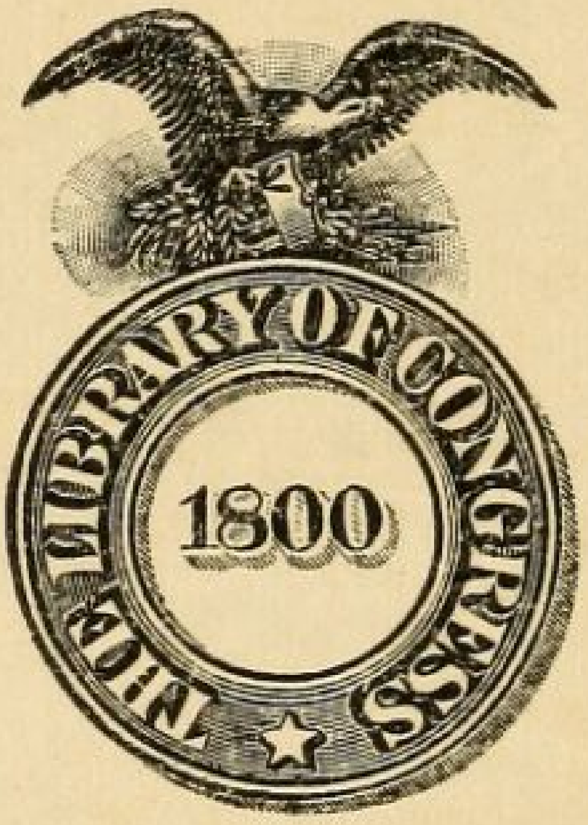
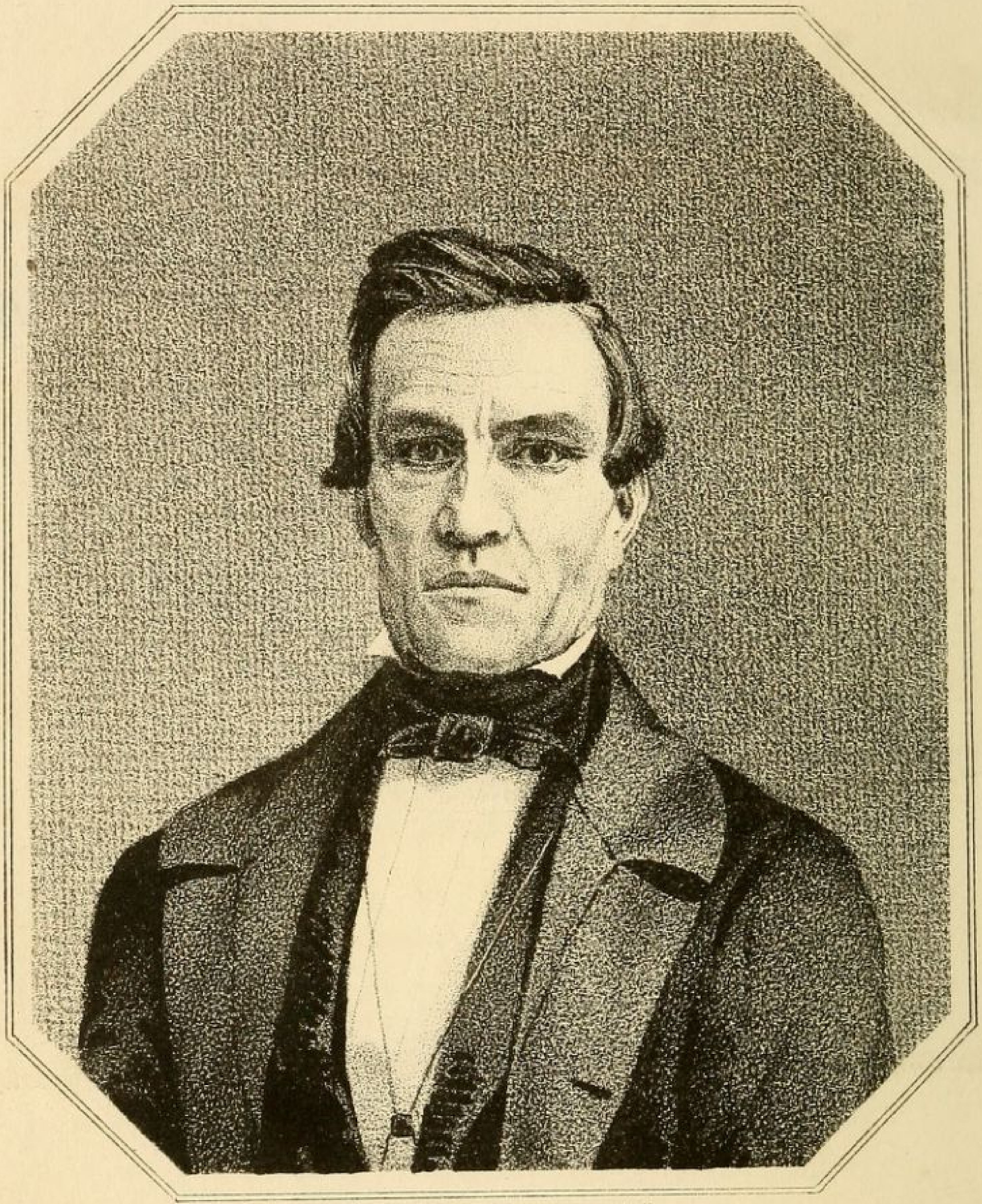




W. Schuchman, Lith.

John Wallace.

THE

PRACTICAL ENGINEER:

SHOWING

THE BEST AND MOST ECONOMICAL MODE FOR MODELING, CONSTUCTING
AND WORKING STEAM ENGINES, WRITTEN IN A PLAIN, CONCISE AND PRACTICAL STYLE, AND DESIGNED ESPECIALLY FOR PRACTICAL ENGINEERS, STEAMBOAT CAPTAINS AND PILOTS.

ILLUSTRATED WITH NUMEROUS DIAGRAMS, DRAFTS AND PLATES.

BY JOHN WALLACE,
PRACTICAL ENGINEER.

PITTSBUGH:
KENNEDY & BROTHER, PRINTERS AND PUBLISHERS, THIRD STREET
1853.

PREFACE.

The author presents to the public this volume on "practical engineering," in the full confidence that such a work has long been desired, and is very much needed by the practical engineer, as well as those who have had little or no experience in this department of science, but whose business requires the aid of steam power. There have been many scientific works published upon the subject of steam, and various other matters connected therewith, altogether foreign from the object sought to be explained; if they were, indeed, intended to assist and instruct the practical engineer. We venture the assertion that there are a hundred things, aye, a thousand, the knowledge of which would be beneficial to the practical engineer, which have not been alluded to nor mentioned in the books hitherto published on this important subject. The reason of this may be attributed to the fact that men of *mere theory* have undertaken to put forth books for the purpose of instructing *practical* men in matters which the authors have never learned, and about which they are totally ignorant. So far as the therory is correct, they are entitled to credit for its promulgation.

But abstract theory can never meet the wants and instruct and assist the practical engineer in working steam engines. In other words, it is folly to presume that a theorist alone, can be possessed of such a correct and praciical knowledge of steam engines, as will meet the hearty response and approbation of that class of persons for whose benefit he publishes his treatise. It will readily be conceded then, that a work, in order to be useful, must issue from one who is acquainted not only with the *theory* but with *practical* engineering; and it must exhibit in every page evidence of the author's practical experience. When such is the case, practical men will not only at once perceive the author's capability to explain and elucidate the different branches of the subject upon which he writes, but will be much pleased and instructed from a perusal of the work. Such a book is now presented.

The author of this work had long experience in practical engineering, extending through many years, in various places, and with almost every description of engines. His sources of knowledge are therefore extensive, and the results of his information are given in the pages of this work in a plain, concise and practical style. He has been employed in constructing and working at engines of various kinds, in Pittsburgh, Wheeling, Cincinnati, Louisville, and New Albany, Indiana; and was for some length of time a practical engineer in running the Ohio and Tennessee rivers.

His knowledge of land and stationary engines is quite as extensive as that of any other persons in general, and he feels therefore confident of the utility of the present work to practical men.

The author has had in contemplation to publish a work of a character corresponding to the present one, for some eight or ten years, thinking that the public would be benefitted from its perusal; but hoping that its place would be superceded by some one of merit and usefulness, the project was time after time abandoned. After having perused many works from which engineers (himself among them) expected to derive benefit and information, and finding them wide off the point sought to be obtained, he was persuaded to rusume the task of compiling a book applicable to the wants of the practical engineer.

This volume, therefore, has been written and compiled especially for the practical man; but its pages will be found both interesting and instructive to the engine builder. They would do well to consult its pages previously to modling machinery for steam engines. It is entitled "The Practical Engineer," and should be in the hands of every steamboat Captain, as well as engineer. It will not only instruct him in many things of which he is ignorant respecting the machinery and workings of the engine, but will be of great use in enabling him to draw up an order for an engine, with so much clearness and accuracy as to enable the builders to perfectly understand what is required, and upon what terms it can be filled. This is an important consideration, and one which, unfortunately, Captains have been heretofore too little acquainted with. It will also be found of interest and profit to the Pilot to read this work, as it may lead him to the discovery of danger from the working of the engine, and put him upon cautionary guidance of the helm, &c.

The second volume will be devoted exclusively to mill, factory, and other stationary engines.

In conclusion, I would say to the practical engineer, engine builder, captain and pilot of boats, make this book your study, so far as duty requires, and you will find that your time has not been lost; but, on the contrary, you will be possessed of such a general knowledge of steam engines, as you little thought of previous to its perusal; and upon the strength of which you can each embark upon your respective duties with confidence, knowledge and a certainty of greater success.

JOHN WALLACE.

Pittsburgh, July 1, 1853.

CONTENTS.

BOILERS.

DIAMETER OF BOILERS.

FOR the use of steamers in general we are not in favor of small boilers,—nothing less than 34 inches in diameter. This is as small as a man can properly clean out, and small enough for raising steam. Nor do we think it would be good policy to go over 4 feet in diameter for our high pressure engines. 40 and 42 inch boilers are as large as they are generally made, but we believe large boilers make much more steam, in proportion to the amount of fuel used, than small ones.

SHORT BOILERS.

A great quantity of the heat is lost in using the short boilers, and we have frequently seen the blaze issuing from the tops of the chimneys of both river and land engines.

LONG BOILERS.

Long boilers are now coming into general use. They have used them on our rivers 40 feet in length, and cylinder boilers have been made 42 feet long for land use. This, we think, is going to the opposite extreme ; 40 feet is too long for a steamboat boiler. Such a boiler can hardly stand under its own weight without a center bearing, and under a steamboat boiler we do not approve of it. We believe it is too great a distance to carry the heat for making steam, whenever your boiler goes beyond that length, that it ceases to create steam. It only adds unnecessary weight, takes up unnecessary room, and acts as a condenser to cool what steam has already been made, and of two evils choose the least. It is better policy in this case, that the boiler be too short than too long, for several reasons: long boilers require much longer time to raise steam, and they will spring easier than if they were shorter, and by being too long they condense the steam at one end of the flue while you are making it at the other end of the boiler. Besides, they will not stand their own weight in hauling, or rolling, without being materially dinged, unless they are handled by skillful persons with the greatest care and precaution. The medium length of boilers is generally the best. Never choose either of the two opposite extremes. We would say, for general use, from 24 to 34 feet in length will be about the best length, varying the length from the one to the other to suit the different diameters of boilers and sizes of boats on which they are to go.

THICKNESS OF BOILER IRON.

No steamboat boiler made for high pressure engines, having boilers 24 inches and upwards in diameter, should be allowed to be put on boats less than $\frac{1}{4}$ inch thick, and all boilers over 42 and up to 48 inches in diameter, should be made of 5-16 iron. We would here suggest an idea for the consideration of those who are ordering engines to be built, about the propriety of having four sheets or more of the boiler iron above the fire, 1-16 of an inch thicker than the balance of the boiler, as that part of the boiler is the most exposed to the heat or action of the fire and is more likely to burn or bag than any other part of the boiler. We think it would be economy to make boilers in this way. In addition to this, we would suggest another idea to your minds for consideration, and we are fully satisfied on this subject that we are right. It is this: that the last sheet of iron in the bottom of each of the boilers should be made of iron $\frac{1}{8}$ of an inch thicker than the iron in the boiler hull. This is the sheet to which the boiler stand is to be fastened to.

The object of this sheet being thicker is, that the boiler will stand more firm and secure, and have a larger and stiffer bearing upon the body of the boiler than it now has upon a sheet of the usual thickness, bearing upon the small surface of a narrow flange outside of the stand pipe.

The sheets of iron on top of the boiler, which the steam pipe is fastened to, we would have the same way; and all boilers fastened together with screw bolts should be ⅛ thicker than the boiler hull iron, because ¼ inch between the bolt springs. The iron is not sufficiently strong to be screwed up tight and hold large boilers together.

We are aware that wrought iron steam and stand pipes are now used, and that they are riveted on to the boilers and hold the iron close together between the rivets; but still that does not prevent the boiler from springing up and down, like a basket, on the boiler stands, owing to the great weight on such a small surface of thin iron.

If you could bring your boiler stand, like a land engine, to rest on the boiler head, then it might do—but this cannot be done. Had the plan which we now speak of been adopted when the cast iron steam pipes were in general use, the use of the extra flages inside the boilers under each steam pipe branch, with six holes in it, for the purpose of making the boiler iron stiff enough to be screwed up tightly, and help to stiffen the iron between the bolt holes, could have been entirely dispensed with. This method of strengthening the boiler iron is frequently adopted, and we deem it *patching up something that was not sufficiently strong in the first place.*

If boilers were made stiffer, as we have proposed, there would be less danger of the joints breaking, or of them leaking whenever exposed to stormy weather, or any ill-usage caused by the motion of the boats.

We think that our government should not allow any steamboat boilers to be used of less than $\frac{1}{4}$ inch iron, of good quality and warranted. Boilers over 42 inches in diameter, 5-16 of an inch thick, and the extra $\frac{3}{8}$ sheets we have alluded to for the boiler connections and the steam pipes, you may not at present be disposed to adopt; but the last sheet of iron on the bottom of the boiler that rests upon the top of the boiler stands and bears up the whole weight of the boiler, should be made $\frac{1}{8}$ of an inch thicker than the boiler hull. Let every one who is interested in the welfare of the community, and especially the traveling community, see to it. We have no doubt but that the time will soon arrive when this plan will be generally adopted.

THICKNESS OF FLUE IRON.

The iron used for making boiler flues should be full as thick as the iron used for the boiler hull, for three reasons:

1st. It is much easier to collapse a flue than to burst a boiler.

2d. We very frequently hear of flues collapsing where it is stated that there was a sufficient quantity of water in the boilers; and we believe it, from the fact they have frequently collapsed when about starting out, and also when obliged to stop for a few minutes on account of business, after having started. We recollect once seeing a boat, below the Falls on the Ohio river, that had collapsed her flue, and which, we believe, was under way at the time the accident happened. When we saw her she was in the middle of the river, and they were endeavoring to bring her to shore. The bow was covered with steam.

3d. If the water gets a little low in the boiler, the tops of the flues becomes bare and are liable to become red hot; and by being heated more on the top they become weaker just in proportion as they are heated, and under the pressure of the steam, flatten or press together.

Experience and demonstration of the facts will not admit nor allow of any argument to prove to the contrary, but that the flue iron made of the same thickness of the boiler, is weaker than the boilers, and for this reason they should be made proportionably thicker than the boiler hull. Another point requires particular attention in the construction of flues: that they be exactly round,—not having any flat places,—for this materially destroys the strength of the flue; and if any part is more likely to give way than another, it is that part which is out of round.

BOILER HEADS.

THICKNESS OF BOILER HEADS.

Steamboat boiler heads should always be made of wrought iron. The time was when we almost universally made them of cast iron. There are two objections to cast iron heads on steamboat boilers: they often break between the flues, and they are too heavy. Wrought iron heads for 34 inch boilers should not be less than ½ inch thick; 36 inch boilers 9-16; 38 and 40 inch boilers ⅝ thick; 42 11-16 and up to 48 inches in diameter, ¾ inch thick. Both front and back boiler heads should have at least two strong braces in each head, and large boilers more, if thought necessary. The back head in which the man plate goes, should have a large band riveted inside of the boiler head, around the man hole plate, to make the boiler head stiff so as to stand screwing up tight. Sometimes these heads are made of a solid sheet, and flanged for riveting to the boiler; others are made of gunnel iron, with a flat piece riveted inside. This, we believe, is the stiffest head of the two, but either of them are good enough if they are well made.

SINGLE AND DOUBLE FLUED BOILERS.

We are opposed to the use of single-flued boilers, believing it to be bad economy on the part of those who get them made. No doubt it is generally done with a view to save cost on the part of those who get them; for one flue costs less than two. But the cost does not stop here,—and there are other things to be taken into consideration. There will be more opening in two flues than can be had in one, thereby producing a much better draft, and the flues being less in diameter will be much stronger ; and being lower down in the boiler there will be room for a sufficient quantity of water to cover the flues. In addition to this there will be more room in the boilers for holding steam, and more steam can be produced in a shorter time with two flues than can be made with one.

ELBOW-FLUED BOILERS.

Formerly elbow-flued boilers were much used, but are now dispensed with altogether. The elbow flue joins the bottom of the boiler about three inches from its end, and by this arrangement a great deal of heat (which in the present boilers is lost on the back of the fire bed and back plates,) is applied to the raising of steam. The principal advantage to be gained by the use of elbow-flued boilers is the power they have of generating more steam than those now in use, but this advantage is of no practical account from the fact that the pressure of steam is unequal on the elbows of the flue; and although they are braced up with bolts, yet they cannot be made sufficiently strong, but are apt to collapse in the elbow which is the weakest part of the flue. This makes it unsafe and of course unfit for use.

FLUED BOILERS.

Quarter circle flued boilers are quite as dangerous as elbow flues. They work on the same principle but differ a little in their construction. They take up about two feet less room in the length of the fire bed and absorb most of the heat returning into the flue; but they are unsafe for high pressure engines and therefore unfit for use.

CAUSES OF BOILERS EXPLODING AND FLUES COLLAPSING.

The explosion of boilers and collapsing of flues proceed from various causes, a few of which we will endeavor to show. First we will speak of the explosions of former years and then refer you to some of modern days and compare them together. In former times boilers were seldom made more than half the length of those in present use. Sixteen, eighteen, and tweenty feet used to be a common length for steamboat boilers, and being so short they were sooner filled with water than the present large boilers can be, and also much sooner boiled dry or emptied of water by the blowing off of steam. As soon as the engine stopped the steam would be blowing off, carrying more or less of the water in the boiler with it, and consequently required more regular attention to the water than the boilers of the present day,—owing to the additional length. The extra length of the boilers of the present day allow about double the room for steam, and by opening the furnace doors and flue caps, there is but little necessity for blowing off steam, compared to that of former days.

We would also state that although the long boilers generate more steam in the same length of time, in proportion to the amount of fuel used, than the short ones, when either of the engines are stopped, the short boilers will commence blowing off steam almost instantly, and that with the furnace doors and cap flues open. The reason of this is that the heat is much greater on the short, to the amount of boiler, than it is on the long boilers. Hence we believe that the principal cause of explosions in former times to have been the small amount of water that was carried on the top of the flues in the boiler. The lower gauge cock, which was also the water gauge, was placed at about an 1½ or 2 inches above the top of the flues, and the upper cock was about 2½ or 3 inches above this. Now while long boilers generaly carried from five to six inches of water on the top of the flues and had scarcely any occasion to blow off steam, and if it is considered necessary at the present day to carry a greater amount of water than formerly for safety, this proves that the lower water gauge cock carried water too low for safety, and had it been carried in short boilers in proportion as it is now carried in long ones, the lower gauge cocks instead of being one and a half or two inches, would have been 8 or 10 inches above the top of the flues, and this would have prevented many of the short boilers from blowing up, and the same amount of steam blown off as soon as the engine was topped, would have made them nearly as safe as the long boilers.

Taking all things into consideration, it is a wonder that explosions have not been of more frequent occurrence. There was something radically wrong in the former construction of engines. No doubt many good boats have been blown up for want of doctors to keep up a regular supply of water during long stoppages at wood yards, landing passengers, &c. It was formerly customary to stop boats in the channel of the river and send or receive passengers from the shore in a yawl. During these stoppages more or less steam would be blown off, and it was impossible to pump any water into the boilers until the boat could be got under way again. Sometimes, in receiving or discharging passengers, where the width of the river would admit, the boat would run around in a large circle to keep the engines in motion for the purpose of supplying the boilers with water ; and at wood-yards, the wheels were unshipped for the same purpose.

Very soon, however, single engines were succceded by double, which proved of no advantage, for it was more difficult than ever to supply the boilers with water when the engine was stopped. If the boilers were supplied at all the water wheel must be kept in motion, and often the shore engine could not be run at all. To run the outside wheel to pump up water would probably take as much steam as it would require to run the boat, and to supply the boilers at such an expense would have been bad policy. This shows that there was something wanting in the machinery to make it complete.

Not having had time to ascertain the particulars, or to make any inquiries whether there were any doctors used previous to this, we cannot, therefore, give any definite information on the subject. The first doctor we heard of was used on a small steamer called the Orleans, and some four years elapsed after this before they were deemed so important as to become general.

It was about this time that engines were changed from single to double, and this plan was adopted upon the steamer Missouri, a large seven-boiler boat. Immediately after this the doctors came into general use, and are now considered indispensable, especially on large steamers. We can now stop our steamers when and where we please, and as long as may be required, without any fear of water from not running the engines, for the doctor is ready at all times independent of the main engine.

We would here state some particulars in relation to the explosion of boilers. We will also mention the kind of boilers used and state where they exploded. The first was the Moselle, a small three-boiler boat, that exploded while putting out from Cincinnati, and killed about 150 persons. We were well acquainted with both her engineers, the principal one having worked at a shop in Wheeling in which we were a partner. The Moselle made use of the short boilers, and had no doctor. She exploded as she was about putting out, immediately after starting the engines. The Ben Franklin had started just ahead, and we understand the captain said he would beat her, &c.

The Gen. Brown, a four-boiler steamer, running between Louisville and New Orleans, burst her boiler while putting out from a wood-yard, when about mak ing her second revolution. We were acquainted with both those engineers, one of whom was instantly killed. The other survived, but had both arms broken. The latter worked under the same firm while we were principal foreman, at New Albany, Ind. Some forty persons were killed by this explosion. We were but little surprised at the blowing up of this boat, as she was in the habit of making "*brag trips*" from New Orleans to Louisville. The Brown's boilers were short, and she had no doctor, and no doubt there was too much steam and too little water in the boilers, which was the cause of the explosion.

The Tri-Color burst her low pressure boiler while lying at the Wheeling wharf, and killed seven or eight persons. The Wyoming, Kanawa, Kate Fleming, Lucy Walker, Louisiana, and many other boats have burst their boilers, though we cannot say whether they were all lying to or not when the explosions took place, but we are inclined to think they were making ready to put out when the accidents happened.

We will now make some remarks with regard to the collapsing of flues. We saw a steamer called the Chochuma that was said to have collasped her flues while under way just below the Falls of the Ohio, on her trip downward. We saw her in the river, and noticed the steam flying around her bow. At that time they were trying to get her to shore on the Indiana side. Although it may seem strange to some that a boat could burst her boiler or callapse her flues while under way, yet it does not seem in the least strange to us so long as the steam is kept back by checking it off in the throttle-valve, in order to keep up high steam in the boilers. If the engineer should happen to have his throttle-valve a little too close, so as to work off less steam than he makes, the boiler must blow off steam; and if this should be the case, the engineer, not thinking the steam being throttled off so clcse to be the cause of its blowing off, they no doubt hang a wrench or two on the safety-valve lever, and in this way overload it and explode the boiler or collapse the flues while the boat is under way.

We have frequently heard of explosions when there was plenty of water in the boilers, and the engines running at the same time. This may be easily accounted for in the manner we have referred to; but we do not think this has ever happened on the river while working off steam on the engine with an open throttle-valve. We think it bad policy to throttle the steam off too closely; it causes the engine to labor more, and of course the boat must run slower.

A boat collapsed her flue as she was putting out from the Pittsburgh wharf. One of her engineers was instantly killed and the other died next day. We saw both of them. Several others were scalded.

The steamer Fashion collapsed her flue while passing through the lock. She had a doctor on board, and no doubt there was a sufficient quantity of water in the boilers when the explosion took place, but she had too much weight on the safety-valve.

To this, we believe, may be attributed the explosions of all the boilers heretofore alluded to. Of all the flues that have collapsed on the steamers above referred to, not one of them, that we are aware of, had a doctor for supplying the boilers with water in case of an emergency. And all the boilers (we except the Louisiana—never having seen her, we are not positive as to the length of her boilers—however, we are inclined to think they were short,) were shorter than those used on large steamers of the present day.

Now, when we compare the long boilers with the short ones, we find that there is not one fourth the danger of them exploding; nor can as much steam be made, in proportion to the amount of iron used, with long as with the short boilers.

COLLAPSING OF FLUES.

[See page 18.]

As a general thing, the flues are not made as strong as the boiler hull. The flues of large boilers, 40 and 42 inches in diameter, should be 1-16 of an inch thicker than the boiler hull iron; that is, all flues 14, 16, and 17 inches in diameter, should be 5-16 inch thick, and for 18 inches and upwards in diameter, the thickness of the iron should be increased in proportion to the increased diameter of the flues.

Another cause of collapsing of flues is, the water being suffered to get too low in the boilers, and the dry part of the flue being exposed to the fire becomes weakened and gives way under pressure of the steam. And still another cause is, the carrying of steam too high in the boilers. Flues should be made as round as possible, for if they have flat places in them they are much more liable to collapse.

