chine and carries the boring tool at its lower end. The drill-bar is screwed for about half its length, and the other or lower hexagonal half passes through a cap of similar form at the lower end of the tubular piston rod, so that it must turn with the piston while having independent longitudinal motion through its center. A somewhat similar arrangement admits of the long driving nut either turning with or remaining without revolution on the drill-bar, while it is always at liberty to travel through the bevel wheel connected with the feed hand-wheel. The requisite motion is given to the drill-rod by two cams—see mining machine—on the wheel shaft.

It will be seen that at the lower part of the cylinder a number of holes, A, are made for the admission of air, which in the upward stroke of the piston is compressed in the top part of the cylinder sufficiently to cause the downward stroke to be made with great velocity as soon as the cam has passed the collar. The revolving motion of the bar is secured by the simple frictional contact of the cam against the collar as the former revolves. The collar imparts this

Whithurst, and published in the "Philosophical Transactions" for 1775. The letter describes an apparatus of which Fig. 1 is an illustration. It consists essentially of a reservoir of water, A, from which a fall pipe, B, is carried to the air vessel, H. A short pipe, E, terminating in a cock, F, branches from the main pipe before it reaches the air vessel, H; between this branch and the air vessel a small clack valve, G, is placed in a suitable enlargement of the pipe. A second pipe, or rising main, I, connects the air vessel with a tank, K, placed at a higher level than A.

The action is as follows:—The cock F being opened, water from the tank A flows down the drive pipe B, with a velocity varying with the fall. When a sufficient velocity has been attained, the cock F is closed by an attendant, and the column of water, in accordance with a well-known natural law, continues its course. Having no other outlet, it forces its way through the small valve G into the air vessel H, compressing the air contained therein until brought to rest by its reaction. The elasticity of the air in the chamber H, in return forces the water up the rising main I into the tank K.

water flows through the fall pipe C until it acquires sufficient momentum to lift the counter-weight E and close the valve B; when this takes place, as in the Whithurst machine, the water, having no other outlet, forces its way through the valve A into the air chamber J, and thence passes into the rising main D. The water in pipe C is soon brought to rest by the reaction of the compressed air contained in the air vessel, and the valve A then falls. At the moment the delivery valve closes there is a slight recoil or regurgitation in the drive pipe, which, together with the counterweight E, causes the pulse valve again to open. The action now commences afresh.

Montgolfier's patent includes various modifications of the ram. In one case a siphon fall pipe is used, in order to pass over any obstacle in its course instead of cutting through it; in another instance, two rams are designed to work with one fall pipe, in situations where a current of water passes alternately in opposite directions, as in a tidal river. One ram is placed at each end of the pipe and works alternately, according to the current. A third arrangement is for drainage purposes, where a stream flows at a higher level than that from which the water is to be removed. In this case the pulse valve is placed at the inlet end of the fall pipe. When it closes, the momentum of the water in the fall pipe carries it forward, leaving a partial vacuum behind it, which is filled by the water from the lower level passing through a suitable pipe and clack. This clack prevents any

IMPROVED HAND-POWER ROCK DRILL.

motion to the sleeve on the boring bar, and the rate of feed is regulated by causing the sleeve to revolve against more or less resistance, visited upon it by the thumb screw on the feeding wheel shown at E.

This arrangement forms an automatic adjustable feed. The machines are worked by two men, and the drill makes from about 140 to 180 strokes per minute. We recently saw some of the machines at work. The sinking machine has been proved capable of boring a hole from 1¼ in. to 1½ in. diameter to a depth of 6 ins. per minute in Portland stone when working at full speed. With the quarrying machine a 1¼ in. hole was, in our presence, bored to a depth of 3 ins. in one minute in Aberdeen granite. The mining machine is capable of piercing a horizontal hole 1½ in. diameter in the same granite at the rate of from 1½ to 1¾ in. per minute. Each machine worked by unskilled men is thus capable of doing the work of from two to four skilled men when boring by hand. The machines are kept steady in work by hanging weights on the cross bolts on the lower part of the framing. They are made by the Hand-power Drill Company, Queen Victoria Street, London.—*Engineer*.

THE HYDRAULIC RAM.

By C. L. HETT.

THE first notice we find of an arrangement for utilizing the momentum of a column of water for raising a portion of itself to a higher level is in a letter written by Mr. John

By alternately opening and closing the cock F, a continuous flow of water into the tank may be maintained. The air in the vessel H acts as an elastic spring, and converts the intermittent flow of water to the vessel into a steady stream from it. Without this arrangement, the whole column of water in the rising main would necessarily be put into motion, and stopped at each pulsation of the water in the delivery pipe. This with a short rising main would produce heavy jars, and in a longer one the water could not be put in motion in this intermittent manner.

