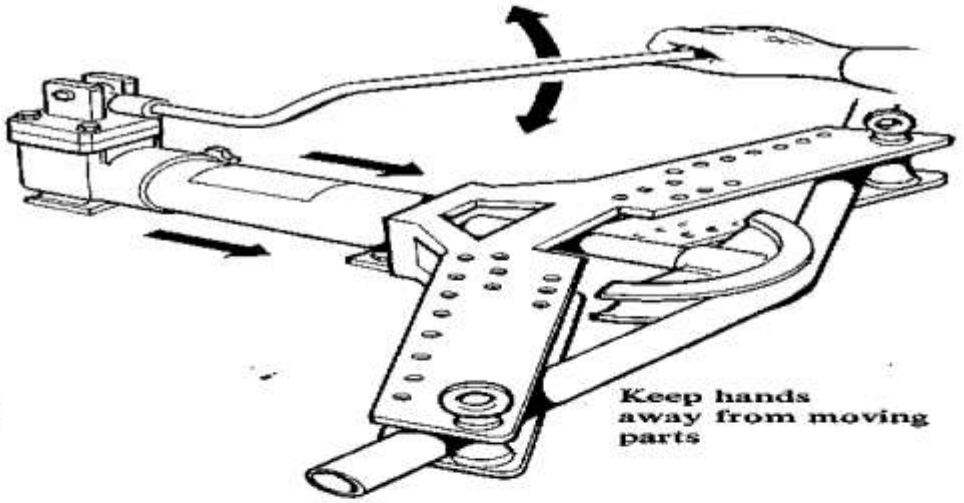
5. Place the pipe between the forming head plates and against the former.



6. Support the pipe and fit dollies (or rollers) between the upper and lower plates of the forming head; secure them in position by passing pins through the plates and the dollies. The dollies should be fitted in the holes marked to suit the size of pipe being bent.

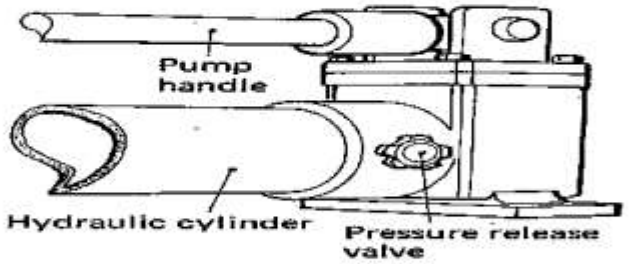


7. Close the pressure release valve on the pump body then start pumping to push the former against the pipe.



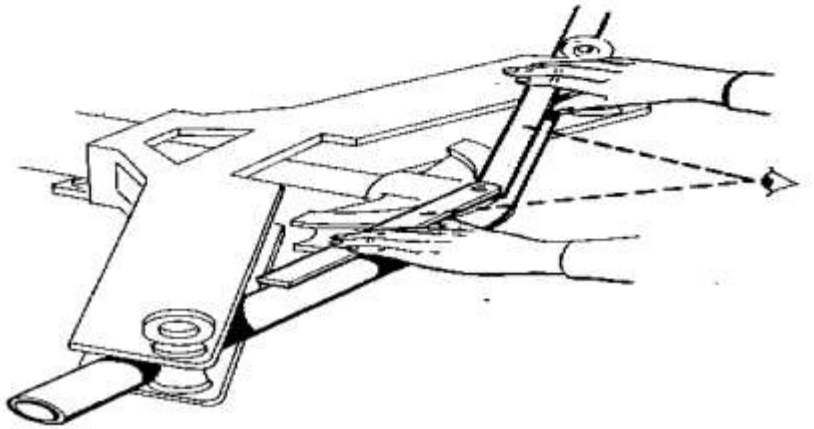
8. Stop pumping when the desired bend has been achieved.

9. Turn the pressure release valve anticlockwise to release the pressure in the hydraulic cylinder. When the ram has moved back about 6 mm (¼ in.) to 10 mm (⅜in.) close the pressure release valve to hold the ram steady.



