NOTES ON FLYING AND FLYING MACHINES.

[From the Cornhill Magazine.]

NUMBER I.

It would be difficult to say how many centuries have elapsed since the first attempt was made to solve the problem whether man can fly. Ages before the "philosopher's stone" was ever sought for, or before the problem of perpetual motion had attracted the attention of mechanists, men had attempted to wing their way through the too unresisting air, by means of more or less ingenious imitations of the pinions of birds or insects. It has even been suggested (see Hatton Turnor's *Astra Castra*), that King David referred to successful attempts of this sort, when he cried, "O that I had wings like a dove, then would I flee away and be at rest." But without insisting on this opinion—which, indeed, may be regarded as not wholly beyond cavil—we have abundant evidence that, in the earliest ages, the same problem has been attacked which the Aëronautical Society of Great Britian took in hand but a few years since, and which, still more recently, the beleaguered Parisians sought earnestly, but in vain, to solve.

By the invention of the balloon the problem of aërial flotation has been solved; but the problem, which has hitherto proved so intractable, is that of aërial navigation or flight—whether by means of flying machines capable of supporting many persons at once, or by means of contrivances enabling a man to urge his way alone through the air. There can be little question that this problem is one of great difficulty. It has, indeed, been long regarded by nearly all practical mechanicians as really insoluble. But of late years careful researches have led competent men to entertain doubts as to the validity of the objections which have been urged against the theory that it is possible for men to fly. Facts have come to light which seem, to say the least, highly promising. In fine, there are not a few who share the convictions of the learned President of the Aëronautical Society, that before many years have passed men will have learned how to navigate the air. The time may not be at hand, indeed, when Bishop Wilkins' prophecy will be fulfilled and men will call as commonly for their wings as they now do for their boots; but it does not seem improbable that before long the first aërial voyage (as distinguished from aërial drifting in balloons), will be successfully accomplished.

It may be interesting to inquire, what are the principal facts on which this hopeful view of the long vexed problem has been founded. In so doing, we shall have occasion to touch incidentally on the history of past attempts at flight; and this history is, indeed, so attractive, that the reader may be disposed to wish that it were entered upon more at length. But our subject is such a wide one, that it will be necessary to avoid discussing, at any length, those strange and sometimes apocryphal narratives, which are to be found in the records of aëronautics. For this reason we propose to consider only such accounts of past attempts as appear to bear on the subject of the actual feasibility of flying.

In the problem of aërial navigation, four chief points have to be considered—buoyancy, extent of supporting surface, propulsive power, and elevating power. At first sight, buoyancy may seem to include elevating power and supporting power, but it will be seen, as we proceed, that the term is used in a more restricted sense.

In the balloon, we have the perfect solution of the problem of securing buoyancy. The success with which men have overcome the difficulty of rising into the air is complete; and this being their first and, seemingly, a most important success, we can, perhaps, hardly wonder that further success should long have been looked for in the same direction. The balloon had enabled men to float in the air; why should it not enable them also to direct their course through the air? The difficulty of rising into the air seemed, indeed, much the more serious of the two before the balloon had been invented; and all who had failed in their attempts to fly, had failed in precisely this point.

Yet all attempts to direct balloons have hitherto failed. It seems clear, indeed, when we inquire carefully into the circumstances of the case, that such attempts must necessarily fail. The buoyancy of balloons is secured, and can be secured, only by one method, and that method is such as to preclude all possibility—so at least it seems to us—that the balloon can be navigated. A balloon must be large, many times larger than any machine to which it can be attached. If we take even the case of one man raised by a balloon, and inquire how large the balloon should be, we at once see how disproportioned the size of a balloon must needs be to the bodies of a heavier nature which it is intended to raise. We know that a man can barely float in water; so that he is about equal in weight to an equal volume of water. But a volume of water is more than eight hundred times heavier than an equal volume of air, even at the sea level, where the air is densest. So that the weight of a man is more than eight hundred times heavier than that of the air he displaces. It follows that if a very light hollow vessel could be made, which should be more than eight hundred times as large as a man, and which could be perfectly exhausted of air without collapsing (a thing wholly impossible), the buoyancy of that vessel would barely enable it to support the weight of a man. But the balloonist is unable to obtain any vessel of this sort. He cannot employ the buoyancy of a perfect vacuum to raise him. What he has to do is, to fill a silken bag with a gas lighter than air, but still not weightless, and to trust to the difference, between the weight of this gas and that of the air the balloon displaces, to raise him from the ground. So that such a balloon, in order to raise a man, must be considerably larger than the hollow vessel just referred to. But further, the balloon must rise above the denser parts of the air; it must carry its own weight as well as that of the man; the balloonist must take a supply of ballast; and other like considerations have to be attended to, all of which render it necessary that the balloon should be larger than we have hitherto supposed. Apart, however, from all such considerations, we find the very least proportion, between the size of the balloon intended to carry one person and the size of the human body, to be about as one thousand to one. Buoyant vessels constructed on such a scale must needs present an enormous surface; and there fore not only must they strongly resist all attempts made to propel them in any direction, but the lightest wind must have more effect upon them than any efforts made by those they carry. As for any power which should avail to propel a balloon against a strong wind, the idea seems too chimerical to be entertained. Until men can see their way to propelling a buoyant body (one thousand times larger than the weight it supports), at the rate of fifteen or twenty miles an hour through the calm air, they cannot expect even to resist the action of a steady breeze on a balloon, far less to travel against the wind. But even if it were possible to conceive of any contrivance by which a balloon could be propelled rapidly through calm air, yet the mere motion of the balloon at such a rate would sway the balloon from its proper position, and probably cause its destruction. A power, which could propel the car of a balloon through calm air at the rate of twenty miles an hour, would cause precisely the same effect, on the balloon itself, as though the car were fixed while a heavy wind was blowing against the balloon. We know what the effect would be in this latter case; the balloon would soon be made a complete wreck; and nothing else could happen in the former case.

