

for them, whether in the midst of cities or in suburbs. Let the ground grow more sacred as the spot where were placed not one but many generations of those connected with us by the ties of filial love, and more beautiful by accumulated treasures of art erected as memorials of the unnumbered dead who have temporarily reposed there. We believe that some method similar to that which has been advocated above, and which is, to the best of our knowledge, brought forward for the first time in this place, is not open to the objections which are justly urged against our present methods of inhumation: that it is in accordance with the latest teachings of Science in this direction, and that it will serve to increase and not diminish the tender love and reverence for the dead, which has steadily grown with all that is most excellent and beautiful in poetry and religion.

#### THE EFFECTIVE POWER OF TURBINE WATER WHEELS.

The failure of turbine water wheels to supply the amount of power expected is not less common than that of steam engines, and the causes are more numerous. Before purchasing turbines, it is necessary to ascertain the head of water available, and that there is an abundant supply; after which large allowance should be made for the friction of shafting, as well as for the power necessary to drive the special machinery, and the whole determined in horse power. The selection of a wheel then becomes necessary. There are legions of makers, each of which is ready to warrant his to be the best wheel made. All of them publish artistic tables of sizes and powers, always guaranteed reliable. The uninitiated purchaser usually procures many of these tables, having voluminous descriptions and letters of commendation attached; and on examining them, he is surprised at the elaborate displays of figures, and often loses himself in contemplating the accuracy of the decimals. When comparing the tables of the various makers, he wonders why there is such uniformity of high powers in wheels so different. In studying the details, he finds that Smith's Excelsior Concave Fluted Turbine of forty-eight inches diameter will give him 84.71 horse power; while Jones' Scroll Flanged Buggy Wheel of the same diameter is fully warranted to yield 85.97, that being a gain in favor of Jones of 1.26 horse power, besides the further advantage of running with or against the sun, as desired. In continuing his comparisons to other wheels, it is needless to say that he becomes bewildered among so many wheels so far excelling each other, and finds himself unable to decide which wheel is the best. He is forced to seek the advice of some competent engineer, and, to his utter astonishment, learns that the figures of the tables so nicely prepared are in almost all cases totally unreliable, there being scarcely a maker's wheel that, in a test flume, under the most favorable circumstances, ever for a single hour indicated the power claimed, and almost none that in actual use approach the figures, many of them scarcely yielding half what is claimed. Under these circumstances, it becomes important, in selecting a good wheel, to be assured that it will furnish ample power. After ascertaining a reliable maker, in order to determine the exact size of the wheel it is necessary that at least one third should be allowed for variations in water levels, and for the loss consequent to the wear of wheels and gates; and, in addition, figures should be made, based on but a little more than a half gate of water to the wheel. The best wheels afford almost all of their power at a five eighths gate or under, and a difference between a half and full gate is not more than should be the margin necessary to regulate speed. In use it will be found that opening gates seven eighths or fully simply amounts to a large consumption of water, generally without producing five or ten per cent additional power. Some good wheels give less power when at full than at part gates. The rule should be to buy a wheel amply sufficient at about half gate, due allowance being also made for over estimate of power. We think the experience of all who have placed wheels with a less liberal allowance will bear out and confirm this rule. Allowing one fourth for the friction of the shafting of a cotton or woolen mill, without adding one third more for a reserve when in actual use, will scarcely fail to cause a manufacturer to wish that he had bought a larger wheel. Actual tests, accurately conducted, of thirty-one styles of turbines show the comparative range of effective force, under the best possible advantages, to be as follows: At quarter gate, from 13 to 50 per cent; half gate, from 11 to 71 per cent; three quarter gate, from 31 to 83 per cent, and at full gate, from 52 to 84 per cent, the best wheels giving out about all of their power at from five eighths to three quarters openings; while the lower classes give but little power unless flooded with water, and even then fall far short of the amount claimed for them. Another reason why large wheels should be used is that, almost universally, high and low points of the head and tail waters so reduce the force of wheels as to cause partial stoppages of machinery, unless there is surplus power when the water is at the ordinary stage. We are acquainted with a mill using ten independent turbines of various styles. Experience has here shown practically that the relative power of the wheels, to that necessary to drive the machinery under constantly occurring unavoidable disadvantages, has not been unduly stated, and that not meager allowances should be made as reductions from makers' over-estimates of the powers of their wheels, as well as farther liberal allowances for the friction of the shafting, loss of power in times of high and low water, and the margin necessary for the action of the governors. It has also been found true here that substituting large wheels, operating at from one fourth to one half gate, for small wheels, requiring seven eighth gates, results in the use of much less water for a given effect. Were wheels accurately tested in places of use, and actual power ascertained, such large fractions of allowances would not be

