the tunnel is advancing towards the Comstock at the rate of ten feet per day, and in a few months will enter the formation in which lies the great lode. Some facts regarding it will, therefore, not be amiss.

Its mouth is in the valley of the Carson River, a stream which washes the eastern base of the Washoe Range, in which the Comstock lies. It has been driven a total distance of 17,000 feet up to date, and is progressing at the rate of 300 feet per month. Not more than 2,800 feet now intervenes between the breast and the nearest mine on the Comstock, the Savage, so that, if the present rate of progression were maintained, about ten months more will suffice to complete the connection. The lode will be cut at a depth of about 1,800 feet perpendicularly below the surface, and very nearly the center, measuring by the extent of the surface workings. It is then proposed, either by the Sutro Company or by a combination of owners along the vein, to run a drift north and south through each claim until the ends of the vein laterally are reached. This will connect every mine on the vein with the tunnel; will drain the entire workings; and, should these lateral drifts be put under one management and made a common highway, will afford the means of working the entire vein through one opening.

It is now about eight years since work was first begun at the town of Sutro, on the Carson River. The expense of prosecuting the work has averaged about \$1,000 per day, and when the Comstock is reached the total cost will have amounted to about \$3,000,000. The tunnel is double-tracked, as straight as an arrow in its course, with a rise just sufficient for drainage. Three air shafts have been sunk along its course.

At the mouth of the tunnel the Sutro Company have laid out a town, have secured magnificent water-powers, and expect to realize largely on that part of their investment by the removal of most of the mining and milling operations on the vein from Virginia City to the Carson.

The fear has been expressed of late that, when the soft and yielding formation in which the lode lies is reached, great difficulties will be found in keeping open the tunnel; that the strongest of timbering, and even masonry, will be unable to withstand the enormous pressure. The trouble Mr. Sutro confidently expects to overcome. Already several ore channels have been crossed in penetrating so far into Washoe Range, and, though some trouble was encountered, it was overcome completely.

There are now many rumors afloat pointing to the consolidation of interests between the Tunnel Company and some of the more prominent mines. The indomitable will and energy of Mr. Sutro have overcome, one by one, each and every obstacle placed in his way by those who opposed his enterprise; there is hardly a chance that, in the hour of his success, he will submit to anything short of a controlling interest in his work. When the vein is at last reached, and the immense benefits that it certainly will bring to all the mines shown, it is very doubtful if the belligerent owners who have all along threatened to control the rights of the tunnel will attempt to injure its usefulness or refuse to benefit by it.—*Engineering and Mining Journal*.

THE UCHATIUS GUN.

Of all the Powers, it is curiously enough steady-going Austria which has taken the boldest and most independent course in the matter of artillery. It was but at the end of 1875 that the Austrian War Office decided to adopt the Uchatius cannon for field artillery, and yet at this moment every artillery regiment of the vast Austro-Hungarian army is armed with the new weapon. Within eighteen months no less than 2,000 of these cannon have been cast and finished, and now the Vienna arsenal is engaged in the manufacture of heavy guns of the same character. Never was a more energetic step taken. A new cannon of some sort was held to be absolutely necessary to uphold the prestige of the army, and a commission having been intrusted with the selection of an arm, pronounced without delay in favor of the scheme brought forward by General von Uchatius. In October, 1874, the first round was fired from an Uchatius gun, and twelve months afterwards a sweeping reform, which was to introduce an entirely new artillery throughout the Austrian service, was decided upon. Government sanctioned an expenditure of £1,800,000, to be spent in two years, and General von Uchatius was directed to give all the assistance in his power toward the fulfillment of the design. The Uchatius gun is made of so-called steel-bronze. Chilled bronze would be a better name, since Uchatius casts his metal in a chilled, or metal mould, in the same manner, pretty well, as Sir William Palliser produces his famous chilled projectiles. Bronze, as everybody knows, has been a favorite metal with gun-founders from the earliest days, and in the East, especially magnificent castings of this nature have been produced. About 90 per cent. of copper and 10 of tin is the mixture commonly employed in making ordinary bronze, but 8 per cent. of tin is the proportion preferred by Uchatius. The difficulty in casting bronze, as those who have any experience know full well, is that of securing homogeneity, soft particles of tin becoming isolated in the mass, and giving rise to the defect known as "tin-pitting." Whether we have lost the secret of bronze-casting, or whether in former times they were more skillful at the work, certain it is that founders of the present day are unable to secure so uniform an alloy as formerly. This was very apparent when some eight or ten years ago our own Government adopted, for a brief time, bronze artillery. The addition of a small percentage of phosphorus did not mend matters, and the highest authorities on the subject were at a loss to suggest an effective remedy. Our bronze guns, too, had another defect which could not be overcome. After firing the bore became affected, and the weapon, as it was termed, "drooped at the muzzle." These were the two defects indeed that led mainly to the abandonment of the bronze gun in this country, and they are, too, the difficulties which General von Uchatius appears to have overcome. He has got rid of "tin-pitting," and his guns do not "droop at the muzzle." Uchatius found that by subjecting the alloy in a liquid form to considerable pressure, he was enabled to secure a perfectly homogeneous mass, a result which was also furnished, he discovered, when he had gone a step farther, if the molten metal was rapidly cooled. Steel bronze is apparently made much in the same way as the toughened glass, of which we have heard so much lately. After being cast in a mould, the alloy is thrust into a reservoir of oil, heated to a high temperature, so that the metal suddenly cools, but only down to a certain point. Then the casting is withdrawn and allowed to get cold more gradually. A regular and crystalline structure is in this way produced, which has none of the defects of ordinary bronze. It is a moot point whether phosphorus enters into the composition at all. Chemists tell us they can find no trace of it, but this is no absolute proof that a small percentage of the

