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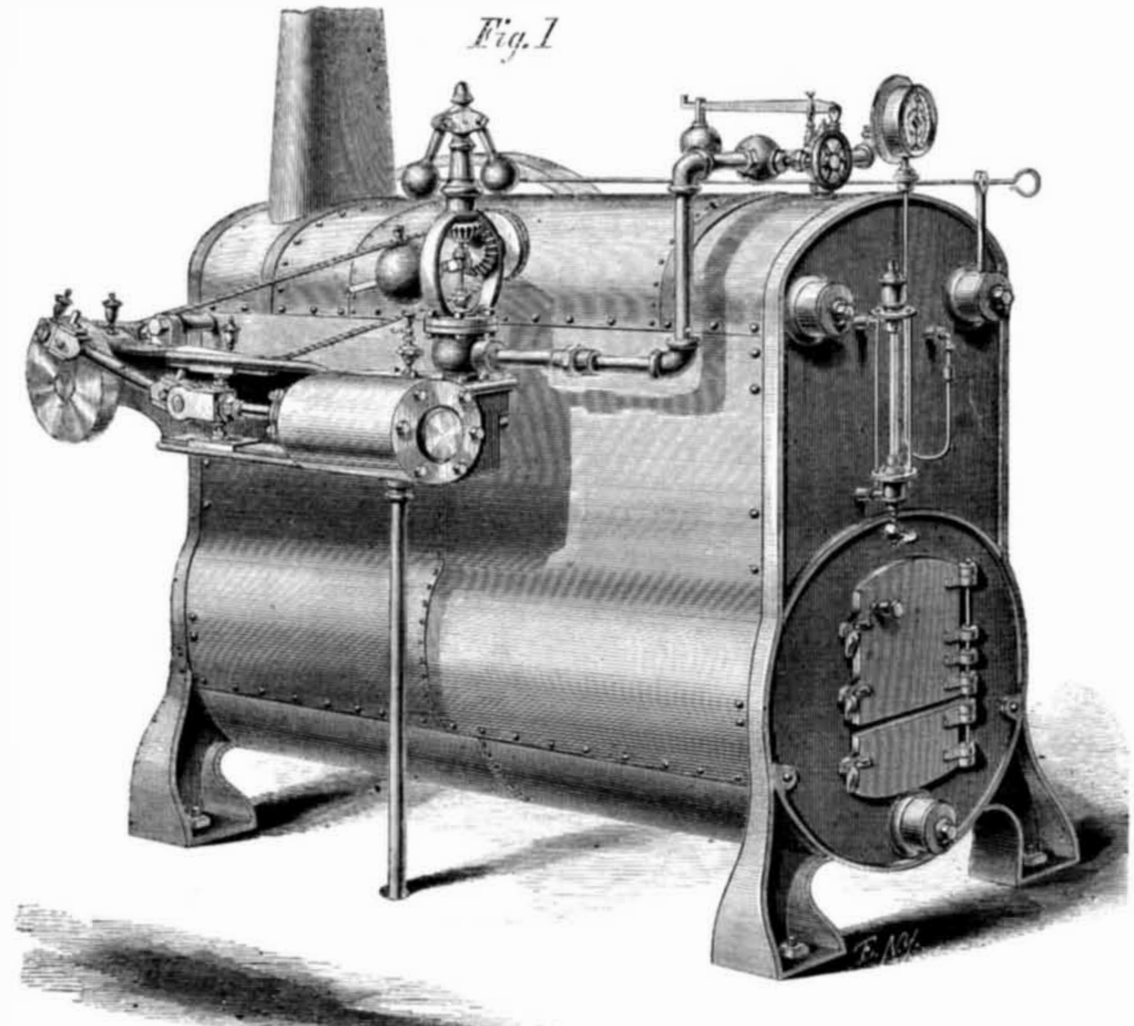
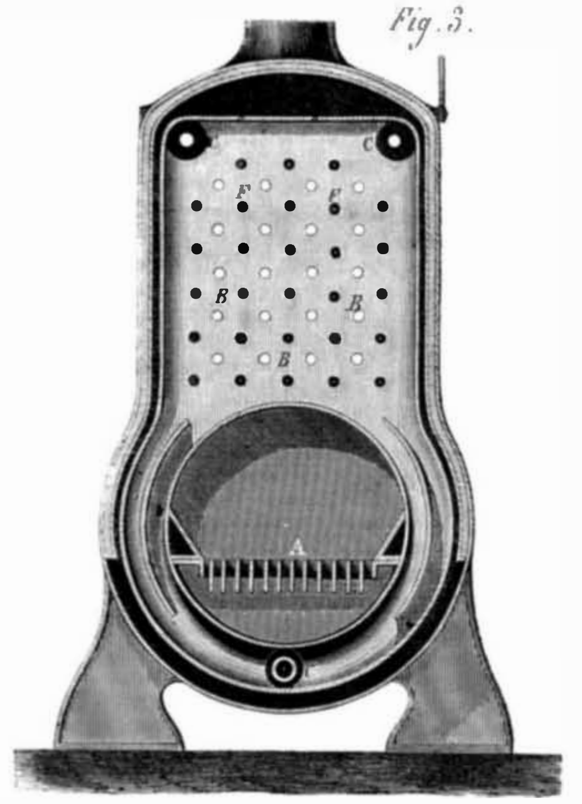
Improved Safety Generator and Portable Engine.

