NEW BONE MILL.

We give a view of a new type of bone mill, by the Savile street Foundry Company, Sheffield, England, and which includes several improvements. We also annex a detail view, showing the arrangement of driving gear employed in this mill. An objection to the use of differential gear as employed in previous bone mills by these makers, was its vertical position, as at each revolution the whole weight of the pinion of the gear, together with the eccentric and tail lever, had to be lifted through a distance equal to the throw of the eccentric, and, at the high speed of 160 revolutions, this produced a rather jerky motion. It was, moreover, impossible to balance the weight lifted, as the roll was driven by friction band and sheave, so that the relative position of the flywheel and differential gear was always changing.

BONE CRUSHING MILL.

In the machine we now illustrate, however, this objection has been quite got over, as follows:

Referring to our detail view, it will be seen that the friction sheave, B, is keyed to the bottom roll or low speed shaft. The internal differential toothed wheel, C, is mounted loosely thereon, but has two lugs through which bolts, D, engage the friction strap, *d*. By tightening this strap the wheel, C, becomes the driver of the roll shaft, and when anything harder than bones gets in the strap allows the roll to stand while it is itself driven round. The wheel with external teeth, A, is mounted loosely upon the eccentric, E, which is keyed to the high speed shaft, and the flywheel outside is also keyed to this shaft, but is balanced at the periphery, F. The screen is suspended by light rods from the top and bot-

tom of the machine, as shown in our engravings. The frame is a box-like casting all in one piece, and is without a single bolt in it for any bearings. The rolls are made to expand by screws so that large bones may be roughly broken, and the rolls then be set up and the bones finely crushed. The rings of teeth are fastened in an improved manner, and can be slipped off and on in a few minutes, and being made to gauge, will always fit without filing. Hard chilled shells can be put on instead of the toothed rings, so as to make the mill suitable for crushing coprolites, phosphates, etc.—*Engineering*.

PICCARD'S BOILER.

EXTRACTION OF SALT FROM SALT WATER.

An improved boiler for the extraction of salt from salt water is exhibited in Paris by Messrs. Weibel, Briquet & Co., of Geneva. They have attempted to utilize the heat of the steam produced by the evaporation of the water in a first boiler by conducting it against the shell of another boiler containing salt water at a lower temperature than the first. The steam produced in the second boiler is brought in contact with the shell of a third boiler cooler than the second, and so on. This principle has long been applied to the apparatus employed in distilleries and sugar refineries. For solving the problem he had undertaken, Mr. Piccard, the inventor of this apparatus, was obliged to observe the

two following conditions: In the first place, the apparatus must be hermetically closed, in order to prevent the escape of the steam obtained from the salt water; and secondly, the apparatus, though closed, must be so constructed as to allow the continual and regular extraction of the solid salt precipitated during the evaporation. The apparatus consists of a closed cylindrical boiler containing a hollow cylinder called the condenser. This latter contains only steam, and is entirely immersed in the saline solution. At the bottom of the boiler is a vertical tube provided with two hand valves, with a certain amount of space between them. The upper valve is usually open, while the lower one is generally closed. When steam is introduced into the condenser at a higher temperature than that of the solution, the condenser transmits this heat to the surrounding liquid, which is vaporized, while the steam is condensed. The condensed steam flows

out by one tube, and the vapor from the solution escapes into another tube. The salt produced by the evaporation forms a crystalline precipitate, part of which falls to the bottom of the boiler, while the remainder adheres to the shell of the condenser, and is detached by scrapers, which slowly revolve at a short distance from the surface of the shell. After it has been detached, the salt falls to the bottom of the boiler, and is there carried by the rotation of the water to the tube mentioned above. As the upper valve is open it falls into the space between the two valves, and can be extracted by closing the upper and opening the lower valve. The admission of air into this tube is prevented by a trap filled with salt water.

COMPRESSED AIR MACHINES.

COMPRESSED air is now largely used in mines and in tunneling in place of steam or water, the application of compressed air in tunneling through Mont Cenis by Sommeiller in the year 1857 being the first great work effected by its agency. It is now successfully applied in our mines in driving coal-cutting machines, hauling-engines, rock-drills, and pumping-engines.

