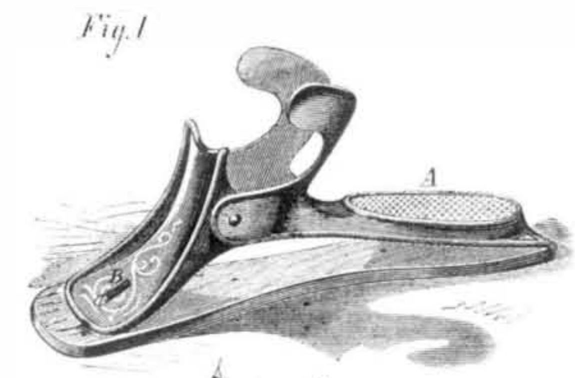
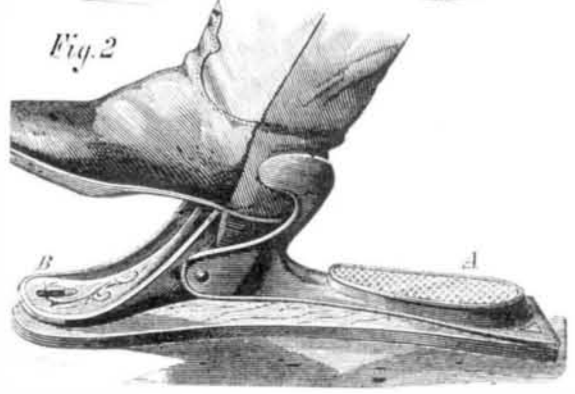
BAKER'S IMPROVED BOOTJACK.

The simple and powerful bootjack, represented in the annexed engraving, will doubtless find a ready welcome from all who expect to experience countless struggles with well soaked boots during the wet weather of the next few months, It will be noted that the device takes a firm grasp, not merely of the heel, which is liable suddenly to come off, causing the operator to sit down with more celerity than grace, but of the entire counter, tightly holding the same until the foot is extricated.

The rear portion, Fig. 1, consists of a casting, A, which is





hinged to the bedplate, and its forward portion is inclined back, and curved, to receive the boot. Pivoted to the front end is a catch plate, which is secured to the bed by a bolt, B, passing through a slot, so that the plate may slide freely in a longitudinal direction. In pulling off the boot, the latter is inserted, as shown in Fig. 2, between the catch plate and the curved part of the rear casting. The other foot is then placed upon the part last mentioned, pressing it down, thereby causing the catch plate to slide outward, so that the boot is clamped tightly between the two portions of the device. While the boot is held, the foot is withdrawn.

Patented through the Scientific American Patent Agency, December 8, 1874, to Mr. Peter H. Baker, of Virginia City, Nevada, who may be addressed for further information.

Private Pisciculture.

Mr. Seth Green, the well known pisciculturist, states that he has invented a new method for transporting and hatching nearly all kinds of fish eggs, by which spawn can be carried for one hundred and thirty days journey, and can be hatched in any room in the house. One million eggs, it is also said, can be hatched by using a pail of water daily.

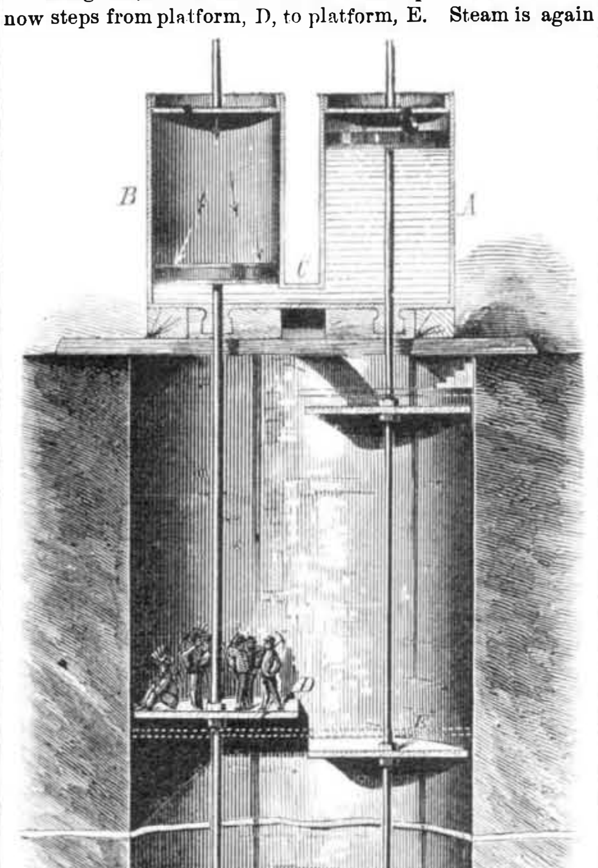
We believe that fish culture by private parties can be rendered a lucrative source of income, provided it is followed with the same care as is exercised in the raising of poultry or any other live stock. Hundreds of farmers have streams and ponds on their lands now of no value save perhaps as watering places for cattle in pasture, and yielding a few worthless perch and catfish, perhaps an occasional trout or pickerel. If Mr. Green has solved the most difficult part of the problem, namely, the successful transportation of the eggs, the mode of stocking of waters and the rearing of the fish are not difficult subjects of which to acquire an adequate knowledge. One species of fish in particular, which is little known, will, we think, prove especially remunerative, and for this reason we commend it to notice. We mean the land-locked salmon, which is a distinct species of the fish, though so closely resembling the ocean salmon as to suggest the idea that, at some remote period, a quantity of the latter fish, being by a convulsion of Nature barred from returning to the sea, had propagated in their land-locked quarters and eventually developed into a separate variety. The habits of the land-locked and ocean salmon are closely similar. The young fry of the former seem to remain in the fast water before going down to their ocean, the deep still water of the pond or lake, about the same time as those of the *salmo salar*. The average size of the fish is about one and a half pounds, though it has been captured weighing as high as eight pounds. It requires running aerated water with access to still pools. As a table fish, the land-locked salmon is said to be superior to its ocean relative; and as game it is reported to be unequaled, rising to the fly from running water even in the hottest summer days.