10. Check the accuracy of the bend with a bevel stick.

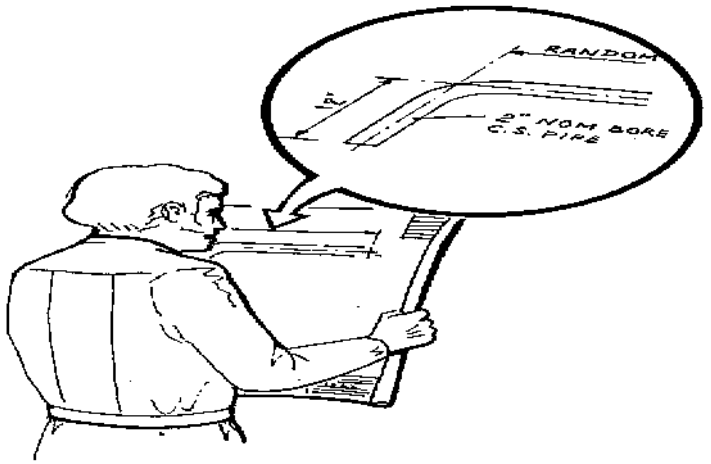
11. Open the pressure release valve and allow the ram to return to the start position. Remove the dollies and the bent pipe from the machine.



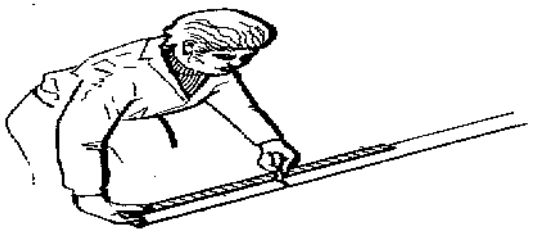
Making a 90° bend using a manually operated Hydraulic Bending Machine

1. Make a full size drawing of the bend on the bench or floor. Mark on the drawing the centre line and double lines representing the outside of the pipe and the radius.
   Keep the drawing clean as it will be needed to check dimensions after the bend has been formed.

2. Collect the pipe and check against the drawing that it is of the correct bore, length and wall thickness before starting work.
3. Determine the position of the centre of the bend by subtracting the nominal bore of the pipe from the leg length of the pipe. For example, in the drawing shown the leg length is 300 mm (12 in.) and the nominal bore is 50 mm (2 in.). Therefore the centre of the bend will be 250 mm (10 in.) from the end of the pipe i.e. 300 mm (12 in.) leg length minus 50 mm (2 in.) bore.

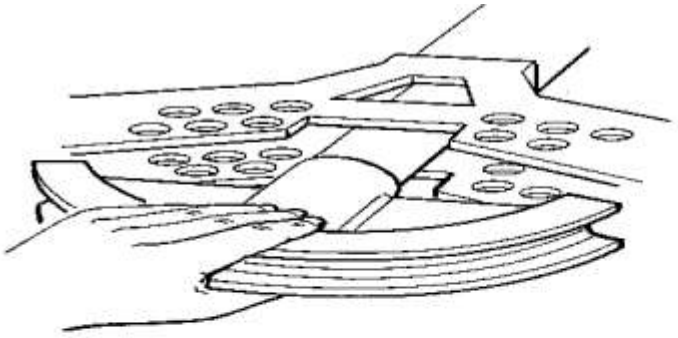


4. Measure from one end of the pipe and mark the centre of the bend with chalk.

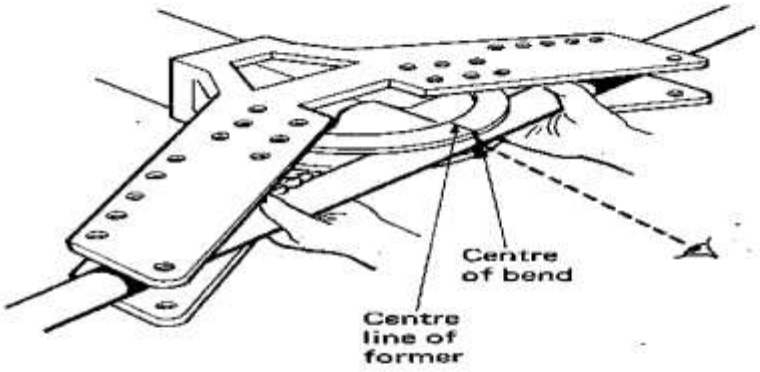


5. Select the correct size of former. Make sure that it is free from dirt and dust and then fit it over the end of the ram.

