

Mr. R. Quayle is so far satisfied with this plan that he has now underway some such arrangement to permit a jib crane, travelling on a single floor rail to propel itself or to hoist at any point in the length of a 500 feet shop.

#### FORGING.

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 Mr. 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 head. Opening a single drain-cock at lowest level gets rid of all the water when men leave the shop at night.

#### COMBINED BORING AND PLANING.

It is an advantage in trying to secure perfect alignment in the boring and planing of large cylinders, pump barrels, etc., that both these operations be done on the one machine table without resetting the work, and this has of late been done by M. C. Bullock Co. of Chicago, \* the

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