Typical Layout

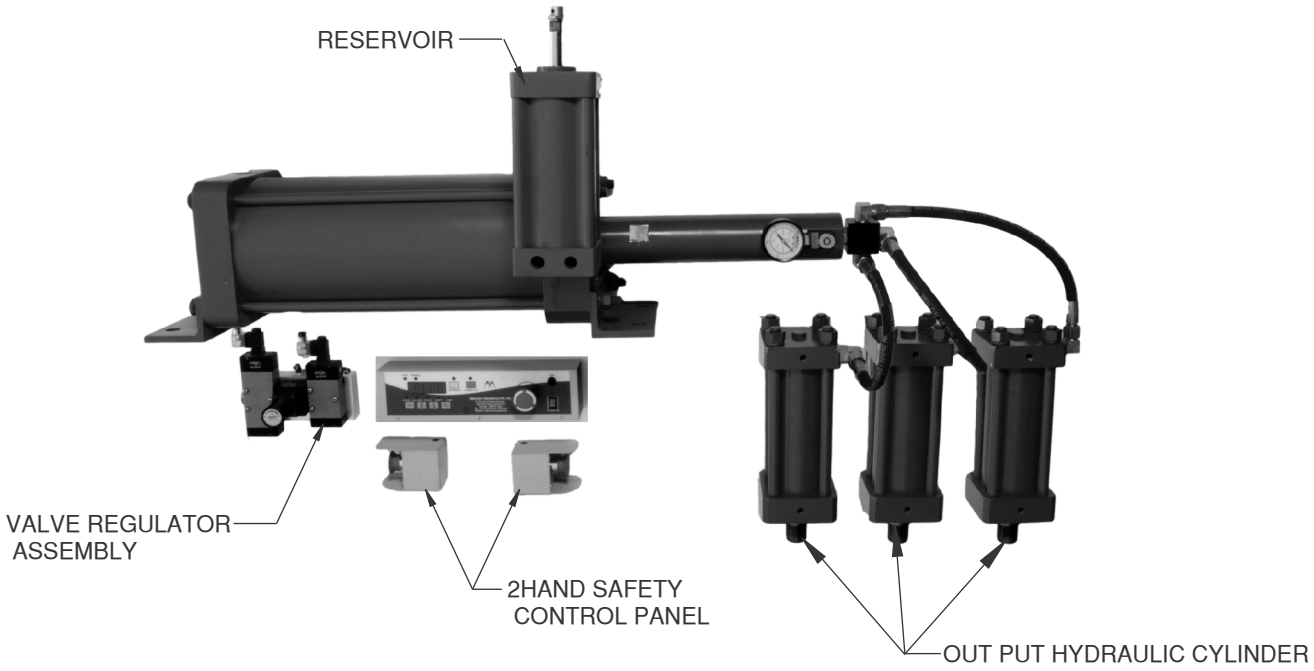


FIG. 1

General Introduction

The series '**Z**' Hydro Pneumatic System has been developed for applications where two or more Cylinders have to be operated from a single Reservoir-Intensifier Power unit. They are also useful for applications requiring a large travel under load (large Power Stroke) and for applications where the length of our standard 'N' Series Hydro Pneumatic Press Systems cannot be accommodated.

The systems consists of :-

(a) An integral Intensifier-Reservoir unit.

(b) Single or several Hydraulic Cylinders connected to the Intensifier-Reservoir unit through suitable high pressure flexible hoses and operated by solenoid valves as shown in circuit Fig. 2.