In 1773 Mr. Whithurst erected one of his machines for supplying a brewhouse at the seat of Philip Egerton, Esq., at Oulton, in Cheshire. In this instance the fall pipe was 1½ in. diameter and 200 yards in length. The cock E was fixed in the kitchen, 18 ft. or 20 ft. below the surface of water in the reservoir A. This cock being regularly used for drawing water for domestic purposes, and in almost constant action, it kept up a sufficient supply to the brewhouse.

The ram as left by Whithurst, although very ingenious, was very limited in its application, requiring, as it did, human aid to work the cock or escape valve.

In the year 1796 the celebrated Montgolfier invented a self-acting escape or pulse valve, which in its crudest form was patented by permission in this country by Mr. Boulton, of the firm of Boulton & Watt, in 1797. Fig. 2, reprinted from the specification, represents the ram in the form it had now assumed. The action will be easily understood. The

return of water, which thus passes out of the fall pipe with the rest of the liquid. After the registration of the patent, Montgolfier appears to have further improved the ram by the introduction of spindle valves with vertical lift, both for the escape and delivery.

From the foregoing it will be seen that the merit of the invention of the ram was undoubtedly due to Whithurst. Montgolfier, however, raised the machine from a position of but little practical value to that of a thoroughly efficient means of raising water. To such a perfect stage had it now arrived that many of the rams made at the present time possess no advantage over the best designs of Montgolfier.

Experience proved that the air in the air vessel was gradually absorbed by the water passing through it, and the working of the ram interfered with, in a greater or less degree, according to the height of lift and length of delivery pipe. The younger Montgolfier arranged a small valve so as to keep the vessel supplied with air. Figs. 3 and 4 represent the ram as improved and patented by him.

The most interesting points in this machine are the air cushions contained in the annular space I, and the means of maintaining a constant supply of air in it and the air vessel. Montgolfier speaks of the air cushion as if it had been used before the date of his patent, but claims the use in connection with the air-supplying arrangements of one of a larger size than had previously been practicable. Its object is to reduce the shock at the closing of the pulse valve; but we have not found it answer the purpose, or, indeed, to be of any use whatever. C is the pulse valve, working in guides g g; D is a similar valve, closing externally, the purpose of which will be afterward explained; L and K are two clack valves, closing either end of an air passage otherwise open to the atmosphere at one end and into the end of the ram at the other. The action is as follows:—While the water escapes through H H, the valve K is closed. As in the previously described rams, the valve C shuts—delivery into the air vessel takes place—and a recoil is set up, intensified in this case by the elasticity of the air cushions at I. The valves C and D both drop, and D prevents any return of the water through the escape passage.

FIG. 1.

HYDRAULIC RAMS.—THE EARLIEST AND THE LATEST.

The recoil of the water is sufficient to create a partial vacuum in the air space I. The valve K then opens and fresh air rushes in; the force of the entering air closes the valve L, and prevents too great a quantity gaining admission. The air thus admitted in excess of what is required to fill the space I rises and lodges under the delivery valves, to be forced into the air vessel at the next stroke.

The inventor has provided ample means for the delivery of the water to be raised by means of seven small clack valves, a provision which is insufficiently attended to in many modern rams. A ram with this arrangement of delivery valve was erected at St. Elloe.

The same patent includes an arrangement by which a stream of salt or impure water may be used for pumping pure water from a spring or well. Fig. 5 shows the arrangement. The working of the ram proper is exactly the same as in its more simple form. Assume the pipe Q T to be primed as shown in the drawing; at the moment the escape valve closes, the water rushes up the bent pipe P, compressing the air in it. The air forms a kind of piston, reacting on the surface of the water at Q, and forces it through the valves E into the air vessel. The water having

chamber, one side of which was in contact and pulsated with the water in the body of the ram. To the center of the diaphragm a rod was attached, which communicated its motion to a lever working a common force pump. The use of the diaphragm was an important step, but the mode of transmitting its movement to the water to be raised was very roundabout. Mr. Douglas has latterly used a piston working in a cylinder in place of the diaphragm, which appears to be a very doubtful improvement.