necessary; and a less rate of proportion between that wanted and that claimed by makers is accordingly found satisfactory with wheels where such claims are based upon tests. It will always be found to be by far the most economical, with both steam and water, to provide abundance of motive power.

#### ARMY ANTS.

It is a suggestive circumstance that, among the many varieties of animal forms, those which approach man most nearly in social and mental development are not his nearest allies, but creatures of an entirely different order, and those which stand at the head of their class, the articulates, as man does at the head of the vertebrates.

The closeness of formic mimicry of human civilizations is all the more surprising when we take into account the vast difference between the physical conditions of the two types of life. With nothing apparently in common, not even similarity of structure, men and ants have fallen into lines of development so nearly parallel in many instances as to suggest the existence of something far more imperative in the tendencies of life, and at the same time a much greater limitation in the possibilities of development, than are commonly suspected. Especially to those who regard mind as an unmixed product of material conditions, and would measure mental power by weight of brain, nothing can be more perplexing than to see the almost microscopic cerebral ganglia of the ant evolving products so like those of the immensely more bulky brain of man that their practical identity is unquestionable.

But our purpose is not to study the mystery of formic intelligence in general, but the peculiar manifestations of it by certain species whose modes of life have been recently investigated.

As a general thing, ants are found in settled communities, which change their habitations rarely, and then for causes not under their control. A remarkable exception to this rule is found in the *ecitons*, or army ants of Central America. These, while existing in thoroughly organized communities, numbering myriads if not millions, never make permanent settlements, but are constantly roaming about the forests in vast multitudes, scouring the insect world as the migrating armies of Attila scourged the less warlike nations of Europe.

The traveler's attention is usually called to one of these predatory swarms by the twittering of birds which follow their course to feast on the flying insects which they scare up. Approaching, he will discover a dense body of ants, in a column three or four yards wide and of enormous length, moving rapidly and examining every nook and corner where their game may hide. The captured insects are speedily torn to pieces and carried to the rear, or to their temporary camp, by relays of workers. On the flanks and in advance of the main army, smaller columns of skirmishers are thrown out to flush the insects they are in pursuit of, many of which, in their terror, bound right into the midst of the main column, to be torn to pieces instantly. The greatest catches occur in masses of brushwood. Here the cockroaches, grasshoppers, spiders and other insects take refuge among the branches, while the ants are occupying the ground below. But their security is brief. In a little while explorers are sent up, following every branch and driving the refugees to the ends of the twigs, to fly into the air and be snapped up by the birds, or drop among the throng of ants below. In this dilemma the spiders alone have any means of escape; they can suspend themselves in mid-air and remain in safety until their enemies have retired from the bushes and passed on to other conquests.

The individuals of this species of ants (*eciton predator*) are of various sizes, the largest being about a quarter of an inch long, the smallest less than an eighth of an inch. A much larger variety (*eciton hamata*) pursue their prey in a similar manner, but vary their tactics somewhat as occasion demands. When on a general hunt, they spread their columns over a considerable breadth and sweep everything before them, crickets, grasshoppers, scorpions, centipedes, woodlice, cockroaches, and spiders falling almost certain prey. Exploring parties are also sent up trees to look for nests of bees, wasps, and probably birds. The moment a prize is found the fact is reported to the army below, and a column is sent up to take possession. Mr. Belt, to whom we are indebted for these observations, and whose "Naturalist in Nicaragua" gives more numerous and valuable additions to the science of natural history than any book of travel since Wallace published the "Malay Archipelago," describes these ants as pulling out the larvæ and pupæ from the cells of a large wasp's nest, while the owners were hovering about, powerless, from the multitude of their invaders, to render any protection to their young.