We have never heard of long boilers, say from 30 to 40 feet, blowing up. But we do not wish it to be inferred from this that they cannot be blown up. Now, when a boat is detained, for the purpose of discharging or receiving passengers, although the furnace doors and flue caps are thrown open, the fire remaining in the furnace is quite sufficient to explode or collapse the flues of the short boilers; yet the same fire under the long boilers would not, nor could not do any harm, and if let alone, would burn out. To explode them at all would require additional fuel. A double length boiler, 40 feet, as we have already shown, will not generate as much steam as two 20 feet boilers, and the amount of steam less will be just in proportion to the difference of heat in the first 20 feet of the boiler, where the fire lays, and the last 20 feet, where it is much fainter. The heat of the fire being much stronger, in proportion to the amount of iron used, and the water being carried much lower than at present, was one of the great causes of explosions of former days.

CYLDINDER BOILERS.

Cylinder boilers, from 18 to 30 inches in diameter, have frequently been tried for propelling light steamers, ferry boats, tow boats, &c. Those who used them no doubt thought they would answer a good purpose, but a few trials soon proved the contrary. We recollect of two steamers, the Harlem and the Franklin, that used them for a short time. The Harlem had five of these small boilers, 18 inches in diameter, and the Franklin four, of the same diameter ; but after giving them a fair trial, they were taken out and replaced by doubled-flued boilers.

There are many objections to these small cylinder boilers: they are too small to be properly cleaned out, and a great deal of the heat is lost in the chimney. The heat from the chimneys, in warm weather, is a great annoyance, and the boat at all times is liable to take fire from it.

The small cylinder boilers at best, are but poorly calculated for generating steam, and as a general thing should not be used on steamboats.

DISTANCE BETWEEN BOILERS.

It has been the custom to set boilers but 2 inches apart between the boiler heads, leaving, where the iron was not more than $\frac{1}{4}$ inch thick, but $1\frac{1}{2}$ inch between the hulls of the boilers; but at present it is quite common to have them 6 and 8 inches apart. This gives more fire front under the boilers, allows the flame and heat of the fire to get between the boilers to better advantage, and makes steam much sooner than if they were closer together. For proof of this, examine two boilers that are close together and they will be found black and sooty; then examine two that are from 6 to 8 inches apart, and they will be clean and white, like a well-heated oven.

HOW TO SET BOILERS.

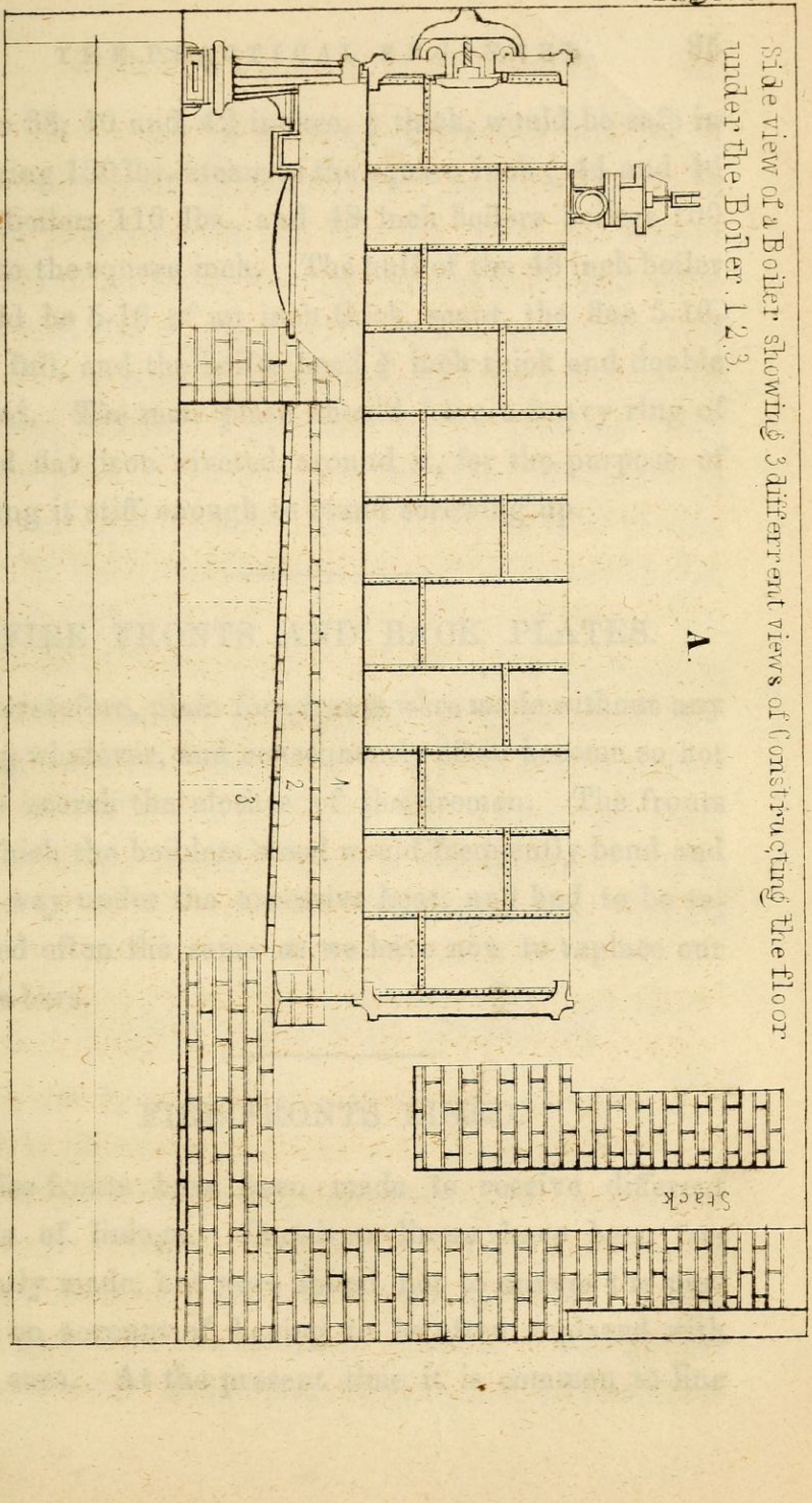
In order to set boilers on a level when the boat is in trim, fore and aft, some persons measure from the kelson up, allowing for the thickness of the deck plank, and thus make the boilers level or parallel with the kelson, fore and aft. The most simple and correct way, however, after the boat is equally trimmed, is to place a little clay in each end of the boiler flues and then put some water into them. Should the boat be a little more draft, at the head or stern, of course a proportionate allowance should be made.

WEIGHT OF STEAM TO BE CARRIED.

The experience and practice of our engineers proves beyond the shadow of a doubt, that the steam used for propelling boats on the Western rivers is sometimes carried too high. Explosions of boilers and collapsing of flues are of frequent occurrence. These things need not be—should not be. And, therefore, we think it is the duty of the government to set limits and bounds to the actions of those who go beyond reason, and know not where to stop. Those who thus recklessly endanger the lives and property of their fellow beings, have yet to learn their duty. Government, we say, should interpose its authority by regulating the weight of steam to be carried. Humanity demands this, and points to thousands of widows and orphans, left destitute and unprotected through ignorance or negligence. Is man his brother's keeper ? Most assuredly, we answer ; and government should prove the careful keeper of its subjects by framing efficient laws to protect their lives and property. Proper officers ought to be appointed, whose duty it should be to investigate all the circumstances connected with the explosions of boilers and collapsing of flues, and bring the offenders to public account.

We have been agitating this subject for some years, remarking the danger of carrying steam too high, and are glad to learn the government has taken the matter in hand. We understand that it is carried from 150 to 175 and up to 200 lbs. per square inch. Actions speak louder than words, and we want no apologies in justification of the past, but should see to it for the future that steam is not carried too high.

All boilers 36 inches in diameter, made of ¼ inch iron, and the boiler heads in the proportion, having the flues full ¼ inch thick, might be safe in carrying 130 lbs. of steam to the square inch. Th pressure of steam should be reduced in proportion to the wear of the boilers. All boilers 38 and up to 40 and 42 inch. having flues and boiler heads proportioned as above, boiler hull ¼ inch thick, full flues 5-16 inch. and boiler



Side view of a Boiler showing 3 differrent views of Constructing the floor under the Boiler. 1.2.3.

heads 38, 40 and 42 inches, $\frac{5}{8}$ thick, would be safe in carrying 120 lbs. steam to the square inch ; 44 and 46 inch boilers 110 lbs., and 48 inch boilers boilers 100 lbs. to the square inch. The hull of the 48 inch boiler should be 5-16 of an inch thick, scant, the flue 5-16, very full, and the boiler head $\frac{3}{4}$ inch thick and double braced. The man plate should have a heavy ring of broad flat iron riveted around it, for the purpose of making it stiff enough to stand screwing up.

FIRE FRONTS AND BACK PLATES.

Heretofore, plain fore-fronts were made without any lining whatever, and consequently often become so hot as to scorch the clothes of the firemen. The fronts on which the boilders stood would frequently bend and give way under the excessive heat, and had to be replaced often the same as we have now to replace our grate-bars.

FIRE-FRONTS LINED.

Fire-fronts have been made to receive different kinds of linings. Cast-iron liners have been frequently made, but were found not to answer the purpose on account of having to be often replaced with new ones. At the present time it is common to line fronts with fire-bricks, which is by far the best plan of any yet adopted. Sometimes the liners that are to receive the brick, are cast on the fire-fronts, and at other times cast separately, and bolted on to the fire-fronts with screw-bolts. The latter is the best plan. These fronts are quite cool and pleasant for the firemen, and seldom need repairing. Another great improvement in fire-fronts would be to let the grate-bar bearer, in front of the liner, extend five or six inches beyond the liners for receiving another course of brick, the narrow way, *b* (or lengthwise, if you please, nine inches,) the casting to be, say 4½ inches in the clear. This would keep the furnace doors still more cool, and be easier on the edges of the liners. The fire in this place can do no injury to the fronts or liners for want of air. [See letter *b* in brick, draft A, a side view of a boiler, page 50.]

BURNING OUT GRATE-BARS.

In order to prevent the burning out of the grate-bars, it is necessary that the ash-pit should be kept well-cleaned out. Some ash-pits require cleaning out oftener than others—depending altogether upon the depth. Formerly ash-pits were made so shallow as to require almost constant cleaning, and still they were continually burning out the grate-bars. Now they are much deeper, but still they must be cleaned out occasionally, yet not half so often as the shallow ones of former days.

BACK PLATES.

Back plates should be firmly fastened to the boilers. They are sometimes laid on top of the brick wall and on the top of the flue, with nothing to hold them fast to the boiler when expanding or contracting, and the result is, that the draft is partially destroyed, the smoke and sometimes sparks escape, making it quite disagreeable. There is also much danger to be apprehended of fire from the sparks. The best plan for fastening them securely to the boiler, is to cast lugs on the back plates, drill holes in the lugs and boiler heads and tap them, and then fasten the plate to the boiler head with set screws, cover the joint over with mortar, and the job will be complete. [See back plate on draft C, page 50.]

STEAM AND STAND PIPES.

CAST-IRON STEAM PIPES.

The pipes used on the first steamers were made of cast-iron altogether. The steam pipe, from the boiler to the cylinder, had a stuffing box and a slip joint allowing it to come and go as the spring of the boat might require. The supply pipes, from the force pump to the boiler, were also made of cast-iron. These were the kind of pipes used on the Western steamers about the year 1820. They answered very well for slow running boats, but as the speed of steamboats began to increase something of a more malleable nature was required,—something that would yield and accommodate itself to the spring or settling of the boat, and not be liable to break or crack. But a few years elasped however before this deficiency was supplied, and the cast iron were superceded by the copper steam and supply pipes, which proved to be far superior, and are still in general use.

But we wish to call your attention more especially to the cast-iron steam pipes, now gradually going out of use. Where they were strong they answered a very good purpose. Frequently, no doubt, steam and stand pipes have been broken by the boat being ladened out of trim, or by its settling. Steam pipes are less liable however to be broken by the settling of the boat than stand pipes. Steam pipes have frequently been broken by coming too suddenly in contact with the shore when landing, or striking a bank or bluff, seriously injuring those on board by being scalded with hot steam. Pilots cannot be too careful in landing a boat, and should approach the shore as steadily as possible.

Wrought-iron steam and stand pipes, we think, are still better, and will soon come into general use. They will come and go without danger of suddenly breaking. In this they are similar to the copper, but in other respects they are vastly superior to the cast iron pipes: they need no joints, being riveted close to the boiler.

We would recommend to all those who wish to fit out good boats to have wrought iron stand and steam pipes, and copper or wrought iron steam and supply pipes, from boiler to cylinder, and from force pump to boilers.

CAST-IRON STANDS CONNECTED WITH COPPER PIPE.

The plan of cast-iron stands with copper connecting pipes was in use at an early day in the history of steam. The boilers rested upon the stands which were connected, one with the other, by copper pipes, on each end of which were stuffing-boxes, so arranged as to allow them to come and go. This, while it answered the intended purpose, was attended with great labor and expense.

WROUGHT-IRON STEAM PIPES.

Wrought-iron steam pipes, placed upon the top of the boilers, are considered a great improvement, as there is no danger from breaking or cracking from the settling or springing of the boat. Another advantage is the steam drum, on top of the boilers,—which acts as a small reservoir, and is a preventive to the drawing of water. If any water at all, may be drawn by the steam in this drum, it has a chance to go back and return again to the boiler. It is not good policy to have too large a steam drum. We would say that there might be as much capacity in the steam drum as in the two cylinders. If it goes beyond this, the drum will act as an unnecessary condenser. It acts as a condenser at the best; still, it may be a necessary evil to prevent the drawing of water and give dry steam to use in the cylinder.

It is not essential that the drum be very large, so that the openings from the boiler to the steam drum are sufficiently large to prevent the water from rising with the steam, as it is taken from the boiler into the steam drum.

WROUGHT-IRON SUPPLY-PIPES.

Wrought-iron supply-pipes are now coming into general use, and we would say that they are superior to any heretofore in use. There is one thing, however, which we wish to impress upon the minds of persons fitting out large steamers, (or even small ones with large boilers.) It is, (and they should see to it,) that the last sheet of iron in the bottom of the boiler, on which the stand-pipe is riveted, and upon which one end of the boiler rests, should be ⅜ inch in thickness. It will then take a more general bearing upon the body of the boiler, than the small stand-pipe with a narrow flange can do. This we consider essentially necessary to the making of a better and a stiffer job than can be done without it. It is the lack of this stiffness in the boilers, at this point, owing to the small bearing of the stand-pipes on ¼ inch iron, which causes them to spring up and down like a basket, or as though they were resting on a spring-board. When they come into rough water, or the waves caused by the passage of another boat, the safety-valve will spring up and down, bound and rebound, and causes the blowing off more or less steam, in proportion to its height in the boiler.

We would say to those who wish the boilers to stand on a good foundation, try the recommendation above noted; you can lose nothing by it, but will be sure to gain what we have mentioned. The boiler will be stiffer and firmer than it was on the former plan.

THE DIFFERENT PLACES FOR ATTACHING STEAM AND STAND-PIPES TO BOILERS.

As a general thing, steam is taken from the boilers at the most convenient place, to the engine. For our part, we do not think it makes much difference from what point it is taken. If we had our choice, and it was convenient to do so, we would prefer supplying at the back end of the boilers always, both river and land engines, and take the steam from the middle of the boiler, or from the end over the fire. But on steamers, some take it from the back ring of the boiler, some from the second, some from the third, some from the fourth, and some from the middle, &c. But we do not think that it would make any material difference where it is taken from; we would prefer, however, to take it a little distance from where the water comes into the boiler.

STEAM TAKEN FROM END OF PIPE.

This is known by experience, to all those who have taken steam from two, three, and from six boilers, &c., at the end of the steam pipe, that it always draws the water to the side of the boiler from whence the steam is taken. On the side from which the steam is taken, the water will be found above the upper guage cock, while in the far boiler it will be below the lower guage cock. The diagonal line drawn on the six boilers [draft C, page 50,] shows the position of the water in the boilers. By the exercise of a little judgment in this case, the water may be brought very nearly to a level in the boilers; by opening the furnace doors beneath the boilers furthest off from where you take your steam, and firing up hard under the opposite ones. But to do this and keep up steam, would require more boilers than would be otherwise necessary. The steam should be taken from double steam pipes attached to the center of a single steam pipe, where there are three, four, five, six, or more boilers, as seen on draft, page 50.

STEAM TAKEN FROM THE CENTER OF A STEAM-PIPE.

The very best place to take steam from two boilers, is from the center of the steam connecting pipe.

STEAM FROM CENTER AND DOUBLE PIPE.

To prevent the drawing off water from boilers, while using steam, the double steam-pipe has been invented. It is used for three or more boilers. This is truly a great improvement, as will be seen by the accompanying drafts—page 50.

STEAM TAKEN FROM STEAM-DRUM

On two-boiler boats, many of which navigate our rivers, the steam is taken from each end of a steam-drum. This is the safer and more practical mode for boats of that class; but it is said to be better that three and four boiler boats should have but one pipe from the center of the steam-drum, branching off to connect with the two engines. For four, five, six, or more boilers, there should be two steam-pipes, taken from the back of the steam-drum to each engine.

BRASS STOP-COCKS.

DANGER OF BRASS STOP-COCKS BETWEEN THE BOILER AND THE FORCE-PUMP.

Brass keys in stop-cocks, require to be tightly screwed to prevent them from leaking, and when thus secured, they are likely to corrode, and require the nut to be slacked off below, or the key to be hammered back, before they can be turned; and unless there be a good thread and nut on the bolt below, they are liable to fly out in the act of turning them. Every engineer has witnessed this fact. To turn the cock after it has been slackened will demand some effort to tighten it again. A slight frost will so far destroy brass keys that they cannot be used until repaired. Thus it will be seen, they are more troublesome than profitable.

The only way in which they can be used with safety for stop-cocks, between the boilers and the force-pumps, is to screws the keys in with a bridle and a set screw. For this purpose, the stop-valve is used in its place, in which it is superior.

FREEZING OF STOP-COCKS.

This is one of the greatest objections to the use of the brass stop-cock about a steam engine. They are liable to be continually out of order, especially when subject to frost. They are more a matter of expense than profit.

BLOW-OFF STOP-COCKS ON BOILER STANDS.

This was the mode of blowing off the water from steamboat boilers in their early history; they are, however, liable to get out of order in the several ways already mentioned. Their place has been superceded by the use of the blow-off valve, which is superior to the old plan.

VARIOUS MODES OF CASTING CYLINDERS.

It was customary to cast two nossles on the one end of the cylinder in the early days of steamboating, and upon this plan were the majority of our engines constructed. Laterly nossles were cast upon each end of the cylinders,

FOUR LUGS CAST UPON THE CYLINDER.

In early years, cylinders were made much shorter than those now in use. Four lugs might well do for them, while they would not answer for the long cylinders now in use. Every old engine has had the trial of them, and find that the keys could not be kept tight on account of the continual expansion and contraction of the cylinder. If, when hot, it were closely keyed up, there would be danger of the lug breaking when the cylinder contracted by cooling. Who has not experienced this in practical engineering? The only way in which four lugs can be made to operate correctly, is to key fast one on either side, and leave the other without keys. This will do, but it leaves the expansion and contraction confined to one end of the cylinder.

FOUR NOSSLES CAST ON THE CYLINDERS.

It was, for a long time, considered an improvement to cast four nossles on the steam cylinder; because it looked better and was more pleasing to the eye than the plan previously used. It made an artistic job.

SIX LUGS CAST ON THE CYLINDER.

The casting of six lugs on each cylinder, has obtained for many years, and has been found of great utility. The cylinder is keyed fast by the center lug, and screwed fast to the cylinder timbers by the four end lugs. This gives the cylinder a fair chance to come and go, from the center each way.

SUB-CYLINDER.

In the early history of constructing steam engines, there was much uncertainty connected with the casting of cylinders. For the purpose of avoiding risk and difficulty, there is no doubt the experiment of casting the sub-cylinder was adopted. The main cylinder was cast without any nossles, and but two on the sub-cylinder, which is bolted to the main cylinder; and the other two nossles are cast on the cylinder-head.

The first engine of this construction was placed upon the steamer Hercules, and was afterwards used on the steamer Sampson. It was the only one of the kind which came within our knowledge; and facts compel us to say, it worked admirably. It was constructed at Pine Creek, (near Pittsburgh,) Allegheny County, by Mr. Bellknap.

STROKE OF CYLINDER.

In the early days of steam, we used much smaller cylinders with shorter stroke than we now do, and worked steam, nearly full stroke on the piston, ¾ to ⅞, &c. Our cylinders in use at the present day, are nearly twice as long and large as those formerly used, and the steam generated in the boilers raised to a much higher pressure to the square inch. They cut off more closely in the cylinder,—sometimes ½ stroke, ⅝, and ¾, &c., in order to make as much from the expansion of the steam as possible.

The remarks in regard to the long and short boilers, may well be applied to the long and short stroke cylinders. When persons are about changing from one thing to another, and find the change for the better, they are apt to carry it to the contrary extreme, and over do their work in their search after expediency. The medium stroke, between the long and the short, as a general thing, is the safer, more econominal, more powerful, and of more utility for all practical purposes.

We could add much to this, but defer it till a more fitting opportunity.

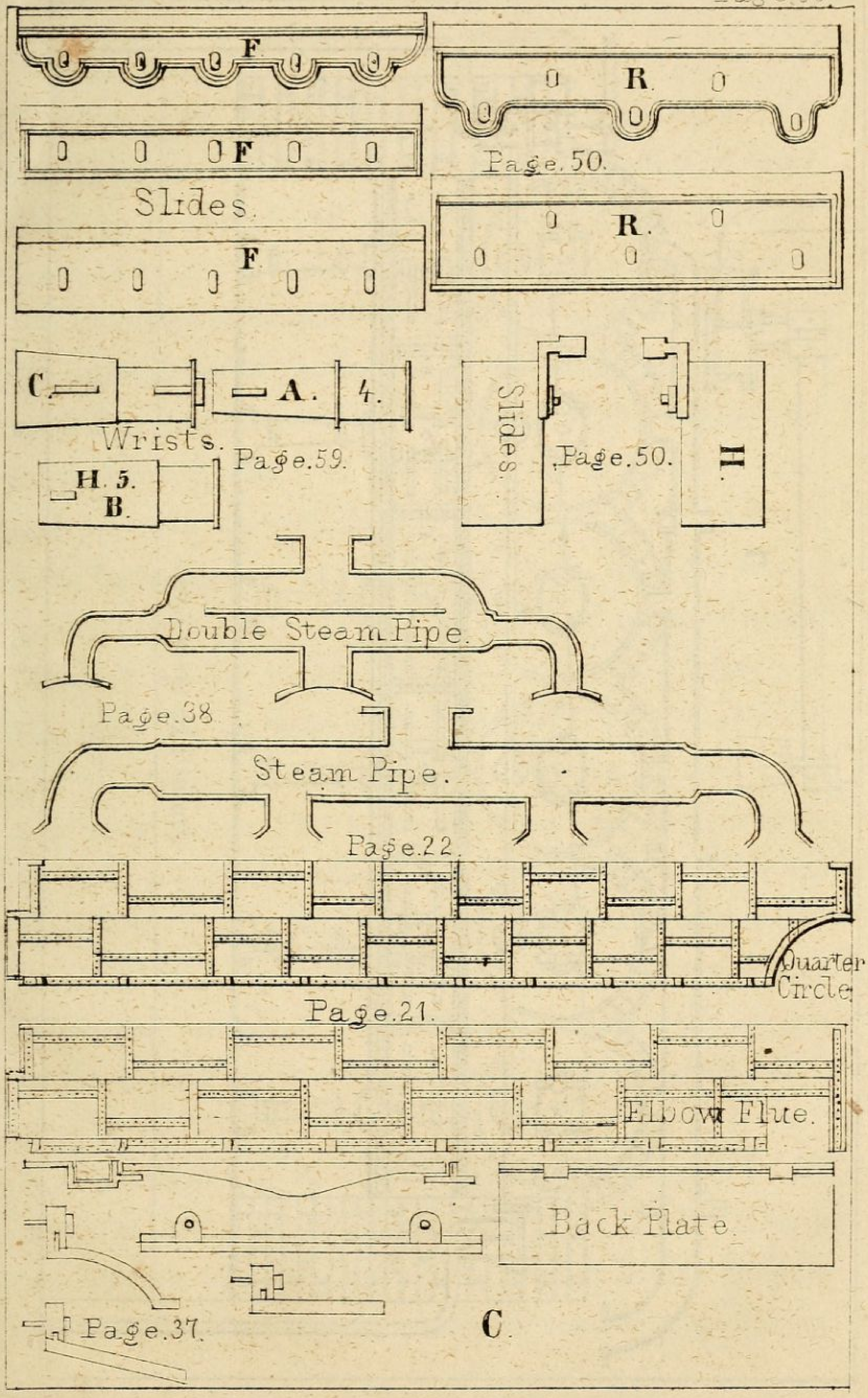
BEARING, THICKNESS, AND WIDTH OF SLIDES.

Slides should be so made as to have a large bearing on the part where the shoving-head jaws are to run, in order that they may bear up under the weight of heavy pitmans, shoving-head, piston rod, &c., otherwise the cylinder cannot long continue in line. Our slides formerly had not more than one half the bearing they should have had, to stand the wear they were subject to, and which the necessities of the boat which they were propelling required.