Ensure that the former is a good fit and push it firmly on to the ram.

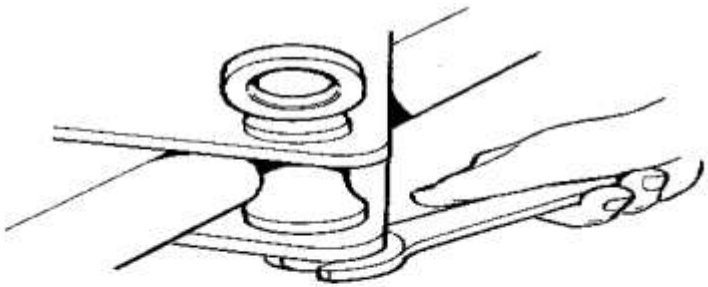


6. Place the pipe in the machine between the forming head plates with the centre of bend of the pipe in line with the centre line of the former.



7. Position the dollies in the forming head to suit the size of the pipe.

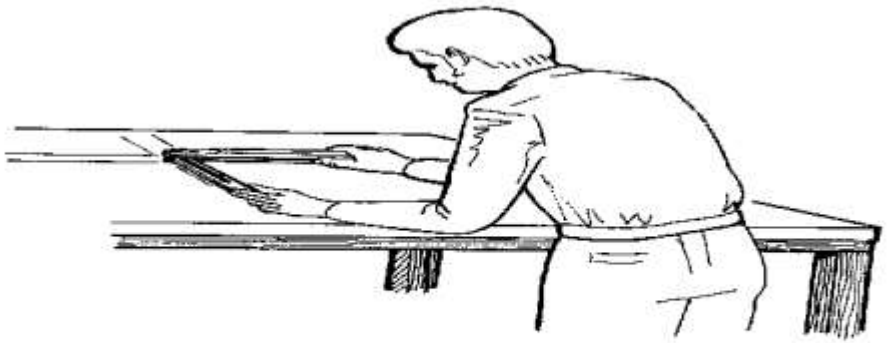
8. Ensure the dollies are correctly secured in position.



9. Close the pressure release valve on the pump body.
10. Hold the pipe against the dollies. Make sure that the centre of the bend corresponds to the centre line marked on the former.
11. Pump steadily.
12. Stop pumping when the pipe is held firmly between the former and the dollies.

Keep the hands away from moving parts.

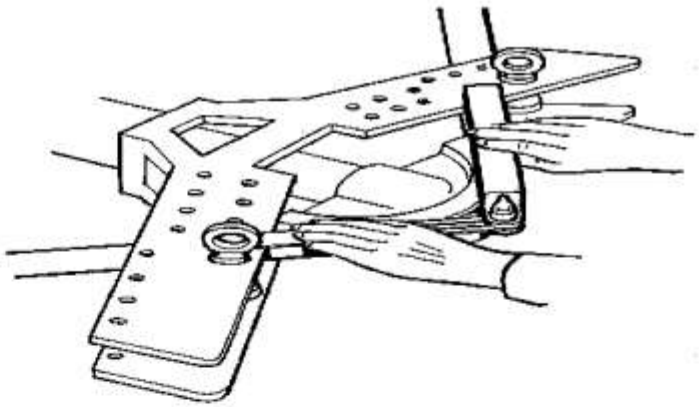
13. Place a bevel stick on the centre line of the bench drawing and lift the angle of the bend.



14. Place the bevel stick on top of the forming head then pump until the pipe is bent slightly more than the angle of the bevel stick.

15. Measure from the front centre of the forming head to a chalk or other position on the pump body. Make a note of the measurement then open the pressure release valve and allow the ram to retract about 6 mm (¼ in.). Close the valve.