The inconvenience attending the use of steam for underground engines is well known, not only from the condensation of steam, but from the difficulty in getting rid of the exhaust when the engine is placed at a distance from the up-cast pit. The loss of power when ropes of great length are used for hauling amounts in some cases to 75 per cent. of the motive power. Hydraulic power is now used to some extent for pumping water in mines, with good results when a considerable pressure can be obtained; 700 lbs. was at one time considered to be the maximum working pressure, now 1,500 lbs. per square inch is not unusual. Assuming the compressed air to be at 40 lbs. pressure per square inch, and water at 700 lbs., it will be seen that to obtain the same result it will require about 17½ times more air than water, and the velocity through the pipes will be in the same ratio. The friction increases as the square of the velocity, therefore the friction of the air would be 306 times greater than that of water, and there would be 17½ times the quantity to deliver; the power required to overcome this and friction would be as the cube of the velocity, requiring a power 5,359 times greater than water. The density of the air, however, at 40 lbs. pressure is about 225 times less than that of water—then $306 \div 225 = 1.4$ nearly more friction, and $5,359 \div 225 = 24$ times greater power required with air than with water. This would be the result in pipes of the same size and length, but by increasing the size of pipe and reducing the velocity the practical difficulty in the transmission of air is to a great extent overcome. Water-power may be applied to a pumping-engine in a mine—say, with 300 lbs. pressure per square inch on the piston—to pump ten times the quantity expended in driving it, to an altitude of 69 ft., minus the friction of the engine and of the water in the pipes. This may in some cases be a convenient application of water power, but it is not generally applicable. But compressed air is not only suitable as an underground motive power, but also as an aid to ventilation. The air discharged from a pair of 14 inch hauling-engines, at 120 strokes per minute, and 30 lbs. pressure, would be about 2,000 cubic feet per minute, and this would be at a low temperature, about freezing point, so that it would have a most beneficial effect in cooling the air and augmenting the current in the working part of a mine, where it is most needed.

The advantage claimed for hauling-engines actuated by compressed air is that they can be placed at the furthest extremity of a mine, and moved from place to place as the circumstances of the mine may require them for convenience of haulage by ropes or for pumping water. The useful effect obtained from compressed air-engines is small, but this will evidently vary with the length and size of the air-pipes, the construction of the air-compressor, and the condition of the hauling-engine. As much as 65 per cent. of useful effect is stated to have been obtained in the working of one of the hauling-engines at Ryhope Colliery, Durham.

The steam-engine on the surface consists of a pair of 32-in. cylinders, 5-ft. stroke; average pressure, 15 lbs., giving out a power of 78-horse, after deducting its friction. The distance from this engine to the underground hauling-engine is about 1,500 yards; the power given out by this is 51-horse, without deducting the friction of its own parts. The air-compressors at bank are a pair of 33-in. cylinders, 5-ft. stroke, cylinders and covers jacketed; in the space between the cylinders and jackets a circulation of water is maintained. The useful effect obtained from compressed air in other cases is stated to be only 30 per cent., or 20 per cent. of the motive power; but the latter may be due, in a great measure, to imperfect machinery, and limitation in the area of the pipes. It is well known that when the air is being compressed, great heat is given out from the compressor; it is to prevent this loss of power that the cylinders are jacketed and cooled with water. The temperature of the air at the outlet of the compressor at Ryhope was 212°. The temperature of the air at the receiver at the bottom of the pit was 74°, and the pressure 44 lbs. The temperature at the receiver near the hauling-engine was 58°, and the pressure averaged 38 lbs., the engine being in motion most of the time.

Another cause of loss of useful effect is due to the outlet orifice of the compressor being so constructed that the compressed air cannot escape freely from the cylinder, neither can the air enter freely into the cylinder for compression. It has been proposed to inject cold water into the compressor in the form of spray, to keep the temperature nearly uniform, and prevent the great increase of volume by heat, which compression always occasions. This expedient may be said to favor the formation of ice at the exhaust orifice of the hauling-engine, but this could be prevented by injecting water at the ordinary temperature into the cylinder of this engine also, and enlarging the orifice, so that practically no difficulty would arise from this cause. If the quantity of water injected were such as to keep the temperature nearly uniform in the compressor, and the same in expanding at the orifice of the hauling-engine cylinder, the loss of power that arises from the air heating and cooling would be much reduced; and the practical loss would be in the machinery and in the passage of the air through the pipes.