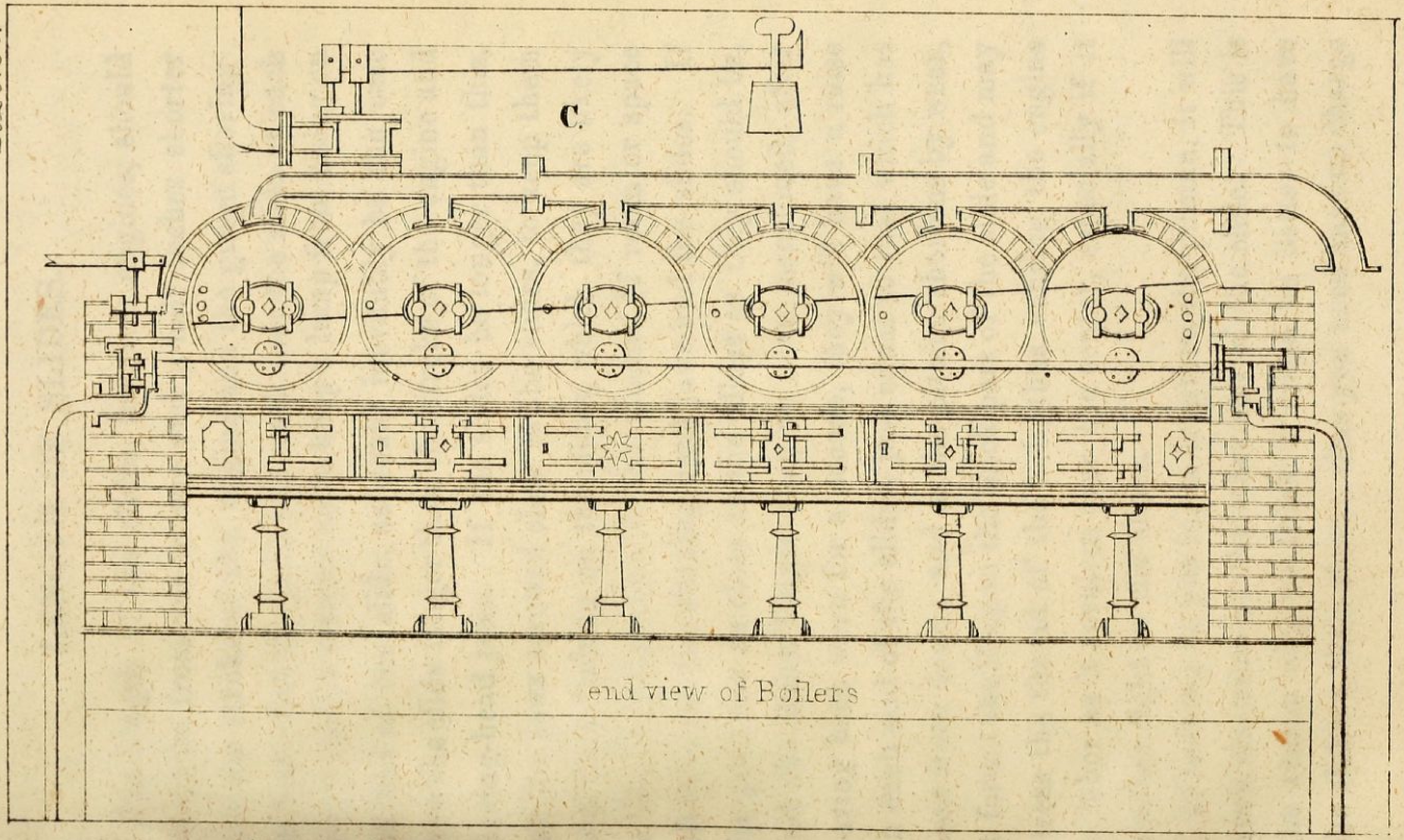
The slides should be much thicker than they are ordinarily made, so that both the bearing and the balance of the slide, will not spring in screwing down. Slides are very often made too narrow, and by reason of this, they do not get a sufficient bearing upon the timber to keep them from rolling. There is another thing which should, as much as possible, be guarded against; that is, the putting of bolts in a straight line in the center of the slide, as may be seen in plate F. They should be placed out and in, as may be seen in draft, plate K.

On the timbers H, may be observed another mode of putting on slides, which was in use in the early stages of steamboat navigation. See plate H.

Page 50


F
R.
Page. 50.
F
Slides.
R.
F
C.
A.
4.
Wrists.
Page. 59.
H. 5.
B.
Slides.
Page. 50.
H.
Double Steam Pipe.
Page. 38
Steam Pipe.
Page. 22.
Quarter Circle
Page. 21.
Elbow Flue.
Back Plate.
Page. 37.
C.

Page. 50.



LENGTH OF SLIDES.

The length of the slides, for river engines, should always be from one to one and a half inches shorter than the stroke of the engine and the guage shoving-head, so that the jaws will work over the slide at each end in such a manner as to keep a lump from rising on the end of the slide, as would inevitably be the case were the slide longer than the stroke of the engine and shoving-head jaws. If the slides be longer than this, and the jaws screwed close to the slides, to keep them from back-lashing on the slides, which they are likely to do, in proportion to the amount of room or space left between the shoving-head jaws and the slides. If the jaws are as close to the slides as they should be, and the slides longer than we have mentioned, after having been worn for a season, they will have a raise on each end of the slides, just equal to that which has been worn down; and as the pitman shortens by wear, it forces itself upon the thick part of the slide and may stress the thread of the bolt, thus causing the engine to labor as it revolves over the center, especially if it pinches tight on the slides.

If backing be put in, to lengthen the pitman, it will work the same at the other end of the slide. This is the reason why we think it would be better to have the slides a little short; thus you need have no charge on your mind for the safety and security of the engine. All intricacies about engines, beyond what is absolutely necessary, should be avoided. They not only tend to confuse and puzzle the engineer, but cause them unnecessary labor. The more simple the engine can be constructed—so that it has all necessary appliances, the better; it will take less labor to manage it, and engineers are well aware that they have little time to lose while running the plainest and best engine.

SHOVING-HEADS BORED OUT.

Shoving-heads should always be bored out in a lathe. The center of the wrist on the shoving-head should be parallel with the center on the lathe, while the opposite end is being bored out.

We could add much to this branch of the commentary; but forbare, for want of room.

BOLTS FOR SHOVING-HEAD JAWS.

It is within my recollection of once having witnessed a steamer with four boilers. Were it necessary her name could be given. She had twenty-four inch cylinders, and from five to six foot stroke. We give it not as a certainty, but as recollection warrants. She had but one bolt in each of the shoving-head jaws, and we understood from the engineers that it answered the purpose for which it was intended.

We do not approve of shoving-head jaws, large or small, with only one bolt. They are not safe, for this reason: there is nothing to prevent the bolt from working out, if the nut happened to be a little slack. The bolt will instantly drop from its position, because there is nothing to hold it. In order to keep the nut from turning and working it should be a little tight—that is, the nut on the end of the bolt. The bolt will then drop out while the engine is working; unless a jam nut be used.

It is within the knowledge of many engineers, that this has happened, even with two bolts in the jaws. When this has happened, the nuts were made fast from turning, by a piece of wood being drove between the nuts; the bolts will then sometimes, after all precautions, turn, and find their way out.

The object we have in view, in reference to two and three bolts, is, that the nuts upon the shoving-head jaws may be locked so that they cannot be turned; this may be done by driving a piece of wood between the nuts. If this should not answer, it is necessary that the bolts should be kept from turning. This may be done in two ways; one is by having square holes in the lower jaws; the other is, by making such large heads upon the bolts, as that they cannot pass one another. The latter is considered the easiest plan and will answer all useful purposes. In this way, and by these means, the nuts may be held fast to the bolts.

The reason why two or three bolts should be preferred in a shoving-head jaw, is simply this: when they are secured, as above mentioned, they are safe in the hands of any person, whether he understands his business or not. It would also be safe in the hands either of a fireman or a boy, because the bolts are thus rendered stationary, until they are unlocked by drawing out the wood or iron which may have been put in between the nuts for the purpose of holding them fast. Now, by way of contrast, the author will give his views, while he feels the spirit and interest of the subject strongly upon him. The subject now in review, may seem a small matter, but it is truly important. In the beginning of the lecture upon this branch, it will be remembered that strong objections were made against the use of but one bolt in the jaw of a large shoving-head, for the reason that it might possibly work out. It might do so, in case of friction produced by working dry slides, or from other causes, which nothing but experience and practice can avoid.

It should be impressed upon the minds of all who read and understand what they read, that that which is perfectly safe within itself and completely under the control of one man, would be quite dangerous and unmanageable in the hands of another. Now, the author can, and there are many others within his acquaintance who can take the largest steamer that floats on the Ohio, and run her engine with safety with but one bolt in the shoving-head jaw, provided that bolt is as perfect as it ought to be when it comes from the hands of the machinist who forged it. The nuts should not be loose upon the bolts, but should on the contrary, be so tight as to turn easy with the short wrench, accompanied by the use of a second wrench to hold the head of the bolt below. They must be screwed hard and fast to the papers between the shoving-head jaws, in order both for safety and use. If the slide be constructed on the long order, as heretofore described, as the pitman shortens it will crowd upon the thick part of the slide, and be very likely to strip the thread or break the bolt. Herein lies the difficulty with all but the most experienced engineers; for, if the nut be put on slack, or loosely, as it is in many other places, the engine will become unsafe and unmanageable. All having control of steam engines should be careful to understand this, as much harm might readily result from neglect, carelessness or inexperience. Therefore, it is better that two bolts be used; because, where the inexperienced may not be able to get along with one bolt, the scientific man might work his engine with a bolt even of smaller dimensions. The one would not know how to keep it in position. A jam nut might answer the purpose, but there are many who have not sufficient constructiveness to think of such an expedient.

But, lest the length of the remarks upon this branch should weary the reader, it may be said in conclusion, that although some persons can work with but one bolt where others could not, on account of the superior skill and judgment which some possess in a greater degree than others, yet it would be the sounder policy, that all engines from the smallest to the largest, which have labor to perform, should be supplied with two bolts to the smaller and three to the larger, for the reason that if by chance or accident one bolt should break, the other one, or two as the case may be, will altogether likely hold out until it has been discovered wherein the weakness consists.

It may well be considered a nice matter, where paper is used in a shoving-head, to so adjust it as that in every way it shall fit on the slides, both above and below, as well as upon the outer and inner edges of the slides. There is a great degree of skill required on the part of those who undertake this difficult job, to accomplish it as it should be done ; and when it is well done, it is, in many respects, far superior to any set screws which may be used for regulating the brass liners which are moveable on the jaws.

There has been much said on this branch of the treatise, and much more might be said, but prudence requires that it should be cut short, as there are other branches that require attention.

LENGTH OF PITMANS.

It used to be a general rule to make pitmans three times the length of the stroke. Some have used them shorter than this, say about two and a half lengths of stroke; but these are considered, however, exceptions to the rule. It has been customary for rolling-mills to construct their pitmans one foot longer than three lengths of the stroke. We do not vary but slightly from this rule at the present day, in the constructing of land engines. But for river engines, they should be about four times the length of the stroke as a general thing. There may, however, be exceptions, and more or less length used in order to accommodate the peculiarities of the engine for which they are intended to be used. There may be forcible objections urged against the use of long pitmans. They not only are more liable to spring in their working than short ones, but add much to the weight which bears upon the top of the slides, and on the crank-rists to which they are connected. Thus it will readily be observed that the friction must be greatly increased. There is a medium between the long and short pitman which should always be observed by the builder. Extremes ought, in all cases, to be avoided.

WOODEN PITMANS.

The pitmans of our steamers are mostly, if not, in fact universally made of wood, (light pine wood,) and this had been found to answer the purpose admirably, when carefully watched and kept in perfect working order. Exceeding caution should be observed in the adjusting of the pitman straps, in order that the timbers be not cut too lean next the brass boxes; because this would, when screwed up, throw the jaws too wide apart at the point.

On Eastern American rivers, as also on Ocean steamers, pitmans are all made of wrought-iron. A wooden one would be as great a novelty to them, as a wrought-iron one would be to those who navigate the Western waters.

IRON PITMANS.

Iron pitmans for the most part remain about the same as when first constructed; but wooden ones require continual watching, and more or less screwing up, as the timber from which they are made, shrinks; and moreover, there is much danger from their liability to rot. The exposure to which they are subject, in all kinds of weather, is certain, sooner or later, materially to affect them. This fact requires vigilant watching on the part of those in charge of river engines.

PLACING IN WRISTS.

In order that wrists may be kept firmly in their place, it will not answer to give too large a draft, because the larger the draft, the more wedge-like it becomes; hence the easier pulled out. It ought not to taper more than one fourth of an inch to six inches in length, and give three-eighth draft in the key-hole; when drawn firmly up, split the key and all will be right.

COLLAR-WRISTS AS FORMERLY USED.

(See plate 4, A.) This was a bad way of putting in wrists, and the only object that could have induced its adoption must have been to save a little iron on the back of the collar, which costs more labor in its construction than the difference of iron would amount to.

If this wrist should at any time be drawn up to the collar, and should happen to work loose, it could not be ascertained by reason of the collar, without especial attention. If it be found loose, the only remedy is to take it out and bush it. It would be found that the fault consisted in making the wrist too small to allow sufficient bearing to hold itself in form without chawing and working loose.

WRISTS, AS NOW USED.

Either of the secured wrists will answer the purpose. (See diagram H, No. 5,) the wrist B was brought into use long after the use of the wrist A, which has heretofore been fully alluded to. It was of greater utility, and worked to to better advantage, because it had no collar to prevent its being drawn up if slack; nor had it any obstruction to prevent its being bushed, if found necessary.

It was found to be much more convenient, and far more practical, because it worked more easily. It had no collar to look after and fit in, or see to when it became loose; nor had it any play from the motions of the engines. By use of a large wrist, there is greater strength and more bearing, which prevented hard keying and heavy pressure upon the wrist, when performing its labor, from bedding itself in the eye, as a small wrist will always do.

C, is a wrist which is larger on the back end; this was found necessary from the use of wrought-iron cranks, on account of boring out the holes, both of them true from one side, without changing the crank in the lathe; whereas if it were changed, in order to bore out the other side, it would be almost impossible to get the two holes as true to each other as on the former plan. The outside collar is sometimes separate and screwed on with a set-screw. The only object of this would be to save iron; it is bad policy, although it has in many instances been found to operate well. In many more, it might be found the cause of much trouble. The wrist should be in one piece, as may be seen in plate I.

WRISTS WITHOUT KEYS.

This plan has been introduced lately upon the Western waters. It is the putting in of wrists, in the cranks of our steamboats, without keys. They are made with little or no draft, and are forced in by means of a screw, which being properly adjusted, the wrist is riveted in, or hammered a little around the outside edge of the wrist. This plan has been practically tried, and many engines bear testimony that it has answered the purpose admirably; but in all cases it would be much better that the wrists should be firmly keyed in.

If it becomes necessary that a wrist should be taken out, which has been forced in and burred, it would, beyond doubt, become necessary to take off the crank and carry it to a shop in order to have the burr cut off, and it will require to be placed above a screw in order the more conveniently to take it out.

PILLAR BLOCKS.

BOTTOM BRASSES IN PILLAR BLOCKS.

In the early history of our steamers, as a general thing they made no use of bottom brasses, but instead thereof used side brasses, considering this sufficient, inasmuch as the labor of the engine is principally fore and aft upon the side boxes. Notwithstanding this, there was still found to be considerable wear on the bottom blocks, owing to the weight of the main shaft and fly-wheel; and owing to a little wear of the pillar-blocks (by lack of the brass) the whole block might be lost; which otherwise, would last as long as the rim of a fly-wheel that would be as good when the boat is worn out as on the day when it was placed on board.

KEYS IN SIDE BOXES.

Side boxes are frequently keyed up to the journals by means of narrow keys through the caps, with four holes cast in the pillar-block, for the purpose as well of securing the keys as they are driven down, as that of keeping the side-boxes tight to the journals. Objections to the use of these keys may be urged for many reasons; they weaken the cap as well as the pillar-block; they may slip back and leave the boxes loose; and being thus exposed, at all times, to view, they may often be driven down where there is no occasion, and thereby heat the shaft, and produce unnecessary friction. They are also liable to cut the shaft and boxes unnecessarily.

BACKING IN SIDE-BOXES.

This mode may be considered much better than any other plan now in use. When the boxes are once keyed up to the place, and the caps on, there is no danger of your backing coming out; and at any time when side-boxes are becoming slack, the cap can be taken off, (which should be done immediately on discovery of looseness,) the slack may be taken up by putting in a thin piece of sheet-iron.

BORING OUT PILLAR BLOCKS.

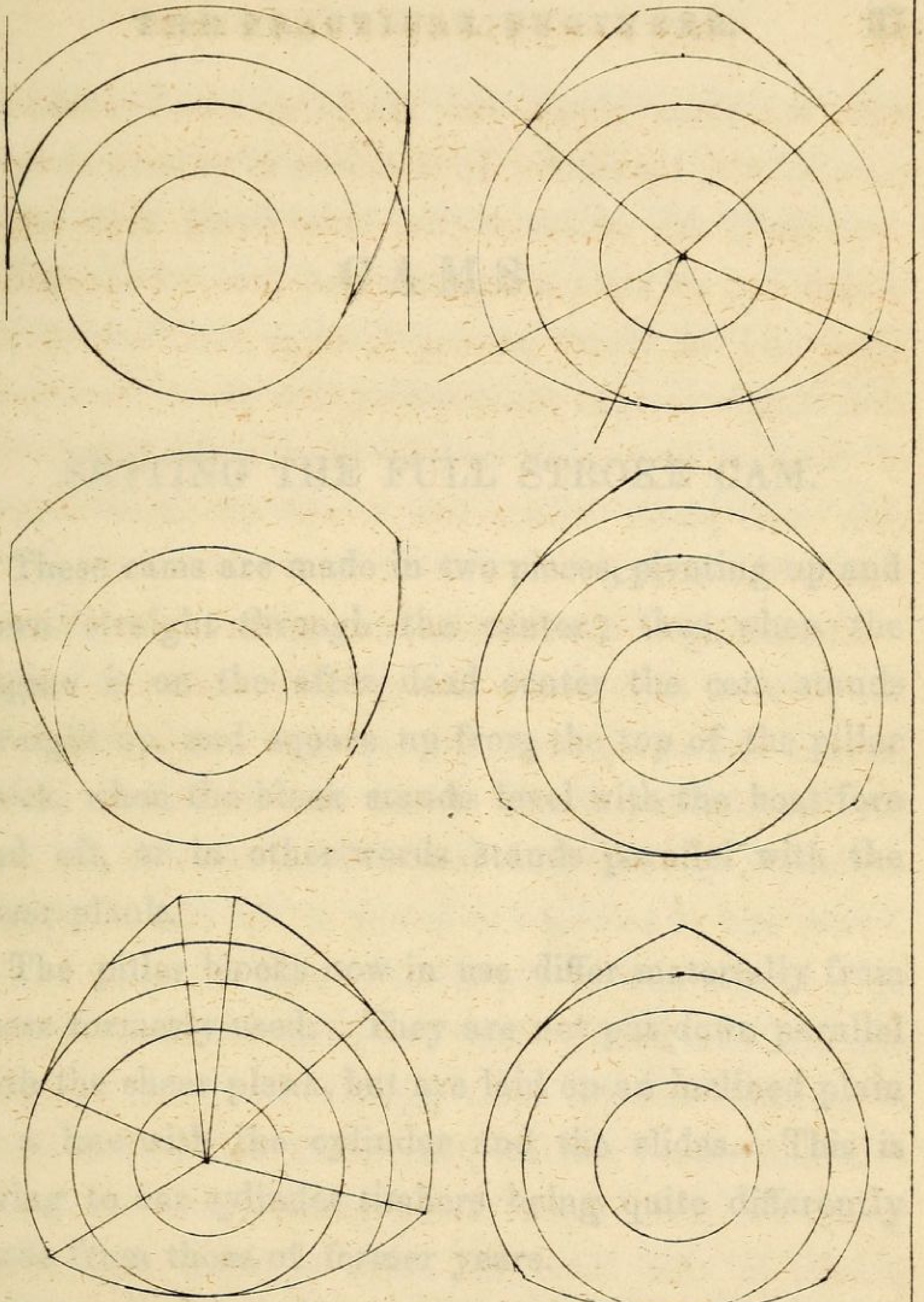
To make anything like perfect pillar blocks, it is absolutely necessary that they should be bored out as smoothly and as true as a cylinder, and each pillar faced off on each side perfectly true in the lathe.

LARGE COLLARS ON SHAFTS.

Our large steamers should all have large collars on each side of the journals, varying from one to one and a half inches, as the collars on the shaft always bear hard on the pillar blocks when the boat is on a list. Thus it will be sufficiently plain that a false motion is continually on the increase; this can be remedied by cutting the side-boxes in two pieces and driving a key between the brass and the collar on the pillar blocks.

SMALL COLLARS ON SHAFTS.

In the early years of steam boating there were four shafts, and they all had small collars. In a very short time during the running of the boat these collars would be found to have bedded themselves in the pillar-blocks on both sides; and this, in addition to the back lash in the coupling blocks then in use, would make a tremendous noise as the boat would roll from one side to the other, while making short turns, which would be quite as unpleasant to a nervous or sensitive person, as the sound of trip-hammers.



Cut off & full Stroke cams

CAMS.

SETTING THE FULL STROKE CAM.

These cams are made in two pieces, pivoting up and down straight through the center; thus when the engine is on the after dead center the cam stands straight up, and square up from the top of the pillar block, when the block stands level with the boat fore and aft, or in other words stands parallel with the shear plank.

The pillar blocks now in use differ materially from those formerly used. They are not put down parallel with the shear plank, but are laid on an inclined plain in a line with the cylinder and the slides. This is owing to our cylinder timbers being quite differently made from those of former years.

Our cylinder timbers now are skeleton timbers, and they run the whole length on an incline. Those in use many years ago, were filled up of different pieces of timbers, solid, while the cylinder timbers, generally in this case run on an incline up to the pillar block, and then this part of the timber was level or parallel with the shear plank, and the pillar block would be parallel with the same. In this case, as we have already described, the center of the cam would then stand plumb up, or square up from the face of the pillar block and the center passing through each half of the cam stands upright and parallel with one or both faces of the cam frame, (as may be seen in the full stroke cam and plate, which has a cut off cam mostly within the same.)

The sitting of the full stroke cams on our engines at the present day, where the cylinder timber is on the incline, and straight on the top the whole length of the timbers the center of the cam is still as above described, parallel with one or both faces of the cam frame, and of course, the center of the cam is square up from the face of the pillar blocks, the same as the one first mentioned, where the pillar blocks were level or parallel with the shear plank. There is, however, this difference : on the plan which obtained in early years, the pillar blocks being parallel with the shear plank ; in this case, the faces of each cam would would also be plumb, or in other words, both faces of the cam frame and the center of the cam would be square up from the center of the pillar block ; but the faces of the latter, being on an equal inclination with that of the cylinder timbers, (as they are now used,) the center line through the exhaust cam hangs as much over the plumb as the face of the pillar block in the same length of cam is below the level.

It should be remarked that neither the plumb nor the level is used on water crafts, but the author has made use of them, in this treatise, in order that he may be the more easily understood. If the top of the pillar block is level when the boat is in trim, the center of the cam would be found perfectly plumb. To repeat the substance of what has been already said in regard to the setting the exhaust or full stroke cams, when the engine is on the after dead center; when the nose of the cam is up and the center line, through the middle of the cam is always found to be square up from the middle of the face of the pillar block, and of course the center line through the cam will be parallel from one or both faces of the cam frame; and the easiest manner in which these cams can be set, is to make the center line through the cam frame parallel, or at equal distances from the face of the cam frame; thus that frame will be equi-distant from the center of the main shaft. This rule will always be found right. It makes no difference if the pillar blocks are on a level with the shear planks, or on an incline. The principle remains one and the same, for horizontal or incline engines.

After the full-stroke cam has been set, it is advisable to make a mark both upon the cam and upon the cam flange, (opposite the first one,) upon the shaft; so that if this cam should slip either way whilst in the act of setting the cut off cam, there will be nothing to do but bring mark to mark; and when the cut off cam is properly adjusted it would be well to mark it also, so that in case it should at any time slip by reason of the bolts becoming slack, or from any other cause, it will be much more easily discovered and adjusted, by comparing the marks made on the cam with those made upon the cam flange, or upon the main shaft.

It should be well noted that double arms upon the rock shaft which is worked with a full stroke cam for backing, and sometimes for going forward, should be taken to the boat by the proper persons, and placed upon the cross shaft, and then the cam-rod to ship on both the upper and lower pin. The arm and rock shaft should be marked with a center punch and the hole drilled; this is the most correct plan of performing this part of the work. These arms are sometimes put on and drilled before coming to the boat; others put them on as before stated.

To those who put these arms on the rocks in the shop instead of placing them on in the boat, on both pins while the engine is on the dead center, it will be well to say that they will sometimes require a little raising or lowering of the bearer of the cam-rod above or below a straight line, as it may require to make the cam-rod ship on both pins in the arm. It is to avoid this and also to keep the cam-rod bearers in a straight line, that mention has been made of the propriety of not making this arm fast in the shop where the engine is constructed; but rather having it taken to the boat and there set, so that the cam-rod will readily ship on both pins. After which the arm should be marked, taken to the shop and drilled and made fast. This may be considered the safest and best plan for executing this part of the work.

