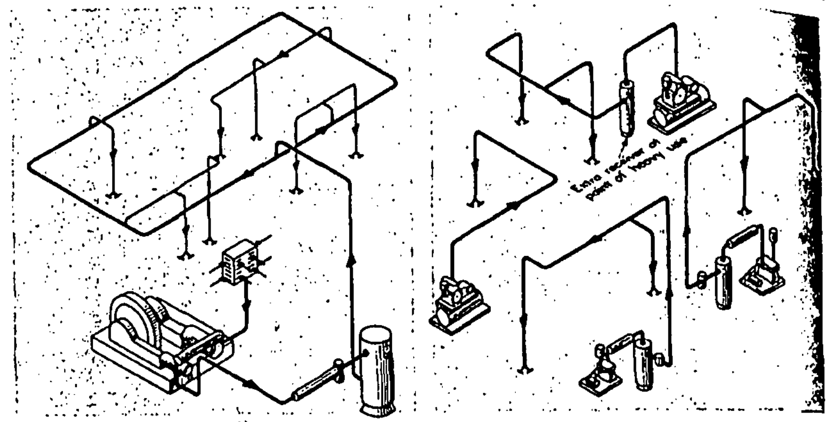
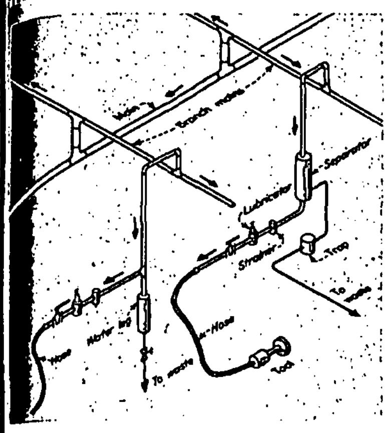
Study plant air needs before choosing distribution system, then pipe air tools properly





System Layout

First step: Study your plant to see if it would be better served by one large compressor in a central location, or by several smaller ones in areas needing air. This important decision affects system costs from start to finish.

Central system, above left, has one or more large compressors in a more or less central location. Supply piping, often in the form of a loop, runs to areas needing air.

Advantages claimed for central systems include: low investment cost per unit of capacity, low unit power cost, chance to use synchronous motors to correct power factor, good pressure regulation, minimum wiring for motor drive.

Unit system, above right, has compressors spotted in areas using air. In the usual plant, each compressor serves the area in which it is located, with only emergency connections between the different areas.

Advantages cited for unit systems include: low initial investment, less pressure loss in piping, reduced engineering and planning, simpler installation, greater flexibility, easier financing of plant expansion, simplified purchasing. All these are fully discussed in POWER, Jan 1953, pp 75-77.

Study Needed. There are no simple rules to use in choosing a system. Each plant must be analyzed separately and the decision based on the results. For many years central systems have been popular in large industrial plants, and have given excellent service. Unit systems, while used in both large and small plants, are newer and are not yet as extensively applied in large plants.

Compressed-Air Piping

Regardless of compressor or distribution system chosen, piping is of major importance in every setup. Because piping conveys air from high-pressure source (compressor) to point of use (tool), it can be a definite help or hindrance in plant operation.

Good piping design limits pressure drop between compressor and tool because low pressure at the tool cuts production. We haven't space for a complete rundown on all angles of piping design but here are some helpful pointers:

Intake, Discharge. Have intake pipe at least as large as compressor intake opening. For every 10 ft of run from compressor, make line diameter one inch greater. Keep air velocity in intake below 2500 fpm. This cuts friction loss.

Make discharge line at least as large as compressor outlet opening; use as few bends as possible. Be sure run is short and direct. Fit valved drain to lowest point of discharge line and in any pockets formed by piping.

Support intake and discharge piping so vibration and strain don't reach compressor cylinder, aftercooler or receiver. Use gate-type shutoff valves in air lines to keep friction loss low.

Distribution Piping. Line from receiver to point of use is generally sized so pressure loss is reasonable—below 5 psi. Provide outlets on each header or main for connection of hoses to air-operated tools or devices. Fit outlet to top of pipe so moisture won't drain from main into hose. If several tools connect to one outlet, be sure it is big enough to prevent excessive pressure loss. Sketch, *above,* shows a typical main with connections for several tools.