Authorities differ much as to the useful effect obtainable from air compressing machines. As this must depend on various conditions already alluded to—the valves of the compressors, the machinery, size of pipes, etc.—if these were constructed on the best principles the loss of power would not be so great as some state it to be—75 per cent., whereas others give the useful effect as 65 per cent., or a loss of 35 per cent. only. The application of compressed air to driving hauling engines underground has been largely carried out at the Powell Duffryn Collieries in South Wales. The steam cylinders are 34 inches diameter, the compressors 40 inches diameter, with 6-foot stroke; steam pressure, 70 lbs., cut off at one-fourth; air compressed to 40 lbs. above the atmosphere. The engines make 20 revolutions per minute, and indicate 480 horse-power. There are 26 hauling-engines driven by compressed air at the Powell Duffryn Collieries in three different sizes. First, for the main roads the engines have two 12-inch horizontal cylinders, 12-inch stroke, geared in the ratio of 1 to 5, with two drums 4 feet in diameter. Second, for the branch roads single cylinder engines are used of similar construction to those above, with 14-inch cylinder, 12-inch stroke and two drums. Third, the portable hauling engines, the extreme dimensions of which are—Length, 6½ feet; breadth and height, 4 feet. Each has one cylinder 8 inches diameter, 9-inch stroke, geared in the ratio of 1 to 6, with two drums of 2 feet diameter. This engine can be moved about on the roads, being provided with four wheels for the purpose. The latter engines are intended to supersede the ponies and boys employed in bringing coal from the workings to the branch roads. Experiments made with the air-compressors and engines show that the greatest useful effect is obtained with low pressures.

At 40 lbs. pressure of air the useful effect was 25.8 per cent.

34	“	“	“	27.1	“
28½	“	“	“	28.5	“
24	“	“	“	34.9	“
19	“	“	“	45.8	“

—M. E. in *Mining Journal*.

THE ST. GOTHARD TUNNEL.

By GEO. J. SPECHT, C.E.

THE building of the Mont Cenis Tunnel through the Savoy Alps to France, and the Brenner-road to Austria, have made it absolutely necessary for Germany and Switzerland to choose between losing the commerce and travel of the South and building a mountain railroad. Of the stage routes crossing the passes of the Alps, only four were found which could be followed by a railroad, viz: the Septimer, Splügen, Lukmanier, and St. Gothard Passes.

For the St. Gothard Railroad, three lines were projected, with the following results:

PROJECT	I.	II.	III.
Length of tunnel, feet,	35,030	48,544	50,413 feet
Length of tunnel, miles	6.63	9.19	9.55 miles
Highest point of line, feet	4,797	3,785	4,187 feet
Highest point reached by open line, feet	4,772	3,690	3,969 feet
Time required for constructing it, years	11 to 12	15 to 16	15 to 17 years
Estimated costs,	7,800,000	10,600,000	11,000,000 dols.

Project No. II. has been adopted, and is the one now in course of construction. It has been selected on account of its being the lowest above sea level; the object being to avoid snow blockades in winter. This selection is in so far interesting, as we have some cases in point on this coast. We refer to the obstructions in the rocky mountains of the Sierra Nevada, the summit of which is passed by an open line, instead of a tunnel.

The contract for the St. Gothard Tunnel is the most interesting. It was granted to Louis Favre, of Geneva, he being the lowest bidder of twenty-three competitors, and his bid \$196.40 per foot of tunnel, complete. By the terms of the contract, Mr. Favre promises to deliver the works of the tunnel, completed, in eight years, viz: by the 1st October, 1880. For each day the work may be done before that time, the company agrees to pay him \$1,000. On the other hand, however, for every single day in arrear of contract he forfeits \$1,000. If delay continues six months, the forfeit is \$2,000 per day; and should he be one year in arrear with his work, he surrenders the contract and forfeits \$1,600,000, which he and his friends for him have deposited with the company as security. The contractor calculates to

make a profit on this premium, rather than on the work itself.