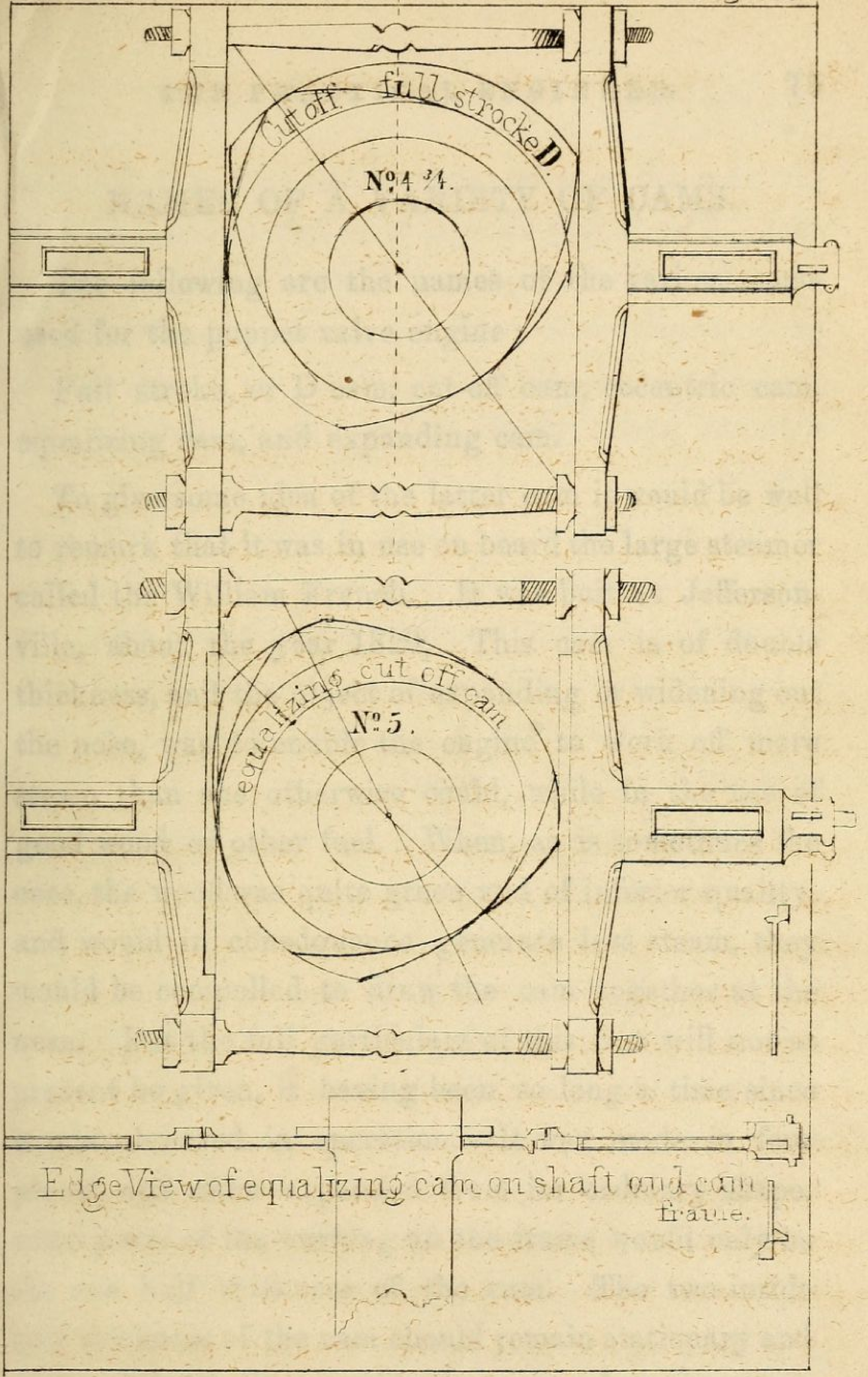
No. 2 is a draft of an equalizing arm, the object of which is to cut off the steam equally at both ends of the slides inasmuch as the common cam has failed to do this; the latter cut off the steam at the lower center, passing out slower than it comes in at the upper center. The reason of this will be discovered by examining the shoving-head, when its center is in the center of the slide. For instance, suppose the crank to be three feet from center to center, when the shoving-head is in the center of the slide coming over the dead center the wrist will be about six inches over the center of the shaft, with a plumb, while on the other center going out it will be found six inches behind the time. This is why the nose of one cam requires to be considerably wider than that of the other; the deficiency must be made up in this way. The cam is partially double and has an off-set in the cam frame so adjusted as to accommodate the difference of the points as the cam passes over, as may be seen in plate No. 2.

SETTING THE CUT-OFF CAM.

Where the engine is on the after dead center, the nose of the cam is uppermost; let the cam then be turned until the consecutive circle comes hard up on the face of the cam frame and ready to move it the moment the wheel begins to move over the center, (the face of both the cam frames, full stroke and cut-off, will be equi-distant from the center of the main shaft.) It is well in this place to make especial note that upright or walking-beam engines, the noses of the cams stand in an entirely different position to the crank upon the main shaft, to what those used on horizontal engines do.

The reason why the center line through the nose of the cut-off cam does not stand perpendicular with the nose of the full stroke cam, is because it is a cut-off cam, and narrower on the nose, and on this acccount the center line forms an accute angle, as may be seen described on draft, cam No. 4$\frac{3}{4}$ and No. 5.

The sharper the nose of the cam the greater the angle, and the wider the nose of the cut-off cam the less will be the angle. (See drafts of different cams.)



Edge View of equalizing cam on shaft and cam frame.

NAMES OF A VARIETY OF CAMS.

The following are the names of the various cams used for the puppet valve engine:

Full stroke, or D cam, cut-off cam, eccentric cam, equalizing cam, and expanding cam.

To give some idea of the latter cam it would be well to remark that it was in use on board the large steamer called the William French. It was buit at Jeffersonville, about the year 1820. This cam is of double thickness, and the object of expanding or widening out the nose, was to enable the engine to work off more steam than she otherwise could, while in the use of good wood or other fuel. When, as is sometimes the case, the wood was quite green and of inferior quality, and would in consdquence generate less steam, they would be compelled to draw the cam together at the nose. But the full particulars of this cam will not at present be given, it having been so long a time since it was observed in operation. It was made in four pieces, and when expanded from its ordinary shape, some parts of the working on the frame would only be the one half thickness of the cam. The two inside half thickness of the cam should remain stationary and close, while the two outside ones opened at the nose; and just as far as the latter passed beyond the former, just so much must be taken off the heel of each inside cam. This is very difficult to be understood from verbal or written description; it must be seen to be properly comprehended, either in practical operation or by model, and then dissecting and laying it down in its different parts; which cannot well be done in this treatise.

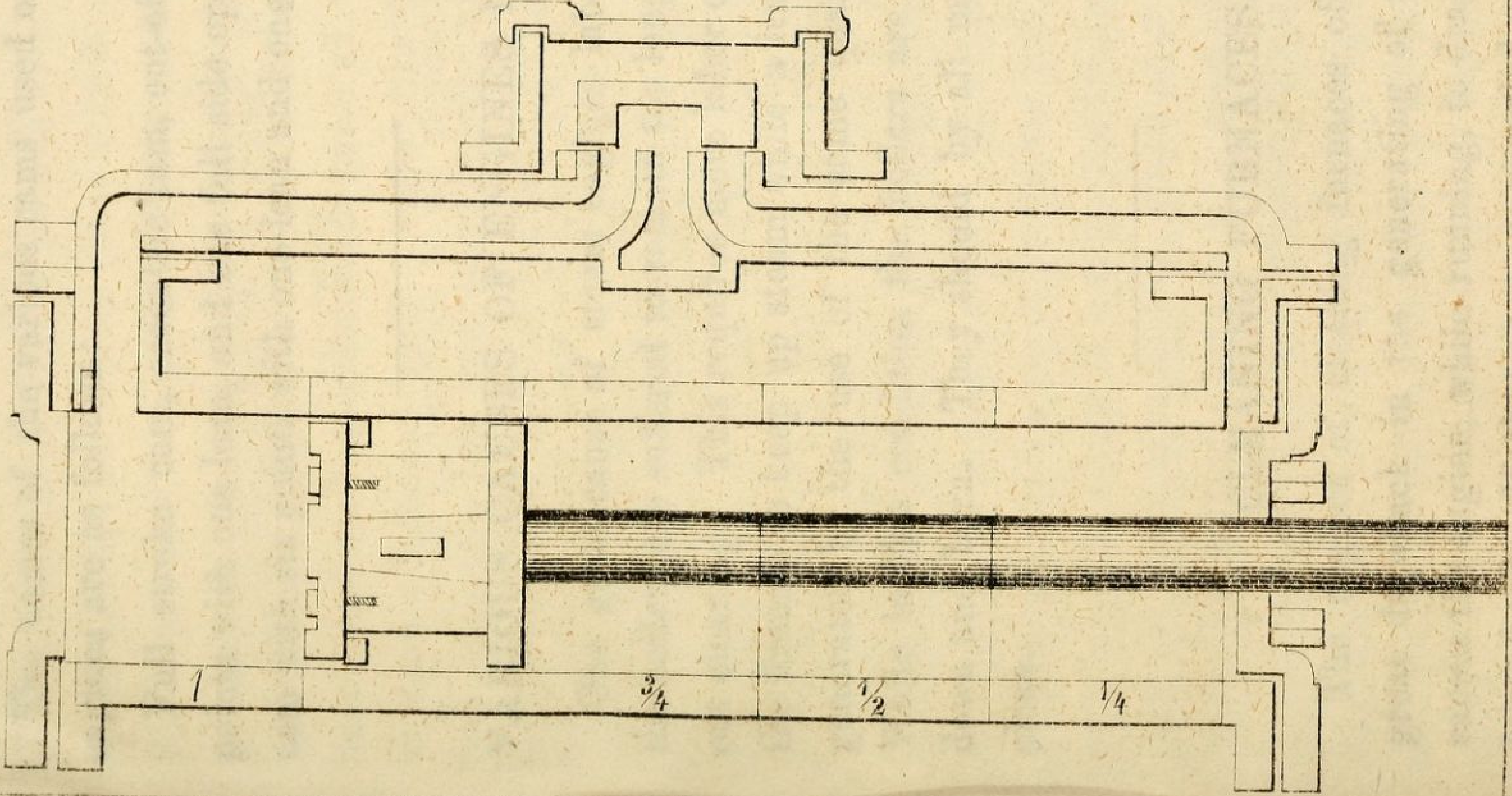
This cam will be, no doubt, a novelty to most readers, but it was only our purpose in this work to give it a passing allusion, to gratify curiosity and stimulate a desire for more knowledge on this complicated machinery. It may lead to important truths in the use of steam never before known.

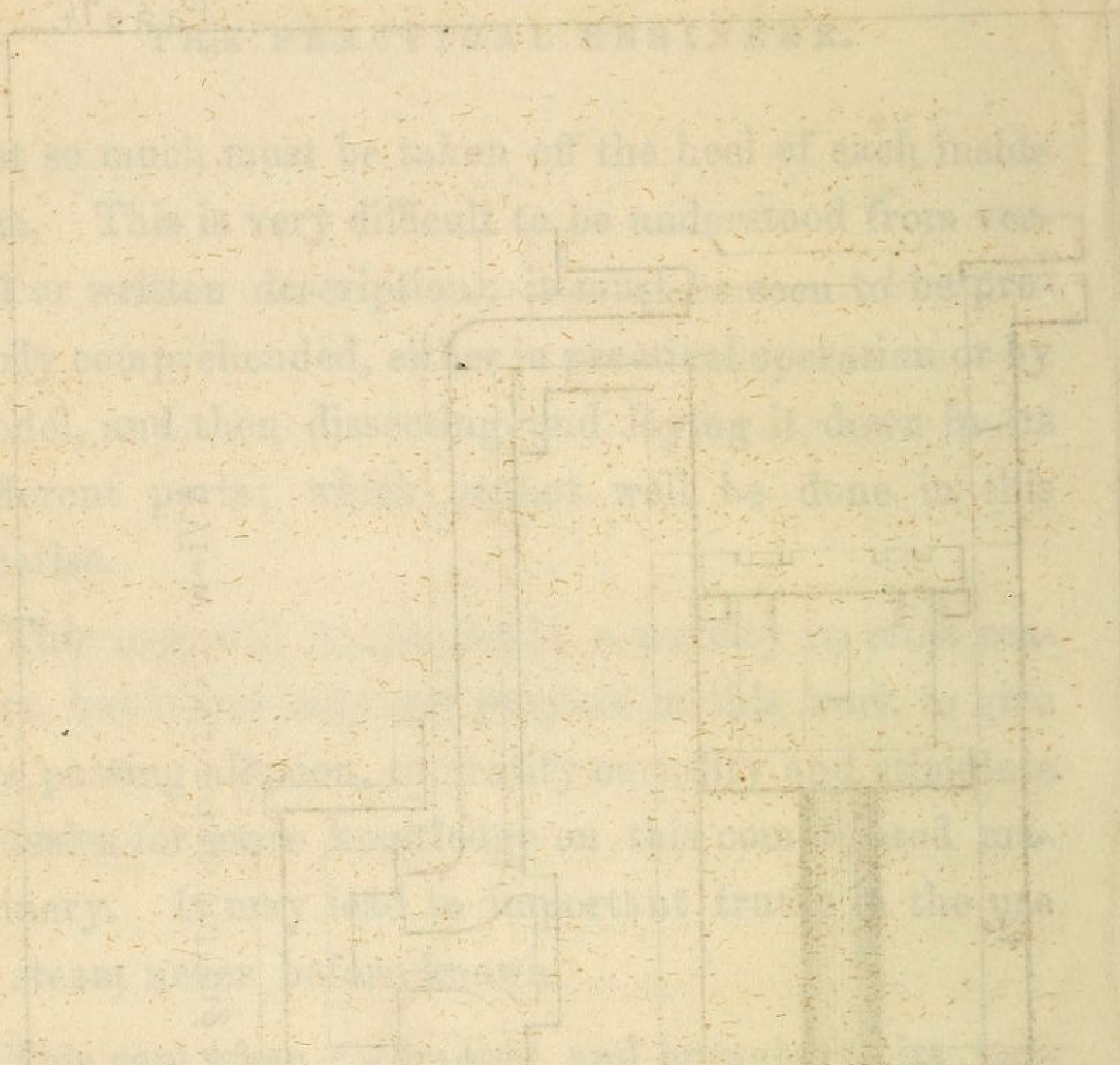
This cam when contracted and brought to its narrowest working point at the nose, required the two heels of the inside cams to be cut off as much as the two points of the noses of the outside cam extended over the inner ones. Say, for the sake of argument, the whole cam was three inches in thickness; then some parts of it, while working in the cam frame, would be three inches in thickness whilst other parts would be but 1½ inches thick—one half the thickness of the cam when closed together.

If there should be a call for another edition of this work, the author will so prepare himself as to give a satisfactory explanation of the expanding cam.

Page 74.

A View of Cylender Cutting of at ¾ of the Stroke





SLIDE-VALVE CAMS.

The names of the various cams used on slide-valve engines are as follows:

Full stroke cam, eccentric cam, cut-off cam, (four points with one lean, and one full side opposite cut-off cam with six points with one lean and one full side.)

VARIOUS CAUSES OF ENGINES LABORING.

One great cause of steam engines laboring, is that the boilers are suffered to remain too long in use without cleaning. This requires more labor on the part of the firemen to keep up steam while a less quantity is generated by the use of the same quantity of fuel. While in this condition the boilers are liable to bag down and burn. They should by all means be kept clean.

CLEANING FURNACES.

The neglect of cleaning furnaces often proves a great drawback in the generating of steam, which causes the engine, while running, to drag heavily and labor hard. If the ashes are crowded up close to the boilers it will be found that the fire surface is measurably destroyed, while at the same time the draft will be greatly obstructed and the fire prevented from burning freely. The effect is easily seen in the running of the engine To those who have charge of land engines, it would be well to remark that they should see that the flue leading to the stack of the chimney be kept perfectly clean. In many instances these have been found nearly closed with ashes. They cannot be kept as they should be without great care and attention, and it is indispensably necessary in order that the engine may run freely.

FALSE MOTION IN THE CAM FRAME.

It is to often neglected to gather up the false motion in the cam frame. This is a matter which requires especial care and attention, as very much depends on this motion being kept right. It would be equally as bad policy to take steam too soon as it would too late, and should you have $\frac{1}{4}$, $\frac{3}{8}$, or even a half an inch false motion (false motion means no motion to the cam frame, and of course none to the valve with the exception of that which is thrown by the cam over and above the unneccessary space that is between the cam and the cam frame.) If the cam should throw four inches and there should be one half inch false motion of the cam frame, it would amount to the one eighth of the whole motion, which would be a dead loss.

FALSE MOTION IN THE CAM—PAWS AND JOINTS.

It is a well known fact to all engineers who have paid any attention to the working of cam paws, that as a general thing there is a great deal of false motion suffered to accumulate by wear, before stopping to have it bushed and placed to rights. In addition to this there is more or less false motion tolerated in the joints.

Suppose there should be one-fourth of an inch false motion in the cam-paw, and one-fourth of an inch in the balance of the strap-joints connected to the same, it would amount to one-half inch, which added to the other half inch makes a full inch, and would be equivalent to one-fourth of the whole throw of a four inch cam ; and thus one quarter of the whole power of the engine would become a nullity,—a dead loss. This may, therefore, readily be seen to be highly important and worthy of serious attention by all practical engineers.

CAMS MAY SLIP.

Cams do sometimes slip. There may be several reasons; one is, too few bolts to hold it fast; another is, that the bolts may not have been screwed up sufficiently tight to hold it firm; another is, that the cam frame may have been screwed up too tight, which will in this case heat and cause the cam to slip; another reason is, that the slide valve may have become dry for the want of oil, and grate and quiver, thus causing it to drive heavily.

Another reason may be assigned for slide-valves grating and quivering; and that is, that the valve-seat and slide-valve may both be alike very soft; and it is a well known fact that two bodies of alike temperature will not work well in contact with each other, because there is too much affinity between them, and by rubbing them together they become electrified and produce heavy friction.

There should always be different metals used for the valve-seat; one should be harder than the other, in order to work well together.

SLIDE-VALVE SEAT OUT OF ORDER.

This is often another gand cause of engines laboring and dragging. It arises from the valve and the valve-seat being worn out of true, and letting the steam blow through the exhaust opening without entering into the cylinder at all. There are many reasons for them wearing out of their true position, which time precludes particularly mentioning in this volume. They may merely be hinted at and leave the reader to study the particulars at their more convenient leisure. One reason is, that the valve-seat has not been properly laid out and proportioned to wear evenly. The bearings in the seat may be much greater in some cases than in others, and the use of muddy water, filled with sand (as in the Mississippi,) may be and is another reason. The metal itself may be uneven, or it may have hard spots or places in the valve or valve-seat.

This is a portion of the work which requires great care on the part of the builder and the engineer.

PUPPET BALANCE AND CUP VALVES MAY LEAK.

There may be a great waste of steam by reason of the above, unless the valves are properly attended to and well kept in order. The object of the balance valve is to make less friction and cause the engine to be more easily managed by the engineer; this to some extent has been done. The single valve and seats in the opinion of many experienced engineers, will hold more tightly than it is possible to make a double valve and seat hold, on account of its having bearings to bed themselves upon two different seats. Single valves and seats can be made tight, but double ones are hard to make tight. It is a matter of doubt among some of our engine builders, as also with many practical engineers, whether they can be made tight at all. Many things appear to be true to the naked eye, that would seem to be very much out of true if the magnifying glass were applied.

CYLINDERS OUT OF LINE.

It is a well ascertained fact that cylinders are often used too long without being kept properly in line, and thereby great violence has been done to the engine.

To work it when it needs to be lined, would be forcing it to do what ought not to be done under such circumstances.

CYLINDER OUT OF TRUE.

Cylinders are often out of true in several ways, and many have been used that never were in true. There are probably as many out of true from the latter cause as from any other.

If a cylinder is anything like as true as it ought to be, when first started, it will run first without any packing in the piston head at all, and be capable of doing a great deal of work at the same time. Many new engines have been started to running in this way, and both single and double engine cylinders will wear out of true in course of time by constant running; that is, horrizontal, not upright cylinders.

The reason for this, is on account of the heavy piston head and rod constantly running on the bottom of the cylinder; it will in the course of time, especially if the metal be very soft, become somewhat elyptic.

It would probably make but little difference in the running of the engine if the cylinder should be $\frac{1}{8}$ of an inch, or even $\frac{1}{4}$ of an inch larger one way than the other, but it would not work with the metallic packing so well until bedded to the cylinder, but with hemp packing it would do very well, and but little difference would be observed. A true cylinder is, however, preferable. Upright cylinders wear more evenly than horizontal ones.

CYLINDER PACKING.

It is well known that it sometimes happens that the cylinder leaks. Cylinders have been run until they were completely run down for the want of packing. It is within the experience of many, that it has been used in the cylinder till it has become completely rotton. The steam has been seen blowing out through the heater while seaching for the difficulty, first apparent from the laboring of the engine.

Again, packing has been known to be cut out before it had been much used and when still good. This no doubt was partly caused by small holes in the cylinders, and it is sometimes caused by the stroke being too long for the cylinder, when the packing in the piston-head comes nearly up to each opening in the cylinder. In case the pitman shortens a little by the wear of the boxes, it would bring the packing into the opening of the cylinder, and this would be an additional cause for the cutting of the packing.

PACKING SCREWED UP TIGHT.

Very often the cause of labor in an engine, may be traced to the screwing up the packing too tight. It is not necessary that packing should be screwed up as tight as it can be; it is sufficiently screwed up when it is steam tight and this may be easily ascertained by letting steam into the cylinder, and observe whether it blows through the piston head before the cylinder head is put on, and while screwing up the packing. To make the packing any tighter than this would be to create unnecessary friction and cause the engine to labor.

CAPS SCREWED TIGHT ON THE JOURNALS.

This is too often done, and its discovery is frequently not made until the shaft and pillar block begins to speak in language not to be misunderstood, and tells to all within reach, who have not lost the sense of sight and smelling, that something is out of order. The oder produced by the heating of the shaft and pillar blocks is very offensive, from the burning of the grease and oil. Smoke may also be seen to arise from the same cause. The discovery is frequently made in this way. At other times it may be discovered by the labor of the engine, before it has time to heat.

The pitman-keys on the crank-wrists, as well as on other wrists are sometimes driven too hard. There should never be one stroke too much nor too little. But if error should arise in this, it would be safer to be rather too easy than too hard. The other extreme is unsafe and dangerous; not knowing what the result may be. The author knows of a pillar-block which was broken by driving down the backing of the side-box when it was almost down. One blow too much, in such places, will sometimes cause great injury.

CAM-ROD.

The cam-rod may have been altered. This has been the case frequently. After the cam-rod, and all other matters are set right, and the engine set running, those in charge of it not content to let well enough alone, have undertaken to try their hand at alterations, and have made the cam-rod or rods sometimes too long or too short.

STEAM THROTTLED OFF TOO CLOSELY.

No doubt this has often been a serious draw-back to the engines both upon water and on land. It makes no difference how much nor how high the steam may be in the boilers, if it be held back or choked off by the throttle-valve; the benefit received from it is only in proportion as it is used in the engine. There is little doubt that steamers may have been exploded from this cause, as well as flues collapsed.

An instance of this kind has been stated in another part of this work, which the author witnessed, while standing on the Kentucky shore, as a steamer was passing over the falls of the Ohio. She collapsed in the middle of the river while on her way down. At the time when he first saw her, the steam was flying all over the bow of the boat, and they were then trying to get her to shore, on the Indiana side of the river. (See particulars on page 27.)

It is not probable that a flue would collapse merely because the steam has been throttled off, unless there was considerable extra weight hung upon the safety-valve when the boat is under way, to keep the safety-valve from simmering, or blowing off steam. This, no doubt, may be the cause, although unknown to the engineer: he may have the steam throttled off a little too close, so that the engine works off a trifle less steam than the boilers make while under way; the safety-valve will then, as it should, begin to blow off the extra charge of steam that is accumulating. The engineer, not being altogether conscious of the cause of blowing off steam at this time, inasmuch as the engine at different other times worked off more steam than they could raise in the boilers—thinking there is no danger—he may hang on two or three extra wrenches upon the safety-valve line, and thus imposes more upon the boilers and the flues than they are able to bear, and the consequence is that the weakest places in them will always first give way. The weakest part should always be the safety-valve; then all will be safe.

HORIZONTAL FORCE PUMPS.

The principal of force pumps is the same, whether horizontal or upright. The valves and the chambers are identically one and the same thing. The only difference being that one has a horizontal barrel for the plunger to work in, while the other works in an upright barrel. This may be assigned as the reason why one is called horizontal and the other upright. The main object to be attained in using the horizontal force pumps, is the saving of labor and material to the builder of engines. It often, however, increases the labor of the engineer to keep them in order. The horizontal pump dispenses with the use of the pump stands and caps; the pendulum and pendulum shaft, the connecting link between the shoving-head and the pendulum and the connecting rod from the arm to the plunger. This is no doubt the object of using them in general. In some places there may not be room for an upright force pump, in which case it becomes indispensably necessary to use the horizontal pump in its stead. The latter suit better for short stroke engines than they do for long ones, because they are easier kept in line. When the brass in the shoving-jaws wears and settles down, it throws the end of the plunger hard upon the barrel of the force pump, and the end of the plunger begins to leak badly, by reason of this uneven wear; and the longer the plunger the worse it is in this respect. Three different times has the author known a horizontal plunger to be turned down on this account, when a larger one had afterwards to be put in its place because of its becoming too small. More engines than one have had their plunger worn flat upon the point on account of the shoving-head sinking down on the slides by wearing. It is worthy to remark in this place, that when these pumps are put in line their centers should not be parallel at both ends with the centers of the cylinder; the end of the pump barrel next to the loose head of the cylinder, when the line is run through it parallel with the center of the cylinder, the engineer should allow all clearance of the barrel on top of the plunger, which would be keeping this end a little higher than the center of the pump-barrel line; then, when the jaws settle down on the slides by wearing, the end of the plunger will be found to run twice as long as it would otherwise do, before it rubs the top off the pump barrel, owing to the clearance all being on the top at the far end of the pump.

UPRIGHT FORCE PUMP.