But it may be seriously questioned, whether buoyancy is a desirable feature in any form of flying machine. We have seen that a degree of buoyancy sufficient to secure actual flotation in the air is incompatible with aërial navigation. We may now go further, and urge that even a less degree of buoyancy would be a mischievous feature in a flying machine. M. Nadar, the balloonist, makes a significant, though not strictly accurate observation on this point, in his little book on flying. Passing through the streets of Paris, during the ædileship of Haussmann, he heard a workman call, from the roof of a house to a fellow workman below, to throw a sponge up. "Now," says Nadar, "what did the cunning workman, who was to throw the sponge, do? The sponge was dry, and therefore light and buoyant. Was it in this condition that he threw it up to his fellow? No; for it would not have been possible to send it above the first floor. But he first wets the sponge, and so makes it heavy; and then, when it has been deprived of the lightness which is fatal to its flight, he throws it easily to his fellow on the house roof." M. Nadar infers that the first essential in a flying machine is weight!

Now, what is true in the above reasoning is, that buoyancy renders flight—as distinguished from aërial floating—impossible, or, at least, difficult. It is not true, however, that the flight of the wet sponge exemplifies the kind of flight which the aëronaut requires. The sponge, in fact, was neither more nor less than a projectile; and most assuredly, the problem of flight is not to be solved by making projectiles of our flying machines, or of our bodies. It may be, and, in deed, we shall presently see that it probably will be necessary that some form of propulsion from a fixed stand should have to be applied to the flying machines of the future. But after such propulsion has been applied, the flying machine must be supported in some way, not left, as an ordinary projectile is left, to the action of unresisted gravity. M. Nadar's wet sponge is no analogue, then, of the flying machines we require.

Before leaving the subject of buoyancy, however, it will be desirable to inquire whether buoyancy is, in any marked degree, an attribute of the flying creatures we are acquainted with—birds, bats, and insects. The structure of such creatures has been supposed by some to be such as to secure actual buoyancy, to a greater or less degree; and many would be disposed, at a first view of the matter, to regard the hollow bones and the quill feathers of birds as evidences that buoyancy is essential to flight. We have even seen the strange theory put forward, that during life, the quills of birds, as well as theirhollow bones, are filled with hydrogen. "Flying animals," says a writer, in *All the Year Round* for March 7, 1868, "are built to hold gases everywhere—in their bones, their bodies, their skins; and as their blood is several degrees warmer than the blood of walking or running animals, their gases are probably several degrees lighter. Azote, or hydrogen, or whatever the gas held in the gaseous structures may be, is proportionately warmer, and, therefore, proportionately lighter than air."

But it appears to us that on a careful consideration of the structure of flying creatures, the hollow portions of their bodies will be found to fulfil a purpose quite distinct from that of imparting buoyancy. If we examine a quill we find that the most remarkable feature, which it presents to us, is the proportion which its strength, especially as respects resistance to flexure, bears to its weight. It would be difficult indeed, to construct any bar, or rod, or tube, of the same length and weight as a portion of a bird's quill, which would bear the same pressure without perceptible flexure; and it is scarcely conceivable that any structure, appertaining to a living creature, could possess greater strength with an equal degree of lightness. In the hollow bones, again, we see the same association of strength and lightness. Precisely as a tubular bridge, like that which spans the Menai Straits, is capable of bearing far greater strain than a solid metal bar of equal weight and length, so the hollow bones of birds are far stronger than solid bones of equal weight would be. We see then, that lightness is secured in these parts of a bird's structure. But lightness and buoyancy are different matters. We can understand that it is absolutely essential that the weight of a machine intended for flight should be as small as may be, due regard being had to strength and completeness. But there is little, we conceive, in the structure of flying creatures, which points to buoyancy as a desirable feature in a flying machine.

We come next to a much more important point, namely, extent of supporting surface. We are to consider the air now, not with regard to its density, the quality which enables a balloon, filled with rarer gas, to float in air, but with reference to its power of resisting downward motion through it; that is, of resisting the effects of gravity. We have to inquire what extent of surface, spread either in the form of wings or as in parachutes, will suffice to support a man or a flying machine. It is here that the researches recently made seem to bear most significantly upon the question of the possibility of flight.