element was not originally contained in the alloy, being burnt out after it had done its work of harmonizing the two metals. The inventor is rather reticent on the point, but in any case it is very certain that the produces a uniform and homogeneous alloy of a hard crystalline nature. One other expedient Uchatius has recourse to in making his cannon. When he has cast his gun and chilled it he proceeds to dilate the bore. Wedges of steel, shaped in the form of cones, are forced in the tube of the gun one after another, until the calibre of the weapon has been increased by something like 7 or 8 per cent. This expansion or dilation of the tube has not only the effect of hardening or steeling the core, but also of rendering the gun more elastic and capable of resisting more effectually the strain put upon it at the moment of firing. The gun, after this process, is in a state of elastic tension, and it is said that there is a pressure from without, inwards, equal to that which was exerted to dilate the gun in the first instance; and that this is actually the case can scarcely be doubted, since it is a fact that a section of the gun, before being quite severed, will tear itself loose with considerable violence, and will be found on separation to have partially returned to its former calibre. So far as practicable trials have been conducted with the weapon, the Austrian Government have every reason to be satisfied with the Uchatius gun, which compares favorably with the Krupp steel cannon in the matter of accuracy and durability; while as regards its cost, it is far cheaper than any other rifled ordnance. A steel field-piece costs upwards of £100, even when not protected with rings, while the iron steel weapon manufactured in this country costs about £70 sterling; the steel bronze cannon of General von Uchatius, on the other hand, are made for £35 apiece. In construction, the Austrian gun is so similar to that of Herr Krupp, of Essen, that the latter claimed compensation for an infringement of his patent when the manufacture of the Uchatius gun was first commenced. The Essen works, our readers may know, supply not only Germany with steel breech-loaders, but have provided the present belligerents with all their modern artillery. Russia has still many brass cannon on hand, and Turkey a goodly number of Armstrongs, but both Powers mainly depend upon their steel Krupps. These stood the German army in such good stead during the last war that their reputation is firmly established. They are of crucible steel, and the breech, instead of being upon a hinge, or in the form of a block, moves round a D-shaped socket, the escape of gas being further prevented by rings of phosphor-copper.—*Nature*.

IMPROVEMENT IN THE MANUFACTURE OF BARRELS.

By RALPH M. MUNROE, Edgewater, N. Y.

LET us suppose the two cylinders of wood, D and E, one within the other, to have been placed in position while the forming and compressing parts of the machine O and P were further apart, so that the ends of the barrel-cylinder would rest in a part of the compressing die which has a greater diameter than the end of the barrel. As the compressors approach each other, the sides are contracted and the barrel shape given to the cylinder. In order that the

head shall be in such a position that the contracting ends of the barrel shall meet and catch it, but yet shall be able to continue their movement into the compressors and close firmly upon it, I place in the compressing or forming part of this machine two head-carriers, A and A'. Upon these head-carriers are placed the heads C, attached thereto by glue, or some other way.

These head-carriers are not firmly fastened to the moving compressors, but are carried by shafts S and S', controlled by springs B and B'. This movable head-holder performs three functions. In the first place, it holds the head in such a position that it is grasped by the incoming barrel-sides. Then, after the head has been seized by the sides, the head-holder yields to the forward motion of the barrel or of the machines, and thus it forces the inner barrel to assume a central position with reference to the outer barrel. I limit my mechanical invention to the improvement in head-holders just described.

Now, let us suppose the machine to be operated and the compressors to approach; the sides of the barrel, as they are compressed in the die, move one over the other, in order to assume their compressed condition, as shown in Fig. 1. In order that they may accomplish this readily, and may easily take the required shape, I heat or steam them thoroughly, and place between them some oil or lubricating substance, or glue, which has the same effect—namely, to allow the pieces of wood to move freely over the other.

Now the position of the head C, held upon the holder A, and the sides of the barrel, is such that, as the sides or ends of the barrel approach one another, the inner barrel E will pass inside the countersunk outer head M, so that the two corners will catch or bear against one another, as shown at M. As the compressors approach one another the head can pass no further into the barrel, being held at the corners M and N. The action of the spring now begins, and the head being held firmly in position against the ends of the inner

keg, or the barrel E, the machine continues to compress the sides until they embrace and hold firmly in their dovetailed recess the heads of the barrel.