Upright force pumps, in a general way, are easier to keep in order than horizontal ones are, and usually put up true from the first; so that on a good foundation they will need more lining while the engine lasts. Not so with the horizontal, it is continually getting out of line. The pump itself is stationary, but it is the plunger to which we allude, owing to the shoving-head sinking on the slide.

UPRIGHT FORCE PUMPS WITH BORED CHAMBERS.

This pump was considerably used in the earlier years of steam. It is the same in principle with the upright pump last treated of, only differing in this, that instead of using a plunger, they use a piston-head packed with hemp; and the two valves, one on each side of the pump barrel, are at the foot of the pump.

RULES HOW TO FIND THE STROKE OF A PLUNGER BY FIGURES.

To find the stroke of a plunger by figures, it is necessary to multiply the stroke of the engine by the length of the pump-arm, and divide by the length of the pendulum from center to center, and the product will be the stroke of the plunger.

Example.—You want to find the number of inches throw of a plunger. The engine is five feet stroke, the pendulum is 72 inches long, and the pump-arm is 16 inches from center to center. What number of inches stroke will the plunger have?

60 inches stroke of engine.
16 inches length of pump-arm.
———
360
60
———
Pendulum 72 inches) 960 (13$\frac{1}{3}$ inches stroke of plunger.
72
———
240
216
———
$24\,\frac{24 \mid 1}{72 \mid 3}$

COLD WATER PUMPS.

There is an endless variety of ways for raising water, but there is no plan which can be invented to do it which will require less power than the weight of the water to be raised, adding the additional friction of the pump to that weight.

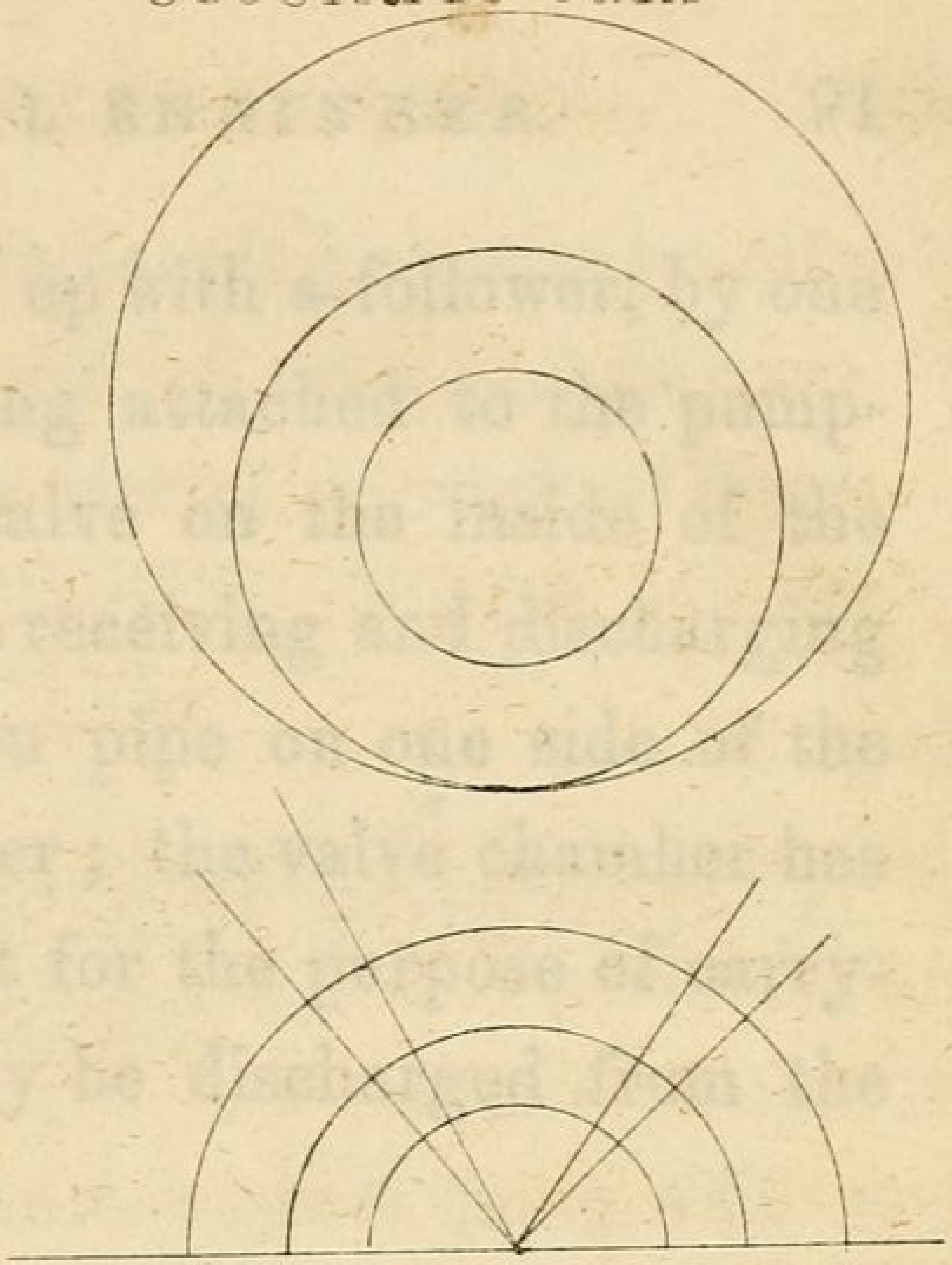
For raising water there have been invented the screw, working in an outside barrel; a variety of patents; rotary pumps of various kinds; Mixwell's patent double chamber pump with an air vessel; Warner's patent forcing and suction pump, &c. Here it will not be out of place to mention the kind of pumps we generally use:

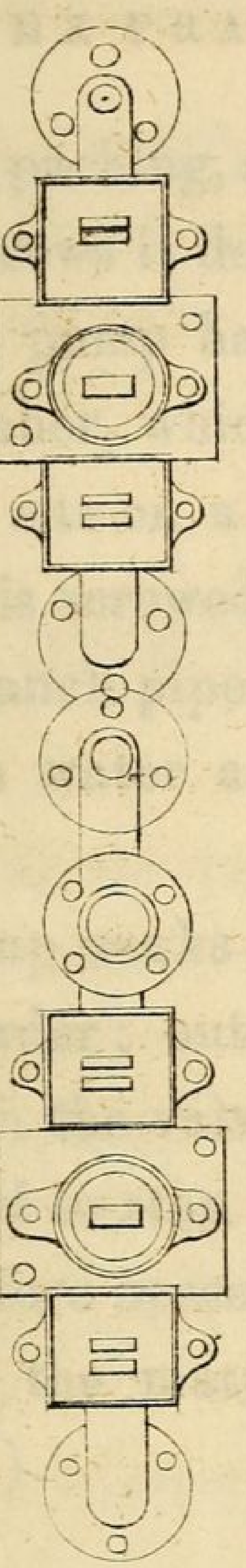
The common well or lift pump, with two boxes,—the upper and the lower box. This pump can raise water from 26 to 28 feet high. (See draft of a pump marked I.)

It is said that the pressure of the atmostphere could sustain a perpendicular column of water from 32 to 34 feet in height.

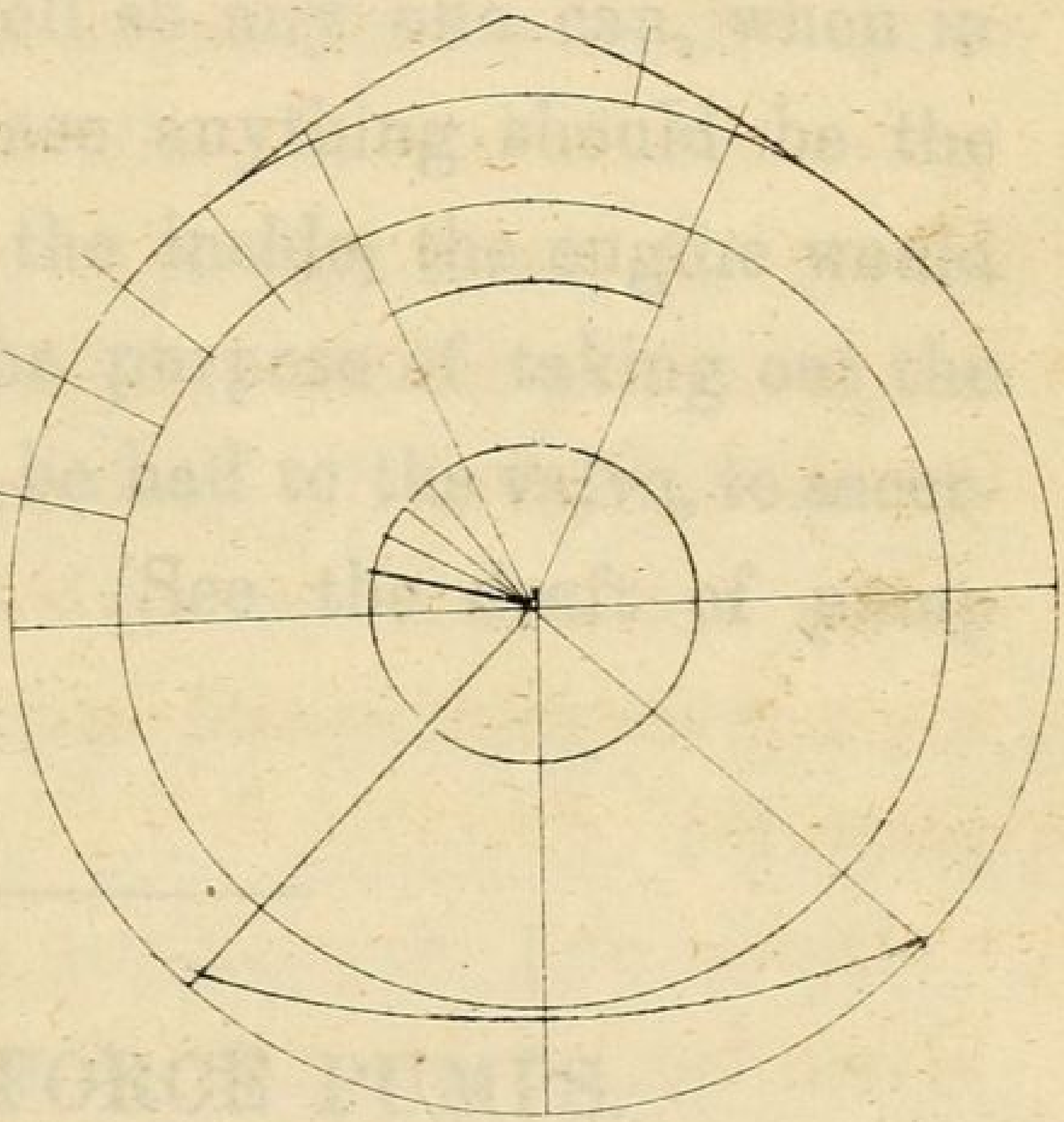
FORCE PUMPS.

The barrel of this pump is generally made of cast iron, bored out true, in which a piston head works, eccentrie Cam





Bottom of Cold Watter pump



cut of Cam.

COLD WATER PUMPS.

There is an endless variety of ways for raising water, but there is no plan which can be invented to do it which will require less power than the weight of the water to be raised, adding the additional friction of the pumps for that height.

For raising water there have been used the screw, working in a cylinder barrel; a variety of crank or rotary pumps of various kinds; Lever and Sprague's patent double chamber pump with an air vessel; a Worcester's patent forcing and suction pump, &c. Here it will not be out of place to mention the kinds of pumps in general use:

Wooden ones, or the lift pump, with two boxes, viz.: the upper and the lower box. This pump can raise water from 28 to 30 feet high. (See draft of a pump marked L.)

It is said that the pressure of the atmosphere could sustain a perpendicular column of water from 32 to 34 feet in height.

FORCE PUMPS.

The barrel of the pump is generally made of cast iron, bored out true, in which a piston head works with hemp packing, screwed up with a follower, by one nut that screws it down, being attached to the pump-rod. This pump has one valve on the inside of the pump chamber, which is the receiving and discharging valve, and sits on a cast-iron pipe on one side of the pump and is screwed together; the valve chamber has another branch pipe upon it for the purpose of carrying off the water as it may be discharged from the pump.

This pump works as well as any one can, when in working order; but in case anything should be the matter with the valve on the inside, the engine would be required to stop for the purpose of taking out the plunger before access can be had to the valve, to ascertain what the matter is. (See the draft of pump marked H.)

SUPERIOR FORCE PUMPS.

The barrel of this pump is similar to the last one about which we have been speaking, but the valves are both on the outside of the chamber, just as they were on the cold water force pumps. The fact of the valves being thus placed on the outside is what gives it superiority over any other pump that can be used, because access to the valves can be had at any time without stopping the engine, and you can get through your examination in less than one fourth the time it could be done on former pumps. (See pump on draft marked R.)

A SUPERIOR FORCE PUMP WITH AN AIR VESSEL.

This pump is the same in all respects as the above, only with the addition of an air vessel, which is of great benefit towards relieving the pump from surging, where the water has to be thrown to a considerable height above the drum, as it gives elasticity to the non-elastic fluid, thereby enabling the pump to work more easily and smoothly, while at the same time throwing a more regular and uniform stream of water. (See plate S.)

Drafts and disquisitions of other pumps might be given, but let this suffice for the present.

THE FORM OF AN ORDER FOR A STEAM ENGINE.

Persons in ordering steam engines are not sufficiently definite to be understood in regard to particulars; and in handing in their orders, to receive proposals for the building of the same, as a general thing, they are too vague. They are sometimes written in the following manner:

"*Sir*—I wish to know your price for a 14 inch cylinder, 4 foot stroke, with two boilers, 36 inches in diameter, 28 feet long. Put up at M'Keesport.

"Please let me know your lowest. Yours in haste.
JAS. LOWRIE."

Now, persons answering this letter may each have his own way of building such machinery. One may make it as light as he can, while another may make it heavy. Much depends in this case upon the principle of the man who is employed to construct the engine, whether he will come up to the mark, or whether the sizes must be specified and their fulfilment exacted at the hands of the builder.

Now, the above order should be written thus:

"*Sir*—I wish to know your price, and terms of payment, for an engine of the following description: 14 inch cylinder, 4 foot stroke, side valve, good plain finish; main shaft about 13 or 14 feet between the journals; journals to be 8 inches in diameter, with bottom brasses; fly-wheel 16 feet in diameter, rim 5000 lbs; with two cylinder boilers, 36 inches in diameter and 28 feet long, made of $\frac{1}{4}$ inch iron; a governor and a cold water pump; well not more than 10 feet deep; we will want abcut 20 feet of well-pipe, 10 feet between cylinder timbers and boiler wall; to be ready by the middle of June, 1853."

ANSWER.

Terms as follows: half cash on contract, and the balance in two equal payments of ninety days each, with interest from date.

GENERAL REMARKS.

Single Engines, Double Engines, and Stern-wheel Engines — The advantages and disadvantages of one compared with the other—Stating which we consider the best, taking all things intoconsideration.

Single Engines.—Our steam engines, when first introduced upon our Western rivers, we made use of but one cylinder, using two main shafts and two water-wheel shafts which were connected by couplings. They were used for about thirty years; and with very few exceptions they answered the purpose very well as long as we had nothing better.

But we will now state some of the difficulties we had to encounter in the use of these engines. The passage way upon the deck was obstructed very much by the line of shafts passing all the way across the boat; and it was found more difficult to keep these shafts in line, one with another, than the shafts on our single engines are. The coupling blocks wearing loose and often backlashing and breaking the coupling of the shaft, and sometimes the coupling block. In addition to this there would be a considerable power lost in the backlash of the engine. Backlashing is always lost power; it is first acting then reacting, bounding and rebounding. Another difficulty arose from the fly-wheel cutting through the deck of the boat; and then again one wheel would have to be unshipped and go ahead with the other, in order to turn the boat, which took more time and required more room than the double engine does. These single engines, in general, only required two engineers; and boats of larger sizes required a carpenter to attend to the water wheels and see to such repairs as are required to the boat. The single engine would cost a little less than double ones, and cost a little less expense for engineers than the others require; but the difference is but little after all, as but one first rate competent engineer is required to take charge of an engine, whether single or double, and the wages of assistant engineers less in proportion.

Double Engines.—Our river engines are now most generally used double, either for two side wheels, or for the stern wheel; working with two cylinders.

We will now treat upon the side wheels, with two cylinders, each separate and independent of the other.

The advantage of having two wheels consists in this: you have the deck of the boat clear from the back of the boilers to the stern; the boat can turn in much less room and time by going ahead with one wheel and backing with the other at the same time. And another great advantage may be found in the fact, that should one engine give out while under way, you can get along with the other until you make into port. These are some of the advantages which result from the use of the double engine, and the only objections which we are aware of, that may be brought against them, is that they cost a little more to fit them out than the single engine, and they require a trifle more expense to furnish two assistant engineers; but when the advantages of the double engine are compared with those of the single, and the difference in the cost of running the single engine, with the difference in the cost of running the double, we say the side wheel double engine will be found far superior in the long run to that of the single engine, when all things are considered.

We would here remark, for the information of those who are not aware of the fact, (and it is fare to suppose that many are not,) that although the double side wheel engines came into general use only about the year 1840, yet, they are no new invention, for it was in use something like twenty-five years ago, or about the year 1827.

The author saw one of these double engines when on board the George Washington, as she was lying up at Shippingport, below Louisville. She had a double engine, with six boilers and three decks. Mention is made of this merely to show that here was an isolated case of the very same thing we are now using, and that it was in use about 27 years ago, and some 17 years before they were introduced into common use upon our rivers.

STERN WHEEL ENGINES have their advantages as well as their disadvantages. The wheel being in the stern, they can get along in a narrower channel than our side wheel boats can do. They are also said to run better in strong water. Two engineers are sufficient to run one of these boats; in case of any backing or going ahead, in the absence of one of the engineers, a fireman can ship or unship the cam rods of one of the engines, by direction of the engineer in charge of the other engine at the time. Now, it is stated by Haswell, in speaking of animals, that two men working at windlass at right angles to each other can raise 70 lbs more easily than one man can raise 30. According to this calculation, two men working in this way could do one-sixth more work than they could if they were separate. Well, if the two cylinders working at right angles, gain power in the same ratio, (which it is reasonable to suppose they do,) here is a gain of one-sixth more power than those engines would have if used separate for the drawing of side wheels. Another advantage the stern wheel boat possesses, is that they can run during times of ice and drift when other boats can not, on account of their water-wheels being exposed to the floating rubbish, drift, &c.

The first stern wheel steamer that was ever built is said to have been fitted out in Pittsburgh. She was constructed by Mr. Blanchard, to run up the Allegheny. She was called the Allegheny and was built about the year 1830. We are not exactly positive of dates, not having been fully posted up in this matter. In the next, we will enquire more minutely into particulars, and if possible give our readers the precise date.

It will now be proper to point out some of the disadvantages of the stern wheel boat, with our own thoughts thereon, and then leave you to draw your own conclusion.

The engines being on the stern of the boat and the water wheel behind the stern, throws so great a weight upon that part of the boat, as to be liable to break it down, if not very stiff; and to bring the weight of the cylinders as far into the boat as possible, from the stern, some times very long pitmans are used. We object to over long pitmans being used. (For particulars see Pitmans, on page 57.) Another objection to the stern wheel is that it hides the view from the stern of the boat, which might otherwise be had while running. The boilers being placed in the bow and the engines in the stern, is well calculated to break a boat down at each end, while it raises her up in the middle, unless well braced and stiffened with timbers and bolts. Another objection is the great length of the steam and supply pipe which is required; the steam must necessarily condense considerably in travelling from the boiler to the cylinders, and thus the engines will be likely to work off a good deal of water in this way. (It is well here to remark that we are fully in the belief that the greater part of the water made from condensed steam in the steam pipe might be forced to return to the boilers, by placing the end of the steam pipe next the boilers a foot lower than that which enters the cylinders the water would run back to the boilers, and we do not think the draft of steam would fetch the water out; it would settle to the bottom of the steampipe, and then run back to the boilers.) The water in the supply pipe also cools considerably in the long supply pipe, (which might be called a cooler,) whilst traveling from the cylinder to the boilers.

The stern wheel boats require a great deal more room to turn round in, than either of the two above mentioned boats. This is owing to her motion being entirely straight ahead or straight backwards.

But, notwithstanding all the disadvantages here mentioned against the stern wheel boat, she nevertheless has advantages more favorable than any other boat has. It can run in a narrower channel than any other boat can. It is not so likely to injure its wheels in putting out from shore; it can run safer and better during floating ice or drift, and is said to run better in strong water than other boats can on account of stern wheels working more in an eddy.

We have thus undertaken to point out the advantages and disadvantages of the different engines, leaving each to draw his own conclusion, after having read and heard ours, for we believe the perusal of this work may be the means of giving the reader new light on this subject, and of causing in him such thought and reflection as may be parent to some new ideas on this important branch of science.

Double Engine Boats Superior.—We have already given the reader to understand, that the double engine boats are far superior to the single engine boats built in early years; and we will now state, in conclusion, that side wheel boats with double engines make a much more beautiful appearance, when running than the stern wheel boats do; this is owing to their superior finish around the water wheel clear down to the guards of the boat. A stern wheel boat does not look so well on account of their water wheels being naked and exposed; and they are always rough and black, which does not contrast well with the finished painting.

We would say to those who wish to build a neat boat, one that would attract the eye for its beauty, build a side wheel boat with an engine for each water wheel: but if you are not particular as to looks, and wish to have a small boat to run on small streams then build a stern wheel boat.

COUNTER BALANCE.—The use of a counter balance is to put a weight on one side, to balance the weight that may be on the oppcsite side. Some of our earliest engines on the river, were put down on a level, or parallel with the deck of the boat; in which case they require a counter balance equal to the weight of the crank, from the center of the shaft out, including the wrist and the half weight of the pitman; nothing more than this was wanting. This counter balance was regulated by the fly wheel rim, being light on the crank side and heavy on the opposite side from the crank, just in proportion as the weight of the crank wrist, and half weight of the pitman required. But our water wheels are now made about one half larger in diameter than those of early years, which brings the shaft several feet higher up from the deck than they formerly were, and the cylinder is still kept down to the deck, as usual. This throws the cylinders quite on an incline, and they require more counter balance on this account, in proportion as the increase in the degrees of the height of the shaft. It is necessary, then, to get the number of degrees of incline; then the weight of the piston head, rod, and shoving head, as also the other half of the pitman; then in proportion as they rise on the incline with this weight, then will be required a similiar weight on the opposite side of the crank or wheel, in order to equalize the motion. Without this counterbalance, in coming up the inclined plain, the engine would scarcely be able to come over the center, and in coming over, it would pass down in such haste, that there would be danger of its driving all before it. Hence arises the necessity of a counter balance.

VARIOUS WAYS OF USING THE COUNTER-BALANCE. —Sometimes the opposite side of the crank was made heavy; another plan was adopted of using a circular segment of cast iron, bolted on to the side of three or four of the water wheel-arms; and another mode yet superior to this, was the casting of one or two flat pieces of cast iron, nearly the length of the buckets on the water wheel, 1½ or 2 inches thick, 6 or 8 inches wide, (more or less than this, as occasion required) for a counter balance to the opposite weights. This plan was better than the segment on the side of the arms; but all these are now dispensed with and three heavy buckets of double thickness, used in their stead.

DEFECT IN FORCE PUMPS MADE IN EARLY YEARS.

Very many of the valve-seat chambers in force pumps, used in the early days of steam, were made entirely too shallow. We have seen the top of the valve-seats, in force pumps, and check valve chambers about level with the opening in the bottom of the pipe leading from the valve chamber to the force pump, on the one side of it and on the other side of the pump, from the valve chamber to the discharge pipe, to which the pipe is attached that feeds the boilers with water. In some instances the tops of the valve seats were higher than this; in which case the valve stood the thickness of itself above the top of the valve seat, (with the exception of the level.) It is no wonder that force pumps, thus constructed, could not be depended upon at all times, to throw a regular supply of water into the boilers.

In the first place, the valve when bedded in its seat, stands above the opening in the pipe; and when raised by the plunger, for the purpose of letting the water pass through into the boilers, the valve being above the opening, it is thrown over on its side by the pressure back from the boilers, and sometimes remains in this position without falling; and of course, while in this situation, it will throw no water. By frequent tapping with a hammer, the valve may be caused to fall into its seat; it may then work a while; but, after a short time, when the steam becomes a little higher, the pressure on the side of the valve will be greater, and the friction so strong that the valve cannot fall, when of course, the pump cannot work.