Fig. 1 of the accompanying engravings represent the Wilcox portable steam engine and safety steam generator combined. The engine is placed horizontally on the side of the generator. The cylinder, bed piece, slides, and main bearing are cast in one piece, and therefore cannot get out of line by displacement or the working strain upon the parts, and are not subject to unequal contraction and expansion either by the heat of the boiler or of the cylinder; indeed, the generator is so constructed, as will be presently described, that there is little heat given off from the exterior. The cylinder has a cast-iron polished jacket, the crank is balanced, the material is excellent, and the workmanship—as was evident to all who examined the engine exhibited at the late Fair of the American Institute—of the very best description. The connection of the governor with the inlet pipe is direct, and the pipe itself as short as possible, and of ample diameter; thus the steam is never cramped and the quantity admitted to the cylinder is under perfect control. The pump and fly wheel are placed on the side opposite the cylinder, the shaft crossing the back end of the generator. On the front are seen the steam gage, water gage, damper handle, etc. The whole arrangement is neat, compact, and serviceable.



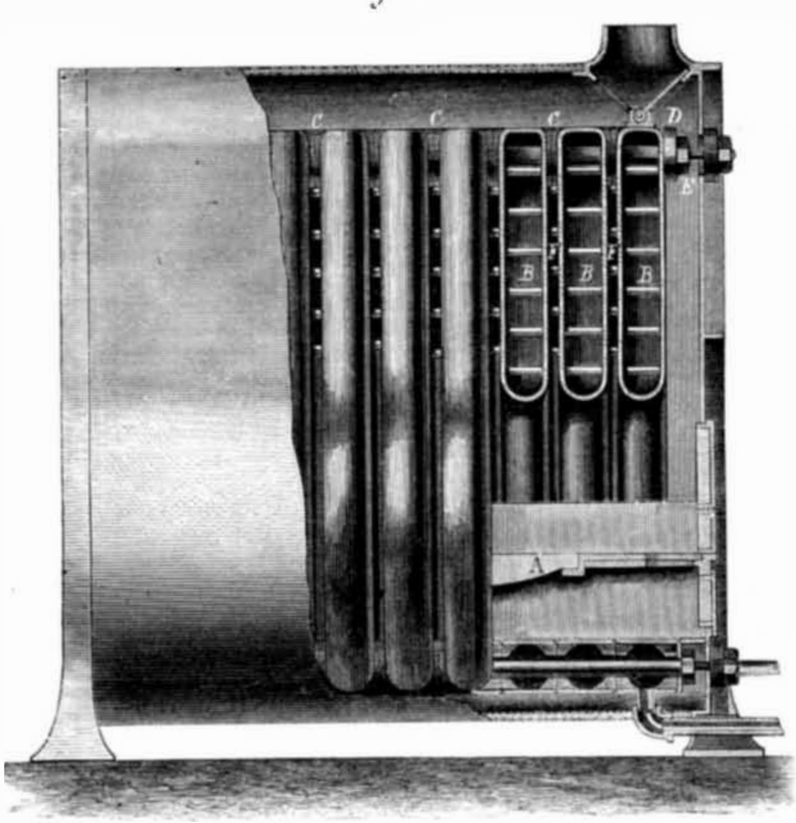
Figs. 2, 3, and 4 present different views of the generator, of which Fig. 1 is a perspective representation, which, however, is a small one, intended for a portable engine of from three to ten horse-power. Fig. 2 is a semi-sectional view of a portion of the generator. As will be seen, the generator is constructed in sections, one of them being shown very perfectly in Fig. 4. These sections are of cast iron, forming hollow chambers, which are fitted and bolted together to any required number. The lower portion is a ring which surrounds the grate, forming the furnace and ash pit, the grate being seen at A Figs. 2 and 3. The form of the fire box and ash pit is seen in the end section, Fig. 3. The upper portion of these sections is the steam chamber, or steam and water space. The flat sides of these chambers are stayed by numerous studs, cast in, which are represented at B, Fig, 2, and by the white circles in Fig. 3. There are three openings in each section surrounded by circular flanges, C, and by these openings each section communicates with those adjacent. These flanges are milled off to form the joints, each alternate one having a slight lip that fits in a corresponding recess in the next. The sections are then brought together and secured by means of a stout bolt passing through each of the apertures, C, upon which is placed a cap, D, and nut, E, Fig. 2. The sections are held by the milled flanges sufficiently far apart to allow the flame and gases to pass between their respective sides. The stays, B, are made with an excess of strength over the flat surfaces they support, so that when dangerous pressure occurs a small hole will be formed by the giving way of the metal between the stays before the stays themselves will part, and a disastrous explosion be thereby prevented.