When hunting in solid columns, these *ecitons* were found to be generally, if not always, in search of the young of another species of ants (*hypoclinea*) which make their nests in fallen timber. When a log is found, the column spreads out over it, searching all the holes and cracks, the smallest individuals pursuing the unfortunate *hypoclineas* to the furthest ramifications of their nests. The invaded ants rush out bearing their young in their jaws, and are despoiled of them so quickly that it is quite impossible to see how it is done. The *ecitons* do not harm the mature *hypoclineas*, caring only for the larvæ and pupæ, which are hastily borne to the rear of their column. What they do with their plunder finally does not appear. It would seem that they cannot rear the young *hypoclineas* for slaves, as certain northern ants do with their prey, since no mention is made of any such addition to the membership of their communities.

When marching, these *eciton armies* appear to be directed

by numbers of individuals, of a larger size and a lighter color than the regular workers, scattered at intervals of two or three yards. They stop often, and occasionally run back a little and touch some of the other ants with their antennæ, as though giving orders. At the headquarters there are individuals of still greater size and more ferocious aspect, which soon make any one molesting the nest acquainted with the efficiency of their enormous jaws. The temporary resting places of these ants are usually in hollow trees or underneath large fallen trunks that offer suitable hollows. One which Mr. Belt found in a hollow log, open at the side, must have contained a cubic yard of ants clustered in a dense mass, like a swarm of bees. And these were but a part of the whole community, as many columns were outside, some bringing in the pupæ of other ants, others the legs and dissected bodies of insects captured on their foray. These incomers proceeded directly into the interior of the living mass through tubular passages, which were kept open just as though it were formed of inorganic materials. Like the hunting races of mankind, these predatory swarms are compelled to make frequent removals to new hunting grounds. The migratory columns are easily known by all the common workers moving in one direction, the larvæ and pupæ of the community being carefully carried in their jaws.

Many observations and experiments were made by Mr. Belt, testing the individual intelligence of these wonderful creatures. Though inferior in some respects to ants which hunt singly, he does not hesitate to place them at the head of their order for intellectual and social development.

#### SCIENTIFIC AND PRACTICAL INFORMATION.

##### STEAM LIFE BOATS.

Mr. H. G. A. Mitzlaff, in a paper read before the Institute of Naval Architects, proposes the use of steam in life boats, and suggests the hydraulic propeller or rotary pump as best adapted for propulsion. He proposes the following dimensions for such boats: Length 45 feet, breadth 11 feet, draft 3 feet. The boat is provided with airtight chambers to prevent sinking.

##### THE HEAT OF THE SUN.

Father Secchi, the distinguished Italian astronomer, has recently published the result of his investigations in the solar temperature, made during last summer, and states that his efforts were directed toward the determination of the relation of the solar radiation with that of the electric light. The instrument used was a thermo-heliometer of the investigator's own invention, and the conclusion reached was that the radiation of the sun would be  $36\frac{1}{2}$  times that of the carbon points. If, therefore, the temperature at the surface of the latter is fixed at  $5,432^{\circ}$  Fah., a number not exaggerated, and supposing the radiation proportional to the temperature, we obtain for the potential temperature of the sun  $240,836^{\circ}$  Fah.