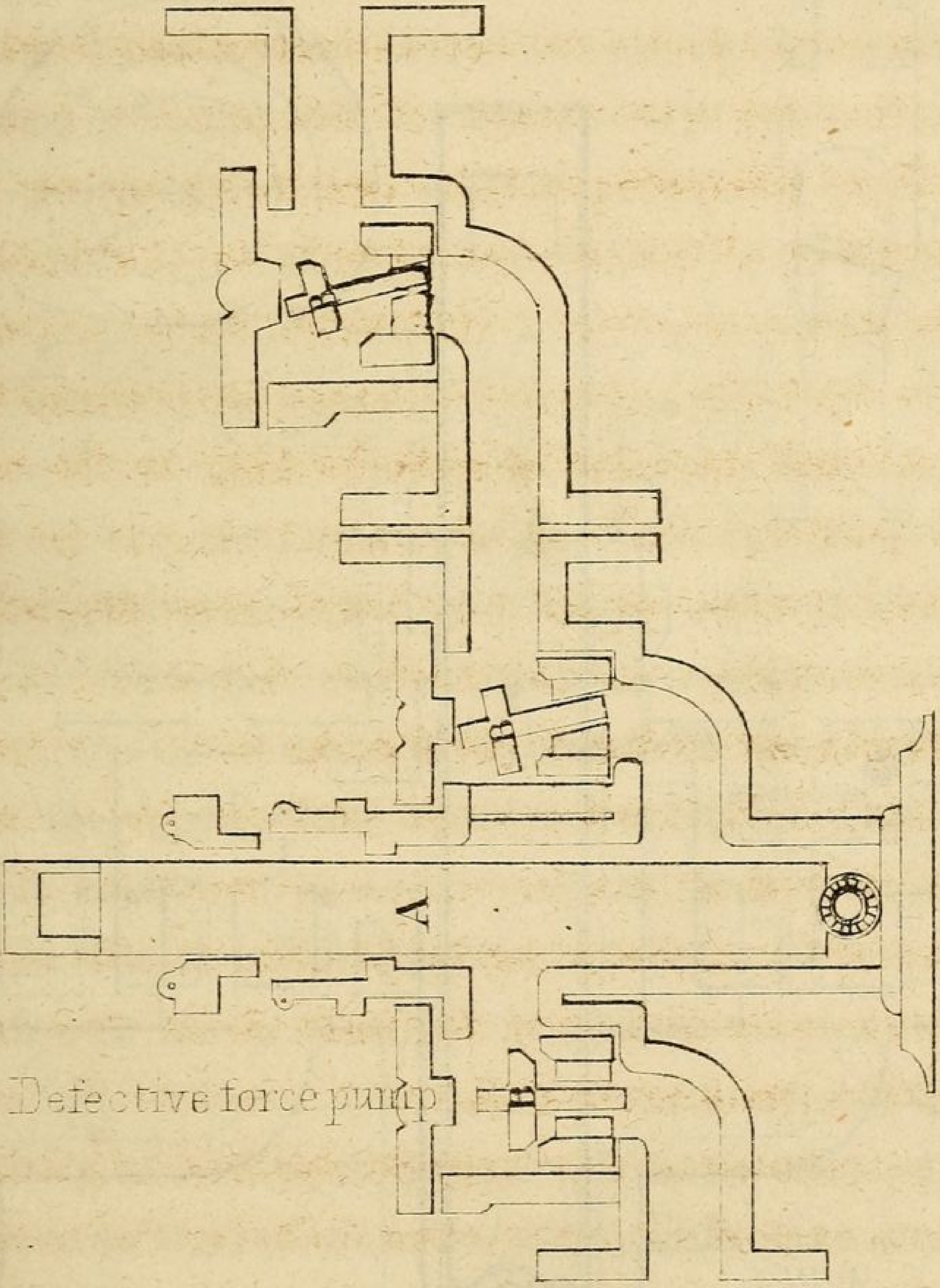
We believe this to be the reason why many force-pumps refuse to do their part: it is because they were not properly designed by their constructors. We have seen and heard of engineers frequently throwing cold water on their force-pumps when their engines were running in order to start them to work when they had quit throwing; and they would beat the cap of the force-pump very frequently with a hammer, for the same purpose. Now, we ask what sense there would be in beating upon the cap of a force-pump, with a hammer, if it were not to bed the valve in its seat, which they must suppose to be up? If it be up, let them ask themselves the cause, and they will find it to be just exactly as we have described it above; viz: that the valve chambers were made too shallow to allow the valve seat to sink a proper depth below the opening of the pipe in the valve chamber.

We do not believe the cause to be what many engineers have stated; "that the water was too hot, and that the force-pump was working steam," &c.; but one thing is certain, the pumps frequently refused to work, and of course, some of our engineers would often be put to their wits end to find out what was the matter. If a bystander were to ask them the trouble they would feel very strangely if they could not answer him. And they (no doubt not knowing the real cause) would think it was occasioned by the water in the force-pumps being too hot when received from the heater; but the true reason of the pump becoming overly hot, was owing to the valve being up on the discharge side of the force-pump next to the boilers. Suppose there was but a little leak on the opposite valve, between the valve and the seat, or between the valve seat and the valve chamber, owing to the lead having partially oxidised or wasted away. In this case the hot water would come back from the boiler through the pump into the heater; this would make the pump as hot as steam could make it.

We have laid down a draft of force pumps with shallow valve chambers, showing how the action of the water operates on the valve, by pressing it over to the one side, as may be seen in the valve B, in the draft of the force pump marked A.

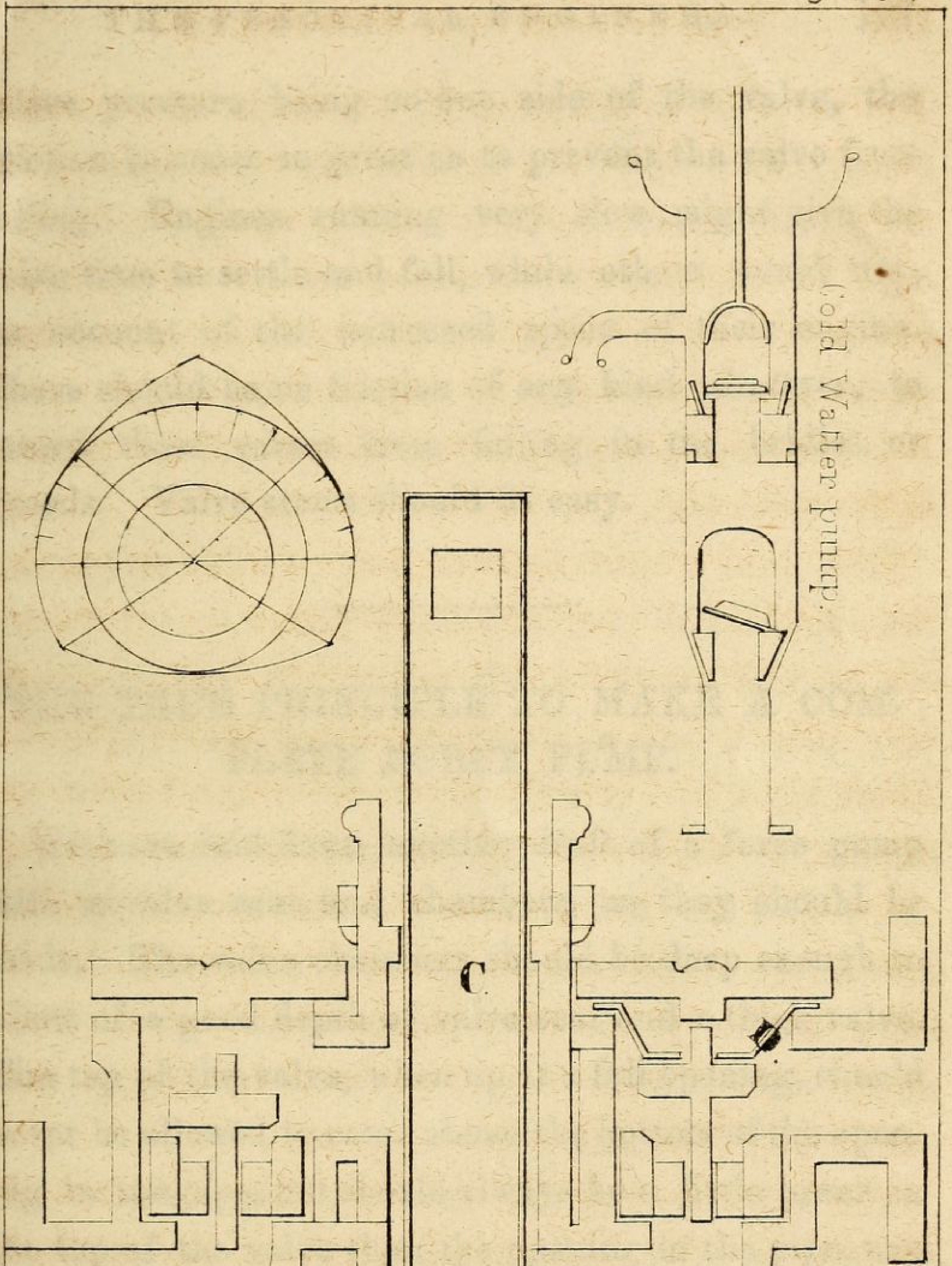
But perhaps some may suggest the idea of putting a bridle on top of the valve-stem, in order to keep it in its place, and from tipping over on one side. They can see the top bridle D in the force pump marked C; but this bridle will not answer the purpose. The re-

Page 106.



Defective force pump

Page.107.



active pressure being on one side of the valve, the friction becomes so great as to prevent the valve from falling. Engines running very slow might give the valve time to settle and fall, while others would not, on account of the increased speed of their engine. There should be no friction of any kind whatever, to retard these valves from falling in the bridles or guards. Valve stems should fit easy.

THE TRUE PRINCIPLE TO MAKE A COMPLETE FORCE PUMP.

We have laid down another draft of a force pump with a valve seat and chambers, as they should be made. The valve chambers should be deep enough to allow of a good depth of valve seat and a thick valve. The top of the valve, when up at a full opening, should never be allowed to come above the bottom of the opening in the pipe, but should always be a little lower in the top of the valve than the opening in the pipe, say from ¼ inch to an inch lower, according to the difference in the sizes of pumps. The reaction of water back from the boilers upon valves thus below the openings, will assist them to fall or close; as the reaction or pressure of the water from the boiler comes more directly on the top of the valve, and hastens its fall.

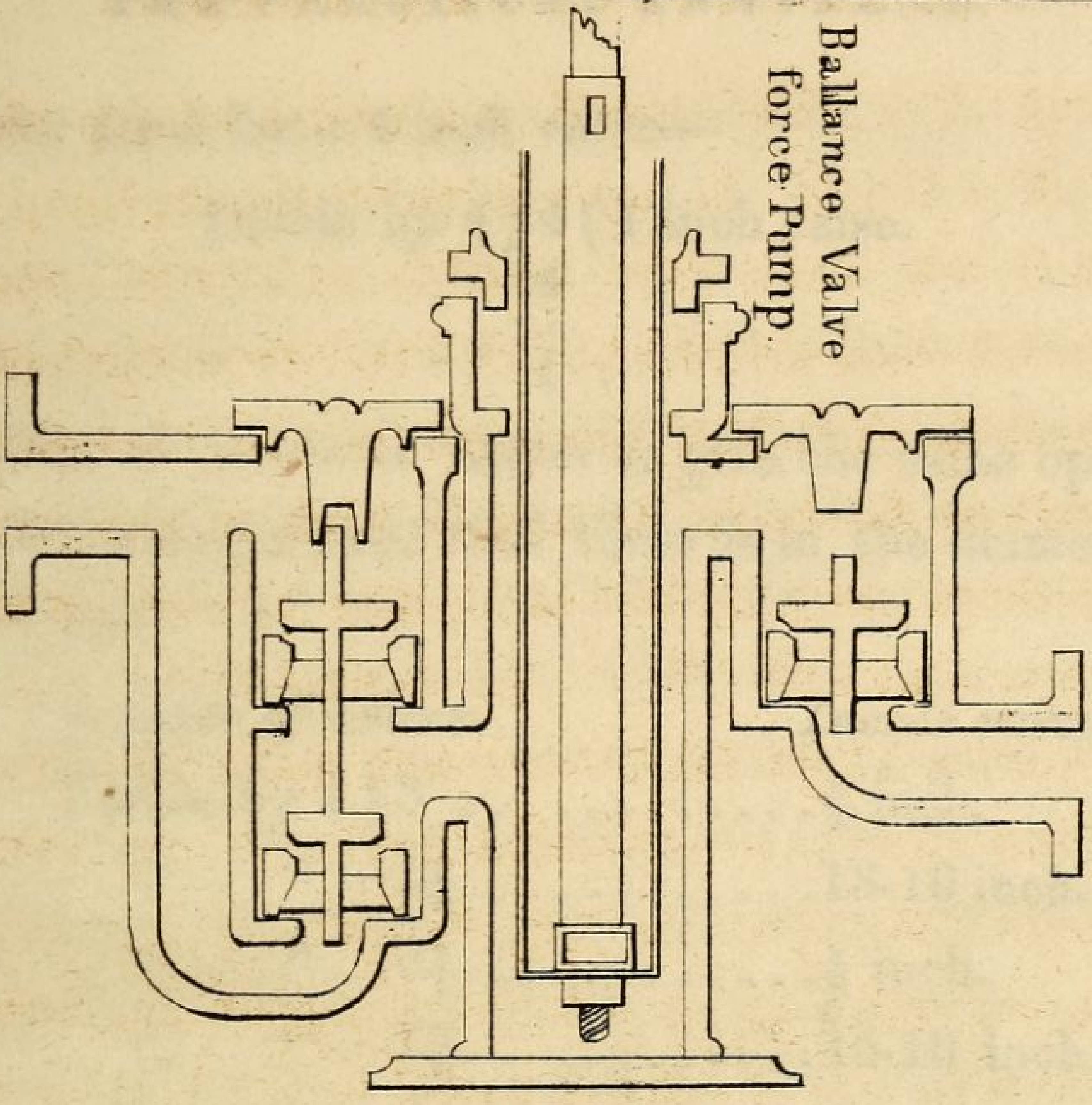
The valve F, in the pump E, is a model of a perfect pump. The top of the valve is below the opening in the pipe G, whilst the valve itself is up at a full opening. In this case, the reaction of water from the boiler passes over on the top of the valve (instead of striking on the side of the valve, as may be seen in the valve B in the force pump A) and helps it to fall into its bed in the valve seat.

HOW HIGH A VALVE SHOULD RISE TO MAKE THE OPENING AROUND THE CIRCUMFERENCE EQUAL TO THE OPENING IN THE DIAMETER OF THE VALVE.—This rule is very simple, and also very important that engineers should know it. It is equally useful to the builder of engines, to know how high his puppet valves should rise to give the same number of inches around the circumference of the valve seat itself. It is useful also to know how high the force pump, check valves, &c., should rise in order to give as much opening in the valve seat. The rule is this :

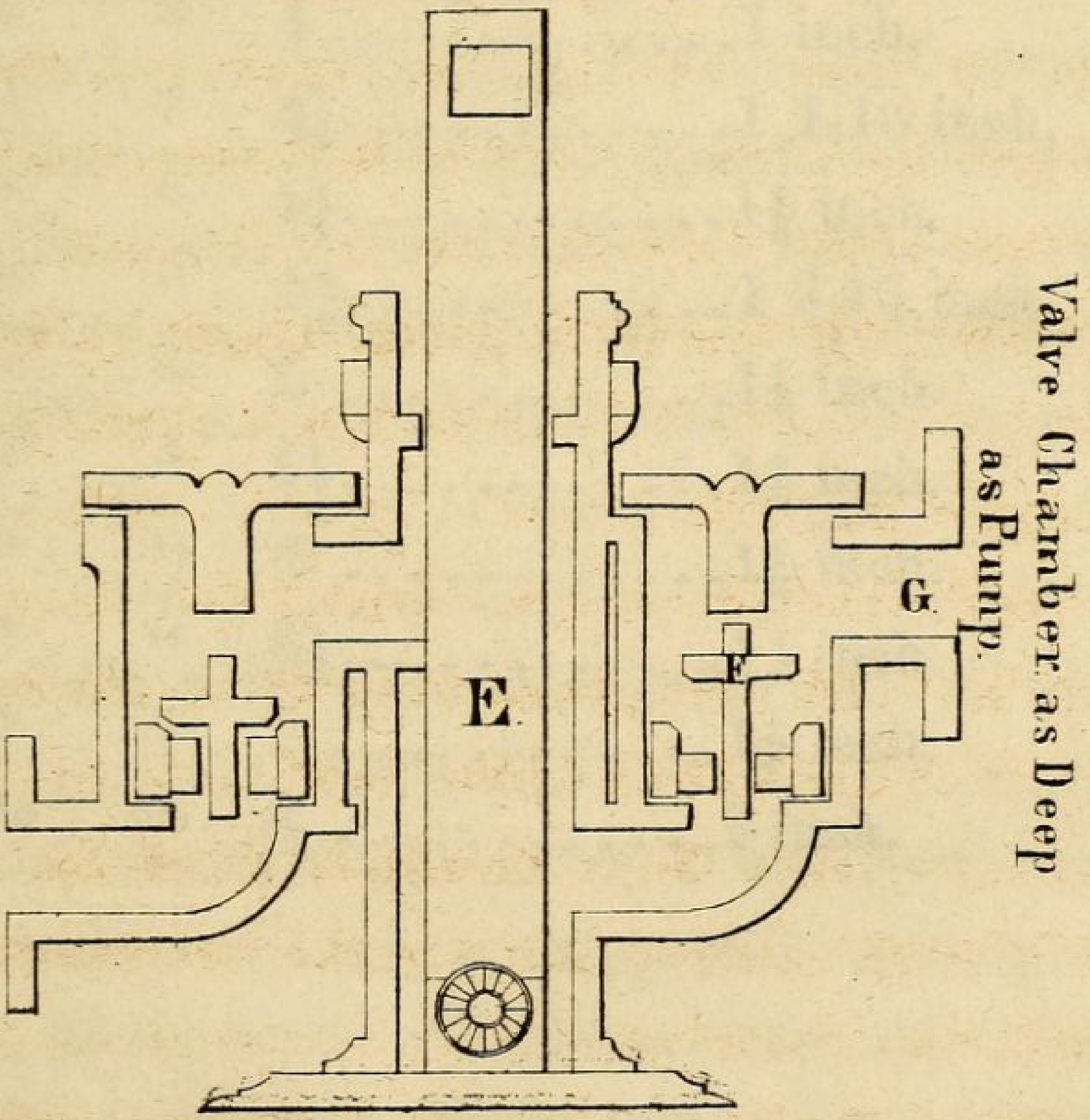
The valve should rise one-fourth the diameter of opening in valve seat, measuring it at the smallest place, just at the bottom of the bevel.

EXAMPLE.—How high should a three inch valve rise, to give as much opening in the circumference as there is in the diameter :

Divide by 4) ¾ inches (0, ¾ inches rise.
0



Ballance Valve force Pump.



Valve Chamber as Deep as Pump.

And for a for a 4 inch valve—

Divide by 4) 4 (1 inch raise.
4
—
1

Table of inches of valves to give the same opening in the circumferences that there is in the diameter of the valve :

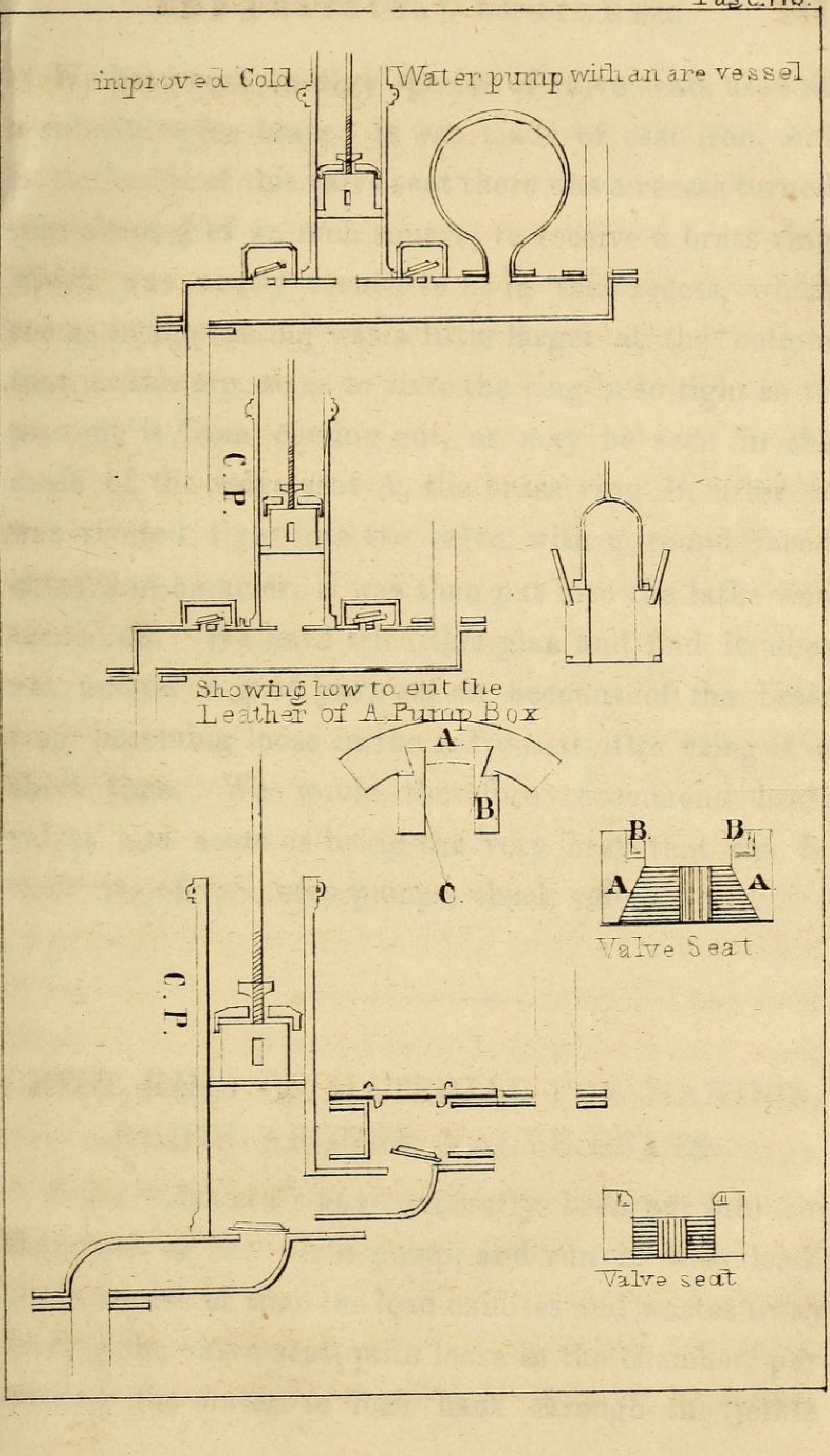
Diameter of valves.	*Inches raise.*
Divide by 4) 3	¾ inch.
“ “ 3¼	13-16 inch.
“ “ 3½	⅞ inch.
“ “ 3¾	15-16 inch.
“ “ 4	1 inch.
“ “ 4¼	1 1-16 inch.
“ “ 4½	1⅛ inch.
“ “ 4¾	1 3-16 inch.
“ “ 5	1¼ inch.
“ “ 5½	1⅔ inch.
“ “ 6	1½ inch.
“ “ 6½	1⅝ inch.
“ “ 7	1¾ inch.
“ “ 8	2 inch.

HOW TO CUT THE LEATHER FOR A PUMP BOX.

To cut a leather out to fit a pump box, it must be cut circular; and in order to get the small diameter, it is necessary to continue the flare of the pump box until it meets in the center, and this will give the distance for the inside circle; and the outside circle will then be as much larger as it is intended the depth of the leather of the pump box should be. A box and leather may be seen laid down in draft; A is the shape of the leather; B is the pump box, and C is the center. It is upon this principle that strips for laying out boiler iron are made, owing to rings being smaller at one end than they are at the other. The difference of the diameter of boiler rings at each end, are equal to the difference of the boiler iron; and the strips for laying out the boilers must be made accordingly.

BEST KIND OF VALVE SEATS FOR FORCE PUMPS.

The best kind of valve seats that can be used for force pumps, check valves &c., are made of brass. Brass valve seats stand the water better than any thing else that has been tried; iron seats soon rust out, and wear away much faster than brass.


improved Cold Water pump with an are vessel
C. P.
Showing how to cut the Leather of A Pump Box
A
B
C.
B.
B.
A
A
Valve Seat
C. P.
Valve seat

We have seen another species of valve seats used as a substitute for brass; it was made of cast iron, and in the inside of this valve seat there was a recess turned out, about ⅜ of an inch square, to receive a brass ring which was neatly turned to fit in this recess, which recess in the casting was a little larger at the bottom than at the top, so as to rivte the ring in so tight as to prevent it from coming out, as may be seen in the draft of the valve seat A, the brass ring B, after it was riveted tight into the valve, with a round faced chisel and hammer, it was then put into the lathe and turned off. We have tried this plan and find it does not answer a good purpose on account of the brass ring becoming loose in the valve seat after using it a short time. We would therefore recommend brass valves and seats as being the very best that can be made use of for force pumps, check valves &c.

BEST KIND OF MATERIAL FOR MAKING JOINTS AROUND VALVE SEATS.

Brass valve seats have generally been put into the chambers of the force pump, and run in with lead; but in course of time the lead oxidises and wastes away leaving the valve seat quite loose in the chamber, permitting the water to leak back through the joints.

They are frequently corked tight with an iron kept for that purpose, and very often they are taken out and run in again anew; but lead is continually giving out. It does not stand in steam or hot water as well as it does in cold.

Others put these valve seats in with tin; this is much better then lead. Tin shrinks a little after it has been run in about the valve seat and requires to be made tight with a corking iron before using it.

Others again have wondered whether cements would hold around brass valve seats. We have tried cements around brass valve seats for the purpose of testing it, and witnessing how it would answer, in asmuch as the lead was exceedingly troublesome. We have found the cement answers the purpose admirably; it will stand firm from year to year, as tight as a bottle.

Some bore out their valve chambers and turn their valve seats, so as to make a tight fit, and then put a little red led around the valve seat and force it into its place, and it remains tight and permant also. It would require some little work to get these valve seats out, when put in this way. It is true, they seldom want taking out when properly put in, but it sometimes so happens that it becomes necessary to take them out for repairing.

(N. B.—It is worthy of especial note that these pumps which have very small valve seats, will wear out of order much faster than those that have larger seats and openings; and of course, would be required to be repaired much oftener.)

We believe, upon the whole, that the cement is the very best material, and the very best mode for putting in force pumps and check valve seats into the chambers. There is no mistake about their holding tight. Have a good, deep valve seat, and from ⅛ to ¼ of an inch all around for driving in the cement. Do not have your cement space too large; ⅜ of an inch would be too large if you can have less; but if you cannot do better, perhaps even this will hold if your valve seat is deep.