There are curved partitions within the ring portion as shown in Fig. 4, for the purpose of aiding the circulation of the water. The column of water next the furnace is being constantly converted into mingled steam and water which being lighter than the solid columns of water on the opposite side of the partition, the difference in gravity induces rapid circulation, by which the steam is swept from the heating surface as fast as generated and fresh water is as constantly brought in contact with the heated sides of the surface, the steam being carried to the chamber above, where it separates from the water and rises into the steam space, while the solid water returns to the other side of the partition, carrying with it the sediment, which settles in the quiet space below the grate, and may be blown out through a cock on the back end of the generator.



The same bolts that hold the sections together extend through the cast-iron ends and support the whole structure. The sides, top, and bottom of the generator—in fact the whole space between the cast-iron ends—is covered with a sheet-metal jacket made double and filled with plaster of Paris or some other non conductor, which prevents loss of heat by radiation.

Boilers constructed in sections have within a few years attained a great popularity, and this is not strange when it is considered that when the large mass of water and steam finds vent through the shell of a boiler, its sudden liberation spreads destruction around. If a hole of a few inches in area is made, the steam and water escape only gradually and without doing serious harm. It is impossible, probably, to prevent the giving out of boilers through carelessness or ignorance; the remedy appears to be to so construct the boiler that when any part fails, only a portion can give out at a time. This object may be attained by building the boiler in sections, so that if one fails the others are left intact and their contents liberated gradually by escaping through the small openings communicating with the ruptured section. The sections, however, of this generator are of such great strength that they can be burst only by the grossest stupidity. They



THE WILCOX COMBINED STEAM GENERATOR AND ENGINE.

are tested to a pressure of from 400 to 500 pounds per square inch before being combined, even when the working pressure required is from 60 to 100 pounds only.

In small boilers there is not always sufficient steam and water capacity in proportion to the work demanded, and in case of a heavy load being thrown upon the engine or fresh fuel put upon the fire there will be fluctuations in the water level, the steam pressure inducing foaming and demanding constant care and the most skillful management.

This generator is so proportioned as to be free from the above objections, and is very economical in fuel and perfectly safe from danger of explosion. For further information apply to the Wilcox Caloric and Steam Engine Company, Providence, R. I.

SURFACE CONDENSATION FOR MARINE ENGINES.--THE LOSS BY "BLOWING OFF."

The subject of the surface *vs.* the jet condenser is a constant theme with engineers, and although we do not by any means desire to pronounce against the employment of surface condensers in sea-going steamers, we think the economy attainable from their use is to a considerable extent overrated. In order to appreciate this, let us in the first place look at the possible theoretical gain attainable by the use of a surface condenser (irrespective of the cost of the apparatus and the expense of its maintenance), and then examine the drawbacks attending its employment.