The history of the parachute affords some insight into the supporting power of the air—some, but not much. The parachute has been commonly suffered to fall from beneath the car of a balloon. Suspended thus, in the lee, so to speak, of the balloon's mass, and with its supporting surface unexpanded, the parachute descends under highly unfavorable conditions. A great velocity of descent is acquired before the parachute is fully expanded, and thus the parachute has to resist a greater down-drawing force than would be the case if the machine were open, and surrounded on all sides by free air, at starting. The consequence is a great and sudden strain upon all parts of the parachute, as well as a degree of oscillation which seriously risks its structure, besides impairing its supporting power—since this power would obviously act most effectively if the span of the parachute remained horizontal throughout the descent. The following account of Garnerin's descent, in 1797, illustrates the foregoing remarks:

"In 1797," says Mr. Manley Hopkins, "Garnerin constructed a parachute by which he descended from a balloon at an elevation of 2,000 feet. The descent was perilous, for the parachute failed, for a time, to expand; and after it had opened, and the immediate fears, of the immense concourse which had assembled in Paris to witness the attempt, had been removed, the oscillations of the car, in which Garnerin was seated, were so violent as to threaten either to throw him out, or, on arriving at the ground to dash him out with violence. He escaped, however!" We notice the same circumstances in the narrative of poor Cocking's disastrous attempt in 1837. "When the cords which sustained the parachute were cut, it descended with dangerous rapidity, oscillating fearfully, and at last the car broke away from the parachute, and Mr. Cocking was precipitated to the ground, from a hight of about one hundred feet."

But apart from these considerations, the parachute affords no evidence whatever of the increased sustaining power of the air on bodies which traverse it rapidly in a more or less horizontal direction. The parachute descends, and descends quickly: we have to inquire whether the air may not resist descent so strongly that, with comparatively small effort, a horizontal or even ascending motion may be effected.

A familiar illustration of this supporting power of the atmosphere is given in the flight of an oyster shell or piece of thin slate, deftly thrown from a schoolboy's practised hand. Such a missile, instead of following the parabolic path traversed by an ordinary projectile, is seen to skim along almost like a bird on resting pinions. It will sometimes even ascend (after the projectile force has ceased to act in raising it), as though in utter disobedience to the laws of gravitation.

The fact appears to be that, when a horizontal plane traverses the air in a horizontal direction, the supporting power of the air is increased in proportion as the plane moves more quickly, or in proportion to the actual quantity of air it glides over, so to speak. Indeed we have clear evidence to this effect in the behaviour of the common toy kite, the supporting power of which is increased in proportion to the force of the wind. For a kite, held by a string in a strong horizontal current of air, corresponds exactly to an inclined plane surface drawn swiftly in a horizontal direction during a calm. The same supporting power which results from the rapid passage of the air under the kite will be obtained during the rapid passage of the kite over still air.

When we study the flight of birds, we are confirmed in the opinion that velocity of horizontal motion is a point of extreme importance as respects the power of flying. For though there are some birds which seem to rise almost straight from the ground, yet nearly all, and especially the larger and heavier birds, have to acquire a considerable horizontal velocity before they can take long flights. Even many of those birds, which seem, when taking flight, to trust rather to the upward and downward motion of their wings than to swift horizontal motion, will be found, when carefully observed, to move their wings up and down in such sort as to secure a rapid forward motion. The present writer has been much struck by the singularly rapid forward motion which pigeons acquire by what appears like a simple beating of their wings. A pigeon which is about to fly from level ground may be seen to beat its wings quickly and with great power; and yet instead of rising with each downward stroke, the bird is seen to move quite horizontally, as though the wings acted like screw propellers. We believe, in fact, that the wings during this action do really act, both in the upward and downward motion, in a manner resembling either screw propulsion or the action by which seamen urge a boat forward by means of a single oar over the stern. (Sailors call this *sculling*, a term more commonly applied to the propulsion of a boat by

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a single oarsman using a pair of oars, or sculls.) The action of a fish's tail is not dissimilar; and as the fish, by what seems like a simple beating of its tail from side to side, is able to dart swiftly forwards, so the bird, by what seems like a beating of its wings up and down, is able—when occasion requires—to acquire a swift forward motion. At the same time it must be understood that we are not questioning the undoubted fact that the downward beat of a bird's wing is also capable of giving an upward motion to the bird's body. The point to be specially noticed is that when a bird is taking flight from level ground, the wings are so used that the downward stroke gives no perceptible motion.

But since a horizontal velocity is thus effective, we might be led to infer that the larger flying creatures, which, *cæteris paribus*, travel more swiftly through the air than the smaller, would require a smaller relative extent of supporting surface. We are thus led to the consideration of that point which has always been regarded as the great, or rather the insuperable difficulty, in the way of man's attempts at flight —his capacity or incapacity to carry the requisite extent of supporting surface. We are led to inquire whether a smaller extent of supporting surface than has hitherto been deemed necessary may not suffice in the case of a man, and *à fortiori* in the case of a large and powerful flying machine.

The inference to which we have thus been led is found to accord perfectly with the observations which have been made upon flying creatures of different dimensions. It has been found that the supporting surface of these creatures—whether insects, birds, or bats—by no means varies in proportion to their weight. This is one of the most important results to which the recent inquiries into the problem of flight have led; and we believe that our readers cannot fail to be interested by an account of the relations which have been observed to hold between the weight and the supporting surface of different winged creatures.