In 1852 an English patent was granted to Thomas Hanson, of New York, for further improvements, consisting of (1) a leather clack, for preventing the recoil in the fall pipe taking place, and (2) for a disk delivery valve, working into a short cylinder, the periphery being made water-tight by means of a cup leather such as is used for the bucket of a common pump. Neither plan appears to have met with sufficient success to be at all generally adopted. This patent may be said to have completed the history of the American rams. Although other makers have entered the field, their productions are generally but very slightly modified copies of Douglas'.

Messrs. Bollie & Son obtained provisional protection,

to place these two valves as close together as possible, and he arrived at the construction indicated in Figures 7 and 8.

The outflow valve *a* is constructed as a double seat valve and hollow. It rests in the open state on the eight noses *h h*, and is guided below by as many bars, placed above the noses *h h*; above, by the wings of the pressure valve; the valve seats are formed of caoutchouc rings.

From the figures will first be observed the large cross section of outflow; further, that only in the neck of *b* is there any water during the opening of *a* in the state of rest. The shock of the water can, therefore, be but small. To further reduce it, the arrangement shown above Fig. 8 is adopted. From the pressure pipe *a* a narrow pipe *d* proceeds upward, terminating in the lower part of a triple chest, whose middle and upper parts communicate with the lower through the valves *f* and *g*, while the lower, after opening of the valve *e*, is put in communication with the open air. The upper part of the chest again communicates through the pipe *c* with the space under the valve *b*. Whenever the outflow valve *a* is closed, and consequently a shock occurs, water is forced upward in *d*, compresses the air there, and opening the valve *f*, forces it partly into the middle division of the chest. After cessation of the shock, this air passes through the valve *g* into the upper part of the chest, into the pipe *c* and lastly under the valve *b*; there it serves, first as a cushion for the impact of the water, and then for abundant replacement of the air which is gone out of the air vessel, so that the water streaming through the open valve *b* only meets air.

The ram described has not been constructed, but only a model with about 40 mm. width of inlet pipe. In the experiments referred to the audible shock was very small.—*Engineer*.

HANK DYEING, WASHING, OR SIZING MACHINE.

THE dyeing, washing, and sizing of yarns in the hank is still mostly done by hand; and though several machines have been invented, and are also in use for this purpose, their application is only limited. The machine which we here illustrate is, we think, worthy of consideration, being different from those which we have seen.

The dye-beck, D, Fig. 1, which contains the hanks, is slightly inclined so as to facilitate the flow of the liquor; the

FISCHER'S HYDRAULIC RAM.

expended its energy, recoils with very great violence, being assisted by the expansion of the air at P. This recoil produces a partial vacuum. The entrance through H being closed by the valve D, the pressure of the atmosphere on the surface of the water whence the pure supply is drawn forces a portion of it through the foot valve, into the rising pipe T Q. The water recommences to flow, and the action is repeated.

The manufacture of rams in England was for a long time carried on almost entirely by Messrs. Easton, of London, who introduced various alterations in their construction. The size of the air cushion was much increased, and we believe the introduction of ball delivery valves and double pulse valves is due to them. Mr. Glynn, in his "Power of Water," states that a patent was taken out by this firm for their improvements; but a careful search in the indexes published by the Commissioners of Patents, for such a specification, has been entirely unsuccessful. The ram was comparatively unknown to the general public at this period of practical monopoly. An amusing proof of this occurred in 1832, when a correspondent, writing to the old *Mechanics' Magazine*, described one of a very crude design as an entirely new invention. Mr. Freeman Roe appears to have entered the English field soon after this date. His ram and that of Messrs. Easton & Amos were exhibited in the Exhibition of 1851, and submitted to a series of trials under the direction of the jurors. It is to be regretted that no particulars of the dimensions of these rams are on record, as without them the results obtained are of no practical value. Our American cousins appear to have so far appreciated this means of raising water as to induce Messrs. Douglas, of Middletown, Connecticut, to take up the manufacture, and exhibit at the fair held at New York in 1847, where a silver medal was awarded them by the American Institute. Their ram is well arranged, and is designed so as to be produced at a very low cost. The escape valve works in a short cylinder, and is guided by a perforated shrouding. The stroke is adjustable by means of a screw, which is very much better than the clumsy expedient of packing the valve up with washers on the spindle, which is still adhered to by some of our English makers. The objectionable points are the leather clack delivery valve, the want of an air supplying arrangement, or snift valve, and insufficient strength for high falls and lifts. For use with low falls, and where the water is not carried very far, the type introduced by Mr. Douglas is so good a one that the writer has commenced making rams of this class, with improvements suggested by experience, for use under such circumstances. In 1848 the same makers introduced a pumping ram of original design. The air piston of Montgolfier was replaced by a diaphragm inclosed in a globular

under our English law, for improvements in hydraulic rams, in 1862, and also exhibited a specimen in the Exhibition at London in that year. Their improvements consist in a counterbalanced escape valve, which is designed so as to stop the escape of the water before the valve reaches its seat, thus mitigating the shock which takes place. The second improvement is a rather complicated air pump for supplying the air vessel. Neither of these novelties has come into use in this country.