Pneumatic Circuit Diagram

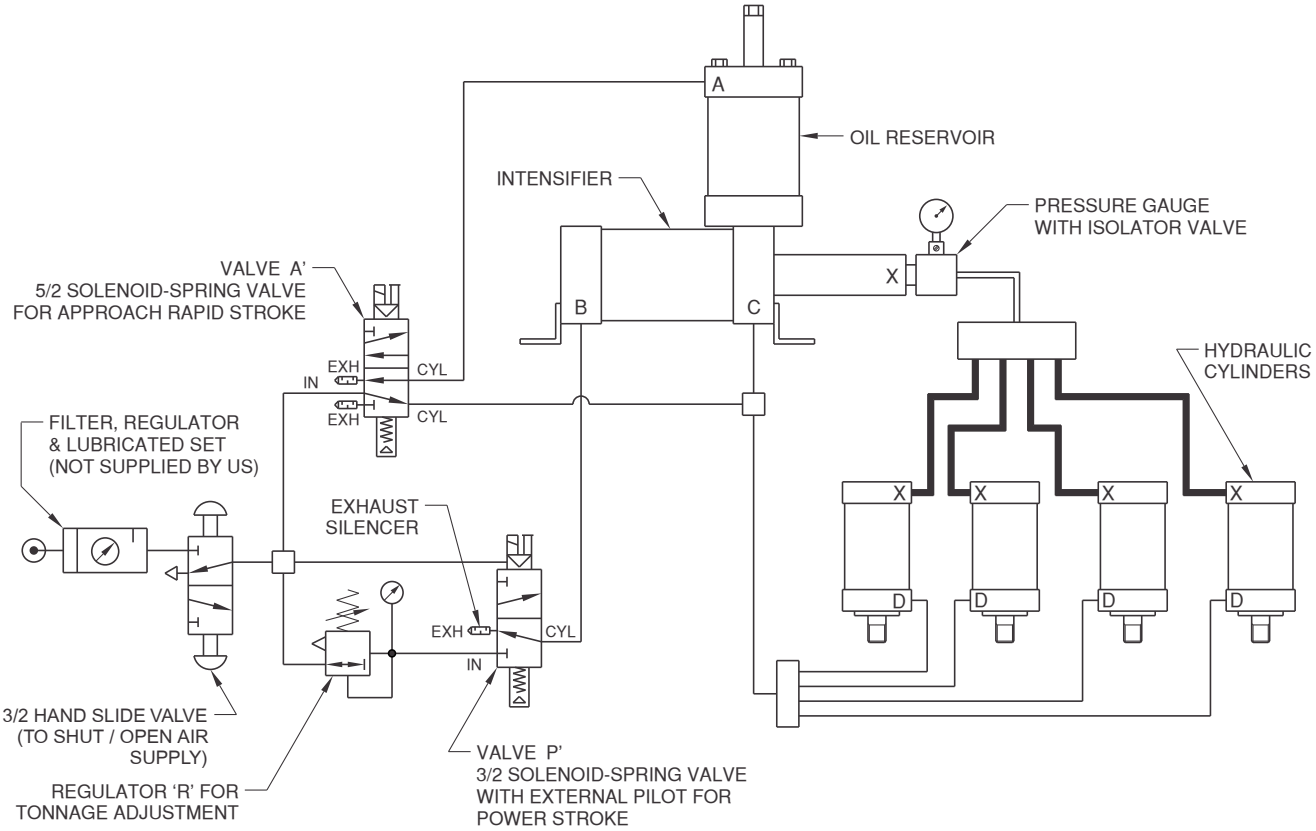


FIG. 2

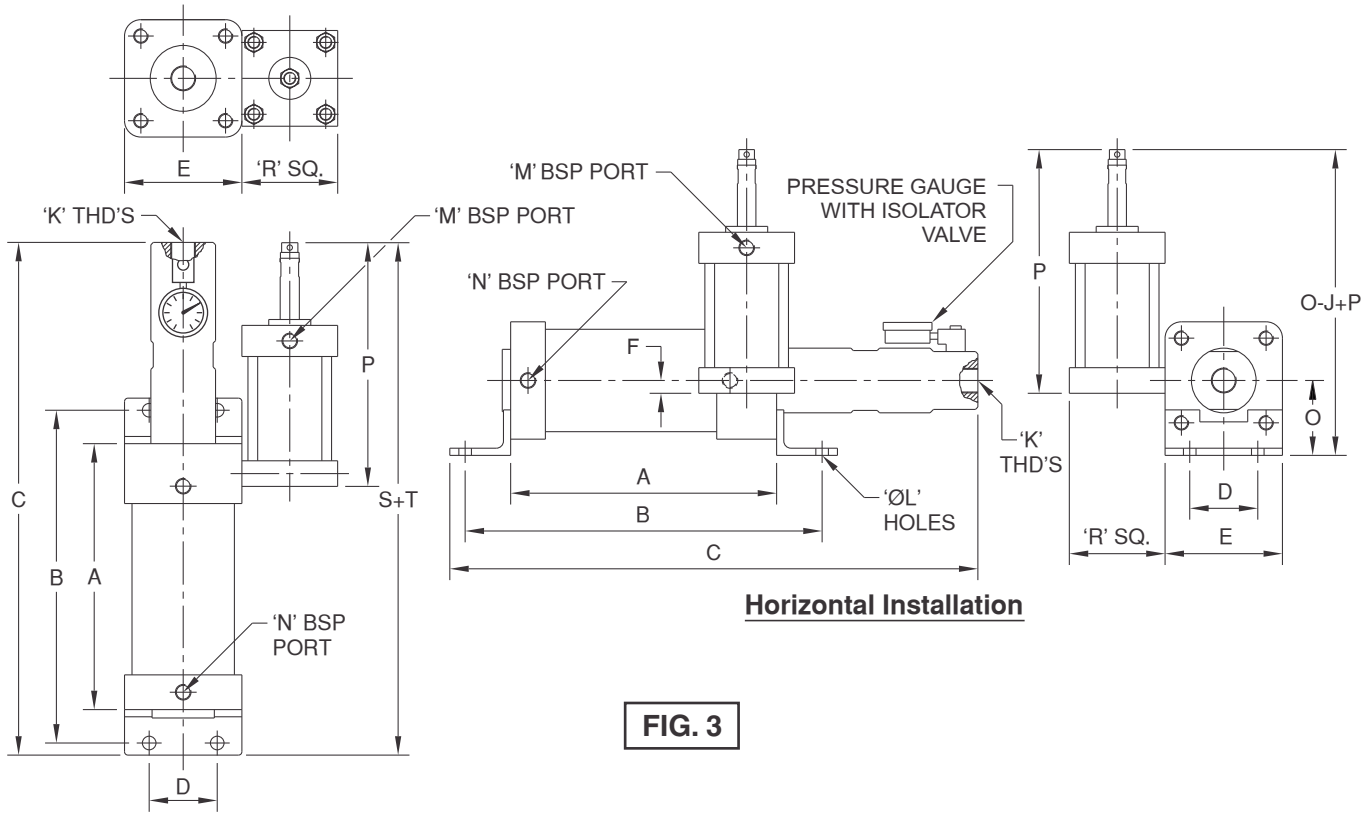
Sequence of Operation

(a) When the Approach Solenoid Valve A' is switched ON , air is admitted to port A' and exhausted from ports C' and D'. The output Shafts of Hydraulic cylinders extend rapidly, with a low force due to air pressure acting on the Reservoir piston through port A'.

(b) When the Hydraulic Cylinder shaft and connected tooling touches the job, the Power Stroke Solenoid Valve P' is switched ON . This cause Regulated air to be admitted to port B'. The Intensifier piston now moves forward and oil pressure in the Hydraulic Cylinders is increased. This high pressure oil now acts on the large diameter Hydraulic Cylinders to give the large output force. The output force can be varied by adjusting Air Pressure Regulator R'.

(b) After the machine cycle is over, all the Solenoid Valves are switched OFF , causing air to be admitted to ports C' and D' and exhausted from ports A' and B'. The Cylinders now retract rapidly.