[Concluded next week.]

The Finish and Preservation of Metallic Surfaces.

The following excellent remarks upon the above subject are extracted from the *Technologist*:

All metals in common use are liable to corrosion; and it has always been an object with mechanics to find out the best means of preventing this, since such corrosion is not only unsightly, but tends to weaken the metal and to add greatly to the friction when it occurs on moving surfaces. In general, the greatest safety has been found in surfaces which have been either well painted or highly polished. When a piece of metal has been highly polished, it no longer presents to the air the same extent of surface that is presented by the same piece in a rough state. The reader will readily appreciate this statement if he will consider the difference between the surfaces presented by a smooth lawn, and by the same field after it has been thrown up into ridges and furrows by the plow. Of course, the greater the extent of surface presented by any given piece of metal, the more powerfully will air and moisture act upon it to corrode it. Besides this, it has been found that the condition of the surface has a great deal to do with the force with which water adheres to it. It is almost impossible to wet the blade of a well polished razor; and a highly polished needle, if carefully laid on the surface of water, will float, because the water will not wet it easily. These facts explain why it is that highly polished surfaces do not corrode easily, as is seen in the case of fine cutlery and instruments made of steel; and they enforce the importance of carrying the polishing process to the last degree of perfection.

It is undoubtedly true, however, that we are apt to put too much polished work upon our machinery, and especially upon our engines; and we thereby not only incur a greatly increased expense in the first instance, but the subsequent cost of maintaining this high polish is a serious item. It was therefore with a good deal of pleasure that mechanics saw the new mode of finishing by plating with nickel introduced. This process has already been applied with the very best results to tools of various kinds, and even to machines of considerable size. We have seen an engine which had all the exposed and polished parts nickel plated. The appearance was very fine, and the labor involved in keeping the engine bright was reduced to a minimum. Nickel does not corrode by exposure to ordinary vapors and gases; and consequently a mere wipe with an oiled rag or cotton waste is all that is needed to keep it bright.

Unquestionably, the cheapest and most effective method of protecting metallic surfaces is to paint them. For very coarse articles coal tar is frequently employed; and we have often seen great mistakes made in the methods employed in its application. Coal tar, if simply applied to any surface as a paint, takes a very long time to dry. Indeed, we have seen it remain for years in a sticky, semi-solid condition. To avoid this, the tar ought to be boiled until reduced to pitch, and then, if necessary, thinned by the addition of naphtha, or applied while hot to a hot metallic surface. Tar treated in this way dries rapidly, and forms a hard paint or varnish that does not soil other objects. In using tar, however, we are prevented from obtaining any other color than black—an objection which does not apply to many objects, such as the coarser articles of agricultural implements, boilers, etc. For such purposes, a cheap varnish made from coal tar has come into very extensive use. A very fine black varnish may be applied to any coarse iron surface that will bear the operation, by simply heating it to such a point as will cause it to decompose linseed oil, and then brushing it over with this liquid. When it gets cold, the iron will be found to be covered with a fine, smooth, black varnish which adheres very closely to the metal.

One of the greatest difficulties in the way of protecting iron surfaces by means of paint is the difficulty of producing a firm adhesion between the paint and the metal. When applied to surfaces that have been polished, the difficulty is not so great; though, even in this case, anything that will cause a more perfect adhesion is to be welcomed. It is when paint is applied to the rough surfaces of iron castings, and especially to those that have been scaled by the action of vitriol, that the difficulty of producing a perfect and permanent adhesion is found. In order to secure the best results, iron that has been vitrioled ought to be well washed and carefully dried before the paint is applied. If the articles are small and will bear the application of a strong heat, they should be heated until oil applied to them smokes. They may then be brushed over with a thin coating of boiled linseed oil; and, when this has become thoroughly dry, they may be painted. When the articles are too large, or when, from other reasons, it is impossible or inconvenient to heat them, the oil may be warmed before it is applied. A thin coat of hot oil will penetrate every pore, displace all adhering dampness, and stick to the metal so closely that no exposure to air or moisture will ever cause it to separate. To such an oiled surface paint adheres well; and when this process is adopted, we never find the paint falling off, in large flakes, owing to moisture having crept into some crack and gradually producing a thin layer of rust between the paint and the metal.

These remarks of course apply to metal that is exposed to the open air and subjected to the action of frost, moisture, and air. It is easy enough to protect metal that is kept within doors, in a dry place, and consequently needs no protection; but iron exposed to the elements is a different affair. And here we may perhaps be allowed to remark that these directions, in regard to hot oil, apply to wood quite as well as they do to metal. A coat of oil applied hot and allowed to become thoroughly dry is a powerful preservative, and makes an excellent groundwork for a subsequent coat of paint.

Patents.

[From the Report of the Secretary of Interior.]

There were filed in the Patent Office during the year ending September 30, 1871, 19,429 applications for patents, including reissues and designs; 3,337 caveats, and 181 applications for the extension of patents. Twelve thousand nine hundred and fifty patents, including reissues and designs, were issued, and 147 extended; 514 applications for trade marks were received, and 457 trade marks issued. The fees received during said year amount to $671,583·81, and the expenditures for the same period were $560,041·67, leaving a surplus of $111,542·14 of receipts over expenditures. The appropriation asked for the next fiscal year is $606,400.