The northern entrance of the tunnel is situated near the small village of Goeschenen, in the Canton Uri, in the German speaking part of Switzerland; its height above sea level is 3,637 feet. The southern entrance is near the village of Airolo, in the Italian speaking Canton Tessin, and its height is 3,756 feet. It is the largest tunnel of the world, and exceeds in length that of the Mont Cenis, the Hoosac, and the Sutro tunnel. The total length of the Mont Cenis is 40,084 feet, or 7.6 miles, the Hoosac, 25,040 feet, or 4.74 miles, and the Sutro tunnel, 20,370 feet, or 3.84 miles. The strata of the rock have mostly been gneiss and mica slate, also granitic gneiss and quartz.

The grade of the tunnel, beginning at the northern entrance, is 5.82 feet in 1,000 feet, or 30.7 feet per mile, for a length of 24,459 feet, raising the line to a height of 3,785 feet above sea level. The line is then level for 590 feet, and is then descending one foot in 1,000 feet, or 5.28 feet per mile, for a distance of 20,628 feet. This grade has lately been changed to 2.5 feet in 1,000 feet or 13.2 per mile. The tunnel has a double roadway, and it is probable that it will be arched from beginning to end.

In regard to the mode of construction, the following may be of interest: The French or Belgian system of building railway tunnels is to lay the advance drift in the top of the cut, while the system of placing it at the bottom is more frequently employed in Germany, Switzerland, Italy, etc. In this case the latter method had been projected, but it was left to the option of the contractor. He has seen fit to locate it at the top, which has been to some extent a cause of delay. The advance drift is 8.2 feet square. About 600 feet behind it two segments, one on each side of the axis, were excavated, thus giving space to the whole width of the arch. In the rear of these side cuts another one is following on the east wall, about 12 to 15 feet below the floor of the header. The latter is 9.8 feet wide, and is worked in two sections, one above and the other below. In some places, where the nature of the rock requires it, the arches were built, as the side cuts were finished; but generally this is done after the sole cut on the left side has been completed. The arch is on one side supported by the ramp, and on the other temporarily by timber. After excavating the ramp the sustaining walls are erected, and the tunnel completed. The header is about 67 square feet, and is worked by

mode of working is the same as in the side cuts. Six drills are used, which are mounted on a car of very solid construction. For each car eighteen reserve drills are kept on hand, and 13 men are employed.

The sections which then remain to be excavated are the following: The arch section of 40.9 to 45.21 square feet; the abutment section of 58.13 square feet; and the ramp, of 207.74 square feet. The work here is done by hand, and the number of men employed is varying, as the nature of the work may require.

APPARATUS FOR LIFTING SUNKEN VESSELS.

We illustrate a proposed mode of raising sunken vessels, which has been designed and patented by Mr. Thomas Archer, Jr., of the Dunston Engine Works, Gateshead-on-Tyne, England. The mode of operating proposed by Mr. Archer consists in the attachment of a series of buoyant cylinders or pontoons, B, Figs 1 and 2, each of which is to be sunk by a weight attached to it, this weight being subsequently drawn to the surface again after the pontoon has been attached to the wreck by the diver. Fig. 6 shows the manner in which the weights are to be slung to the pontoons so as to tilt the latter into a convenient position for being dealt with by the divers. One of the chief features of Mr. Archer's plans is the means adopted for passing ropes under the vessel when the latter is embedded in a muddy or sandy bottom. This arrangement consists in the employment of what Mr. Archer terms "needles," or long sharp-pointed piles, such as are represented in Figs. 7 and 8. The needle has a recess on one side adapted for holding the bight of a steel coiled rope, as shown, and Mr. Archer proposes to drive one of these needles, with the wire rope in place, into the bottom ahead of the vessel, as indicated in Fig. 3. The "needle" has a wire rope attached to its head, and the driving is to be accomplished by weights slid down this rope. When the needle has been driven so as to carry the rope sufficiently far down into the bottom, it is to be withdrawn, and the rope pulled under the bottom of the vessel by tugboats hauling at either end, as shown in Figs. 3 and 5, these boats going ahead and astern alternately, so as to give the rope a sawing motion. In case of wear of the rope, Mr. Archer proposes that one tug shall pay out a first length and the other haul in, so as to bring a fresh portion of the rope on to the sand. One rope having been got under the bottom, others can