Steam and Water Power.

According to Mr. Batchelder's book, in 1863, where he quotes Montgomery on cotton, at Lowell or Lawrence, the interest, at six per cent, on the purchase of a mill power, and of land for the mill, will average about $15 per horse power per annum. The rent for water power, also, in cases where the mills are not owners of the water power, would appear to be from $300 to $500 per annum, per mill power of 62½ horses net, showing a rate, per horse power, of $5 to $8.33⅓ only. In Holyoke, the price is about the same. At Manayunk, Philadelphia, the rent of water power and land used to be (1863 about $60 per horse power per annum. I am not aware that the price has been diminished. To these rents should be added a comparatively small expense for labor, oiling, etc., and for repairs. It is obvious that Lowell and Lawrence, and a few places equally well situated, have, after deducting the value of land for the mill, advantages in water power which do not form, however, an average for the United States. I understand that no water companies, with such profitable terms for mills as that of Lowell, are now formed, although, in 1863, it was considered that, such is the superabundance of water power in New England and other parts of the country, it could be obtained in situations favorable for manufacturing for half the cost at Lowell. The reason, or at least one reason, is that the labor required in preparing the water power has increased, as the cost of using steam power has diminished. Another, probably, is that the cost of freight is so much higher, that this and other considerations of a like nature are of more moment, in selecting the site for a mill, than the advantage of water.—*H. Gastrell.*

THE BELGIAN MODE OF LOWERING MINERS IN SHAFTS.

Mr. J. W. Cole, of the Tanite Company, of Stroudsburg, Pa., sends us, from Brussels, Belgium, the following interesting account of his recent visit to the collieries of the *Sociétés des Charbonnages de Mariemont et Bascoup.* These large corporations own an area of some 500 square miles of coal fields, and employ 9,000 men, producing, from fourteen mines, 7,000 tuns per day. The apparatus for lowering and elevating the miners to and from their work is very ingenious, and of especial advantage where a large number of men are to be transported. Its operation will be understood from the annexed engraving, in which A and B are two steam cylinders, connected by the pipe, C, and containing water in the spaces below the pistons. The latter are attached to platforms, D and E. The parts being as shown by the full lines in the engraving, a miner steps upon platform, D. Steam is now admitted above the piston in cylinder, B, forcing said piston down, and hence driving the water into the other cylinder. This of course raises platform, E, and, as is evident, brings the two platforms on a level, when the piston in A is at its highest, and that in B at its lowest point. The miner now steps from platform, D, to platform, E. Steam is again



admitted, this time above the piston in A; platform, E, sinks, and eventually comes on a level with a third platform, D', secured below platform, D. This operation is continued, the workmen entering at the top and stepping from one platform to another until the bottom is reached.

The societies own 14 locomotives and 123 stationary engines; the boilers for the latter are so arranged that no fire door can be opened without closing the flue, thus avoiding the evil effects of a cold air draft.

COMBINED WRENCH AND BOLT CUTTER.

The expensive and cumbersome bolt cutters heretofore provided for blacksmiths and carriage trimmers led Mr. P. Broadbooks, of Batavia, N. Y., to invent a simpler and more effective tool for his own shop; for this he obtained letters patent, dated March 18, 1873. Recent improvements have added to the value of the invention, the moderate cost of which makes it a feature of interest to every mechanic having occasion for its use.

The engraving represents a side view, and shows the manner in which the tool is applied. A and B represent lever handles, pivoted at C. On the lever, B, is found a cam-shaped head, beveled so as to form a cutting edge on the inner side, which operates (with the head, D, of the opposite lever) like a pair of shears. The head, D, is formed with a deep notch or recess, so that it will fit on a nut, and may be used for turning the same like an ordinary wrench. This recess has an offset, E, for turning smaller nuts, and supporting them while the bolt is being cut off by the cam head. The wrench

head is also provided with a half round notch, F, for supporting wires and small rods while being cut off.