##### ELECTRICAL FIGURES UPON CONDUCTORS.

M. Schneebeli has investigated the conditions on which depend the dimensions of Kundt's electrical figures, which result from the adherence of a fine insulating powder on a metallic conductor, from which a discharge is emitted. In the experiments, the discharge of a Leyden jar took place between a horizontal metallic plate sprinkled with lycopodium and an electrode in the form of a ball or cone above the plate. It was found that, the circumstances being equal, the diameter of the figure augmented with the distance from the electrode to the plate, but never in a constant ratio. The size of the figure augments also with the quantity of electricity which produces it. When the electrode is composed of a certain number of points, a regular circular figure is formed beneath each one. If in the path of the discharge a small plate of glass be introduced, a space clear of powder appears on the metal plate of exactly the form of the glass plate interposed. With electrodes of conical form, presenting an angle of  $60^{\circ}$  or  $30^{\circ}$ , it is stated that the electrical figure is larger as the angle at the summit of the cone is smaller. Finally, the diameter of the electrical figure is larger when the discharge takes place in a rarefied gas than at normal atmospheric pressure.

##### JAPANESE BRONZE.

A curious bronze is produced in Japan, which, when made in thin plates, resembles slate, and is covered with designs in silver. M. Morin has lately analyzed and examined the properties of the alloy, and finds that it contains, in addition to copper, from 4 to 5 per cent of tin, and on an average 10 per cent of lead. The combination is easily molded into thin plates. These are varnished, and through the covering the designs are scratched with a burin. The plate is then plunged in a silver bath, when the silver is deposited on the unprotected portions. Lastly, it is placed in a muffle furnace, when the copper blackens and the silver remains bright.

##### CURIOUS PHENOMENON OF ENDOSMOSIS.

If the membrane which lines the interior of an egg shell be used to close the tube of an endosmometer, the latter being filled with sugar and water, and its containing vase with pure water, an odd circumstance will be noted. If the external surface of the membrane is toward the pure water, endosmosis is very rapid, and the water rises at the rate of some 4 inches per hour. But if, on the contrary, the interior surface is turned to the water, the phenomenon is almost annihilated. Matteucci, it appears, has noticed a somewhat similar peculiarity in the skin of a frog. It would seem that the phenomenon is worthy of study, since it shows that a liquid does not traverse the interior of a cellule with the same facility outwards in as in the contrary direction.

**THE VERTICAL MULTIPLIER BORING MACHINE.**

We have already laid before our readers three applications of that ingenious combination of gearing, the vertical multiplier, to woodworking machinery. By its use the band saw, the jig saw, and the circular saw have been adapted to run by the foot power of the operator, thus enabling the mechanic whose shop is not of sufficient extent to require the work of a steam engine to supply its place, on the machines most employed, by a device which affords a means of applying his available force at perhaps the best advantage.

We now present, in the annexed engraving, a representation of still another adaptation of the invention, recently made to the boring machine. The nature of the peculiar mechanism through which the power is communicated has already been fully described and explained in other connections, so that no further allusion to its construction is necessary. By its aid, however, in the present machine, forty revolutions of the shaft, actuated by the treadle, correspond to 1,640 revolutions of the bit, a four inch pulley being connected with the latter, making a proportion of one to forty-one. The general arrangement of the boring mechanism will be readily understood from the engraving. A table is provided which, by a slotted support through which passes a set screw, may be adjusted at a height suitable to the dimensions of the work to be operated upon. It has a longitudinal slot on its surface, in which travels a guide piece, against which the wood to be bored is held by the hand of the operator, as it is advanced toward the tool. This guide piece, by means of a slotted semicircular bar and set screw, may be placed at any desired angle so as to allow for the boring of inclined holes.

We recently had occasion to examine this machine, and found that the tool penetrated through knots or woods in any direction, with much facility and with the exercise of a quite small amount of effort on the part of the operator. It is evident that any sized bit, which can be adjusted to the shaft, may be used. This device will doubtless prove a useful addition to the shops of wood workers generally.

For further information, address the Combined Power Company, 23 Dey street, New York city.