A great many valve seats are made entirely too shallow. A valve seat with a two inch opening should not be less than one and a half inches deep. A seat for a three inch valve, 2½ inches deep; and a 4 inch valve 2¾ or 3 inches deep.

DIFFERENT CAUSES FOR STEAM BOATS TAKING FIRE.

We were once present when they were getting up steam upon a new boat, for the purpose of running the engine when we discovered smoke arising from the ash-pan beneath the boilers. Alarm was given and it was immediately extinguished by throwing water under the pan as soon as it made its appearance. No doubt this was owing to carelessness on the part of the engineer, in not having water thrown into it, to keep it cool while raising steam, and while waiting for the engine to be put in motion to feed the pan with water.

There would be less danger from fire, in case of carelessness in this way, if these ash pans were paved in with brick; still, if well watered at all times, there would be no danger even without brick. Boats may have been burnt in this way; and this may be considered as one of the ways in which they may take fire through neglect.

Another cause of steamboats taken fire. Not being able to particularize, we will merely say, that some sixteen or seventeen years ago, the Ben Sherod, an eight boiler steamer, one among the largest class of boats built in her day, caught fire in the night, on her way up the river from New Orleans, we think. It was reported at that time, that she was running a race with another boat when the fire broke out; and the rumor was that they had been firing the boilers until they were red hot. This, of course, is not to be believed at all, for steam boilers cannot be made red hot wherever there is water in contact with the iron. But we will simply suggest several different ways in which steamers might take fire, and then point out the manner in which it is most likely for the Ben Sherod to have caught fire.

In early days wood was universally used for fuel on our rivers, to raise steam; and to a considerable extent it is still used upon the trade below the falls of the Ohio. It was common and indispensably necessary to have a rack or skeleton frame on each side of the fire bed, on the outside of the boilers, some ten or twelve inches off from the fire bed. This rack was necessary for several reasons: had the wood been piled up close to the fire bed, it might take fire, and if any of the brick wall on the inside would fall down, as they frequently do, the wood thus piled up would be sure to take fire. Now, the object of this rack was to keep the wood off from the fire bed, as well as to prevent the brick from being knocked down inside the fire bed, while carrying it aboard and piling it up. This work was usually performed by deck hands and deck passengers, and of course they threw it down roughly; often it would be sport to them to cause mischief.

(N. B.—To steamboat captains we would suggest that the wood should be carried in by the deck passengers, while it should be the duty of the deck hands belonging to the boat, to pile it up, for this being an every day business with them, they would fully understand the manner in which it should be done. On the other hand, passengers are changing almost every day and if allowed to do this part of the work, (to pile wood on the boat,) they no doubt might occasionally throw sticks carelessly between the boards of the rack and strike the fire bed, and knock down the brick work within it. In this way fire might be communicated to the wood some ten or twelve inches off from the fire bed.)

Deck passengers should not be allowed to pile the wood on board the boat, especially after night, or in rough, cold, stormy weather, unless under the direction of the confidential hands belonging to the boat, to see that it be done with care.

Another way in which steamers may have caught fire, is in shaking up the fires on the outside doors. The sparks are liable to fly back into the wood, and there lodge until the whole pile becomes ignited. Fire may also originate on low boiler decks from sparks, in the same way. The deck itself, when low, becomes greatly heated from the boilers, and would burn like a match if brought in contact with fire or sparks.

Fire might originate in this way: sometimes the tile or brick work between the boilers on top, may become wracked more or less from various causes, and the joints of the same may be open sufficiently to let heat enough escape to set fire to the deck. And it might be possible in some cases, especially if the brick work has not been well done; or if some of the brick or tile were cracked when put in; it might happen that they would break to pieces and fall into the furnace sometime afterwards, without the knowledge of any one upon the boat. In this way the boat might be set on fire although the tile may have been put on double thickness, breaking joints at the same time.

Another manner in which boats may have, and no doubt many have been set on fire, is by leaving candles burning in the state rooms, or down in the hold of the boat, where it may be near some combustible matter, where if it should gather a waster and run down, the wick might fall into spirits of turpentine; or the candle might emit sparks of fire, as they sometimes do, especially if the wicks have been wet whilst being made, and thus set fire to combustable matter. Cases of this kind have occurred. If this be so, it is dangerous to leave lights in any part of the boat, unless there be some one present to use and attend to them while burning. In secret or retired places, such as the hold, berths, or any like localities, lights should not be allowed to remain burning, as they run the risk of setting the boat on fire, and also put in jeopardy the lives of all on board.

Without detaining you any longer, by giving you further explanation on the subject of the various ways in which steamboats are liable to take fire, we will state to you how, in all probability, the Ben Sherod caught fire. It was in the night that she took fire, and it was said she had been running a race at the time with another boat and that they had been firing the boilers until they became red hot. Now, we do not believe the boilers were red hot, for such a thing is impossible if they had water up to the guage cocks, which we are inclined to think they had. It is very likely she took fire from the sparks flying, from shaking up the fires on the outside furnace doors, and these sparks of fire, no doubt, lodged and remained in among the cord wood until fanned into a flame by the running of the boat.

Another way by which she may have caught fire, is that the brick work in the fire bed may have been worked partly down by the firemen, (this we have had done by firemen while running as engineer on the river, and therefore speak from experience, as well as observation) and the fire bed being thin, would be very soon made red, and being red hot, would be very easely mistaken for the boilers being red hot. In this way, the wood along side of the fire bed may have taken fire, and been the cause of the burning of the boat and the loss of some 150 human beings. It was in the night, as before stated, and no doubt while many perished in the flames, many others were drowned in endeavoring to make their way to the shore.

The stsamer Ben Sherod was a very large and magnificent boat, commanded by Captain Russell during the time of this disaster.

This would appear to be the way in which she took fire. Report says her boilers were made red hot. Now, we think it probable the brick work had been knocked down by the firemen while pushing the fires during the excitement of the race, and the fire bed becoming red hot, would set fire to the wood at its side, and running against the wind, would instantaneously envelope the boat in flames. This may have been the very way in which this boat may have taken fire.

We think this a proper occassion to suggest some ideas on the subject of guarding against fires, let them arise from what cause they may about the boilers. Boats which use wood for fuel, should have a bulk head in front of the wood, next the fire bed of the width of the wood pile. It should be lined with sheet iron to keep the sparks of fire from falling in among the wood while shaking up the fires. The fire bed should flare out considerably on top, so that the brick work at the fire end will not be so easily tumbled down by shaking up the fires. The tile, between and on top of the boilers, should be examined every now and then, to see that the joints are good, and the morter between the brick has not fallen out, so that heat and sparks may pass through them and set fire to the boat. Some line the under part of the boiler deck with sheet iron, and it being a non-conductor of heat, keeps the deck cooler than it would otherwise be; and this may also be considered a preventive against fire, which otherwise might be occasioned by sparks and heat from the opening in crevices of the brick work. These crevices and openings in the brick work on top and around the sides of the fire bed, should be examined and put in order every time the boat lays up to repair.

DIFFERENT RULES FOR SQUARING AND LINING OF SHAFTS.

Rule 1.—For squaring and lining of shafts, as used upon our steamers in early years, with one cylinder and four shafts—two main and two water wheel shafts; First—stretch a line through the center of the cylinder timbers fore and aft with the boat; then fit a flat piece of board between the cylinder timbers, even with the top of the timbers and at the center of the shafts; then make a center point on this board for the tramble point at the center of the shafts, and also on the line passing through the center of the cylinder timbers and main wrist; then take any distance you please on the trambles—say 10 feet—and from the center of the shaft; make a scribe or point from the shaft each way from the center, 10 feet each; then from these two points on the straight line in the center of the cylinder timbers; place the trambles and describe two circles that will intersect each other on the timber which is to receive the pillar block on which the end of the main shaft is to rest; then stretch the line across the curves on these timbers, and this line for your shaft will be square with the center line through the cylinder timbers. The next thing, then before laying out for your pillar blocks, is to get the line for the shafts parallel, or at equal distances on both sides of the boat, with the shier plank, and then the shafts would be level when the boat is in trim.

Rule 2.—How to square the shaft line to the cylinder lines by figure: 6, 8 and 10, or any other numbers, more or less, in the same proportion: Draw the center lines in the cylinder timbers, as in rule 1st, then make a mark on this line with a black lead pencil at the point where it is intended the center of the shaft is to come; then measure 6 feet from this center, each way on your line, and mark these points with a black lead pencil; then measure 8 feet each way from the center point, out from the center line, and then take a ten foot pole and try it to these points on the lines, and if they are more or less than the pole, bring the shaft line round at either end, keeping the line to the center on the line fore and aft and when you get two of these points to fit the length of the pole, the other three spaces will be the same length, and the lines will be square one with another. (The center line for the shafts will be equal, or parallel distances from the shier plank, as in rule first example for squaring of shafts. See plate.

N. B.—Before the shafts are put into the pillar blocks, put a parallel straight edge accross the two main pillar blocks on the top of the bottom brasses, and then some 2, 3 or 4 feet aft of the slides, put on another parallel straight edge across the top of the cylinder timbers, aud see if these straight edges are out of twist on top; and if not, plain a narrow place across the top of the cylinder timbers until they are out of twist, and this place will be a guide, after the shafts are in their place, to put your slides and cylinder lugs true, and level with the line through the center of the shaft.

Rule 3.—*How to line cylinders and square shafts for side-wheel boats, with double engines:* When the cylinder timbers for both engines, are each one parallel from a line through the center of the boat, fore and aft, you will then stretch two center lines through the cylinder timbers parallel or equal distances with each other,—then stretch the center line for the shafts across these parallel lines where it is intended the center of the shafts are to come, and then proceed to square the shaft line with the cylinder line according to rule 1st, as laid down on page 120 or according to rule 2d, as found on page 121.

Stern-wheel engines are squared in the same way as side wheel boat engines are, when the timbers of the side wheel boat are equal and parallel with each other but not otherwise.

RULE 4.—*How to square shafts with cylinder timbers, when the timbers are not parallel with each other.* —We would here remark, that it is a common thing on side wheel boats with double engines, to have the cylinder timbers, at the water-wheel, something like six inches narrower then they are at the cylinder, sometimes more and sometimes less, as it may happen. We are opposed to this, for the following reason: The water wheels being turned several degrees out of square from a line drawn through the center of the boat, they will not pull straight ahead, but lose power in proportion to the number of degrees it is out of square.

Whether this be done intentionally, by the ship carpenter, or not, we cannot at present say. But there are some who allege that it is better to be a little out of square, saying that it throws the water in on the rudder, thereby causing a stronger current against the rudder-blade; there by enabling the pilot to steer the boat more easily. We have also heard that it was advantageous in another respect. The boat is narrower at the stern, and the water being displaced by the wheel a little out of square, it is said causes the water displaced by the boat to return more rapidly to fill the vacancy, and that this acts upon the stern or narrow part of the boat in the same manner that any pressure would upon the narrow part of a wedge, thus assisting to propel the boat along.

Our opinion is, notwithstanding these arguments, that the cylinder timbers should be parallel and the water wheel square with a line through the center of the boat; and then, if the rudder is constructed as it should be, the boat will be easily stered without any additional assistance from the water wheels.

But to square shafts with cylinder timbers that are not parallel with each other, a line must be drawn through each cylinder timber, and square each shaft from its own line, according to rule 1st, as laid down on page 120, or, as rule 2d, page 121.

Notwithstanding these two shaft lines are not straight with each other, sideways across the boat, (the cause of which is the cylinder timbers not being parallel with each other,) yet they would be and are straight the other way; the line being equal distances from the shier plank up. When relining shafts, after the boat has been running awhile, it may be that one or the other side of the boat has settled, sometimes an inch more or less. In lining the shafts in this case, it is not necessary that they be equal distances from the shier plank, so that the centers of each shaft are at parallel distances from a line reaching across the boat which is parallel with the shier planks; and the shaft can be squared by a line running through the cylinder; this can be done by making a small center mark with a file or cold chisel on both sides of the wrist in its center, and turning over and trying fore and aft on your line and keying your pillar blocks one way or other until both these marks fit the line which passes through the cylinder.

For getting the shaft in line the other other way, or up and down: Stretch a line across the boat, from the center each way; that is parallel from the shier planks, straight on top, though not straight sideways. Let this line be some three, four, or five feet above the top of the journals or caps; then take two small strips of wood, ½ or ⅜ inch square, and let there be a difference in the lengths of those strips equal to half the distance there is between the collar on the large journal and that of the smaller one; and then, if the long strip fits the collar on the small journal, and the short strip fits the collar on the large one, your shaft will be in line this way as well as the other. We suggest it as the easiest plan to measure from the tops of the collars, as it answers every purpose, and also saves the trouble of taking the caps off the tops of the pillar blocks which would be a great deal of unnecessary trouble.

BEST METHOD OF HOLDING BRACES IN WHEELS.

Various methods have been tried to hold braces tight in water wheels, and very expensive plans been devised for that purpose; among others, that of a wrought iron flat band of large diameter, in two pieces, reaching to the outer braces near the edge of the inside buckets, ond these we believe were bolted fast both to the arms and to the braces.

Another plan was to have two segments of flat iron, say two inches by half an inch, and equal in length to the distance of the arms on which they meet from center to center. These were bolted together by a great number of small bolts, and room enough left behind each arm for the purpose of tightening up the braces by driving in a wooden wedge. This was a very poor plan, as well as very expensive one.

The best plan which has ever as yet been hit upon, and one which we believe admits of no rival, is that of a long bolt, fastened to the water wheel flange by an eye, a nut or a key, one which bolts passes through every set of braces in the wheel. On each bolt is a separate nut for the purpose of screwing down every brace in the wheel, and if there should be three, four, or more braces, there must be three, four, or more sizes of nuts, so that one will pass over the other; and when these braces are screwed down tight, the braces in the water wheel arms will be as tight as a drum head.

MILNER'S CUT-OFF VALVE GEAR.

We think it proper to insert in this place a description of Milner's Cut-off Cam Valve Gear, patented July 30th, 1850. The improvement consists in working the steam valves by the combined action of two D cams; I is the loose cam, with a segmental slot, and index plate on it; the yoke of this cam is attached to the upper end of the oscillating bar N, by the connecting link O, and the lower end of said bar is attached to the yoke of the fixed cam, in the same manner. The steam valves are operated from the center of the oscillating bar by the inside rod V. The fixed cam operates the exhaust valves as usual in other engines, and being attached by its yoke to the lower end of the oscillating bar, also opens the steam valves, as soon as the engine arrives at the point at which the engineer has set the loose cam I, to cut off steam; it moves back the upper end of oscillating bar N, and cuts off steam. By slacking the screw and moving the loose cam to the figure at which it is desirable to cut off steam, it can be cut off at from one-eighth to to seven-eighths of the stroke with precision, enabling the engineer always to use all the steam he can make at any given pressure, and also to cut off at such a point, as to be able to keep steam without throttling it; and as it is well known that boats on the Mississippi, with a load, and a head wind, cannot work off all their steam with these fixed cut-offs, nor supply steam to allow full strokes, they are obliged to lay to, or add pressure to their boilers to make headway. This invention, then, will add to the safety of boats and passengers; for, by changing the cut-off, they can use all their steam and go ahead. Also, when running with fair wind, light load, and favorable tides, they cannot make steam enough, they are obliged to throttle it, and lose much of its elastic force.

This invention will be advantageous for light draught boats, and also for ships on a long voyage, requiring less weight of boiler and fuel for a given power. Example—A boat now running with two cylinders of fifteen inch diameter, and two boilers doubled-flued, forty inches, and cutting off steam at three-fourths of the stroke, would run quite as fast, with one boiler, if the cylinders were twenty and a half inches, and steam cut off at one-fifth of the stroke. Again: the two boilers would supply cylinders of twenty-nine and a half inches, cut off at one-fifth stroke, and would very nearly double the power, with very little additional weight, and no more fuel.

Again: this improvement recommends itself to engineers and steamboat owners by its simplicity and easy construction; also by its durability. Cut-off cams for half-stroke even, are soon worn out, and are a continual cost to engines, whereas, these D cams will answer the purpose to cut off at any point, and are not subject to wear out, as the pointed cams are; they can also be so altered as to suit any change of fuel, from good to bad, and vice versa; or in case of a want of fuel, to use what they have to the best advantage.

AREAS OF CIRCLES, FROM 1 TO 100.

Diameter	Area.	Diam.	Area	Diam.	Area.	Diam	Area.
$\frac{1}{64}$	.00019	.$\frac{1}{4}$	8.295	.$\frac{5}{8}$	45.663	12.	113.09
$\frac{1}{32}$	.00076	.$\frac{3}{8}$	8.946	.$\frac{3}{4}$	47.173	.$\frac{1}{8}$	115.46
$\frac{1}{16}$	.00306	.$\frac{1}{2}$	9.621	.$\frac{7}{8}$	48.707	.$\frac{1}{4}$	117.85
$\frac{1}{8}$	.01227	.$\frac{5}{8}$	10.320	8.	50.265	.$\frac{3}{8}$	120.27
$\frac{3}{16}$	.02761	.$\frac{3}{4}$	11.044	.$\frac{1}{8}$	51.848	.$\frac{1}{2}$	122.71
$\frac{1}{4}$	.04908	.$\frac{7}{8}$	11.793	.$\frac{1}{4}$	53.456	.$\frac{5}{8}$	125.18
$\frac{5}{16}$	.07669	4.	12.566	.$\frac{3}{8}$	55.088	.$\frac{3}{4}$	127.67
$\frac{3}{8}$	.1104	.$\frac{1}{8}$	13.364	.$\frac{1}{2}$	56.745	.$\frac{7}{8}$	130.19
$\frac{7}{16}$	.1503	.$\frac{1}{4}$	14.186	.$\frac{5}{8}$	58.426	13.	132.73
$\frac{1}{2}$	.1963	.$\frac{3}{8}$	15.033	.$\frac{3}{4}$	60.132	.$\frac{1}{8}$	135.29
$\frac{9}{16}$	.2485	.$\frac{1}{2}$	15.904	.$\frac{7}{8}$	61.862	.$\frac{1}{4}$	137.88
$\frac{5}{8}$	.3067	.$\frac{5}{8}$	16.800	9.	63.617	.$\frac{3}{8}$	140.50
$\frac{11}{16}$	.3712	.$\frac{3}{4}$	17.720	.$\frac{1}{8}$	65.396	.$\frac{1}{2}$	143.13
$\frac{3}{4}$	.4417	.$\frac{7}{8}$	18.665	.$\frac{1}{4}$	67.200	.$\frac{5}{8}$	145.80
$\frac{13}{16}$	.5184	5.	19.635	.$\frac{3}{8}$	69.029	.$\frac{3}{4}$	148.48
$\frac{7}{8}$	.6013	.$\frac{1}{8}$	20.629	.$\frac{1}{2}$	70.882	.$\frac{7}{8}$	151.20
$\frac{15}{16}$	.6902	.$\frac{1}{4}$	21.647	.$\frac{5}{8}$	72.759	14.	153.93
1.	.7854	.$\frac{3}{8}$	22.690	.$\frac{3}{4}$	74.662	.$\frac{1}{8}$	156.69
.$\frac{1}{8}$	.9940	.$\frac{1}{2}$	23.758	.$\frac{7}{8}$	76.588	.$\frac{1}{4}$	159.48
.$\frac{1}{4}$	1.227	.$\frac{5}{8}$	24.850	10.	78.539	.$\frac{3}{8}$	162.29
.$\frac{3}{8}$	1.484	.$\frac{3}{4}$	25.967	.$\frac{1}{8}$	80.515	.$\frac{1}{2}$	165.13
.$\frac{1}{2}$	1.767	.$\frac{7}{8}$	27.108	.$\frac{1}{4}$	82.516	.$\frac{5}{8}$	167.98
.$\frac{5}{8}$	2.073	6.	28.274	.$\frac{3}{8}$	84.540	.$\frac{3}{4}$	170.87
.$\frac{3}{4}$	2.405	.$\frac{1}{8}$	29.464	.$\frac{1}{2}$	86.590	.$\frac{7}{8}$	173.78
.$\frac{7}{8}$	2.761	.$\frac{1}{4}$	30.679	.$\frac{5}{8}$	88.664	15.	176.71
2.	3.141	.$\frac{3}{8}$	31.919	.$\frac{3}{4}$	90.762	.$\frac{1}{8}$	179.67
.$\frac{1}{8}$	3.546	.$\frac{1}{2}$	33.183	.$\frac{7}{8}$	92.885	.$\frac{1}{4}$	182.65
.$\frac{1}{4}$	3.976	.$\frac{5}{8}$	34.471	11.	95.033	.$\frac{3}{8}$	185.66
.$\frac{3}{8}$	4.430	.$\frac{3}{4}$	35.784	.$\frac{1}{8}$	97.205	.$\frac{1}{2}$	188.69
.$\frac{1}{2}$	4.908	.$\frac{7}{8}$	37.122	.$\frac{1}{4}$	99.402	.$\frac{5}{8}$	191.74
.$\frac{5}{8}$	5.411	7.	38.484	.$\frac{3}{8}$	101.62	.$\frac{3}{4}$	194.82
.$\frac{3}{4}$	5.939	.$\frac{1}{8}$	39.871	.$\frac{1}{2}$	103.86	.$\frac{7}{8}$	197.93
.$\frac{7}{8}$	6.491	.$\frac{1}{4}$	41.282	.$\frac{5}{8}$	106.13	16.	201.06
3.	7.068	.$\frac{3}{8}$	42.718	.$\frac{3}{4}$	108.43	.$\frac{1}{8}$	204.21
.$\frac{1}{8}$	7.669	.$\frac{1}{2}$	44.178	.$\frac{7}{8}$	110.75	.$\frac{1}{4}$	207.39

TABLE—(Continued.)

Diam	Area.	Diam.	Area.	Diam.	Area.	Diam.	Area.
.⅜	210.59	21.	346.36	.⅝	515.72	.¼	718.69
.½	213.82	.⅛	350.49	.¾	520.70	.⅜	724.64
.⅝	217.07	.¼	354.65	.⅞	525.83	.½	730.61
.¾	220.35	.⅜	358.84	26.	530.93	.⅝	736.61
.⅞	223.65	.½	363.05	.⅛	536.04	.¾	742.63
17.	226.98	.⅝	367.28	.¼	541.18	.⅞	748.69
.⅛	230.33	.¾	371.54	.⅜	546.35	31.	754.76
.¼	233.70	.⅞	375.82	.½	551.54	.⅛	760.86
.⅜	237.10	22.	380.13	.⅝	556.76	.¼	866.99
.½	240.52	.⅛	384.46	.¾	562.00	.⅜	773.14
.⅝	243.97	.¼	388.82	.⅞	567.26	.½	779.31
.¾	247.45	.⅜	393.20	27.	572.55	.⅝	785.51
.⅞	250.94	.½	397.60	.⅛	577.87	.¾	791.73
18.	254.46	.⅝	402.03	.¼	583.20	.⅞	797.97
.⅛	258.01	.¾	406.49	.⅜	588.57	32.	804.24
.¼	261.58	.⅞	410.97	.½	593.95	.⅛	810.54
.⅜	265.18	23.	415.47	.⅝	599.37	.¼	816.86
.½	268.80	.⅛	420.00	.¾	604.80	.⅜	823.21
.⅝	272.44	.¼	424.55	.⅞	610.26	.½	829.57
.¾	276.11	.⅜	429.13	28.	615.75	.⅝	835.97
.⅞	279.81	.½	433.73	.⅛	621.26	.¾	842.39
19.	283.52	.⅝	438.30	.¼	626.79	.⅞	848.83
.⅛	287.27	.¾	443.01	.⅜	632.35	33.	855.30
.¼	291.03	.⅞	447.69	.½	637.94	.⅛	861.75
.⅜	294.83	24.	452.39	.⅝	643.54	.¼	868.30
.½	298.64	.⅛	457.11	.¾	649.18	.⅜	874.84
.⅝	302.48	.¼	461.86	.⅞	654.83	.½	881.41
.¾	306.35	.⅜	466.63	29.	660.52	.⅝	888.00
.⅞	310.24	.½	471.43	.⅛	666.22	.¾	894.61
20.	314.16	.⅝	476.25	.¼	671.95	.⅞	901.25
.⅛	318.09	.¾	481.10	.⅜	677.71	34.	907.92
.¼	322.06	.⅞	485.97	.½	683.49	.⅛	914.61
.⅜	326.05	25.	490.87	.⅝	689.29	.¼	921.32
.½	330.06	.⅛	495.79	.¾	695.12	.⅜	928.06
.⅝	334.10	.¼	500.74	.⅞	700.98	.½	934.82
.¾	338.16	.⅜	505.71	30.	706.86	.⅝	941.60
.⅞	342.25	.½	510.70	.⅛	712.76	.¾	948.41

TABLE—(Continued.)