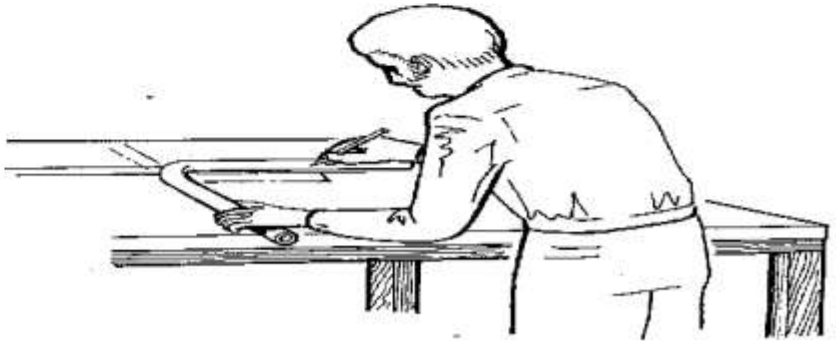
Note:
When released from the bending pressure, the pipe will spring back slightly, altering the degree of bend. By trial and error the trainee will learn how much the pipe should be over-bent to obtain a specified angle.



16. Re-check the bend by placing the bevel stick on the pipe and sighting its edges against the edge of the pipe.

Note:
The pipe can be bent further by more pumping. Ensure that the centre of the bend of the pipe remains in line with the centre line of the former. Before increasing the bend, pump until the distance between the former and the mark on the pump body agree with the measurement taken and recorded earlier.

17. Open the pressure release valve to slacken off the ram, remove the dollies and take the pipe out of the machine.
    Keep a firm grip on the pipe to stop it falling when the pins and dollies are removed.
18. Check the bend for accuracy by placing it on the full scale chalk drawing.



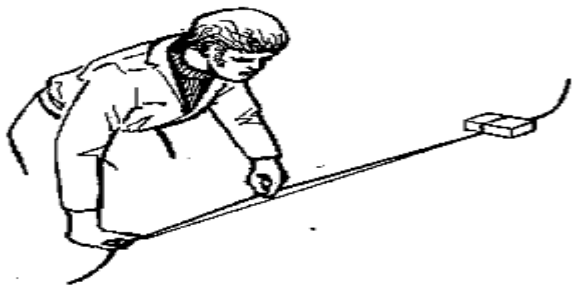
19. Place the pipe on the drawing and mark required cutting length.

20. Cut to size.

Note:
The procedure for bending any angle using this type of machine is similar to that described above.

Making a double 90° bend in the same plane using a manually operated Hydraulic Bending Machine

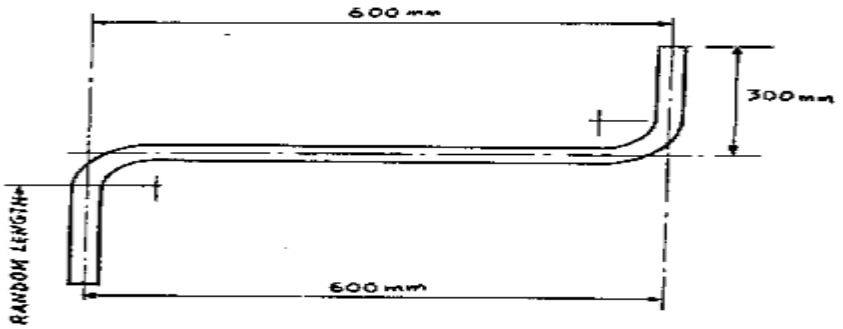
1. Draw the pipe on the bench floor full size, with double 90° bends.



2. Calculate, measure and mark off the position of the centre of the first bend.
3. Bend the first 90° bend and check it against the drawing.

4. Determine the centre of the second bond. Subtract the nominal bore of the pipe from the centre distance between the two parallel legs. In the drawing shown the 2nd leg length = 600 mm (24 in.) and the bore of the pipe = 50 mm (2 in.).