The number of applications for patents, including reissues and designs, received during said year, is a small increase over the number received the preceding year, while the number of patents issued is not quite so great. It is worthy of remark, however, that the labors of the clerical force of the office are increased proportionally more than the number of applications would seem to indicate, inasmuch as each year's operations add about 20,000 to the number of patented and rejected applications, with which the examining corps must become familiar, in addition to those previously filed. The examiners are, generally, men of distinguished ability and untiring industry, but their number is inadequate to properly and promptly discharge the increasing duties demanded of them.

The act of January 11, 1871, abolished the old form of annual report of the Patent Office, and authorizes the Commissioner to substitute therefor full copies of the specifications and drawings of all patents issued, these to be deposited in the clerk's office of each United States District Court, and in certain libraries. This law was passed in the belief that there was very little public demand for, or interest in, the annual reports of the Patent Office, which belief the Commissioner thinks was not well founded, although approving of the law, and regarding it as a means of placing fuller information before those interested, and at a much less cost than before. Beside copies of the specifications and drawings for disposition under the law, other copies are printed for subscribers. These publications are rapidly becoming popular among those interested in patents, and will be of great benefit to the office in various ways. For the convenience of subscribers, the publication of the specifications and drawings has been arranged into 176 different classes, according to their subject matter, so that subscribers need not necessarily pay for the entire issue, but only for the particular class or classes in which they may be interested.

The rapidly extending business of the office requires more room, and although additional room has been provided during the year by the transfer of the Pension Office clerks to another building, the Patent Office is still without sufficient room for the transaction of its business in a satisfactory manner. The general business of the office has been promptly and satisfactorily administered during the term of the present Commissioner, and his efficiency and capability for its delicate duties is cheerfully attested.

Science in Prussia.

Sir William Thomson stated in his recent address before the British Association, that in Prussia every university, every polytechnic academy, every industrial school, most of the grammar schools, in a word nearly all the schools superior in rank to the elementary schools of the common people, are supplied with chemical laboratories and a collection of philosophical instruments and apparatus, access to which is most liberally granted by the directors of these schools to any person qualified for scientific experiments. In consequence there will scarcely be found a town exceeding 5,000 inhabitants that does not offer facilities for scientific investigations at no other cost than that of the materials wasted in the experiments. And further, professors, preceptors, and teachers of secondary schools are engaged on account of their skillfulness in teaching; but professors of universities are never engaged unless they have already proved by their own investigations that they are to be relied upon for the advancement of science.

Fireproof Materials.

Mr. H. J. Ramsdell, in a Washington letter to the *Cincinnati Commercial*, giving an account of an interview with Mr. Mullett, the supervising architect of the Treasury Department, elicits some interesting opinions as to the lessons from Chicago, especially the following, relating to fireproof materials:

"Iron," said Mr. Mullett, "I mean cast iron, absurd as the statement may appear, will not resist as much heat as good sound oak timber of the same dimensions. Fire expands the iron and warps it, and it breaks very easily. Indeed, if oak timber should be treated by any of the processes of liquid silicate, it may be considered almost a fireproof material compared with cast iron. As for stones suitable for building purposes, as I told you before, there are few that are fireproof, though some approximate the necessary conditions, and, except in severe conflagrations, may be generally depended upon. Granite, marble, and sandstone are not to be trusted, as they soon perish by exposure to the heat, as has been shown a thousand times. But I am strongly in favor of liquid silicate as a preparation for wood to be used for building purposes. My attention was directed to this material some years since, but I have not had an opportunity to investigate the subject fully. I believe, however, that it merits more attention than any other suggestion that has been made public, and may yet prove one of the most practical solutions of the question of non-combustible construction that has yet been offered. Whether this or some other process for making wood non-combustible is the more desirable, I am not prepared to say. I am, however, decidedly of the opinion that any process by which wood can be rendered non-inflammable at a reasonable cost would not only be an inestimable blessing to the public, but its use should be rendered imperative by law."

"Well, Mr. Mullett, do you still think that brick is the only fireproof material?" "I looked into that subject at Chicago with much interest. Now, it is very hard to make an absolutely fireproof building; but I believe that a building, properly constructed of bricks that are well made, and of iron or non-combustible timber, protected by fireproof shutters and door, will resist the fiercest conflagration. Remember, I say fireproof doors and shutters, not iron. To make an absolutely fireproof structure, however, well burned and homogeneous brick must be used. The walls must be of sufficient thickness, and should be built with an air space to prevent the transmission of heat. The joists should in no case be carried into the walls, but should be supported on corbel courses of brick, and connected with the walls themselves only by wrought iron anchors. The windows and doors to be protected, as I have said, with fireproof shutters, and the roof to be of slate or metal. The use of roofs composed of coal tar, or other similar substances, should be prohibited by law in cities. Ordinary iron shutters are scarcely more fireproof than those of wood. They heat rapidly, warp from their fastenings, and admit the fire to the interior, and are in fact a means of facilitating the conflagration by obstructing the efforts of the fire department. I see no reason, however, why fireproof shutters should not be produced at a price that would place them within the reach of all."