Always remember: *Low air pressure at tools can cause a far greater loss in plant income than a few points in compressor efficiency.* Next to low pressure, moisture and solids are the worst enemies of good air-tool operation. Make full use of separators, strainers, traps, drop legs.

Intake location is of prime importance because high temperatures reduce compressor output, as Table I shows. See that intake is as far as possible from heat, dirt and moisture sources and not too close to building walls and windows. Put intake on north side of building, if possible.

Receivers that are sized liberally reduce compressor loaded periods and insure more thorough cooling of air before it reaches tools. Use ASME standard receivers and fittings except where local codes differ. It is a good plan to install extra receivers near points of heavy usage to insure adequate volume and pressure, and smooth out flow in supply mains and branches.

Safety devices are needed to protect personnel and equipment from excessive pressure and other conditions that lead to trouble. Table III lists typical devices used in large plants; many would not be justified in small installations. Even the simplest system, however, is always fitted with a pressure-relief device of some sort on the discharge side.

Compressor Cooling

Good cooling is essential to good operation. Though air-cooled compressors may run satisfactorily in warm areas, make every effort to put them in cool spots. Capacity will be greater and there'll be fewer operating problems.

Suitable strainers in main water-supply line to water-cooled compressors protect against solids. Run piping so it won't interfere with maintenance work on cylinders and drive. Put drain valves at all low points so entire system may be drained during shutdown in freezing weather.

Fit each cylinder and intercooler with its own regulating valve, even though an automatic valve starts and stops water flow to compressor. Put such valves on inlet side, with outlet free to flow into an open funnel or sight glass.

Cooling water should enter cylinder or intercooler at bottom, leave from top. This keeps jackets full and helps eject any air. A check valve between cylinder and intercooler above it keeps water from draining back into cylinder when unit is shut down.

Extremely cold water may cause condensation on cylinder walls. This destroys lubricant, increases wear. To avoid this, pass cooling water through intercooler first, then to low- and high-pressure cylinders in turn.

Table II shows recommended water quantities. With them, temperature of air leaving intercooler or aftercooler will be within 20 and 15 F, respectively, of the temperature of water entering the cooler (for ordinary plant loads).

Use enough plugged fittings in water lines to cylinders and coolers to permit cleaning jackets and tubes with an air hose or with a caustic-soda solution.

I—Effect of Initial or Intake Temperature on Delivery of Air Compressors

(Based on a nominal intake temperature of 60F)

Initial temperature, F	Initial temperature, F, abs	Relative delivery	Initial temperature, F	Initial temperature, F, abs	Relative delivery
−20	440	1.18	70	530	.980
−10	450	1.155	80	540	.961
0	460	1.13	90	550	.944
10	470	1.104	100	560	.928
20	480	1.083	110	570	.912
30	490	1.061	120	580	.896
32	492	1.058	130	590	.880
40	500	1.040	140	600	.866
50	510	1.020	150	610	.852
60	520	1.00	160	620	.838

II—Cooling Water Recommended for Intercoolers, Cylinder Jackets, Aftercoolers

Gpm per 100 cfm actual free air

Intercooler separate	2.5 to 2.8
Intercooler and jackets in series	2.5 to 2.8
Aftercoolers:	
80-100 psi, 2-stage	1.25
80-100 psi, single-stage	1.8
Two-stage jackets alone (both)	0.8
Single-stage jackets:	
40 psi	0.6
60 psi	0.8
80 psi	1.1
100 psi	1.3

III—Typical Compressor Safety Devices

Name	Function
Relief valves	On compressor discharge side to relieve excessive pressure. Don't use any shut-off valves between compressor and the safety valve
Overspeed shutdown	Trips out drive when compressor exceeds predetermined safe speed
Oil-failure shutdown	For large compressors fitted with pressure lubrication, this device protects bearings by stopping unit when oil pressure fails for any reason
Jacket-water valve	Shuts down compressor if water pressure fails. It is operated by either pressure or temperature
Over-pressure shutdown	Stops compressor when discharge pressure goes above pre-set safe value
Excessive-temperature shutdown	For isolated compressors this gives protection against high discharge temperature by automatically stopping unit
Main-bearing protection	Thermal shutdown devices stop compressor if bearing temperature goes too high
Multistage temperature protection	Recording thermometers for each stage are good for this, give continuous reading of each stage's outlet temperature