powder, which is simply pulverized charcoal, being sprinkled between each two sheets. The bottom and the cover of each packet of sheets thus piled for polishing are formed by two sheets of greater thickness. This packet is then hammered for the purpose of reducing the sheets still further in thickness, under a hammer, the head of which weighs from 1,000 to 1,100 kilogrammes (say, 2,200 to 2,400 lbs.). For giving polish and luster, the sheets, now almost cold, are brought under a second hammer with a large face, rounded at the edges and of the same weight. Finally they are allowed to cool completely, and are then clipped and classified into three classes, according to the perfection of their polish. The sheets of the first class ought to be like a mirror, without a spot upon their surface. The action of charcoal projected upon the red-hot surfaces, and inclosed between them without access of air, may be easily understood. It cements, and thus enables them to take a high polish, while rendering them at the same time less liable to rust. This cementation once having taken place, the sheet should not afterward be returned to the heating furnace. Whether the non-oxidizable quality is due to a carburation of the surface by cementation or by an oxidation which has been supposed to take place in the somewhat tedious process of manufacture, is not yet fully decided. The high quality of the iron used by the Russians has no doubt much to do with the merited popularity their final product enjoys. In the same category is the fact that, while we make most excellent wire from our own iron, we have not yet been able to produce an article quite equal to the Swedish rods for certain purposes. We have no doubt but that in time the American product, or "imitation Russia," which is now perfectly adapted to many uses, will eventually be made equal in all respects to the genuine Russian and exclude it from our markets; but this result will only be accomplished by greater care and skill in manufacture.

MANUFACTURE OF ARTIFICIAL STONE.

For this purpose a mixture of liquid chloride of magnesium of 20° to 30° Baumé and calcined magnesia is used as a vehicle for binding together the particles forming the artificial stone. Both articles are mixed while cold, so as to form a plastic mass. With this magnesia cement all neutral matter or colors may be mixed, so as to form a conglomerate of great cohesion, which, as the mass is plastic,

APPARATUS FOR LIFTING SUNKEN VESSELS. BY THOS. ARCHER, JR.

machines. The car carries six drills, and eighteen more are kept on hand. They are worked by compressed air. The number of holes bored per lineal meter (3.28 feet) has been 13 to 20, each hole being from 3.28 to 3.94 feet deep, and 1.5 inch in diameter. In granitic gneiss 23 holes per meter (equal to 8.11 cubic cards) were required, while only 14 holes were necessary in mica slate. Repairs for the same progress have been 1.33 drill in granitic gneiss, but only 0.16 drills in soft rock. For the same progress, from 38 to 292 drill required sharpening, the number varying according to the nature of the rock. The drills used were the McKean, the Winchester, and the celebrated Burleigh drill (American). Sixteen hands are employed on the car. After the boring is done the car is moved to the next switch or to a safe distance, say 90 to 130 feet, and then covered with boards to protect it against damage. The blasting is intrusted to two men. Each hole is charged with 7 to 12 cartridges, weighing 3.1 ounce each, except the prime, which weighs 1.3 ounce. For one cubic yard of granitic gneiss, 8.82 lbs. of giant powder, 29.7 feet of fuse, and 3.92 caps were used; while in mica slate only 4.6 lbs. of giant powder and 20.2 feet of fuse were required. The tamping has been very little, sometimes none at all. Blasting by electricity has been tried, but the usual way has been found preferable. The holes are not blasted at once. The holes above are blasted first, those in the center next, and the remaining afterwards.