"What do you think of dry pressed bricks?" "I never had much experience with them, and I don't believe in them. They are certainly not so good as the ordinary kind. A very little experience with brick will show that the more thoroughly the clay is tempered the better the bricks are. One great trouble in obtaining good brick is in the indisposition of brick makers to temper their clay enough." "What do you think of terra cotta?" "Terra cotta is a material to which I do not think sufficient attention has been given in this country, though in Europe many beautiful and durable specimens have been produced. I feel confident that it will be found, if properly made, one of the most desirable articles for the use of an architect in the erection of fireproof buildings. It should be used in a legitimate manner, and not as an imitation of cut stone."

For the Benefit of Chicago.

An esteemed correspondent, R. B. S., calls our attention to the following: "The theatres of the Romans were fitted up with numerous concealed pipes, that passed in every direction along the walls, and were connected to cisterns of water or to machines for raising the latter. Certain parts of the pipes were very minutely perforated, and were so arranged that, by turning one or more cocks, the liquid escaped from them, and descended upon the audience in the form of dew or extremely fine rain. This effectually cooled the heated air, and must have been exceedingly refreshing to the immense multitudes, especially in such a climate as Italy.

The dining rooms of Nero's golden house were ceiled in such a manner that the attendants could make it rain either flowers or liquid perfumes. At one feast 100,000 crowns were expended in perfumed waters." *Ewbank's Hydraulics*, p. 539.

And it is reasonable to suppose that the Romans extinguished flames in like manner.

"TIME IS MONEY;" do not throw it away, but make every day and every hour tell either for your growth, health, or profit.

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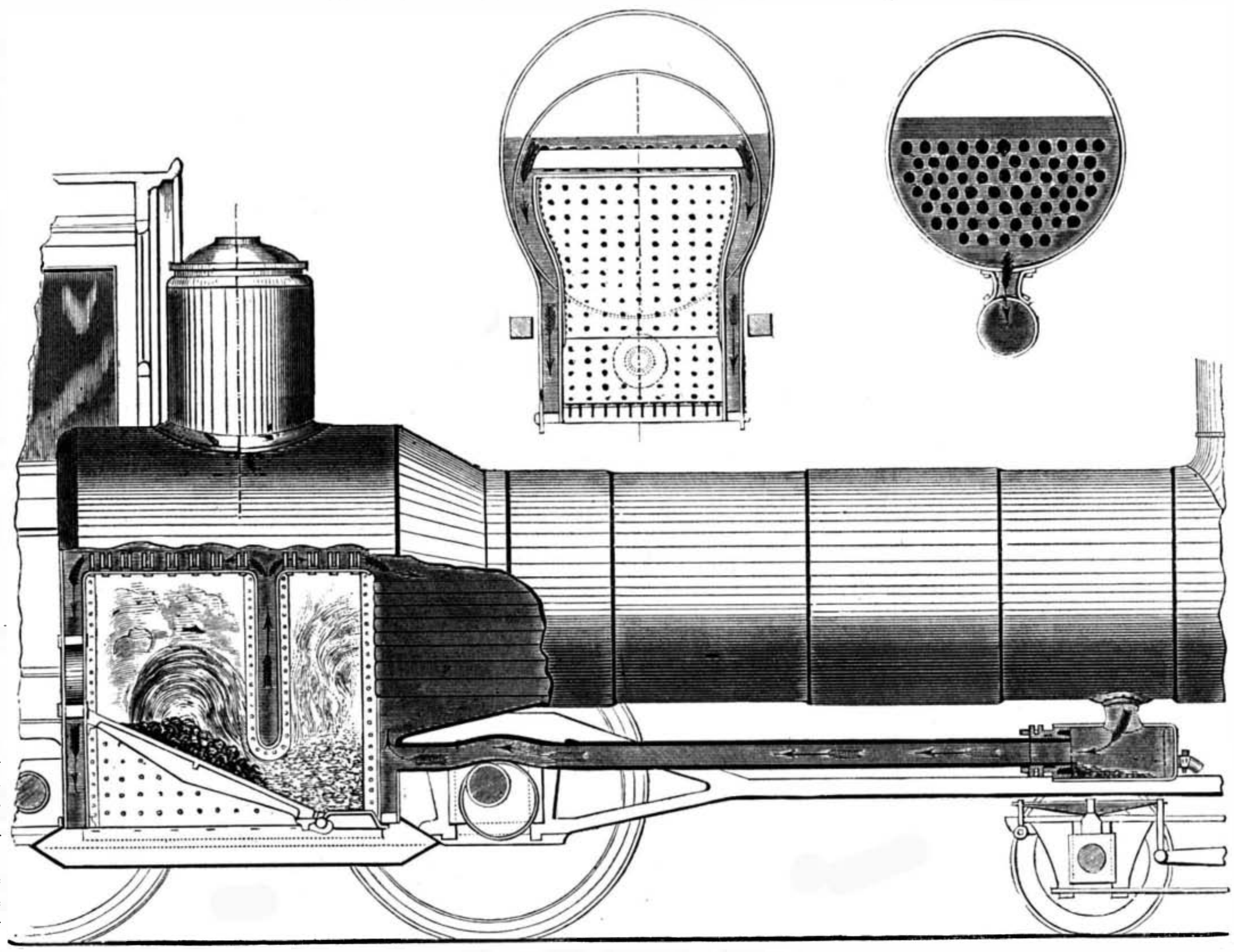
Improved Steam Boiler.