The water of the ocean contains on an average $\frac{1}{32}$ part of its weight of salt, and it is a common practice with sea-going engineers to carry the water in the boilers at about double this degree of saltness, that is, containing $\frac{2}{32}$ parts of its weight of salt. It is clear that if the feed water enters the boiler at a degree of saturation represented by $\frac{1}{32}$ part of its weight of salt, and the water in the boiler contains $\frac{2}{32}$ parts, and it is desired to keep it at the latter degree of saltness, one part of the feed water must be blown off into the sea, and that an equal part will remain to be evaporated. Now, from the fact that in order that the water shall not exceed this degree of saltness ($\frac{2}{32}$), as much feed water must be blown off as is evaporated into steam, many think that this loss is very much greater than it really is. Suppose the sum of the latent and sensible heat in the steam to be 1,210°, that the feed water enters the boiler at 110°, and is blown off at 230° (the temperature of the water in the boiler), the following simple calculation will show the loss by "blowing off"; 1,210° total heat in the steam—120° the temperature of the feed water=1,090° heat required from the furnaces for the water that is to be evaporated. Now the temperature of the water blown off from the boiler is 120°, and this deducted from 230°, the temperature of the water in the boiler, gives 110°, the loss of heat by "blowing off." As one part, requiring 1,090° is evaporated, and one part requiring 110° is blown into the sea, the total heat utilized from the fuel is 1,090°+110°=1,200°; and of this 110° is wasted. Hence 110°×100÷1,200°=9.16, the per cent of loss by "blowing off" to maintain the saturation at $\frac{2}{32}$. This method of calculation is of course applicable to any degree of density of the salt water in the boiler; it is only necessary to allow for the ratio the portion of water blown off bears to the portion evaporated. Supposing, for instance, that the degree of saturation of the water in the boiler was $\frac{3}{32}$ (a saturation sometimes maintained), instead of $\frac{2}{32}$, the calculation of loss would be as follows, bearing in mind that in this case *two* parts of the water pumped into the boiler are converted into steam, while but *one* part is blown overboard. Therefore 1,090°×2=2,180°, is the heat required from the furnaces for water that is converted into steam; and hence, 110° (temperature of the one part blown off) ×100÷2,180=5.04 per cent, the loss by "blowing off" to maintain the saturation at $\frac{3}{32}$. And the same method of calculation may be used to ascertain the economy of using a heater to raise the temperature of the feed water, by passing it around or through a series of tubes, on the other side of which the hot water blown off from the boiler circulates, before being discharged into the sea. But it should be pointed out that it will not give a true result to calculate the loss by "blowing off," first with the heater and then without it, and then to call the difference between these two amounts the gain; for the reason that this method does not bring the important element of the heat imparted to that portion of the water which is converted into steam into the calculation, the saving is the difference between the heat required from the fuel to boil off that portion of the water which makes the steam. Thus, if without a heater 1,250° is required, and with a heater but 1,150°, the gain will be 1150°×100÷1,250=8 per cent.

It need scarcely be stated that the object of blowing off a portion of the water from boilers using sea water, is to prevent the deposit of salt and other substances, which form scale on the heating surfaces. If a portion of the water was not blown off, the boiler would speedily become choked with salt, and the heating surfaces incrusted with a thick layer of hard, non-conducting scale; because only pure water is evaporated, and the solid substances in it remain in the boiler. It will be readily perceived that if the water is carried at such a degree of saltness as to cause the surfaces, which conduct the heat of the furnaces to the water, to become incrusted with a non-conducting substance (such as scale is), that not only will the evaporative efficiency of the boiler become less and less, as the deposition of scale increases, but the incrustation may become of such a thickness, on certain parts, as to almost prevent the heat of the fires from being transmitted to the water; as a consequence of this condition, those portions which are exposed to the highest temperature from the furnaces—particularly the crown sheets—are liable to be made red hot, and to be bulged in and ruptured, allowing the scalding water and steam to escape over the fires. This being the case, if the engineer stints the quantity of water blown off, although at first he will be able to carry more steam and burn less coal, it will not be long before he will find that "she does not steam as well as she did," and the coal pile is being reduced more rapidly; hence it is far better to submit to the constant, but not increasing loss of a liberal "blowing off," than by stinting it to make a little more steam at first, in a short time to be followed by such a degree of incrustation as not only to far more than neutralize the economy attainable at the start, but also to incur a great amount of labor in picking off the hard scale, when the vessel arrives in port, as well as to shorten the life of the boilers by the overheating, and the incessant chipping of the scaling hammers.