The next patent taken out in England is for the application of disk valves of India-rubber, or other flexible material, to the simple ram, and their combination with the flexible diaphragm of Douglas in the pumping ram.

After considerable experience and a long course of experiments, the writer has adopted the form shown in Fig. 6 in his own practice. The machine is arranged so as to give access to all the working parts without disconnecting any of the pipes. When the air vessel is removed, which is done by unscrewing four nuts, the delivery valve is exposed. The size of the escape valve is arranged so that while it is not unnecessarily large, its area is sufficient to insure delivery at a high elevation, it is adjustable by a suitable screw arrangement. The delivery valve is of disk type, with a spherical face. This gives a much larger area than a ball valve of equal weight, and is found by experiment to give much greater efficiency than a ball valve. Provision is made for adjusting the lift of this valve, which is a point of great importance in the working of the machine. The air vessel is made very large, to insure a uniform motion of the water in the delivery pipe; it is supplied with a snift valve of the ordinary form. The delivery valve seat and adjustments should be made of gun-metal, also the guides and adjustments of the escape valve. The nuts holding down the air vessel should also be gun-metal, so as to prevent their setting fast and rendering access to the delivery valve difficult. The studs are preferable when made of Lowmoor iron, thus avoiding any chance of their twisting off. The various parts should be made to templates, and the workmanship should be equal to first-class engine work. It should always be borne in mind that while engines will "go" when very inaccurately made, a ram will not answer without very perfect fitting. A very slight inaccuracy in fitting, which would pass unnoticed in the valves of a pump, is sufficient to greatly impair or quite suspend the useful action of a ram.

In a recent paper to the Hanoverian *Bezirksverein*, Mr. Hermann Fischer states that in the year 1866 he was charged to devise for the town waterworks in Malmö a hydraulic ram, which required a width of one meter for the inlet pipe. With a view to diminishing the considerable shock of the water on the water mass at rest in a given moment between the outflow valve and the pressure valve, he sought especially

hanks are placed upon perforated rollers or winces, which are made to rotate by suitable gearing, but in such a way that each wince turns in a contrary direction to that of its neighbor, in order to avoid entanglement of the yarn; the lower half of the hank floats thus in the liquor, or it may be put upon a submerged roller when desirable, and this latter made to have an oscillating motion, so as to imitate the shaking given to the hank by hand dyeing; this latter object is also attained by making the upper winces revolve eccen-

trically, as shown in Fig. 3. The liquor is contained in a vessel situated at a higher level, furnished with a thermometer and densimeter, and flows from this into the beck, where its level is regulated by ball valves, and whence it is pumped back into the cistern.

We should think that this machine, which is especially mentioned in *Le Jacquard*, would be more complete if there was also a contrivance for wringing the yarn, which is one of the main features of the English machines; for however well the yarn may be saturated, it will be unevenly dyed if not carefully and well wrung.—*Textile Manufacturer*.

PROTECTING METALLIC SURFACES.

THE metallic objects or metallic surfaces which it is intended to submit to the protecting process are either subjected to heat in a retort chamber or other apparatus which is capable of being heated externally and also of being wholly or partially closed, and to such retort chamber or apparatus a tube or tubes is or are adapted in order that air or oxygen, or mixtures of the same, may be allowed to pass over, in, and among the objects contained therein at any desired pressure; or, instead of causing the apparatus to be heated externally, he employs a heated current of air or of oxygen, or of an oxidizing agent composed of mixtures of the same, heated to such an extent as that the objects contained in the apparatus shall become oxidized, and thus become coated with a protective film or covering; or the apparatus containing the objects to be treated may be heated externally, and the before-mentioned oxidizing agents be admitted at the ordinary temperature of the atmosphere. The temperature which he has found to give the best results ranges from a dull to a bright-red heat, whether the objects be heated by the external application of heat or by the internal application of the heated oxidizing agent. The operation is continued until a protective film or covering of the desired thickness shall have been formed, and upon the objects being then allowed to cool they are ready for useful application in the arts.—G. BOWER, Author.