from a two-wheeled tandem trolley moving on a single bar runway, so that load, hoist and trolley have horizontal freedom. If head room is wanting it is set horizontally, and the outer end of the piston rod coupled to a chain passing over one or more pulleys, thus changing the direction of the pull, and so used the piston rod on upper surface has been notched so as to form a rack into which a pall falls, thus locking the suspended weight at any height; and when the hoist cylinder is put on to an old hand crane it is often set at an angle, being for convenience of attachment secured to the diagonal strut. A flexible hose of small diameter gives it elastic connection with the shop air-main. The widest variation in practice is in the controlling valve used, a three-way plug-cock being the cheapest to make and the most troublesome to keep tight. Mitre valves or flat valves with recessed elastic seating are more certain. They require a separate spindle (and cotton-packed gland) for each valve, but each pair is movable by one double-ended lever. Where air enters the barrel of hoist a very small hole or self-closing check valve is desirable, so as to prevent the load running down dangerously fast in case of injury either to the air-main or to the supply hose; also it is desirable to have a check or stop on the piston rod so coupled to valve that in case of over-stroke the valve is reversed and air is admitted to the opposite side of piston cushioning it. The same end may be attained by the piston itself striking and opening a supplementary valve, or if the non-working end of barrel is open to the atmosphere by small hole in the side of the barrel, so locating this hole that the piston will block it and the confined air act, first as a cushion and then as a stop. Such a hole sucks in the shop dust and grit, increasing friction and leakage, so that a valve admitting compressed air or exhaust air only, is the better practice. It is perhaps over the wide surface of a foundry floor, and in the midst of its sand, grit and dust, that pneumatic hoists best show their good qualities, and Russel & Co., of Massillon, O., who early appreciated their value, two years ago were using 26 cranes of 5 ton capacity, cupola stock elevator, and many simpler hoists of from 400 to 1,000 lbs. capacity. Under such shop conditions every foot of air exhausted adds to the health and comfort, and therefore working capacity of the moulders.

In trying to use a portable suspended hoist, and move it under a long length of shop roof, in most cases —even of modern equipment—the flexible air-hose has to be detached, and after the hoisting cylinder has been moved to a new location the air-hose recoupled to the air main branch. To avoid this delay and inconvenience the C. & N. W. Ry. Co. use a long length of air-hose, equal to half the total length of the runway that carries the hoist, coupling the hose to the air-main at the centre of the length of the runway. Then, at points some twenty feet or more apart, the hose is suspended from a two-inch grooved pulley running freely on a horizontally tight-stretched wire. Each such suspending pulley requires an independent wire, and the wires are arranged so as not to be in the same vertical plane. The result of this ingenious arrangement is that as the hoist moves towards the centre of its runway it crowds or loops the hose, and then when closely massed each suspending pulley runs past its neighbor as the hoist passes the centre, then, extending and straightening the looped-up hose, the hoist is free to travel as far to the left hand of the centre (or point of connection to the shop main) as it was originally to the right hand of that point. R. Quayle is so far satisfied with this plan that he has now underway some such arrangement to permit a jib crane, traveling on a single floor rail, to propel itself or to hoist at any point in the length of a 500 feet shop.

The most obvious advantage of air over water as a transmitter of power is its freedom from frost troubles. It is, however, possible under some conditions to effectively combine the two, not only without frost risk, but with added economy and a much wider range of application, without the machine being so large as to interfere with the workman's freedom of movement and his ease in handling the material to and from the tool. This is done by using a pair of tandem differential cylinders, the outer or upper side of the piston of the larger receiving the full air pressure and delivering that power through the piston rod at higher pressure per square inch to the water contained in the smaller cylinder. A third and independent piston at opposite end of small cylinder is coupled direct through its piston rod to the forging die. As developed in detail by J. W. Harkom, M.C.S.C.E., at Toronto, the differential cylinders are vertical, the large (air) cylinder being high up—that is, well above the working level of the man—and the smaller cylinder is made longer than its piston travel, and just above ground level opens direct into a third cylinder, set horizontally. The second and third cylinders are actually one and the same, but in the middle of its length is bent to a right angle, and has a piston at each end not coupled together, so that the distance between these pistons is variable, and the space between them filled with water admitted by valve from the city mains. The piston rod of the third or horizontal cylinder at its outer end carries the forging die, and the piston has water pressure on one side and air pressure on its relief side, so as to carry the die back after the forging squeeze has been given. All the fluid used is that contained between the two small pistons, and is a quantity variable at will, and this is the key to the economy in the volume of the air used. The dies being variable in depth, and the forgings in thickness, the position of the third piston should be variable in position, both before and after the forging movement. When the movement for any particular set of forgings is to be small, the maximum quantity of water is forced in by opening a valve coupled to the city water-main, which lifts the large air piston up closer to the top cover of the large cylinder, and thus effectually shortens its possible length of stroke. If the amount of water (and, therefore, the distance between the two small pistons) was not definitely adjustable, there would be a large loss of air when a small die were in use—or a shallow forging being made—due to the necessary filling and emptying of the cubic contents of the large cylinder at each stroke. The return (after making a stroke) of all pistons is assisted by compensating balance weights, coupled by chains to the piston-rods or tail-rods, and air pressure being always on the relief side of the forging (third) piston, the die is withdrawn from the forging as soon as the air is permitted to escape from the top of the large air cylinder. This is controlled by a three-way cock overhead, with two light cords coupled to its double ended lever, the handles on lower ends of cord just clearing the workmen's heads. Opening a single drain-cock at lowest level gets rid of all the water when men leave the shop at night.

It is an advantage in trying to secure perfect align-