The nuts may be turned up and the bolt ends cut off with one operation of the tool. The cut is smoothly made, and an excellent finish is left. The bolt is riveted on top of the nut, as a slight flange is formed, extending a little over the edge of the nut, sufficient to hold the latter from working off. Specimens cut by this tool (one of them a seven sixteenths inch bolt), forwarded to us, fully corroborate the above.

The great power in this bolt cutter is secured by applying, close to its fulcrum, a cam-shaped cutter to a rod or bolt to be cut. The simplicity of the tool (composed of only two pieces, fastened with a rivet or bolt) insures its durability. By screwing the cam lever into a vise, or fastening it into the bench, the other lever can be operated so as to cut bolts, rods, or wires with great ease and rapidity. By removing the handles, as shown in the engraving, the shanks, A and B, form a serviceable pair of large compasses.

This wrench and bolt cutter, and one of the bolt cutters in the Broadbook system of compound tools (already illustrated in the SCIENTIFIC AMERICAN), will enable a person to reach, and cut easily, any bolt in any part of a vehicle, and the two tools together cost less than one of the bolt cutters now in common use.

Arrangements will be made with manufacturers to make this combined wrench and bolt cutter on royalty. For full particulars address Broadbooks & Co., Batavia, N. Y.

THE ANTHRACITE COAL HARVEST OF 1874.—The total quantity of anthracite coal mined in Pennsylvania, in 1874, was twenty-one millions six hundred thousand tuns, or over five hundred and sixty millions of cubic feet. Placed in one mass, this would form a solid wall one hundred feet high, one hundred feet wide, and nearly eleven miles in length.

If a shaft springs in running, the trouble lies probably in either a too small diameter of the shaft for its weight and velocity, a set of unbalanced pulleys, or an unequal strain on either side by the belts.

Correspondence.

Animal Suicides.

To the Editor of the Scientific American:

A few weeks ago I saw in your paper an account of a scorpion stinging himself to death while being burnt with a sun glass. He did not intend to commit suicide; it was a mere accident on his part. I lived in Brazil for several months, and I have seen more than a dozen sting themselves to death. I used to take a straw or small stick, and lay it across their backs and hold them down with considerable force; and they would turn their tails over and feel very carefully for the straw, and then draw back and strike at it; and often the sting would strike the straw and split it, and so enter the body.

I have taken an iron ring, about 4 or 5 inches across, and heated it black hot and put it over them; and when they began to feel uncomfortable, they would strike all around with their tails. But I never knew one to sting himself. At one time I enclosed two of them within a hot ring; and when they began to feel the heat, they went at each other with their stings, and in a short time they were both dead.

Lynn, Mass. S. A. T.

A New Form of Flying Machine.

To the Editor of the Scientific American:

Screw propulsion is the principle upon which will, probably, be accomplished the great problem of aerial navigation. The plan here proposed is a modification of the device presented by W. D. G., in a recent issue of the SCIENTIFIC AMERICAN. The horizontal driving shaft is attached below the spar, above which the wing propellers revolve in opposite directions. This shaft is rotated by means of cranks actuated by the machinery below, and is connected with the wings by means of bevel gearing. The wing spar is arranged to rotate partially around its own axis, the driving shaft moving with it. The wing propeller shafts may thus be worked vertically, or inclined forward at any angle desired. To rise vertically in the air, the wing propeller shafts are set in a perpendicular position; when a forward motion is required, they are inclined forward. At right angles to the wing spar is a fore and aft spar, and a sail is attached to these after the manner of a kite. Below, about where the string would be attached in the ordinary kite, is suspended a bag of ballast whose position can be shifted at pleasure by means of the lines passing upwards through the bottom of the car. By slackening the forward line and hauling taut the aft line, the inclination of the kite may be increased as circumstances may require. This ballast may be a part of the cargo or the baggage of passengers. When the wings get out of order or need oiling, they may be stopped, and the stern propeller on the car below put in motion. The air ship then sails like a kite when the boy runs with it on a still day.