**IMPROVED FUEL ECONOMIZER.**

Among many novel devices displayed at the recent exhibition of fuel-economizing appliances, held at Manchester, England, is a steam generator composed of three coils of cast iron piping, of four inches internal diameter. These coils are not cast whole, as stated in the inventor's descriptive circular, but are formed of a number of half circles, bored and turned to spigot and faucet joints. The ends of these half circles are reduced to three inches in diameter, and have ribs cast on the exterior surface. After the segments have been placed together an iron hoop or thimble is cast on over the joints, and, by the contraction of the metal in cooling, draws the ends of the pipe close together. The exterior of the thimble is of the same diameter as the pipes, and thus a perfectly smooth joint is obtained for scrapers to travel over; the pipes are held securely together, while all cement or rust joints are dispensed with.

Should a coil become fractured it can be repaired by splitting two hoops and removing the damaged segment.

The form of scraper will be readily understood by referring to the engraving. One half rests upon the pipe, embracing the upper portion of it, while the lower scraper is kept up to the pipe by means of a balance weight; these scrapers are pushed forward by arms or propellers fastened to a center shaft, driven by a worm and wheel at the top of the machine, and supported by a foot-step in the center of each coil; the scrapers follow the line of pipes until they reach the bottom, when, by the action of the reversing motion, they again ascend the coil to the top. These scrapers will, undoubtedly, clean the coils from soot, provided the pipes are cast truly cylindrical and the scrapers made to fit them exactly; but in the apparatus exhibited at Manchester this was not the case—the pipes being very rough castings and far from cylindrical, consequently many portions of the pipes were untouched by the scrapers, the points of which were frequently more than an inch apart. The inventor

states that this machine was not made in his own foundry, but that in all economizers now supplied by him he will guarantee the accuracy of the form of the coils.

Many advantages are claimed for this economizer over those with vertical pipes. The first is that the whole piping presents a surface for the heat to beat against, the back part of the coil being exactly opposite the front space. We can see no difficulty, says the *Engineer*, to which we are indebted for the engraving, in arranging vertical pipes, so that those in the second row should be placed exactly opposite the spaces between the pipes in the first row, and so on alternately. Another advantage claimed is the rapid and continuous circula-

tor to give as good results as an economizer comprising seventy vertical pipes.