The side cuts have an average surface of 77 square feet. They were formerly worked by hand, but now machines are used. The cars employed here are lighter, and carry but four drills, besides which twelve are kept in reserve for each car. The method of working is the same as in the header. In granitic gneiss 16 to 20 holes were bored per lineal meter: in mica slate 10 to 14 holes, each hole being 3.28 to 3.95 feet deep, and 1.6 inch in diameter. For excavating one cubic yard in mica slate, 4.23 lbs. of giant powder and 9.3 to 15.1 fuse were used; in granitic gneiss 5.07 to 5.59 lbs. of giant powder and 15.1 to 20.2 feet of fuse were required. On each side cut ten or twelve men are employed. The sole cut, as has already been stated, is worked in two sections. The upper section is about 54 square feet, and the lower one has a surface of 65 square feet. The

of course be made to follow. In Fig. 2, the lifting of the vessel when made almost buoyant by the attachment of the pontoons, B, is shown as being controlled by what Mr. Archer names regulators, these being roped over the lifting vessels, D D, and attached to weights which descend on the other side of these vessels as the wreck is raised, brakes being provided to control the descent of these weights. The weights, D, are intended to start the vessel from its bed and supplement lifting power of the pontoons, B.

RUSSIA SHEET IRON.

For a long time the method of manufacture of Russia sheet iron was held as a secret, and though this leaked out many years ago, so far as the general principles involved were concerned, yet there were details of manipulation which resisted the ingenuity of manufacturers, and which could not be reproduced by the use of machinery infinitely superior to the crude appliances by which the genuine Russia sheet is manufactured. Since many persons still think the method of manufacture a mystery, says the London *Iron Trade Exchange*, a description of it will be of interest to many of our readers.

Professor S. Jordan, of the Ecole Centrale, in Paris, who is also president of the Institution of Civil Engineers in France, and one of the leading authorities on iron and steel, gives, in his report on the iron industry at the Paris Exhibition in 1867, some details of the manufacture of Russia sheet iron, which, he says, were furnished to him by M. Koulibine, a Russian engineer. These polished sheets are manufactured from charcoal iron, produced in finery fires and brought into the form of blooms about one inch thick. These blooms are heated to cherry heat and rolled into leaves. Each of these leaves is cut into pieces corresponding to the weight of the sheets which are to be manufactured, and these pieces are piled upon one another and rolled together until the desired degree of thinness is attained. Thus the black sheets are manufactured. To transform these into polished sheets, a certain number at a time are heated to red heat and piled one upon another, a black impalpable

can be used for producing articles of most any shape and description. For making emery wheels, emery flour of any number may be used. The mass dries perfectly in three days. Grindstones may be made by incorporating sand, sandstone in small pieces, quartz, with the cement, bringing into proper shape, and exposing to the air for some time. For millstones the refuse and breakage of the natural ones may be used.

For the production of artificial marble, fragments of natural marble are well united by the cement. All desired combinations and all patterns may be easily obtained. When pure bleached and carded cotton is mixed with the magnesia cement, an elastic, very firm mass is obtained, which can be shaped at will while soft, but which hardens soon and forms a compact, pearly white mass, which can be turned on the lathe and carved like ivory. It is well adapted for making billiard balls. In the same way a variety of materials may be obtained by incorporating small pieces of glass, minerals, pieces of metal, organic substances, etc., with the cement.—*Deutsche Gewerbe Zeitung*.

COMPRESSED FUEL.

THE London correspondent of *Scunders* writes: Before long it would seem we shall have every necessary of life in a compressed form. We have compressed hay, meat, tea, coffee, and milk; and now we are invited to do away with coal and go in for compressed peat. It has already been tried on the Belfast and Northern Railway of Ireland, and the engineers of that line state that 21 pounds of peat raised steam for a mile of running, while it took 26 pounds of coal to do the same work. For domestic purposes, when prepared by the new process of compression, it claims the advantage of being almost smokeless, free of surplus, clean to handle, distributing pleasant smell, maintained heat, and can be supplied at half the price of coal. In the manufacture of gas, as compared with coal, its illuminating powers are tested, and put down as 342 to 100. A charcoal is also manufactured from the peat and is being largely adopted for agricultural purposes.