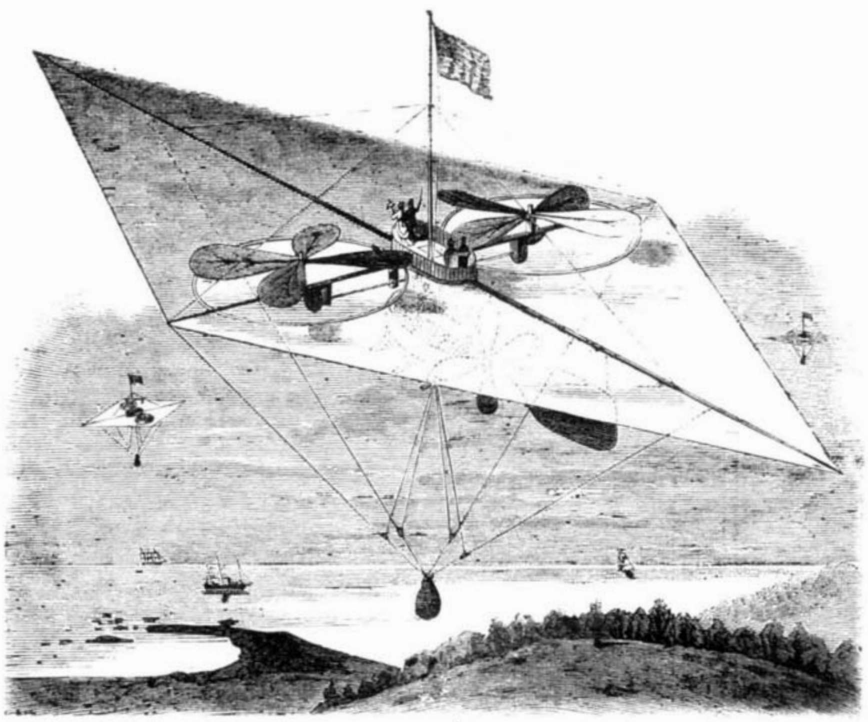
If great speed is required, all three propellers may be run at the same time, the shafts of the wings being placed horizontally: the ship will then fly onward at a level, or rise or descend, according to the slope given to the kite by means of the ballast lines. Working in a socket joint at the end of the stern propeller shaft is a rudder, the other end of which swings by a cord from the spar above. The steering is effected by ropes, not shown in the illustration, attached to the rudder and passed to the deck of the car through pulleys on the wing spar. On approaching the earth, the bag of ballast touches first; and at this elevation, by keeping its wings in gentle motion, our ship may remain suspended until transfers of passengers and mails are effected, or preparations are made for landing. If an accident should happen to the machinery, the ballast may be instantly adjusted so as to bring the kite to float level, in which position the contrivance becomes a capital parachute. The passengers may then repair to the upper deck and calmly await the result.

Increased power and greater security may be obtained by having two propellers on each side of the car, arranged along the wing spar, and so connected that either or both sets may be run. A greater number of fore and aft spars may also be introduced, crossing at the center of the car, like the three sticks of a kite. The rudder might be attached to the rear extremity of the fore and aft spar, in which position it would exercise greater power and render the flight of the ship more steady; it might have a horizontal as well as a vertical wing, and be capable of a vertical as well as a horizontal movement, performing in this way precisely the functions of the tail of a bird.

The great and only obstacle to the successful accomplishment of the problem of aerial navigation is the weight attendant upon motive powers now in use. But even with steam machinery, by using concentrated fuels, the above device would seem practicable. The inclined plane or kite principle is that applied by birds after acquiring momentum by flapping their wings. In this case, the propelling power is continuous, and great velocities might be attained, amply sufficient, no doubt, to dispense entirely with all downward action of the propellers after once starting.

The day cannot be far distant when the inventive genius of the nineteenth century will accomplish a mode of locomotion practised with so much ease by such vast numbers of the animal kingdom. The time may yet come when the present ways of travel will be regarded as we now do the old fashioned 'pike and stage coach; and nations will be brought into such easy, rapid, frequent, and intimate commercial and social connection as to result in a grand unity in language, law, and government on earth. WM. W. BLACKFORD.

New Orleans, La.



BLACKFORD'S FLYING MACHINE.

The Universal Jointed Propeller.

To the Editor of the Scientific American:

In your issue of November 28, I notice a communication from Lieut. F. M. Barber, U. S. Navy, together with an engraving representing a universal joint in the shaft of a propeller, which he claims as his invention, but states that he has no patent, and perhaps some one may get an idea by seeing it.

Mr. Barber, in his praise of the boat to which he has applied it, is correct, as, from my experience and knowledge of its operation on several vessels, I find it absolutely essential in many respects for the security of sea-going and other vessels, apart from its intrinsic value as a means of rapid manœuvering.

I have taken out patents in the United States, Great Britain, France, Belgium, and Canada.

Washington, D. C. JAMES L. CATHCART.

REMARKS BY THE EDITOR.—Several patents have been granted for different means of making the connection between the driving shaft and the propeller, so that the latter could be used for steering purposes. The idea of connecting the propeller with the driving shaft by means of a Hooke or universal joint is quite old, and was shown in an old English patent, the date of which we have forgotten, but it can be found in Bourne's "Treatise on Propellers."

Burning Chimneys.

To the Editor of the Scientific American:

Probably the most prolific cause of fires in houses, especially in the country, is the burning of chimneys. Of the dozen or so of fires I have witnessed, at least one third are known to have been caused by sparks from burning chimneys falling upon the roof. To prevent the burning of chimneys is an easy matter. The soot in the chimney cannot burn, except as the fire of the stove is communicated to it through the pipe. If the pipe, therefore, be kept clean and free from soot, and the damper in the stove always closed, the chimney will never burn out. To free the pipe of soot, take the stove handle or any convenient implement, and rap the pipe smartly on all sides from top to bottom. The soot will fall into the stove and be harmlessly consumed, or it can be removed in the usual way.