Intensifier Reservoir Unit



Vertical Installation

Horizontal Installation

FIG. 3

Intensifier (Table 1)

MODEL	RATIO	OUTPUT OIL PRESSURE @ 5 BAR	MAX. OIL DISPLACEMENT FOR POWER STROKE cu. cm	TONNAGE FOR HYD. CYLINDER				A	B	C	D	E	J	K BSP	L Ø	N BSP	O	S	FREE AIR CONS. PER CYCLE Q (NL)	SEAL KIT No.
				Z 50	Z 80	Z 100	Z 160													
80-14-200	32	160	27	3.1	8.0	X	X	347	433	597	63	98	19	1/2"	12	1/4"	63	373	11.8	129-001
80-14-400	32	160	57	3.1	8.0	X	X	547	633	997	63	98	19	1/2"	12	1/4"	63	573	23.7	129-001
80-20-200	16	80	55	1.5	4.0	6.2	X	347	433	597	63	98	19	1/2"	12	1/4"	63	373	11.6	129-002
80-20-400	16	80	117	1.5	4.0	6.2	X	547	633	997	63	98	19	1/2"	12	1/4"	63	573	23.4	129-002
100-16-200	39	195	35	X	9.8	15.3	X	353	439	603	75	118	19	1/2"	14	1/4"	71	382	18.6	129-018
100-16-400	39	195	75	X	9.8	15.3	X	553	639	1003	75	118	19	1/2"	14	1/4"	71	582	37.2	129-018
100-20-200	25	125	55	2.5	6.2	9.8	X	353	439	603	75	118	19	1/2"	14	1/4"	71	382	18.4	129-003
100-20-400	25	125	117	2.5	6.2	9.8	X	553	639	1003	75	118	19	1/2"	14	1/4"	71	582	37.0	129-003
100-28-200	12.5	64	107	1.2	3.2	5.0	X	353	439	603	75	118	19	1/2"	14	1/4"	71	382	18.1	129-004
100-28-400	12.5	64	230	1.2	3.2	5.0	X	553	639	1003	75	118	19	1/2"	14	1/4"	71	582	36.2	129-004
160-28-200	32	160	107	3.1	8.0	X	32.0	383	513	659	115	185	19	1/2"	18	1/2"	115	435	47.5	129-019
160-28-400	32	160	230	3.1	8.0	X	32.0	583	713	1059	115	185	19	1/2"	18	1/2"	115	635	95.0	129-019
160-32-200	25	125	140	2.5	6.2	9.8	25.0	383	513	659	115	185	19	3/4"	18	1/2"	115	435	47.2	129-005
160-32-400	25	125	300	2.5	6.2	9.8	25.0	583	713	1059	115	185	19	3/4"	18	1/2"	115	635	94.5	129-005
160-40-200	16	80	220	1.5	4.0	6.2	16.0	383	513	659	115	185	19	3/4"	18	1/2"	115	435	46.8	129-006
160-40-400	16	80	470	1.5	4.0	6.2	16.0	583	713	1059	115	185	19	3/4"	18	1/2"	115	635	93.5	129-006
200-32-200	39	195	140	X	9.8	X	39.0	392	532	673	135	227	19	3/4"	22	1/2"	115	449	74.4	129-007
200-32-400	39	195	300	X	9.8	X	39.0	592	732	1073	135	227	19	3/4"	22	1/2"	115	649	148.8	129-007
200-40-200	25	125	220	2.5	6.2	9.8	25.0	392	532	673	135	227	19	3/4"	22	1/2"	115	449	73.9	129-008
200-40-400	25	125	470	2.5	6.2	9.8	25.0	592	732	1073	135	227	19	3/4"	22	1/2"	115	649	147.6	129-008
200-56-200	12.5	63	430	1.2	3.1	5.0	12.7	392	532	673	135	227	19	3/4"	22	1/2"	115	449	72.5	129-009
200-56-400	12.5	63	923	1.2	3.1	5.0	12.7	592	732	1073	135	227	19	3/4"	22	1/2"	115	649	144.8	129-009

Reservoir (Table 2)