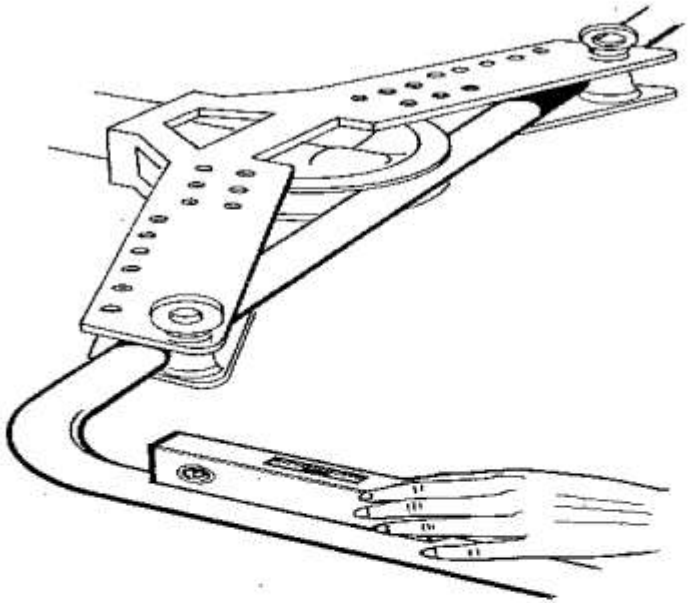
   Measure from the centre line of the last leg 600 mm (24 in.) less 50 mm (2 in.) (i.e. 550 mm (22 in.)) to give the position of the 2nd bend centre. Mark the pipe.



5. Replace the pipe in the bending machine and secure it by pumping until the former holds the pipe firmly against the dollies. Avoid bending the pipe as an error made before it is positioned correctly cannot be remedied.

6. Use a spirit level to check that the former and the first leg of the pipe are both level.

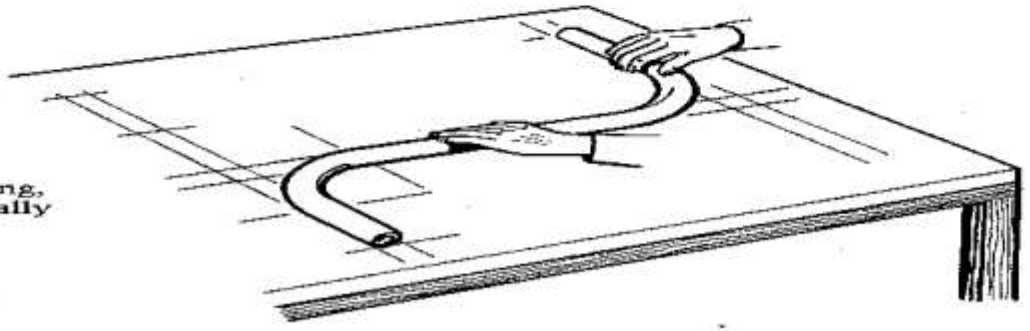
Keep the hands away from moving parts.

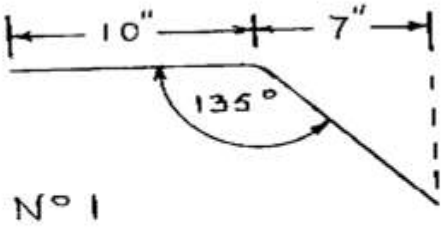


7. Bend the second 90° bend and remove the pipe from the machine.

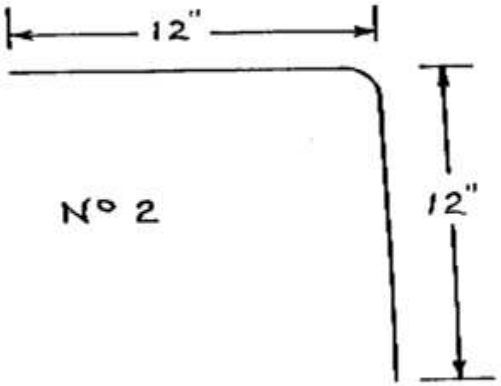
8. Place the pipe on the drawing, check the bends dimensionally and mark off the pipe for cutting to length.