If there be a horizontal pipe, this should be taken down twice a year and thoroughly cleaned. Or if the pipe be only a few feet in length, and the arrangements will admit of it, provide the horizontal pipe with a permanent scraper, as follows: To the end of a stout wire, a few inches longer than the pipe, attach a small segment of a disk of sheet iron, at right angles to the wire. Remove the elbow, and thrust the scraper into the pipe. Pass the other end of the wire through a hole punched in the elbow, loop the end of the wire for a handle, and replace the elbow. After first rapping the pipe, the soot can all be drawn out and let fall into the stove. This arrangement I adopted six years ago, and my chimney has not burned out during that time. I clean my pipe thus, as often as once a fortnight during cold weather.

Franklin, N. Y. J. H. P.

Steam Boiler Explosions.

To the Editor of the Scientific American:

In your issue of January 16, Mr. R. D. Williams attempts to account for the destruction resulting from steam boiler explosions; and although he brings an array of figures to support his theory, I think he is wrong when he assumes that (because a boiler is not torn to pieces when it gives way under a cold water test) it is not the bursting pressure, under steam, which produces the fragments, but that, at the instant of the explosion, a large amount of water heated to a temperature above the natural boiling point is converted into steam, and that alone tears the boiler and causes the destruction which follows. He seems to forget that there is very little elasticity in cold water and a great deal in steam; the former, at the enormous pressure of 15,000 lbs. to the square inch, is only compressed $\frac{1}{20}$ of its volume, while a very large volume of steam can be confined in a very small space.

The opening of a seam or breaking of a rivet relieves water pressure, because, there being so little elasticity, it soon finds its volume; but it is not so with steam. The same rupture would relieve but a comparatively small fraction of the pressure exerted in producing it, and the pressure continues exerting its force upon the broken or fractional part until the whole pressure is relieved and the steam has acquired its full volume. A wooden wedge driven into a cast iron pipe would produce a slight fracture; but a steel spring of the same strength would not only cause a fracture, but would also break it into fragments.

I do not deny, positively, that the conversion of water into steam at the instant of explosion does not lend force, for such a thing is perhaps possible, but I think hardly probable. I do contend, however, that steam of sufficient pressure to rupture a boiler is also sufficient to cause the destruction of life and property which follows explosions.

If Mr. Williams wishes to test the correctness of his theory, let him take an empty boiler that will burst at a pressure of 100 lbs., and connect it by a steam pipe with another boiler, and force dry steam into it until an explosion occurs. In my opinion he will find as many fragments and as much destruction as if the boiler contained the usual amount of water.

I am glad to see the cause of boiler explosions discussed in the columns of the SCIENTIFIC AMERICAN, and are convinced that the interchange of thought on the subject will eventually lead to a solution of this difficult and important problem.

Washington, D. C. C.

Brass vs. Phosphor Bronze for Rolling Mill Uses.

To the Editor of the Scientific American :

I have read in your issue of January 16 an article on phosphor bronze, by a correspondent in this place. Previous to reading it, I was laboring under the impression that it was a superior composition for journal boxes and rolling mill brasses; but on comparing the results of the trials given by your correspondent, with similar work done on brass bearings, my former opinion of phosphor bronze has been changed considerably. The trials made with the bronze brasses were made in a single turn mill, located on the bank of the Monongahela river, a few hundred yards above the mill where some trials were made of which I give you the results.

The water supply of both mills is taken from the same source; and as a matter of course, when the bronze bearings were getting gritty, muddy water, the brass ones were getting the same. The following is the actual work done in the regular way, not by trial bearings. We have no ten inch mill, so I will give you the particulars of a sixteen inch bar mill, for merchant iron. A set of brasses usually run a year in the roughing and finishing, and it is customary to put in new ones every time the mill is stopped to line up and repair, which is done generally in July or August of each year, though the brasses may be but partly worn. This train runs double turns, making over twenty-two millions of revolutions per annum, and turning out in that time about sixty thousand tuns of finished iron. An eight inch train, the driving shaft of which carries two large speed pulleys and a nine foot fly wheel, has journals six inches in diameter and twelve long; it has brass boxes in pillow blocks, the first set of which was put in when the mill was built, and they ran for six years, double turns, equivalent to twelve years of single turns. The second set have now been in some two years or more, and are in good condition. Roughing roll brasses usually run one year as bottom roll brasses, and are then changed to top roll brasses, where they do duty for one year longer. In the finishing rolls (same train) the roller has only had three sets of brasses since the mill has been built (over eight years). These brasses have carried the journals, which revolve over fifty million times in a working year, and turn out about five thousand tuns of finished iron in that time. We also run a thirty-five tun rotary squeezer, cast from the same patterns and fitted by the same parties as the one mentioned by your correspondent. The one under which this most "severe test of all" on a bronze plate was made turns about eleven revolutions per minute, and squeezes puddle balls for nineteen furnaces, single turns. Our squeezer runs sixteen revolutions and does the work for twenty-eight puddling furnaces, double turns, or nearly three times the work, turning out sixty-five tuns of blooms per day of two turns; and under the upright shaft of this squeezer, the builders put a chilled plate of cast iron: and after fifteen months of steady running, as above mentioned, it shows no perceptible wear. I am therefore unable to see where this severe test comes in. The brasses we use are made from ingot copper and pure block tin, in proportion of seven of copper to one of tin. I cannot give its tensile strength, ductility, etc., data which may be very desirable to wire drawers, brass rollers, rivet makers, etc., but which are of no value in determining the value of a composition for journal brasses; but I will guarantee that, if honestly made as above, they will give satisfaction as to durability, and will run smooth and cool, and cost some eight or nine cents per lb. less than bronze. The senior proprietor of this mill, an excellent mechanic, live, progressive, and full of ideas, brought up in a mill, knows the requirements of rolling mill brasses probably as well as any man in this country; and in order to have the best of the kind that could be produced, he has all his brasses made on the premises, for his own use only, out of the best materials that can be procured; hence the extraordinary duty performed by the brasses in his mill. He also adopted a plan of preventing the cinder which gets in between the neck of the rolls; and as it is proved to be a good plan for muck mill brasses, I give it for the benefit of your readers: Bore grooves out of the bearings, 1½ inches wide and ½ inch deep and 1½ inches apart, put them at an angle of 45° with the face of the brass, and fill up said grooves with soft Babbitt metal. Then when cinder or iron gets in, it will travel but a short distance before it reaches the soft metal, and the motion of the roll will imbed it therein so that it cannot protrude and score the neck, as it would were it to stick in the brass.