MODEL	VOLUMETRIC OIL DISPLACEMENT FOR APPROACH (cu. cm)	P	M BSP	R SQ.	T	FREE AIR CONSUMPTION PER CYCLE (litres)	SEAL KIT No.
80-400	400	323	1/4"	98	310	2.3	129-010
80-800	800	483	1/4"	98	470	4.5	129-010
100-1200	1200	467	1/4"	118	454	7.0	129-011
160-2200	2200	285	1/2"	185	267	10.8	129-012
160-3000	3000	505	1/2"	185	487	18.0	129-012
200-4700	4700	536	1/2"	227	518	28.2	129-013
200-6000	6000	600	1/2"	227	582	36.1	129-013

Hydraulic Cylinder

FIG. 4

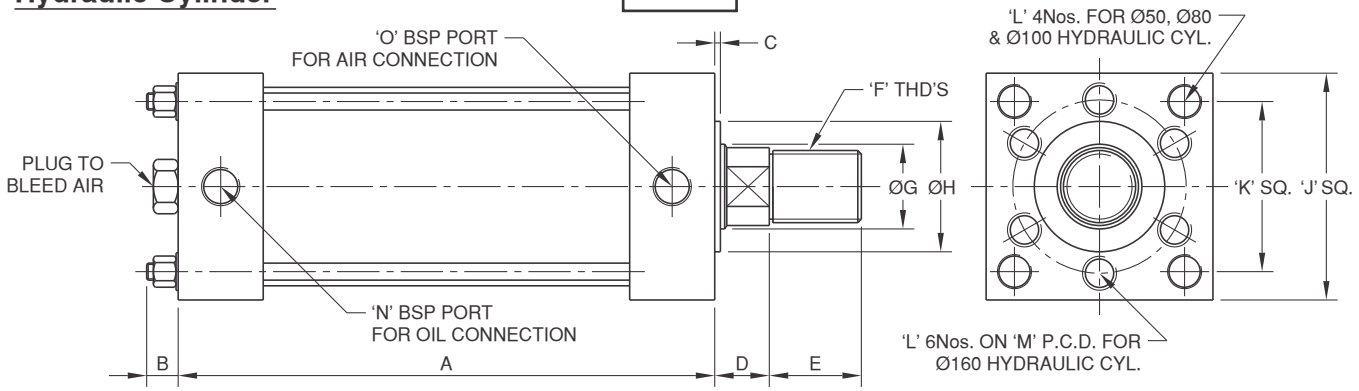


Table 3 Q = FREE AIR CONSUMPTION PER CYCLE (LITRES).

MODEL	FORCE (Kgf) & 5 BAR		OIL DISPLACEMENT (cu cm)		A	B	C	D	E	F	G Ø	H Ø	J	K	L	M	N BSP	O BSP	Q	SEAL KIT No.
	APPROACH	RETURN	PER mm TRAVEL	FOR TOTAL TRAVEL																
Z50-50	98	58	2	100	188	22	4	22	35	M24 x 2	32	45	88	57	M16 x 2	-	1/2"	1/4"	0.35	129-014
Z50-100	98	58	2	200	238	22	4	22	35	M24 x 2	32	45	88	57	M16 x 2	-	1/2"	1/4"	0.7	129-014
Z50-150	98	58	2	300	288	22	4	22	35	M24 x 2	32	45	88	57	M16 x 2	-	1/2"	1/4"	1.0	129-014
Z50-200	98	58	2	400	338	22	4	22	35	M24 x 2	32	45	88	57	M16 x 2	-	1/2"	1/4"	1.4	129-014
Z80-50	250	171	5	250	211	25	4	24	35	M36 x 2	45	60	125	86	M20 x 2.5	-	3/4"	1/4"	1.0	129-015
Z80-100	250	171	5	500	261	25	4	24	35	M36 x 2	45	60	125	86	M20 x 2.5	-	3/4"	1/4"	2.0	129-015
Z80-150	250	171	5	750	311	25	4	24	35	M36 x 2	45	60	125	86	M20 x 2.5	-	3/4"	1/4"	3.0	129-015
Z80-200	250	171	5	1000	361	25	4	24	35	M36 x 2	45	60	125	86	M20 x 2.5	-	3/4"	1/4"	4.0	129-015
Z100-50	392	269	8	400	223	30	4	24	35	M40 x 2	56	75	155	107	M24 x 3	-	3/4"	1/2"	1.6	129-016
Z100-100	392	269	8	800	273	30	4	24	35	M40 x 2	56	75	155	107	M24 x 3	-	3/4"	1/2""	3.2	129-016
Z100-150	392	269	8	1200	323	30	4	24	35	M40 x 2	56	75	155	107	M24 x 3	-	3/4"	1/2"	4.8	129-016
Z100-200	392	269	8	1600	373	30	4	24	35	M40 x 2	56	75	155	107	M24 x 3	-	3/4"	1/2"	6.4	129-016
Z160-50	1000	850	20	1000	238.5	45	4	29	40	M48 x 3	63	75	240	-	M30 x 3.5	135	1"	1/2"	5.0	129-017
Z160-100	1000	850	20	2000	288.5	45	4	29	40	M48 x 3	63	75	240	-	M30 x 3.5	135	1"	1/2"	10.0	129-017
Z160-150	1000	850	20	3000	338.5	45	4	29	40	M48 x 3	63	75	240	-	M30 x 3.5	135	1"	1/2"	15.0	129-017
Z160-200	1000	850	20	4000	388.5	45	4	29	40	M48 x 3	63	75	240	-	M30 x 3.5	135	1"	1/2"	20.0	129-017