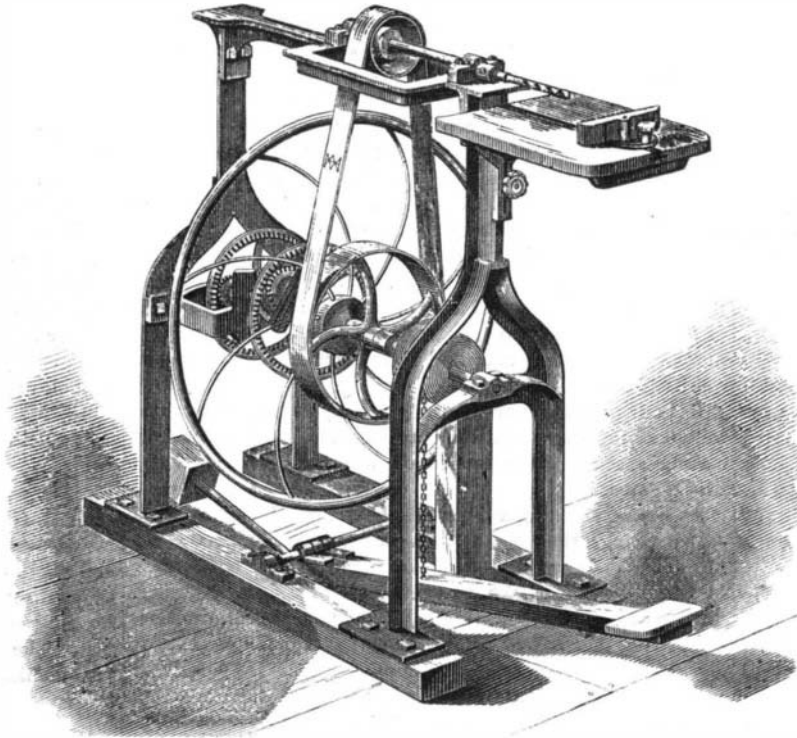
**American and European Locomotives.**

American engines have, as it were, gradually crystallized into certain definite and fixed forms. Outside cylinders and inside frames are now universally used here, whereas, on the continent, cylinders and frames are sometimes placed inside of the wheels and sometimes outside. The steam chests here are always placed on the outside and top of the cylinders; thus there are often placed on the side and inside the frames. Almost the only kind of pistons which seems to be used there is that made with solid heads, with simple grooves turned on the outside, into which steel, cast iron, or brass rings are sprung. Here the varieties of packing in use are numberless. For simplicity and cheapness the European is certainly very much superior to ours. Here the only valve gear now made is the shifting link motion worked from eccentrics on the main axle: there the shifting link, the suspended link, the Allen or straight link, the Walschaert, and several other kinds of valve gear are used. Some of them are worked from eccentrics placed outside of the wheels; and in at least one engine we notice that the axle bearings are outside of the wheels, and then the eccentrics are placed next the bearings, and a crank outside, to which the connecting rods are attached. All wheel centers are made of cast iron; there, of wrought iron. In the tyres of our truck wheels we are imitating Europeans, and steel tyres are now much used here for that purpose. The springs in American engines are, if we except the Boston and Albany railroad, always placed above the axles and frames. In Europe they are often below. Here they are, excepting in four-wheeled engines, always arranged with equalizing levers; there this is not always the case. The use of plate frames is universal in Europe, whereas in this country they are now never used.

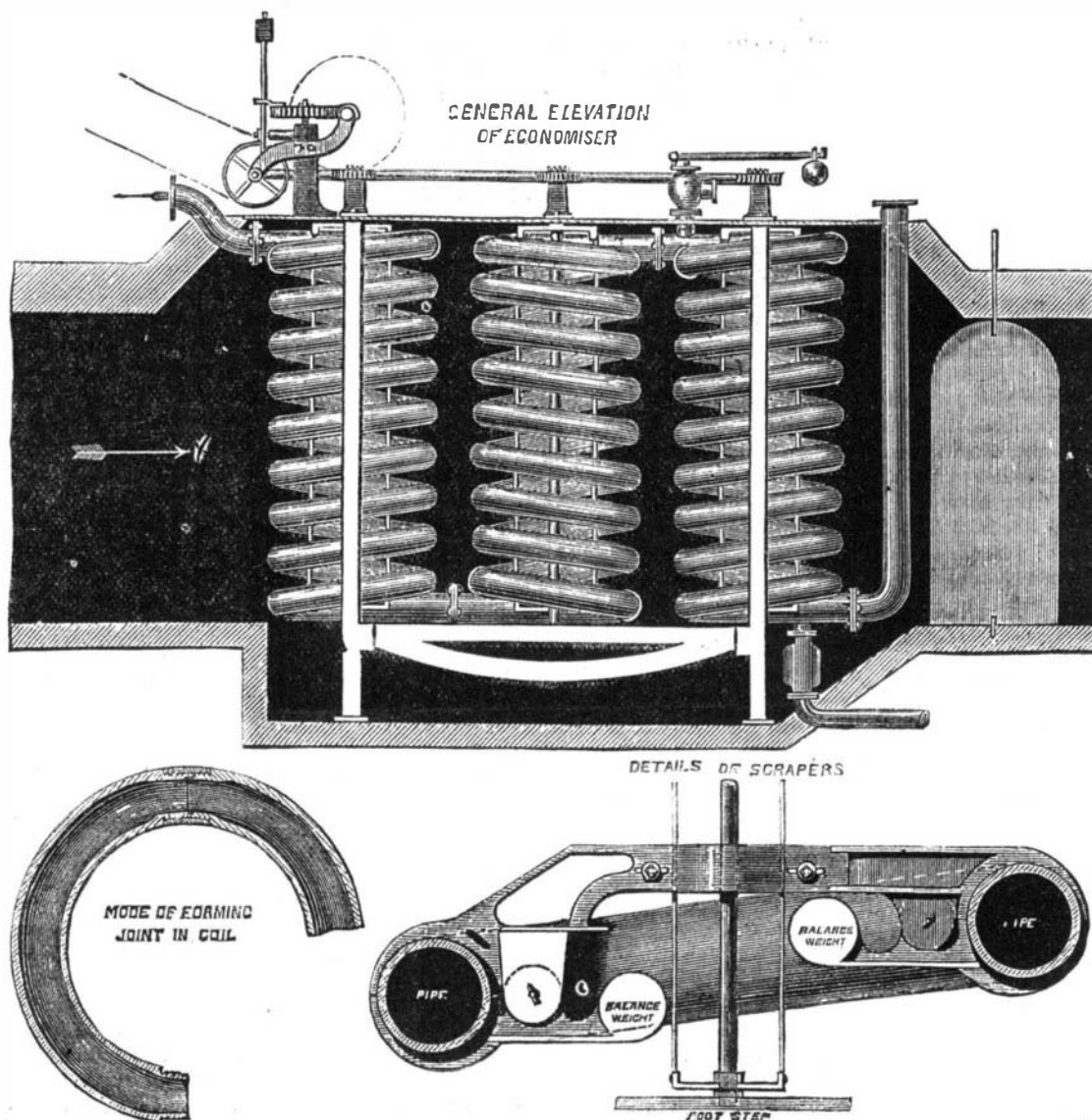
In the construction of locomotive boilers there is also a very great difference in their practice.