Another useful plan, adopted by him and now coming into general use, is a mode of preventing screws from getting tight in their nuts. The plan is to plane a key wa or groove in the screw, ½ inch wide, the full length of the screw and down to the bottom of the threads; and it will act like a tap and scrape all the hard, gummy grease out of the nut and always keep it clean and working free. It is a very simple matter, but saves a great deal of time and vexation.

Pittsburgh, Pa. T. J. B.

To the Editor of the Scientific American:

A letter in your paper of January 16 on phosphor bronze bearings for rolling mill journals, giving the results of three trial bearings, is, I think, fatal to the use of that alloy for the above mentioned purpose, as a much cheaper and more durable bearing can be and is obtained by the use of cast iron lined with Babbitt metal. Under the vertical or central shaft of a rotary squeezers a chilled cast iron plate is used, costing a few cents per pound and giving universal satisfaction, as most mill owners can testify. I am of the opinion that if phosphor bronze were put to a fair test, it would be equal to the best alloy of copper and tin, but for good durable bearings, I think nothing can beat the ones I have mentioned. MACHINIST.

Pittsburgh, Pa.

How to Learn Color Tests for Temper.

Says Mr. J. Richards: "Procure eight piece of cast steel, about 2 inches long by 1 inch wide and ⅜ of an inch thick; heat them to a high red heat, and drop them into a salt bath. Leave one without tempering, to show the white shade of extreme hardness, and grind off and polish one side of each of the remaining seven pieces. Then give them to an experienced tool maker to be drawn to seven various shades of temper, ranging from the white piece to the dark blue color of soft steel. On the backs of these pieces paste labels, describing the technical name of the shades and the general uses to which tools of corresponding hardness are adapted. This will form an interesting collection of specimens, and accustom the eye to the various tints, which will, after some experience, be instantly recognized when seen separately."

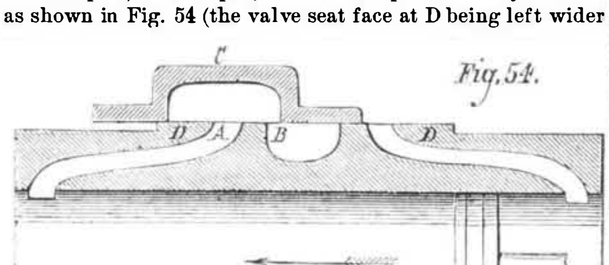
PRACTICAL MECHANISM.

NUMBER XVII.

BY JOSHUA ROSE.

MOVEMENT OF THE PISTON AND THE CRANK.

Let us now place upon the valve a maximum of steam lap, and we shall find an entirely new element under consideration. It is that, although steam lap to a certain amount gives us a more free exhaust, beyond that amount it cramps the exhaust by closing the exhaust port of the cylinder. Suppose, for instance, we give the valve, of the engine upon which we have been experimenting, seven eighths of steam lap (instead of three eighths, as formerly). We shall find that, at one part of the stroke, the valve, after having opened the exhaust port full, will commence to close the cylinder exhaust port, so that, while the steam port (being used as an exhaust port) is full open, the exhaust port of the cylinder is as shown in Fig. 54 (the valve seat face at D being left wider