With this state of affairs staring them in the face, it is not surprising that marine engineers have for a great many years given great attention to the method of condensation which, theoretically, returns pure fresh water to the boilers, and thus saves not only the loss of "blowing off," but also prevents the deposition of scale, and consequently keeps the heating surfaces in contact with the water in the highest state of efficiency. This apparatus, the Surface Condenser, is contemporaneous with the early history of steam navigation. Condensing the exhaust steam from the engine by bringing it in contact with metallic surfaces, the other side of which is maintained at a low temperature by contact with water, and then pumping the fresh water made by this condensation of the steam from the engine back again into the boiler, is a method so obvious that it is not surprising that our forefathers, engaged in steam navigation, made use of it; the more so as they were bothered with scale from the outset, much more, in fact, than we are, because their boilers were but poorly contrived to give the easy access necessary for the use of scaling tools.

Bnt in the early history of surface condensation it was soon found out that the theoretical gain expected to attend its use was not attainable, either as regards stopping the waste of heat by blowing off, or wholly preventing the formation of scale on the heating surfaces.

It was soon established that if the surface condenser was practically perfect—that is, that there was no leakage between the salt and fresh water compartments, and salt water was pumped back into the boilers by the feed pump—that the boilers were speedily corroded or eaten away, and injured even more than by the effects of incrustation. Various hypotheses have been from time to time advanced in explanation of this phenomenon. Among others, that the corrosion was caused by galvanic action; the voltaic current, according to this theory, produced by the contact and circulation of the feed water about the brass of the condenser and the copper of the feed pipes. No sooner had this view of the case been generally talked about among engineers, than copper or brass feed pipes were suppressed, and cast iron substituted; besides, the tubes, and indeed every part of the condenser made of brass which came in contact with the feed water, were covered with tin. So if copper and brass had any thing to do with corrosion, it clearly would stop as soon as that cause was removed. But as far as our knowledge goes, and from conversation with many sea-going engineers of great experience, it does not seem that these changes have effected any good at all, except to save the expense of a little brass. The view, however, which seems to explain this corrosion more satisfactorily than any other is, that it is caused by a chemical action of the feed water on the clean surfaces of the boiler. And means to prevent corrosion founded on this explanation, appear to have been uniformly followed by very satisfactory results. It seems to be pretty conclusively established that if the surface condenser is tight, and the feed water boiled off, condensed, and pumped back again into the boiler for a considerable time, without being changed by blowing off or mixing it with sea water, that the feed water acquires an acid and corrosive property which attacks the seams, and also selects places in the middle of sheets to eat into, until the iron often looks as though it had had the small pox.

This corrosive property of the feed water, so it is stated, is acquired from the decomposition of the lubricants used in cylinders and steam chests, more particularly the tallow, doubtless increased from the sulphuric acid almost always used in its rectification. The means to prevent corrosion, if it is produced by this cause, at once suggest themselves; they are twofold; first, a thin layer of scale must be permitted to form on the interior surfaces of the boilers, and the water in them must be frequently changed, by blowing off and pumping salt water into them. The layer of scale of course prevents the water from coming in contact with the iron, and changing the water cleans it of the corrosive properties it may have acquired by continually passing through the engine. This method is now the usual practice with sea-going steamers fitted with surface condensers, and we believe the difficulties which not long since bid fair to put a damper on its use have been wholly removed. Again, the tallow and oil used in the cylinders is carried over into the condenser by the steam, and sometimes to such an extent as to choke the tubes, and frequently to form hard balls, or pellets, which collect in the condenser and sometimes interfere with the action of the valves of the air and feed pumps.