The steam dome is there always placed either about the middle or near the front end or smoke box. The Becker pattern of boiler is also much used, especially in Germany and Austria. In this plan the outside of the fire box, instead of being arched, is rectangular, that is, the top of what we call the wagon top, instead of being round, is flat, and is raised somewhat above the barrel of the boiler. The corners are, however, rounded somewhat. The crown sheet, instead of being stayed with crown bars and braces, is supported by long stay bolts screwed through the outside shell and the crown sheet. Some of the engines which are to be built at the Grant Locomotive Works, for a Russian road, are to be made in this way. This is, we think, a very excellent plan, and is quite certain to be adopted in this country when its merits become known. Shaking grates are, however, seldom shown in the illustrations of European engines; but grates very steeply inclined are still much used

there. It is very singular that in Europe the exhaust steam almost universally is allowed to escape at the base of the smoke stack instead of the bottom of the smoke box as is the practice here. It will also be observed that there many of the smoke stacks are made conical; that is, the base of the inside of the stack is smaller than the upper part. We have seen it stated that it is found that the steam blast is much more effective with this form than with a straight stack. We do not know, however, upon what the assertion was based, and would be glad to get some further information in reference thereto. The differences in points of detail are almost numberless, and are well worth study. The reasons for many of these differences would be very interesting if carefully examined, and we intend to return to the subject again. A very striking fact, however, is the much greater variety in the methods of construction adopted in Europe than is in use here. The reason for this we believe to be, singular as it may seem, partly political. The suppression, or rather repression, of individuality under republican governments has often been remarked. In this country, perhaps, no principle is more generally believed than that "the majority should rule." The result is that this axiom produces a kind of intellectual subservency of the individual to the will of the majority, which thus, to a very great extent, becomes the standard of right and wrong

**VERTICAL MULTIPLIER BORING MACHINE.**

tion of the water, there being only one unbroken stream, free from all sharp turns and angles, thus avoiding strains upon the pumps and joints. By means of this rapid circulation it is maintained that incrustation and deposit of scale on the interior of the pipes are avoided, and their heating surface kept uninjured. The feed water enters at the bottom of the coil furthest from the boiler, which is the coolest end; it passes into the second coil at the top, and, descending through it, enters the third coil at the bottom, becoming gradually hotter until it enters the boiler at a temperature varying from 200° to 300°. From the absence of abrupt corners and bends, the coils can be well cleaned out by blowing through them with steam. It stands independent of all brickwork, and is self-contained in its own frame, which reduces the cost of fixing. The three coils are estimated by the inven-

**BELL'S FUEL ECONOMIZER.**