The accompanying engravings illustrate a boiler invented by F. A. Woodson, and patented in the United States and England, and for which applications for patents are now pending in Russia, Prussia, Austria, France, Belgium, and Italy.



WOODSON'S STEAM BOILER.

To explain the principles which govern the construction of this boiler, it will be necessary to refer, as concisely as possible, to the laws which control the generation of steam in boilers. When steam is making in a boiler, and, as it is made, is passed off constantly to an engine, the demand being equal to the supply, there is constant motion in the water, arising, first, from the difference in the specific gravity of different portions of the water and the difference in the specific gravity of water and steam; and second, from the expansive force of the steam. The ebullition of water, under these circumstances, is principally due to the expansive force of the steam, generated more rapidly than it can quietly escape by virtue of its less specific gravity. If, under these circumstances, the throttle valve be closed, and the safety valve be kept shut, no ebullition, in the strict sense of the term, can take place; the circulation will then be decreased to that which takes place in water before it is heated to the boiling point. The expansive force of the steam being resisted, it permeates the water like carbonic acid gas in a soda fountain, until the water, becoming saturated, can hold no more. If now the fires be kept up, it is evident that, while the plates in contact with the water and steam continue to receive heat, the power to convey away the heat is greatly decreased, on account of the now almost checked circulation. The consequence is that a thin stratum of steam accumulates next the plates, and separates them from the water. This state of things has been styled *repulsion*, and is assigned as the cause of many destructive explosions. For as soon as this condition takes place, the plates get very hot, and the partial escape of the separating film of steam at once begins, with eruptive force through the stratum of water, the water descending with power enough to force it into contact with the over-heated plates, when the sudden production of steam causes another jump of the liquid, throwing it upward with great force, and, if not exploding the boiler, trying its strength far beyond the limit of safety, and producing symptoms of internal disturbance which are externally perceptible, and often alarming even to experienced engineers.

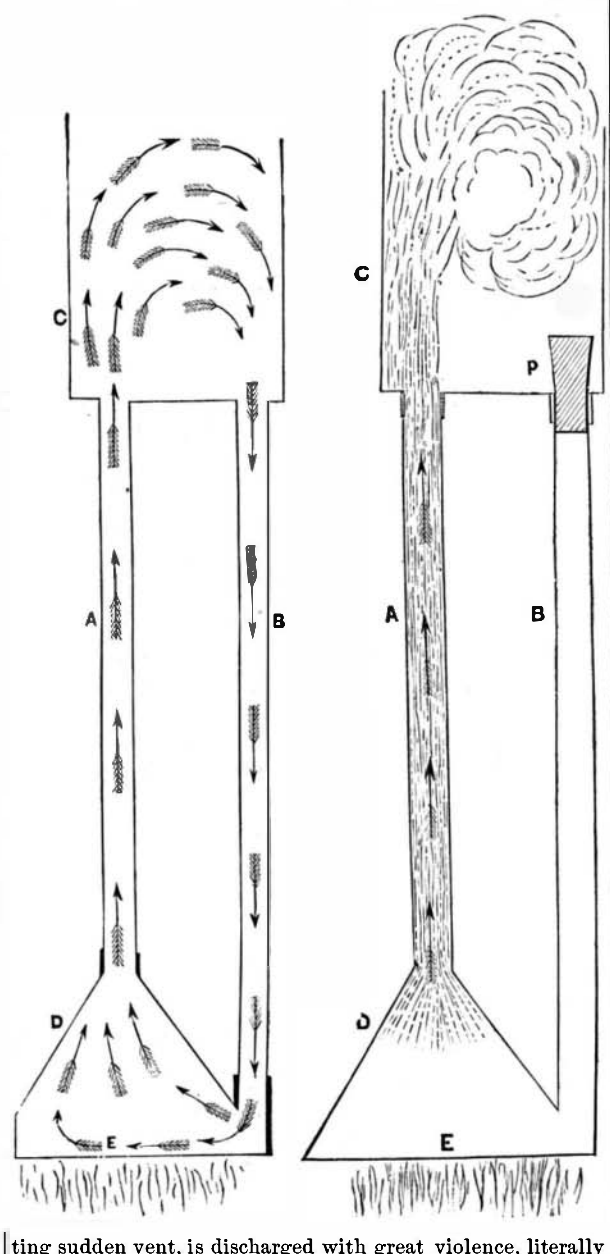
Again, when the circulation in a boiler is diametrical, it is common to find different parts of the boiler very unequally heated. Engineers are aware that it is often possible to draw water in which the hands may be washed from a boiler which is generating steam. Unequal heating causes unequal expansion, and this alone may often strain boilers so near to the point of rupture that the addition of a comparatively moderate steam pressure may complete their destruction.