And this fact leads us to a consideration of the construction of surface condensers. The condensing surfaces almost always consist of a great number of small tubes, by some engineers made $\frac{5}{8}$ of an inch outside diameter, and seldom if ever over 1 inch; now the great end to be attained in the construction of this species of condenser, is to secure these tubes in the tube heads, so that the joints will be tight, and at the same time to allow the tubes to slip back and forth through the joint as their lengths are altered by the varying temperatures within the condenser; further, these joints must be made so that the tubes may be easily and quickly withdrawn, either to clean them from the impurities already alluded to carried over by the steam, or to replace a defective one. Simple as these conditions may appear at first sight, the fact that there is scarcely a point about the marine steam engine which has received so much attention from engineers as this one, and has been the subject of so many patents, shows that it has not by any means been an easy problem to solve. The expense of some of these plans is so great as to almost preclude their use in ships designed for commercial purposes. For instance, in the patent adopted by Mr. Isherwood for the navy, each joint is made in the thick brass tube heads as follows:—first, a hole, a loose fit for the tube, is bored through the head, then this hole is counterbored about half way through, thus forming part of a stuffing box; into this larger hole a rubber ring is inserted, surrounding the ends of the tubes, which projects a short distance beyond the head; a polished brass ferrule, or ring, is then inserted around the tube, and rests on the rubber ring, on which it is pressed by a composition follower, which is large enough to perform the same duty for a great number of tubes. This follower is bored similar to the tube head, that is, first with holes the size of of the tube, and then counterbored to suit the ferrule, which forms the gland of the stuffing box. As many of these condensers have six or seven thousand tubes, and thus require 12,000 or 14,000 such complicated joints as we have just described, the enormous expense of constructing such an apparatus will be easily perceived.

With this plan not only is it almost impossible to discover a leaky or defective tube, but after it is found out, a heavy follower, which makes the joint of several hundred tubes, has to be removed. Again, as this follower presses on the glands of so many stuffing boxes, it is quite impossible to put the exact pressure on each of these stuffing boxes which the packing in them requires to make a perfect joint; the consequence is that a considerable number of the tubes are either so tightly packed that they cannot contract or expand without bending, or they are so loosely packed that the joints leak from the salt to the fresh water side of the condenser.

For these and other reasons it is pretty certain that this surface condenser is not only the most expensive, but at the same time the most inefficient introduced, and yet hundreds of thousands of dollars have been wasted in their construction in the U. S. Navy during the last five or six years.

Now that we have directed attention to the worst closed surface condenser we know of, we will take great pleasure in pointing out the most efficient, and at the same time the most inexpensive one yet introduced. The tubes are the same as in the former one, but they are secured into the heads in a very different manner. The heads are of cast iron, and the holes for the tubes are bored of a uniform diameter straight through them, about twice the area of the tubes. In the annular space between the tubes and these holes, a soft pine cylinder (in length about twice the thickness of the tube head) is driven. This simple device forms a positively perfect joint, because not only is it tight, but it allows in the most complete way for contraction and expansion, and so easy is this joint made, that the tube of a surface condenser of large size can be removed and replaced in one day by the firemen and coal passers of a steamer. This condenser is an American invention, and so complete is it regarded that it has been adopted extensively by the most conservative marine engineers in Great Britain. It is well known as the Horatio Allen patent.

To retrace our steps a little, we will direct attention to the fact that in the first part of this article we pointed out the losses caused by "blowing off," to prevent the deposition of salt and scale; surface condensation is intended to prevent those losses. From our remarks on this point it seems pretty plain that the possible theoretical saving attainable by the use of this type of condenser, is not over 12 per cent at the outside; and when the fact is borne in mind that this theoretical saving cannot, for reasons already shown, be obtained in practice, it is obvious that the actual saving is considerably less than that which is theoretically calculated. Experience and observation sustain the conclusion that the saving in practice is not over 8 per cent., and when against this saving is placed the great excess in original cost of this condenser over the ordinary jet, and its greater complication, it must be admitted that the field for the surface condenser is much more limited than would appear at first sight.

From what has been stated, it is obvious that for ocean routes of moderate length, when the accounts are squared at the end of a year, no real economy will be found to have resulted from surface condensation. For instance, to employ it on a Long Island Sound route, although the steamers scarcely ever leave water as salt as the ocean, is, to say the least, very short-sighted and extravagant engineering.

SOME USEFUL HINTS.

Doctor Hall in his most excellent monthly for December states his views and experience on many utilitarian subjects in his unique way which we transfer to these columns.

By the way, a new volume of the *Journal of Health* commences on the 1st of January and we would recommend it as a most useful and entertaining family magazine. Price $1.50 a year, published monthly. Address W. W. Hall, M. D. No. 2 West 43d street, New York.

DRIVING NAILS.—Within a year we have seen it stated, as a new truth, that if a nail were wetted in the mouth and if, in addition, the narrow edge was placed with the grain of the wood, it would seldom split the board into which it was driven. We well remember to have seen our father do this as far back as in eighteen hundred and eighteen. But errors and truth are alike exhumed from the grave of the past in mechanics