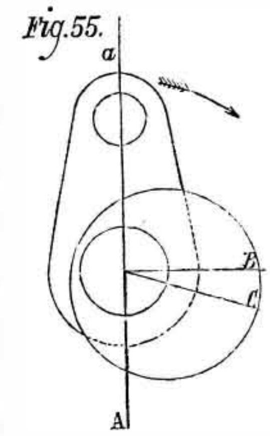


than before, to prevent the steam from blowing through to the exhaust port, as it would do if the face, D, were only as wide as the bridge between the steam and exhaust ports, as in our former experiments), A being the steam port operating as an exhaust port and full open; whereas the exhaust port, B, of the cylinder, is closed to such a degree as to cramp the exhaust to the extent of the difference in width of opening between the ports, A and B. We have, however, already decided that the exhaust opening should never be less (during any part of the exhaust) than one half the full width of the steam port; hence it follows that the maximum of steam lap should in all cases be such an amount as will leave an exhaust opening, at all times, at both the ports, A and B, Fig. 54, equal to one half of the full width of the port, A; and it also follows that the limit to which a valve may be made to work expansively is defined or governed by the width of opening which it will leave at B.

We will now place the engine upon which we have experimented under conditions to work to a maximum of expansion, giving to the valve seven eighths inch of steam lap on each side, by increasing the valve travel to three and nine sixteenths inches, and lengthening the eccentric rod one eighth inch (which will be necessary for the increased travel).

Having effected these alterations and moved the engine round a revolution, the first thing to attract our attention is that the front steam port is not left full open by the valve at any part of the stroke, making it appear that the eccentric rod is either too long or that the valve is not properly set; that neither of these defects exists is proved by the fact that the valve lead is equal at each end of the stroke while our valve travel is sufficient to fully open both ports (provided the valve movement were regular); for the width of the steam port, seven eighths, added to the steam lap, seven eighths, amounts to one and three fourths inches, which, multiplied by two, is three and a half; whereas, our travel is three and nine sixteenths inches, or one sixteenth more than would appear to be actually necessary. The valve travels over and beyond the back port to the amount of the deficiency of the opening of the front port added to the one sixteenth inch of increase of travel, and this irregularity of movement is irremediable in all valves having a maximum of steam lap; so that, if the lead be made equal at each end of the stroke, the front port never opens (as a steam port) to its full width. The irregularity is not, however, a very serious defect, since it does not affect the port unfavorably as an exhaust port, and since the port is, of itself, wider than it would require to be if used as a steam port only, and is, therefore, open sufficiently for the admission of the steam. It will naturally occur to the mind that this defect could be remedied by increasing the valve travel; but were recourse had to this expedient, it would cause the valve, when in the position shown in Fig. 54, to leave the opening, at B, still less; and we must, therefore, leave the valve travel as it is, bearing in mind that an increase of valve travel, while advantageous, as we have already shown, to a valve having a small amount of steam lap, is inadmissible, except it be to a very small degree, in one having a maximum of such lap.

The causes which effect partial closure of the front port are those set forth in Fig. 53 and its accompanying explanation. We have given the valve three fourths of an inch more travel than it had in our former experiment; and the effects of this increase are experienced more in one part of the valve travel than in another, as already explained. We have also increased the lap of the valve, and have had, as a natural consequence, to increase the lead of the eccentric so as to get the same amount of lead on the valve as we had in our previous experiment (that is, one sixty-fourth of an inch); for an increase in the amount of the steam lap on a valve necessitates an increased amount of lead of the eccentric (to get an equal amount of lead on the valve) and therefore a greater irregularity in the movement of the valve. The lead of an eccentric (which gives us the lead of the valve) is the amount to which it is set so that its throw line stands in advance (in the direction in which the engine is to run) of a line at right angles to the center line of the crank, as shown in Fig. 55, A A being the center of the line crank; B a line at right angles to A A; C the throw line of the eccentric; and the distance from C to B, at the periphery of the eccentric, the lead of the eccentric, the arrow denoting the direction in which the engine is to run.



In a former experiment, we found that increasing the throw of the eccentric, and hence the travel of the valve, rendered it necessary to diminish the lead of the eccentric, and therefore tended to diminish the irregularity of the valve movement. The reason, in that case, was that no addition had been made to the steam lap of the valve; for if such an addition had been made, the eccentric would have required to have been given increased instead of diminished lead, as shown in Fig. 53.

Proceeding with our maximum increase of steam lap, we find the movements to be as follows:

TABLE NO. 11.—FRONT END.

Piston moved inches	Port open inch	Piston moved inches	Port open inch
1	5-8	7	1-2
2	3-4	8	5-16
3	13-16	9 1-4	closed, and expansion begins
4	13-16		
5	3-4 full	11 3-8	closed, but expansion ends
6	11-16		
		12	exhaust port open full

TABLE NO. 12.—BACK END.

Piston moved inches	Port open inch	Piston moved inches	Port open inch
1	13-16	6	5-8
2	7-8	7	7-16
3	7-8	8 5-8	closed, and expansion begins
4	7-8		
5	3-4	11	closed, but expansion ends
		12	exhaust port open full

We find here that the steam in the back end commenced to work expansively three quarters of an inch earlier in the stroke than that in the front end of the cylinder, and that it was used expansively during two and five eighths inches of the stroke instead of two and one eighth, as in the front stroke; and furthermore, that the steam in the back end commenced to exhaust when the piston had moved eleven and one eighth inches of its stroke, leaving it to travel the other seven eighths of an inch without any pressure behind it; while the steam in the front end commenced to exhaust when the piston had moved eleven and three eighths inches of the stroke, leaving it to travel the other five eighths without any steam pressure behind it.