Design Considerations for 'Z' Series Hydro Pneumatic Systems

General Information

Due to the closed circuit hydraulic system & the limited amount of oil displacement available under high pressure, the following factors play a significant role in overall performance of the system.

(i) The internal diameter & length of high pressure hydraulic hoses connecting the intensifier to the hydraulic cylinders. Hoses larger or equal to specified I.D. should be used and volume of oil used in hoses can be estimated from Table 4.

(ii) Increase in volume due to expansion of hoses under high pressure. If long length of hoses are used then this volume can be considerable & selection of the correct intensifier displacement should be made to accommodate the extra volume of oil required. A general guide line on volume increase due to hose expansion is given in Table 5.

(iii) Hydraulic fluid compressibility, which though small has to be taken into consideration when oil volume is large due to long length hoses & large diameter hydraulic cylinders. Typically 1% extra oil volume should be considered to compensate for compressibility of fluid.

(iv) Trapped air in the system can cause total failure, as all the power stroke will be used in compressing air rather than intensifying oil pressure. It is very important to bleed the system throughly as per the instructions given in the operation manual.

Table 4

HOSE VOLUME (V_h) PER METER LENGTH FOR DIFFERENT INTERNAL DIAMETER $\left(\frac{cm^3}{m}\right)$						
I.D. (mm)	6	8	10	13	16	20
$V_h\left(\frac{cm^3}{m}\right)$	28.3	50.2	78.5	134	201	314

Table 5

SPECIFIC VOLUME EXPANSION (V_{sp}) OF HIGH PRESSURE HOSES $\left(\frac{cm^3}{m \times bar}\right)$						
I.D. (mm)	6	8	10	13	16	20
$V_{sp}\left(\frac{cm^3}{m \times bar}\right)$	0.01	0.015	0.025	0.035	0.045	0.055

Example : A 5 meter hose of 16mm I.D. Subjected to 200 bar pressure will expand by : V_{sp} x Length x Pressure
= 0.045 x 5 x 200
= 45 c.c.

Selection of Correct Components

Example :-

A Special purpose machine is required to clamp, punch & stamp a component as shown in the layout below.

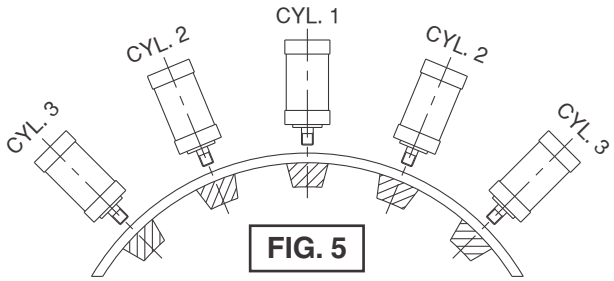


FIG. 5

(a) Stamping force : 7 tonne through CYL. 1 having 50 stroke.
(b) Clamping Force : 2.5 tonnes each through 2 nos. CYL. 2 having 50 stroke.
(c) Punching force : 12 tonnes each through 2 nos. CYL. 3 having 50 stroke.