9. Cut to size.

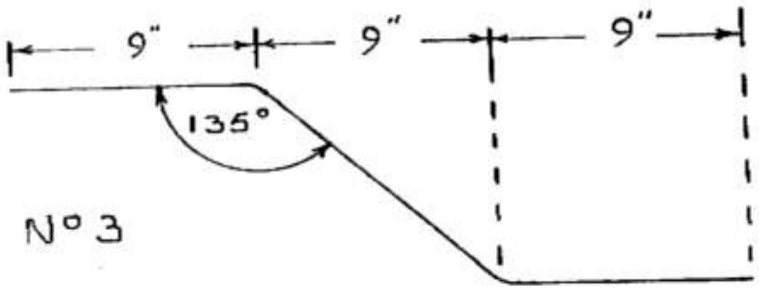




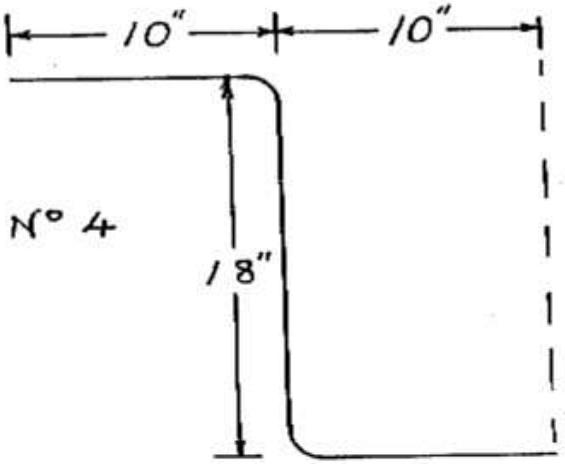
N° 1



N° 2

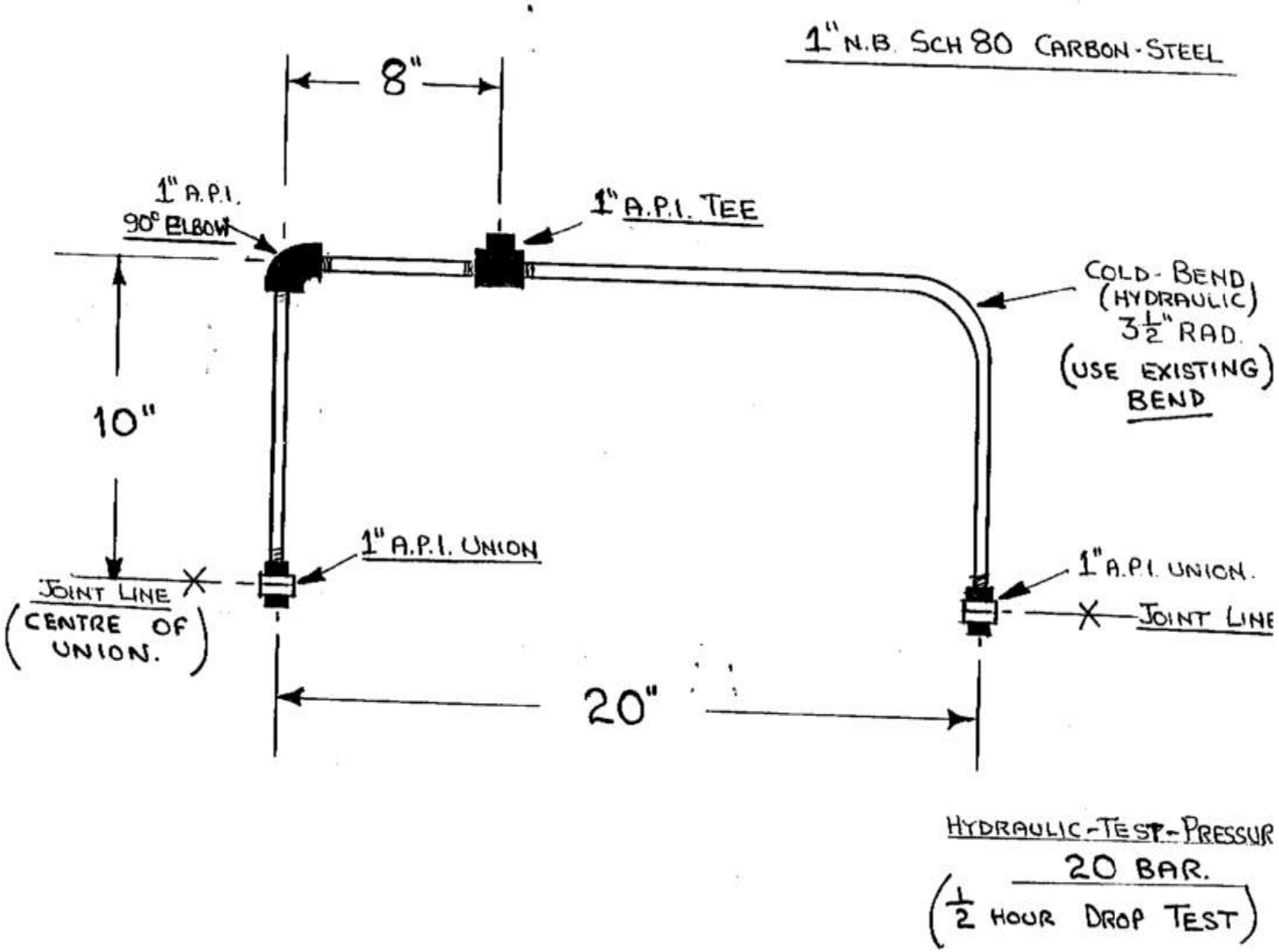


N° 3



N° 4

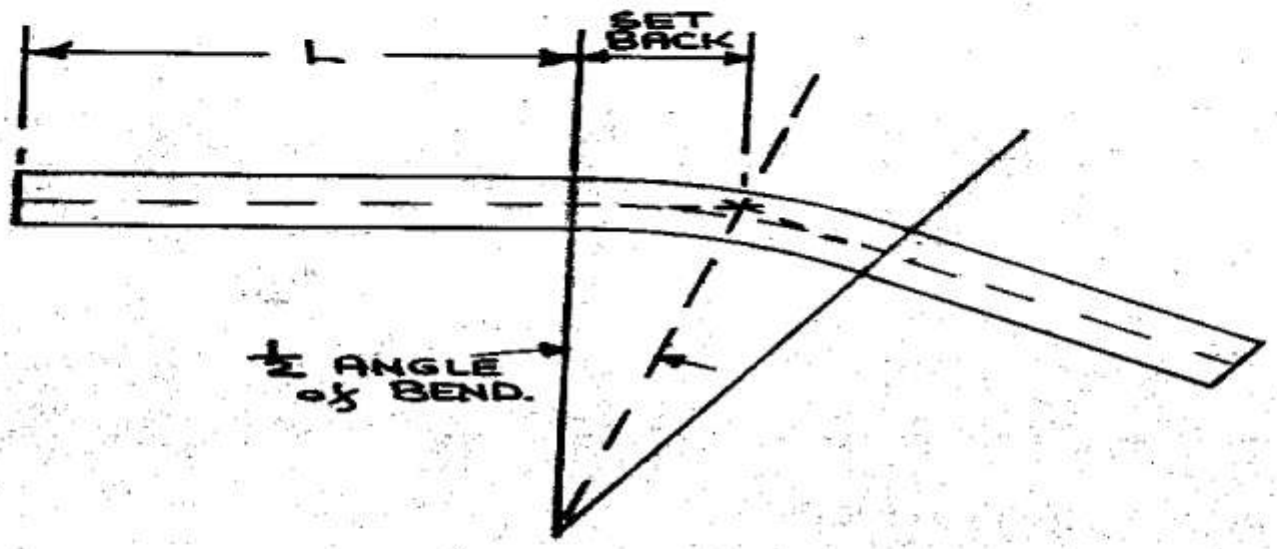
	PF 2A	BENDING METALLIC PIPE USING	MATERIAL	1" N.B. SCHEDULE 80


1" N.B. SCH 80 CARBON-STEEL
8"
1" A.P.I. 90° ELBOW
1" A.P.I. TEE
COLD-BEND (HYDRAULIC) 3½" RAD. (USE EXISTING) BEND
10"
1" A.P.I. UNION
JOINT LINE (CENTRE OF UNION.)
1" A.P.I. UNION.
JOINT LINE
20"
HYDRAULIC-TEST-PRESSUR
20 BAR.
(½ HOUR DROP TEST)

SET-BACK

USED TO LOCATE THE BEGINNING of A BEND IN A PIECE OF PIPE

MEASUREMENTS CAN BE OBTAINED FOR ALL ANGLES | RADIUS.



FORMULA. = (RADIUS x TANGENT ½ ANGLE of BEND)

EXAMPLE = 45° = (3·5 x ·414) = 1·449

= 1½"

B		T		R.		SET-BACK
22½°		·199		3·5		·70 — ¾"
30°		·268		3·5		·95 — 1"
45°		·414		3·5		1·54 — 1½"
60°		·577		3·5		2·00 — 2"
90°		1·00		3·5		3·5 — 3½