Such are the irregularities due to the employment of a maximum of steam lap and its accompanying lead of eccentric, the greatest defect of them all being that the exhaust port opens too early in the stroke, and thus the engine loses a large part of the effectiveness of the steam. It is the variation of the exhaust port opening after the piston has commenced its return stroke (which does not, therefore, appear in the previous tables) that prevents us (as before stated) from adding any more steam lap to the valve, as is shown in the following tables of the exhaust openings:

TABLE NO. 13.—EXHAUST AT THE FRONT END.

Piston moved inches	Port A, Fig. 54, open inch	Port B, Fig. 54, open inch
11 3-4	3-8	1 3-4
12	7-8	1 3 8
Return stroke		
1	7-8	5-8
2	7-8	1-2
3	7-8	1-2
4	7-8	9-16
5	7-8	11-16
6	7-8	7-8
7	7-8	1
8	7-8	1 5-16
[illegible]	3-4	1 5-8
[illegible]	3-8	1 3 4
[illegible]	closed	

[illegible]LE NO. 14.—EXHAUST AT THE BACK END.

[illegible]	Port A, Fig 54, open inch	Port B, Fig. 54, open inch
11 [illegible]	7-16	1 3-4
12	7-8	1 7-16
1	7-8	7-8 barely
2	7-8	11-16
3	7-8	5-8 full
4	7-8	11-16
5	7-8	3-4
6	7-8	13-16
7	7-8	15-16
8	7-8	1 1-8
9	7-8	1 3-8
10	5-8	1 11-16
11	3-16 full	1 3-4
11 1-4	closed	

We here find that the exhaust opening, during the early part of the stroke, that is, from the first to the fifth inch of piston movement, was less at B than it was at A, in Fig. 54, and was, at one part of each stroke, but little more than one half the full width of A, and therefore as small as is compatible with an exhaust sufficiently free for a fast running engine. We have, in point of fact, by the partial closure of B, filched from the exhaust opening to enable us to use the steam more expansively; and in the case of a very fast running engine, we have rather lost than gained by the operation. In locomotives (the piston travel being very fast) sufficient steam lap is employed to leave the opening at B equal, at all parts of the stroke, to the full width of the steam ports.

It has been already remarked that lap on the exhaust side of the valve is sometimes employed to prevent the steam from exhausting too early in the stroke; and that, whatever the amount of such lap, it cramps to a like amount the exhaust opening. How then, it will naturally be asked, can exhaust lap be employed at all, since the opening at B is already as small as admissible, and such lap would make it still less? This leads us to the consideration of the width of the exhaust port of the cylinder, that is to say, of the port, E, in Fig. 47. We have in all our previous experiments made this port twice the width of the steam port, which is the proportion generally employed; and which proportion is ample, providing that the amount of steam lap is not more than three quarters that of the width of the steam port; because, up to that amount, the exhaust opening at B, in Fig. 54, will, at all parts of the stroke, be equal to that at A, in Fig. 54, while beyond that amount it will be, as shown, less than at A.

The width of the cylinder exhaust port may be, if the valve have little or no steam lap, even less than twice the width of the steam port; for instance, the port, E (Fig. 47), has been in all our experiments one and three fourths of an inch wide, the steam ports being seven eighths of an inch wide; but the valve having no steam lap, the port, E, may be made one and one half inches wide only, in which case (the bridges and steam ports remaining unaltered in width) the valve would require to have a narrower exhaust port, and would hence be to that amount narrower in its total width, thus reducing the area of its back face, upon which the steam acts to press it to its seat, and hence reducing the friction upon its face and the power required to move it.

Finishing Microscopic Slides.

The object and a moderate quantity of balsam are covered with thin glass in the usual way, and, if the object is small, held down with a spring clip to prevent displacement. The slide is then boiled either over a spirit lamp or, better still, over an ordinary microscopic lamp. Vapor of turpentine is freely given off, which, as the slide cools, contracts, drawing under the superfluous balsam, which should be kept round the glass cover with a needle. When cool, the balsam may be chipped off with a knife, and the slide finished in the usual way. The cover can never be displaced, as is too often the case where the slide is not boiled. A little practice will tell when the boiling has gone far enough, as, if continued too long, the bubbles formed during the process will not disappear, and the slide will be spoiled.

IN the article on balloons, page 64, current volume, in 1st example: For 5,026·5 pounds, substitute 5,026·5 feet. Section (*e*) of the rule: For buoyant effect, substitute square of the buoyant effect. Formula at end of article: $x = \frac{2a}{b - \left[\frac{8a^3}{b^3}\right.}$, etc., should read $x = \frac{2a}{b} + \left[\frac{8a^3}{b^3}\right.$, etc.