Hoops H H H, etc., are placed in recesses in the compressors, as shown in the drawings. When the compressors have completed their movement, the head-carriers A A' bring up against the sides R of the compressors at both ends. The result of this is, that the inner barrel is now moved one way or the other, so as to register and coincide with the outer barrel, being pressed in equally from both ends by the carriers A and A', which are of equal width. At the same time the heads, being firmly in, are embraced by the contraction of the barrel, so that they can neither be moved in nor out. One half, usually the upper half, of both compressors is made movable, as at x and y, so that on completion of the barrel this half, being thrown upward on its hinge, leaves the hoops behind. The barrel is then removed from the machine, having the hoops in position. In other words, the barrel is taken from this machine complete in all respects.

The amount of lubricating material used in forming these kegs is accurately determined by experiment, so as to be sufficient to fill all interstices and cracks in the barrel, and to allow the passage, one over the other, of the moving parts. It is evidently very important that the countersunk heads should be put in position and firmly fastened, by one movement of the compressor, by apparatus outside of the barrel itself.

In the manufacture of barrels which are to contain petroleum, I use a glue which is insoluble in it, and thus make a tight package.

ON THE PRIMING OF STEAM BOILERS.

By Mr. WILLIAM MAJOR, Engineer, Danish Royal Navy.*

SOME time since the author read a long article in an engineering publication on the boiler fatalities on board her Majesty's transport ship Serapis, on her voyage out to India with the Prince of Wales. The substance of that article was that the engineering profession was still ignorant of the real cause of what is technically called "priming." It is certainly humiliating for the profession to be obliged to admit that one hundred years after the introduction of the steam engine they are still unable to subdue an evil so generally experienced as the priming of steam boilers; yet such is the case, as proved by the Serapis. The first question to be solved is: What is the cause of priming in a steam boiler? and until this question is satisfactorily answered engineers will still go on devising mechanical contrivances for obviating it, and their efforts will end in as many signal failures as hitherto. If we ask a practical engineer what the cause of priming is, we generally have dirty water assigned as a reason, and a specific is given for its prevention; or, what is more usual, since the more general introduction of high-pressure steam boilers, some remarks not very complimentary to the constructor of the boilers of which he may have charge and the priming of which he is unable to master. If we ask the same question of a scientific man—a professor of chemistry for example—he will answer that priming is ebullition caused by the action of heat on the body of water contained in the boiler, but he is not quite certain as to whether this so-called ebullition is a chemical or a mechanical action. With this meagre information the profession has had to content itself, enduring at the same time all the evils attendant thereon.

In the case of the Serapis we have a ship engined with a power sufficient to propel her through the water with a speed of 13 knots an hour, but that engine power was so paralyzed through the priming of the boilers that her speed was reduced to 9 knots. The case of the Serapis is by no means exceptional, the same evil obtains in a greater or less degree on board every steamship afloat, and the introduction of high-pressure steam together with the surface condenser has very considerably increased the evil. Indeed, break-downs from large bodies of water passing with the steam from the boilers to the cylinders of the engine are daily occurrences, and more valuable steam engines are destroyed from this cause than from all other causes put together. The author need not enlarge further on the subject of priming and its consequences, but will observe that he feels assured of having discovered a better theory for the cause of priming in steam boilers than is yet generally known. He has also found a practical means of preventing the evil, and that too without putting shipowners to any expense, but on the contrary, since to stop priming is to save fuel. The author does not propose any costly or complicated machinery for the purpose of preventing priming, not even a wooden deck placed in the boiler, as it was stated was adopted in the Serapis' boilers. As before stated, the cause of priming is said to be ebullition in the body of water contained in the boiler caused by the heat acting on the water. The author is bold enough to alter the word "ebullition" into the more intelligible word "friction," and he ventures to assert that priming in steam boilers is—as nature's simple law ought long ago to have taught us—caused by friction on the outer surfaces of the steam globules as they pass up through the overlying body of water into the steam chest, the amount of such friction being always in due ratio to the velocity at which they pass through the body of water, and also depending upon the state of the water as regards its purity. In other words, the friction is least when the water is pure—distilled—while it is the greatest when the water is charged with all the organic and inorganic matter it can hold in solution. The author is only now, after four years' practical experience on a large scale, publicly making the above assertion, and with the full conviction of its correctness.

Having satisfied himself as to the feasibility of the friction theory, it occurred to him that we had mistaken the real effects or action of the old-fashioned system of injecting melted tallow into boilers for stopping their priming. The reason generally given why tallow or other fatty matter stops priming is because it spreads itself over the surface of the water and quiets it. The author, however, does not believe this is the case, since whenever there is a pressure of steam in a boiler, any fatty matter injected into it immediately diffuses itself throughout the whole contents of the boiler, both water and steam. That this is the case can be proved by simply drawing a glass of water from any part or height of a boiler charged with tallow or by condensing a portion of the steam. Both the taste and smell of tallow will be found in both cases. The author believes that fatty matter stops priming by lubricating the globules of steam as they pass through the overlying body of water, reducing the friction on their surfaces, and, as a natural consequence, causing them to carry less water with them into the steam chest. So long as we continue to supply a boiler with a sufficient quan-

* Read before Society of Engineers.