In all cylinders a Power Stroke of 3mm is sufficient. The cylinders are piped with 16mm I.D. Hoses of total length of 9 meters.

Step 1 : Determining the bore diameter of Cylinders required.

Since all the cylinders will be driven by a single Intensifier-Reservoir unit, the final oil pressure will be same for all cylinders. From Table 2, if we assume an output pressure of 125 bars, then a Ø50 CYL. gives 2.5 tonnes (CYL. 2), Ø100 CYL. gives 9.8 tonnes (CYL. 1) & Ø160 CYL. gives 25 tonnes (CYL. 3).

Step 2 : Determining the Reservoir capacity

(i) From Table 3 Total volume of oil for all cylinders is
  (a) CYL. 1 - Ø100 x 50 Stroke (Model Z100-50) :- 400 c.c.
  (b) CYL. 2 (2Nos.) - Ø50 x 50 Stroke (Model Z50-50) :- 100 x 2 = 200 c.c.
  (c) CYL. 3 (2Nos.) - Ø160 x 50 Stroke (Model Z160-50) :- 1000 x 2 = 2000 c.c.
  TOTAL OIL VOLUME required :- 400 + 200 + 2000 = 2600 c.c.

(ii) From Table 2, Reservoir Model R160-3000 having capacity of 3000 c.c. is suitable.

Step 3 : Determining the Intensifier Model.

(i) For 3mm Power stroke per cylinder, the volume of high pressure oil required (Refer Table 3).
  (a) CYL. 1 - Model Z100-50 (1No.) :- 8 x 3 = 24 c.c.
  (b) CYL. 2 - Model Z50-50 (2Nos.) :- (2 x 3) x 2 = 12 c.c.
  (c) CYL. 3 - Model Z160-50 (2Nos.) :- (20 x 3) x 2 = 120 c.c.
  Total Volume V_1 = 24 + 12 +120 = 156 c.c.

(ii) Volume expansion of hoses (Refer Table 5).

$$V_2 = \text{Vsp} \times \text{Length} \times \text{Pressure} \left(\frac{cm^3}{m \times bar} \times m \times bar\right)$$

$$= 0.045 \times 9 \times 125 = 50.6 \text{ or } 51 \text{ c.c.}$$

(iii) Volume compensation due to fluid compressability

$$V = \text{Total Vol. Of oil in fully closed circuit} : \left(\begin{matrix}\text{Total Vol. of Cyls.}\\ \text{Refer step 2 (i)}\end{matrix}\right) + \left(\begin{matrix}\text{Vol. in hoses}\\ \text{Refer step 4}\end{matrix}\right) = 2600 + (200 \times 9) = 4400$$

$$V_3 = (\text{assuming oil compressibility of 1\%}) = V \times \frac{1}{100} = 4400 \times \frac{1}{100} = 44.00 \text{ or } 44 \text{ c.c.}$$

Total Volume of high pressure oil required = $V_1 + V_2 + V_3$ = 156 + 51 + 44 = 251 c.c.
From Table 1, at 125 bars, Intensifier Model 200-40-200 gives 220 c.c. of oil & Model 200-40-400 gives 470 c.c. of oil. Hence Model 200-40-400 is suitable.

Final ordering specifications.

Series 'Z' Hydro Pneumatic Press System consisting of
(a) Intensifier Model 200-40-400 - 1No.
(b) Reservoir Model R 160-300) - 1No.
(c) Hydraulic cylinder Model Z100-50 - 1No.
(d) Hydraulic cylinder Model Z50-50 - 2Nos.
(e) Hydraulic cylinder Model Z160-50 - 2Nos.