The separation of the water from the plates, by a film of steam, may take place in a boiler which is delivering steam, whenever the boiler is so constructed that the heating surface makes steam faster that the latter can escape through and by the obstructions above it. The stratum of water may be too deep in proportion to its other dimensions, or the space may be obstructed by flues, diaphragms, or tubes, etc. It matters not what interferes with the circulation; without this we cannot have a quiet and safe generation of steam; and without uniform circulation throughout the boiler, we must have unequal expansion and the dangers that follow it.

This lifting of water, by the effort of steam to escape, is illustrated in the accompanying engraving, Fig. 2, of an apparatus described by C. Wye Williams, in his treatise on the "Combustion of Coal," page 142, from which we make the following quotation:

"The violence and intermittent action which ensues when separate channels or sufficient space is not available (in steam boilers) will be well illustrated in the following experiment: Fig. 84 represents two long glasses, each two inches wide by eighteen inches long, A and B, connected by means of a tin apparatus, C and D, at top and bottom, leaving the communication open above and below, the whole being suspended over a fire. On the heat being applied, a current of mixed steam and water will be seen ascending in one glass and descending in the other, as indicated by the arrows. There being here no confusion or collision, a state of things will be produced highly favorable to the generation of steam, the colder water finding easy and continued access to the heated bottom of the vessel at E.

"If the communication between the two glasses be cut off by inserting a plug in one of them, as seen at P, in Fig. 85, the circulation in the glass, B, will be suspended, and the previous uniform generation of steam will then be succeeded by an intermittent action—explosive violence alternating with comparative calm and inaction. This accumulated steam, get-



ting sudden vent, is discharged with great violence, literally emptying both the glasses and lower chamber.

"Here we see the true source of priming in boilers and a practical exemplification of at least one of the causes of explosions, which have lately become so frequent."

Unequal expansion is, without doubt, one of the causes of the rapid deterioration of boilers, which, upon inspection have been passed as sound, and which explode subsequently under circumstances which lead us to doubt the thoroughness of the inspection.

The Woodsen boiler is based upon the principle of uniform *longitudinal* circulation, whereby the steam is easily and constantly brought to the surface of the water with gradually and uniformly accumulating pressure, and the boiler is kept at nearly the same temperature throughout, thus avoiding the evils of unequal expansion, and securing the economy that results from quiet yet rapid circulation. The principle is applicable to all sorts of boilers, but the improvement is shown in our engraving as attached to a locomotive boiler. It consists, principally, in the attachment of a longitudinal pipe, six inches in diameter (more or less) below the boiler proper, and a mud drum, in which an eddy is formed which deposits all the sediment. The water passes from the end of the boiler remote from the furnace downward into the mud drum, thence onward to the water leg at the rear of the furnace, thence upward into the boiler, where it immediately commences to pass back from the furnace over the surface of the tubes, delivering its steam quietly along the route.

The passage of the water, through the pipe or "circulator," is more or less rapid, according to the heat which is generated in the furnace, but in all cases is rapid enough to change the entire body of water in a very short time.

The conflict between ascending and descending currents of water is thus avoided, the back end of the boiler is kept within a degree or two as hot as the end nearest the fire, and the impurities are all entrapped in the mud drum, from which they may at any time be conveniently removed.

From personal observation of one of these boilers, we can vouch for the rapidity and uniformity of the circulation, and the perfect separation of sediment. As to the economy, we have only the testimony of engineers and the statement of the inventor that he will guarantee the boilers to produce 12½ lbs. dry steam at 60 lbs. pressure, by the consumption of one pound of good bituminous coal. That it must be a very economical boiler we judge from general principles; but this amount of evaporation is so large that it is one of the things engineers must see to believe.

The inventor refers this large evaporative power partly to the improved circulation and partly to the construction of the furnace, by which he claims not only to coke the coal when it is first put in, but to wholly consume the combustible gases given off while coking, avoiding loss of fuel and of the heat which the unconsumed gases would otherwise carry away through the uptake.

It will be seen that the grate is inclined, the highest part being in front. The coal thus feeds backward automatically by its own gravity. A descending bridge wall, into the hollow interior of which water constantly flows, intercepts the gases and forms a sort of reverberatory furnace to which air is admitted in sufficient quantity to create perfect combustion.

The plates being thus more highly heated and being brought by the more perfect circulation into constant contact with the coolest water in the boiler, they impart their heat much more perfectly and rapidly, the rate of conduction being, according to Rankin (see page 263 of his work on "The Steam Engine"), "nearly proportional to the square of the difference of temperature, of the heated gases on one side of the plates and the water on the other. This the inventor claims as the principal source of the large evaporative power of the boiler.

In conclusion, we will say that we have formed a very favorable impression of this boiler from inspection of its working, and that it seems to give very much more control, over the uniform generation of steam and gradual accumulation of pressure in steam boilers, than is the case with most other kinds of boilers.

The Woodson Steam Boiler Company, Selma, Ala., or 243 Broadway, New York, may be addressed for rights to use or manufacture.

A VERMONT man has established a steam toy factory at Nuremburg, Bavaria.

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