FUNDAMENTALS OF COMPRESSED AIR AND AIR COMPRESSORS

1) An air compressor is a machine designed to compress air or gas from atmospheric to a higher pressure. The pressure is increased as the space containing the air in the cylinders is decreased. A definition of "Compressed Air" is air which has been taken at atmospheric pressure and compressed so that it occupies less space than it did originally.

2) Various types of compressors are:

   a) Reciprocating piston
   b) Sliding vane rotary
   c) Impeller rotary
   d. Rotary Screw
   e. Centrifugal
   f. Diaphragm

3) Methods of cooling:

   a) "Air-cooled" from flywheel fan blast.

   b) "Water-cooled" in which water is circulated around the valve pockets and cylinder walls to provide cooling.

4) Methods of lubrication:

   a) "Splash" in which oil is splashed on all internal parts by dippers on the connecting rods.

   b) "Pressure" in which oil is fed to the bearings, journals, and wrist pins by means of an oil pump.

5) Single-Stage Compressors:

   a) In a single-stage compressor, air is compressed from atmospheric pressure to final discharge pressure in a single stroke of the piston.

   b) Single-stage compressors operate at a maximum efficiency when pressure is 100 PSI. Continuous service applications should be set at a maximum of 100 lb. of pressure and intermittent service applications set at a maximum of 150 lb. of pressure.

6) Two-Stage Compressors:

   a) In a two-stage compressor, air is compressed from atmospheric to final discharge pressure in two separate steps.

   b) The air is compressed in the initial stage (large, low-pressure piston) to approximately 45 PSI. This compressed air is then cooled in the intercooler before being compressed again to final discharge pressure in the second stage (smaller, high-pressure cylinder).

   c) The work load is more or less equally divided between the two stages; 14.7 PSI atmospheric pressure compressed 3 to 3-1/2 time to about 45 PSI is then compressed another 3 to 3-1/2 times in the high pressure cylinder to the final discharge pressure of 175 P.S.I.

   d) A two-stage compressor is more efficient than a single stage for pressures over 100 PSI, operates cooler and delivers more air for power consumed.

7) Piston Displacement:

   a) The piston displacement of a compressor, expressed in cubic feet per minute, is the volume swept through by the piston. In other words, it is the theoretical volume the compressor would discharge, if it were 100% efficient, which it isn't.

   b) In two-stage compressors, the piston displacement is always given for that of the first stage only. This is because the second stage merely re-handles the same air the first stage draws in and cannot increase the amount of air discharged.

8) Free Air or Actual Delivery:

   a) "Free Air" or "Actual Delivery" is the actual quantity of free air, in cubic feet per minute, delivered at the discharge of the compressor.

   b) The ratio of "Free Air" to the piston displacement gives the volumetric efficiency, in percent, of the compressor.

9) Volumetric Efficiency of a Compressor:

   a) Factors relating to volumetric efficiency of a compressor are: clearances of "dead-space" between top piston and valve plate; volume of air trapped in the valve plate openings beneath the valves; pressure; and the temperature of the air as it is drawn into the cylinder.

   b) If the compressor cylinder is not cooled sufficiently during each intake stroke, the free air drawn into the cylinder heats rapidly and consequently expands, allowing less new air into the cylinder.

   c) In single-stage compression, the factor that has the greatest effect on volumetric efficiency of a compressor is the final discharge pressure. Compressed air, trapped on top of the piston and in the valve plate openings on the discharge stroke of the piston, must re-expand until the pressure is below atmospheric. The intake valve then opens and a new charge of air is drawn into the cylinder for the remainder of the down-stroke of the piston. The higher the discharge pressure, the greater distance the piston must travel on its downward stroke before the pressure of the expanded air is below atmospheric. Thus, less new air is allowed to enter the cylinder on each stroke. Two-stage compressors are not greatly effected by changes in the discharge pressure because of the compression ratio of each stage and cooling of the compressed air between the two stages.

10) Types of Unloaders:

   a) Automatic start-stop units are controlled by a pressure switch which starts and stops the motor at pre-determined cut-in and cut-out pressures. The pressure switch control is used on any installation where the demand for air is intermittent and the compressor operates less than 60% of the time.

   b) "Continuous Run" or "Constant Speed" units are controlled by a pilot valve. This type of control is used when the demand for air is continuous. When the pressure in the air receiver reaches the designated high level, a pilot unloader valve will channel the air being compressed into the atmosphere instead of into the air receiver. During this step the motor or engine will continue to run, (engines will idle). When the designated low pressure in the air receiver is reached, the pilot unloader valve will re-direct the air being compressed to the air receiver (the engine speed will return to the high RPM level).

c) "Hand Unloader" or "Manual Control" units are usually used when the demand for air is infrequent, such as on a sprinkler-system compressor. The unit is started and stopped manually. The hand unloader is used to unload the compressor so that the motor will not have to start against pressure in the compressor.

d) "Dual-Control" units can be operated on either automatic start-stop or continuous operation by opening or closing one shutoff valve. This type of control is used when the demand for air varies greatly. (i.e. The demand for air is continuous during the day shift in a factory while the smaller night shift could operate on automatic start-stop operation.)

CHART FOR USING COMPRESSED AIR FOR BLOWING

Pressure	CFM of Free Air for Orifice Diameter				
PSI	1/32"	1/16"	3/32"	1/8"	1/4"
50	.91	3.64	8.2	14.5	58.2
70	1.19	4.76	10.7	19.0	76.0
80	1.33	5.32	11.9	21.2	85.0
100	1.61	6.45	14.5	25.8	103.0
120	1.90	7.58	17.0	30.2	121.0
150	2.33	9.20	20.7	36.7	147.0

RECOMMENDED MOTOR WIRE GAUGE AND LENGTH

Single Phase Motors								
	115 Volt				230 Volt			
HP	50 ft.	100 ft.	150 ft.	200 ft.	50 ft.	100 ft.	150 ft.	200 ft.
1/2	14	14	14	12	14	14	14	14
3/4	14	14	12	10	14	14	14	12
1	12	12	10	8	14	14	12	10
1-1/2	10	10	8	6	14	14	12	10
2	10	8	8	6	14	12	12	10

PIPE SIZES FOR COMPRESSED AIR LINES:

Length of Pipe Lines in Feet

Cubic Feet Per Minute

	25	50	75	100	150	200	250	300
1	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2
2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2
3	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2
5	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2
10	1/2	1/2	1/2	3/4	3/4	3/4	3/4	3/4
15	3/4	3/4	3/4	3/4	3/4	3/4	3/4	3/4
20	3/4	3/4	3/4	3/4	3/4	3/4	3/4	3/4
25	3/4	3/4	3/4	3/4	3/4	1	1	1
30	3/4	3/4	3/4	3/4	1	1	1	1
35	3/4	3/4	1	1	1	1	1	1
40	3/4	1	1	1	1	1	1	1
50	1	1	1	1	1	1	1	1
60	1	1	1	1	1-1/4	1-1/4	1-1/4	1-1/4
70	1	1	1	1	1-1/4	1-1/4	1-1/4	1-1/4
80	1-1/4	1-1/4	1-1/4	1-1/4	1-1/2	1-1/2	1-1/2	1-1/2
100	1-1/4	1-1/4	1-1/4	1-1/4	1-1/2	1-1/2	1-1/2	1-1/2