Diam.	Area.	Diam.	Area.	Diam.	Area.	Diam.	Area.
.$\frac{7}{8}$	955.25	.$\frac{1}{2}$	1225.4	.$\frac{1}{8}$	1529.1	.$\frac{3}{4}$	1866.5
35.	962.11	.$\frac{5}{8}$	1233.1	.$\frac{1}{4}$	1537.8	.$\frac{7}{8}$	1876.1
.$\frac{1}{8}$	968.99	.$\frac{3}{4}$	1240.9	.$\frac{3}{8}$	1546.5	49.	1885.7
.$\frac{1}{4}$	975.90	.$\frac{7}{8}$	1248.7	.$\frac{1}{2}$	1555.2	.$\frac{1}{8}$	1895.3
.$\frac{3}{8}$	982.84	40.	1256.6	.$\frac{5}{8}$	1564.0	.$\frac{1}{4}$	1905.0
.$\frac{1}{2}$	989.80	.$\frac{1}{8}$	1264.5	.$\frac{3}{4}$	1572.8	.$\frac{3}{8}$	1914.7
.$\frac{5}{8}$	996.78	.$\frac{1}{4}$	1272.3	.$\frac{7}{8}$	1581.6	.$\frac{1}{2}$	1924.4
.$\frac{3}{4}$	1003.7	.$\frac{3}{8}$	1280.3	45.	1590.4	.$\frac{5}{8}$	1934.1
.$\frac{7}{8}$	1010.8	.$\frac{1}{2}$	1288.2	.$\frac{1}{8}$	1599.2	.$\frac{3}{4}$	1943.9
36.	1017.8	.$\frac{5}{8}$	1296.2	.$\frac{1}{4}$	1608.1	.$\frac{7}{8}$	1953.6
.$\frac{1}{8}$	1024.9	.$\frac{3}{4}$	1304.2	.$\frac{3}{8}$	1617.0	50.	1963.5
.$\frac{1}{4}$	1032.0	.$\frac{7}{8}$	1312.2	.$\frac{1}{2}$	1625.9	.$\frac{1}{8}$	1973.3
.$\frac{3}{8}$	1039.1	41.	1320.2	.$\frac{5}{8}$	1634.9	.$\frac{1}{4}$	1983.1
.$\frac{1}{2}$	1046.3	.$\frac{1}{8}$	1328.3	.$\frac{3}{4}$	1643.8	.$\frac{3}{8}$	1993.0
.$\frac{5}{8}$	1053.5	.$\frac{1}{4}$	1336.4	.$\frac{7}{8}$	1652.8	.$\frac{1}{2}$	2002.9
.$\frac{3}{4}$	1060.7	.$\frac{3}{8}$	1344.5	46.	1661.9	.$\frac{5}{8}$	2012.8
.$\frac{7}{8}$	1067.9	.$\frac{1}{2}$	1352.6	.$\frac{1}{8}$	1670.9	.$\frac{3}{4}$	2022.8
37.	1075.2	.$\frac{5}{8}$	1360.8	.$\frac{1}{4}$	1680.0	.$\frac{7}{8}$	2032.8
.$\frac{1}{8}$	1082.4	.$\frac{3}{4}$	1369.0	.$\frac{3}{8}$	1689.1	51.	2042.8
.$\frac{1}{4}$	1089.7	.$\frac{7}{8}$	1377.2	.$\frac{1}{2}$	1698.2	.$\frac{1}{8}$	2052.8
.$\frac{3}{8}$	1097.1	42.	1385.4	.$\frac{5}{8}$	1707.3	.$\frac{1}{4}$	2062.9
.$\frac{1}{2}$	1104.4	.$\frac{1}{8}$	1393.7	.$\frac{3}{4}$	1716.5	.$\frac{3}{8}$	2072.9
.$\frac{5}{8}$	1111.8	.$\frac{1}{4}$	1401.9	.$\frac{7}{8}$	1725.7	.$\frac{1}{2}$	2083.0
.$\frac{3}{4}$	1119.2	.$\frac{3}{8}$	1410.2	47.	1734.9	.$\frac{5}{8}$	2093.2
.$\frac{7}{8}$	1126.6	.$\frac{1}{2}$	1418.6	.$\frac{1}{8}$	1744.1	.$\frac{3}{4}$	2103.3
38.	1134.1	.$\frac{5}{8}$	1426.9	.$\frac{1}{4}$	1753.4	.$\frac{7}{8}$	2113.5
.$\frac{1}{8}$	1141.5	.$\frac{3}{4}$	1435.3	.$\frac{3}{8}$	1762.7	52.	2123.7
.$\frac{1}{4}$	1149.0	.$\frac{7}{8}$	1443.7	.$\frac{1}{2}$	1772.0	.$\frac{1}{8}$	2133.9
.$\frac{3}{8}$	1156.6	43.	1452.2	.$\frac{5}{8}$	1781.3	.$\frac{1}{4}$	2144.1
.$\frac{1}{2}$	1164.1	.$\frac{1}{8}$	1460.6	.$\frac{3}{4}$	1790.7	.$\frac{3}{8}$	2154.4
.$\frac{5}{8}$	1171.7	.$\frac{1}{4}$	1469.1	.$\frac{7}{8}$	1800.1	.$\frac{1}{2}$	2164.7
.$\frac{3}{4}$	1179.3	.$\frac{3}{8}$	1477.6	48.	1809.5	.$\frac{5}{8}$	2175.0
.$\frac{7}{8}$	1186.9	.$\frac{1}{2}$	1486.1	.$\frac{1}{8}$	1818.9	.$\frac{3}{4}$	2185.4
39.	1194.5	.$\frac{5}{8}$	1494.7	.$\frac{1}{4}$	1828.4	.$\frac{7}{8}$	2195.7
.$\frac{1}{8}$	1202.2	.$\frac{3}{4}$	1503.3	.$\frac{3}{8}$	1837.9	53.	2206.1
.$\frac{1}{4}$	1209 9	.$\frac{7}{8}$	1511.9	.$\frac{1}{2}$	1847.4	.$\frac{1}{8}$	2116.6
.$\frac{3}{8}$	1217.6	44.	1520.5	.$\frac{5}{8}$	1856.9	.$\frac{1}{4}$	2227.0

TABLE—(Continued.)

Diam.	Area.	Diam.	Area.	Diam.	Area.	Diam.	Area
.⅜	2237.5	58.	2642.0	.⅝	3080.2	.¼	3552.0
.½	2248.0	.⅛	2653.4	.¾	3092.5	.⅜	3565.2
.⅝	2258.5	.¼	2664.9	.⅞	3104.8	.½	3578.4
.¾	2269.0	.⅜	2676.3	63.	3117.2	.⅝	3591.7
.⅞	2279.6	.½	2687.8	.⅛	3129.6	.¾	3605.0
54.	2290.2	.⅝	2699.3	.¼	3142.0	.⅞	3618.3
.⅛	2300.8	.¾	2710.8	.⅜	3154.4	68.	3631.6
.¼	2311.4	.⅞	2722.4	.½	3166.9	.⅛	3645.0
.⅜	2322.1	59.	2733.9	.⅝	3179.4	.¼	3658.4
.½	2332.8	.⅛	2745.5	.¾	3191.9	.⅜	3671.8
.⅝	2343.5	.¼	2757.1	.⅞	3204.4	.½	3685.2
.¾	2354.2	.⅜	2768.8	64.	3216.9	.⅝	3698.7
.⅞	2365.0	.½	2780.5	.⅛	3229.5	.¾	3712.2
55.	2375.8	.⅝	2792.2	.¼	3242.1	.⅞	3725.7
.⅛	2386.6	.¾	2803.9	.⅜	3254.8	69.	3739.2
.¼	2397.4	.⅞	2815.6	.½	3267.4	.⅛	3752.8
.⅜	2408.3	60.	2827.4	.⅝	3280.1	.¼	3766.4
.½	2419.2	.⅛	2839.2	.¾	3292.8	.⅜	3780.0
.⅝	2430.1	.¼	2851.0	.⅞	3305.5	.½	3793.6
.¾	2441.0	.⅜	2862.8	65.	3318.3	.⅝	3807.3
.⅞	2452.0	.½	2874.7	.⅛	3331.0	.¾	3821.0
56.	2463.0	.⅝	2886.6	.¼	3343.0	.⅞	3834.7
.⅛	2474.0	.¾	2898.5	.⅜	3356.7	70.	3848.4
.¼	2485.0	.⅞	2910.5	.½	3369.5	.⅛	3862.2
.⅜	2496.1	61·	2922.4	.⅝	3382.4	.¼	3875.9
.½	2507.1	.⅛	2934.4	.¾	3395.3	.⅜	3889.8
.⅝	2518.2	.¼	2946.4	.⅞	3408.2	.½	3903.6
.¾	2529.4	.⅜	2958.5	66.	3421.2	.⅝	3917.4
.⅞	2540.5	.½	2970.5	.⅛	3434.1	.¾	3931.3
57.	2551.7	.⅝	2982.6	.¼	3447.1	.⅞	3945.2
.⅛	2562.9	.¾	2994.7	.⅜	3460.1	71.	3959.2
.¼	2574.1	.⅞	3006.9	.½	3473.2	.⅛	3973.1
.⅜	2585.4	62.	3019.0	.⅝	3486.3	.¼	3987.1
.½	2596.7	.⅛	3031.2	.¾	3499.3	.⅜	4001.1
.⅝	2608.0	.¼	3043.4	.⅞	3512.5	.½	4015.1
.¾	2619.3	.⅜	3055.7	67.	3525.6	.⅝	4029.2
.⅞	2630.7	.½	3067.9	.⅛	3538.8	.¾	4043.2

TABLE—(Continued.)

Diam.	Area.	Diam.	Area.	Diam.	Area.	Diam.	Area.
.⅞	4067.3	.½	4596.3	.⅛	5168.9	.¾	5775.0
72.	4071.5	.⅝	4611.3	.¼	5184.8	.⅞	5791.9
.⅛	4085.6	.¾	4626.4	.⅜	5200.8	86.	5808.8
.¼	4099.8	.⅞	4641.5	.½	5216.8	.⅛	5825.7
.⅜	4114.0	77.	4656.6	.⅝	5232.8	.¼	5842.6
.½	4128.2	.⅛	4671.7	.¾	5248.8	.⅜	5859.5
.⅝	4142.5	.¼	4686.9	.⅞	5264.9	.½	5876.5
.¾	4156.7	.⅜	4702·1	82.	5281.0	.⅝	5893.5
.⅞	4171.0	.½	4717.3	.⅛	5297.1	.¾	5910.5
73.	4185.3	.⅝	4732.5	.¼	5313.2	.⅞	5927.6
.⅛	4199.7	.¾	4747.7	.⅜	5329.4	87.	5944.6
.¼	4214.1	.⅞	4763.0	.½	5345.6	.⅛	5961.7
.⅜	4228·5	78.	4778.3	.⅝	5361.8	.¼	5978.9
.½	4242.9	.⅛	4793.7	.¾	5378.0	.⅜	5996.0
.⅝	4257.3	.¼	4809.0	.⅞	5394.3	.½	6013.2
.¾	4271.8	.⅜	4824.4	83.	5410.6	.⅝	6030.4
.⅞	4286.3	.½	4839.8	.⅛	5426.9	.¾	6047.6
74.	4300.8	.⅝	4855.2	.¼	5443.2	.⅞	6064.8
.⅛	4315.3	.¾	4870.7	.⅜	5459·6	88.	6082.1
.¼	4329.9	.⅞	4886.1	.½	5476·0	.⅛	6099.4
.⅜	4344.5	79.	4901.6	.⅝	5492·4	.¼	6116.7
.½	4359.1	.⅛	4917.2	.¾	5508·8	.⅜	6134.0
.⅝	4373.8	.¼	4932.7	.⅞	5525.3	.½	6151.4
.¾	4388.4	.⅜	4948.3	84.	5541.7	.⅝	6168.8
.⅞	4403.1	.½	4963.9	.⅛	5558.2	.¾	6186.2
75.	4417.8	.⅝	4979.5	.¼	5574.8	.⅞	6203.6
.⅛	4432.6	.¾	4995.1	.⅜	5591.3	89.	6221.1
.¼	4447.3	.⅞	5010.8	.½	5607.9	.⅛	6238.6
.⅜	4462.1	80.	5026.5	.⅝	5624.5	.¼	6256.1
.½	4476.9	.⅛	5042.2	.¾	5641.1	.⅜	6273.6
.⅝	4491.8	.¼	5058.0	.⅞	5657.8	.½	6291.2
.¾	4506.6	.⅜	5073.7	85.	5674.5	.⅝	6308.8
.⅞	4521.5	.½	5089.5	.⅛	5691.2	.¾	6326.4
76.	4536.4	.⅝	5105·4	.¼	5707.9	.⅞	6344.0
.⅛	4551·4	.¾	5121.2	.⅜	5724.6	90.	6361.7
.¼	4566.3	.⅞	5137.1	.½	5741.4	.⅛	6379.4
.⅜	4581.3	81.	5153.0	.⅝	5758.2	.¼	6397.1

TABLE—(Continued.)

Diameter	Area.	Diam.	Area	Diam.	Area.	Diam.	Area
.$\frac{3}{8}$	6414.8	.$\frac{7}{8}$	6776.4	.$\frac{3}{8}$	7144.3	.$\frac{7}{8}$	7523.7
.$\frac{1}{2}$	6432.6	93.	6792.9	.$\frac{1}{2}$	7163.0	98.	7542.9
.$\frac{5}{8}$	6450.4	.$\frac{1}{8}$	6811.1	.$\frac{5}{8}$	7181.8	.$\frac{1}{8}$	7562.2
.$\frac{3}{4}$	6468.2	.$\frac{1}{4}$	6829.4	.$\frac{3}{4}$	7200.5	.$\frac{1}{4}$	7581.5
.$\frac{7}{8}$	6486.0	.$\frac{3}{8}$	6847.8	.$\frac{7}{8}$	7219.4	.$\frac{3}{8}$	7600.8
91.	6503.8	.$\frac{1}{2}$	6866.1	96.	7238.2	.$\frac{1}{2}$	7620.1
.$\frac{1}{8}$	6521.7	.$\frac{5}{8}$	6884.5	.$\frac{1}{8}$	7257.1	.$\frac{5}{8}$	7639.4
.$\frac{1}{4}$	6539.6	.$\frac{3}{4}$	6902.9	.$\frac{1}{4}$	7275.9	.$\frac{3}{4}$	7658.8
.$\frac{3}{8}$	6557.6	.$\frac{7}{8}$	6921.3	.$\frac{3}{8}$	7294.9	.$\frac{7}{8}$	7678.2
.$\frac{1}{2}$	6575.5	94.	6939.7	.$\frac{1}{2}$	7313.8	99.	7697.7
.$\frac{5}{8}$	6593.5	.$\frac{1}{8}$	6958.2	.$\frac{5}{8}$	7332.8	.$\frac{1}{8}$	7717.1
.$\frac{3}{4}$	6611.5	.$\frac{1}{4}$	6976.7	.$\frac{3}{4}$	7351.7	.$\frac{1}{4}$	7736.6
.$\frac{7}{8}$	6629.5	.$\frac{3}{8}$	6995.2	.$\frac{7}{8}$	7370.7	.$\frac{3}{8}$	7756.1
92.	6647.6	.$\frac{1}{2}$	7013.8	97.	7389.8	.$\frac{1}{2}$	7775.6
.$\frac{1}{8}$	6665.7	.$\frac{5}{8}$	7032.3	.$\frac{1}{8}$	7408.8	.$\frac{5}{8}$	7795.2
.$\frac{1}{4}$	6683.8	.$\frac{3}{4}$	7050.9	.$\frac{1}{4}$	7427.9	.$\frac{3}{4}$	7814.7
.$\frac{3}{8}$	6701.9	.$\frac{7}{8}$	7069.5	.$\frac{3}{8}$	7447.0	.$\frac{7}{8}$	7834.3
.$\frac{1}{2}$	6720.0	95.	7088.2	.$\frac{1}{2}$	7466.2	100.	7853.9
.$\frac{5}{8}$	6738.2	.$\frac{1}{8}$	7106 9	.$\frac{5}{8}$	7485.3		
.$\frac{3}{4}$	6756.4	.$\frac{1}{4}$	7125.5	.$\frac{3}{4}$	7504.5		

TO FIND THE WEIGHT OF STEAM CARRIED IN THE BOILER.

We will make some explanatory remarks on this subject before we proceed to lay down the rule.

There are of a circle whose diameter is 1. is a decimal .7854, &c.

In the first place, it will be necessary to show how notches in the safety lever should be laid off systematically, and not at random. The distances of the notches on the safety valve lever, from center to center, should always be equal to the distance of the two bolt or pin holes in the end of the safety valve lever, which holes are used, the one to support the lever in the stand, and the other to connect the valve stem to the safety valve lever. And let it be always understood, that the first notch from the valve stem counts two, for this reason: it is twice the distance from the center of the stand in which the safety valve lever is suspended to the first notch in the lever, that it is from notch to notch; or from the center of the safety valve stem, where it is fastened to the lever, to the center of the bolt in the end of the lever, by which it is fastened to the stand or column, it is equal to one notch. Again; the distance from the center of the safety valve stem to the center of the first notch on the lever is equal to another notch, and these two distances are from the center of the valve stem each way equal, and are each when added together two distances. This is the reason why the first notch on the safty valve lever requires to be doubled. Another mode is: suppose the weight on the end of the lever to be taken off and placed on top of the safety valve. This is equal to one notch; now suppose we were to have 12 notches in the lever, instead of putting the weight out 12 notches, which makes it equal to 12 weights of the same weight, just place 12 weights, one on top of the other on the safty valve, which is equal to the weight of 12 notches out on the lever. This is another reason why the first notch on the lever counts two, or is to be doubled.

The next thing now will be to ascertain the nett amount of weight there is on the safety valve seat from the weight of the safety valve, lever, valve stem, valve, &c. This is done by means of a pair of steelyards or spring scales, by being hooked to a string fastened to the lever at the center of the safety valve stem.

(See draft in which the safety valve calculations are made.)

The next and last thing, is to get the number of pounds the pea on the safety valve lever weighs. Multiply the weight of the pea by the number of notches in the safety lever, always bearing in mind to count the first notch two. You then divide this amount of pounds by the number of square inches in the safety valve seat, and the product will be the amount of pressure of steam you are carrying in the boiler, with the weight of the pea, and to this you add the additional weight caused by the lever, valve stem, valve, &c., and those two products, added together, will be the exact weight of steam carried in the boiler.

EXAMPLE 1.—The opening in the safety valve seat is 3 inches in diameter, the pea is 50 pounds, and there are 8 notches in the lever, counting the first notch 2; what is the weight of steam per square inch?

$$\begin{array}{r l} 3 & \\ 3 & \\ \hline 9 & \\ .7854 & \text{a decimal.} \\ \hline 7.0686 & \text{Product of the multiplication of 7} \\ & \text{square inches in the safety valve seat.} \end{array}$$

Multiply a 50 pound pea by 8 notches and divide by 7 the number of square inches in the safety valve seat, and the product will be the weight of steam in the boilers produced by the weight of the pea on the end of the lever; to this you add the additional weight caused by the lever, valve, valve stem, &c.

50 lbs.
8 notches.

Divide by 7 square inches in valve seat. } 7)400 lbs.

57¼ lbs. per square inch.
3

60¼ lbs. of steam per square inch.

Suppose the lever and rigging to weigh at the center of the valve stem 21 pounds, which, divided by the number of square inches in valve seat, which is

7) 21 lbs.

3 lbs. to the square inch to be added for the lever, valve and valve stem.

Example 2.—Suppose the opening in the safety valve seat to be 4 inches in diameter, the weight of the pea 100 pounds, and 12 notches in the lever, (counting the first notch two,) what is the height of the steam in the boiler?

Decimals .7854
16 is the square of 4.

4.7124
7.854

12.5664 Product of the multiplication.

In order to divide 12½ inches into 1200 lbs., both must be brought into halves.

Pea 100 lbs.
12 notches in the lever.
———
1200 lbs. to be divided by 12½ square inches in the safety valve seat.

12½ inches.
2 1200 lbs.
— 2
25 } 2400
225 96 lbs. of steam per square inch.
———
150
150

To which is to be added the extra weight of safety valve, lever, valve, valve stem, &c., which we suppose to weigh 50 lbs., and which is to be divided by the number of square inches in the safety valve seat, which is 12½ square inches to be divided into 50 lbs.

12½ 50 lbs.
2 2
— —
25) 100 (4 lbs. to the square inch is
100 the additional weight of the lever, valve, valve stem, &c., which are to be added to the weight produced by the pea on the safty valve lever, which is 96 lbs. to the square inch, and 4 lbs. added makes 100 lbs. of steam to the square inch.

How to find the weight of steam you are carrying on each notch of the safety valve lever: In a 4 inch valve seat there is 12½ square inches, and that multiplied by 8 makes 100; therefore, every 8 lbs. of 100 pea is the weight on each square inch of 12 inches of the opening, making 96 pounds; and the remaing 4 pounds of the 100 pounds pea, being the half of 8 lbs. is the weight on the remaining ½ inch of the opening of 12.5 area. Now when 100 pounds pea is on the end of the safety valve lever, it gives 96 pounds of steam to the square inch on the safety valve; to this you have to add the additional weight caused by the safety valve lever, valve and valve stem, which is 4 lbs. to the square inch, as shown in example 2.

Weight of steam with the pea on the first notch is equal to		To this add 4 lbs. for the weight of lever, valve, valve stem, &c.			
1st notch	8 lbs.	4 lbs.	12 lbs.	on first	notch.
2nd......	16		20	"	"
3d........	24		28	"	"
4th	32		36	"	"
5th	40		44	"	"
6th	48		52	"	"
7th	56		60	"	"
8th	64		68	"	"
9th	72		76	"	"
10th	80		84	"	"
11th	88		92	"	"
12th	96		100 do.	lbs. of steam to	

the square inch with the pea on the 12th notch.

Example 3.—The diameter of the safety valve is 5 inches; the pea is 140 pounds; there is 12 notches on the lever, counting the valve stem one and the next notch 2; the weight of the valve, the stem, and the lever, weighs, through the hole in the lever at the center of the valve stem, 60 lbs, what is the pressure of steam carried in the boiler?

5 inches diameter of valve seat.
5
—
25 square.
7854
———
39.270
15.708
———
19.6350

Lever &c., 60 lbs., to be divided by 19 inches and 6-10 of an inch:

19.6 60 lbs.
10 10
—— ——
166) 600 ($3\frac{3}{49}$
588
——
$4 \left\} \begin{array}{c} 12 \\ \hline 196 \end{array} \right.$ ($\frac{3}{49}$

140 lbs. weight of pea.
12 notches.

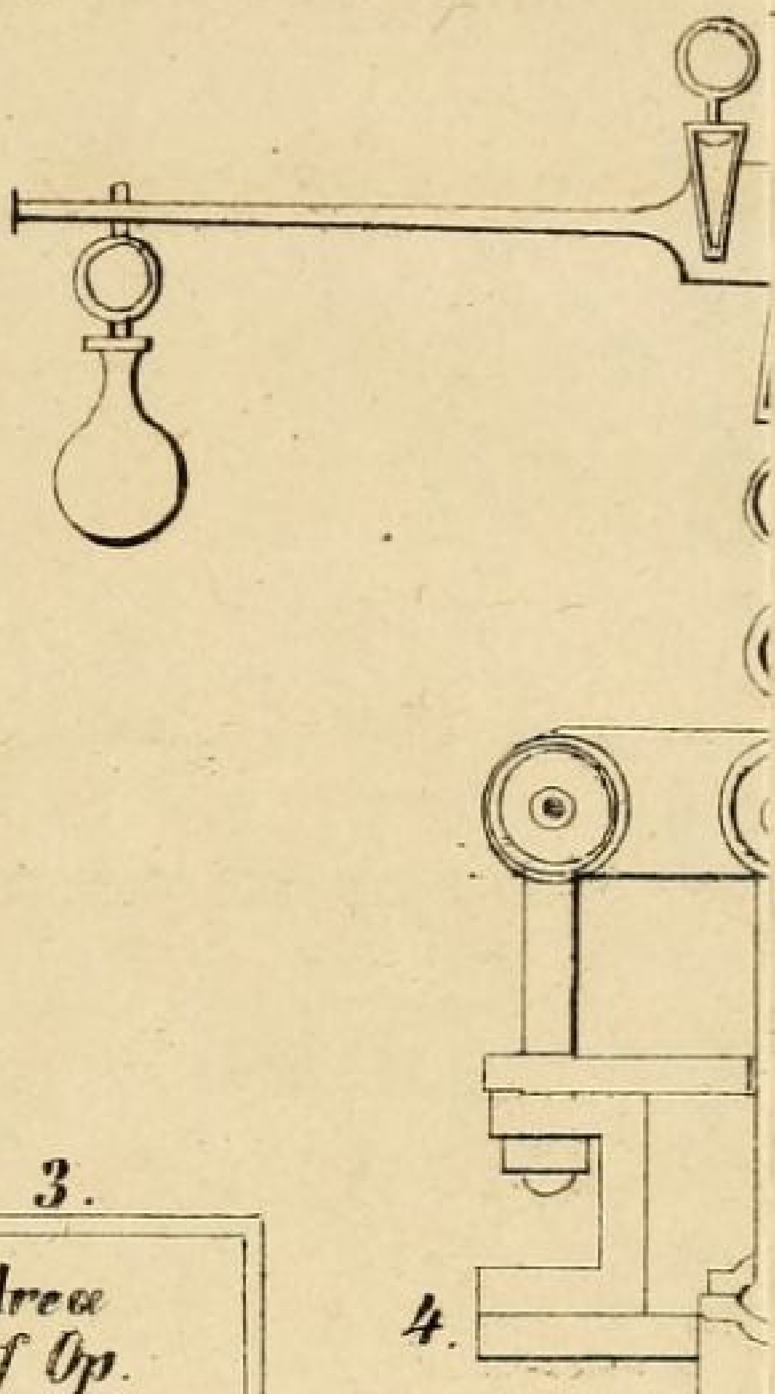
1680 lbs. to be divided by
19.6 tenths of an inch.

$$
\begin{array}{rrl}
10 & 1680 & \\
 & 10 & \\
196 & & \\
196\,) & 16800 & \left\{ \begin{array}{l} 85\frac{5}{7} \\ 3\frac{3}{49} \end{array} \right. \\
 & 1568 & \\
 & 1120 & \\
 & 980 & \\
\end{array}
$$

$28 \left\{ \frac{140}{196} \right. \left| \frac{5}{7} \right.$ are $88\frac{38}{49}$ lbs. of steam pressure to the square inch in the boiler.

PUPPET AND BALANCE VALVE ENGINE.

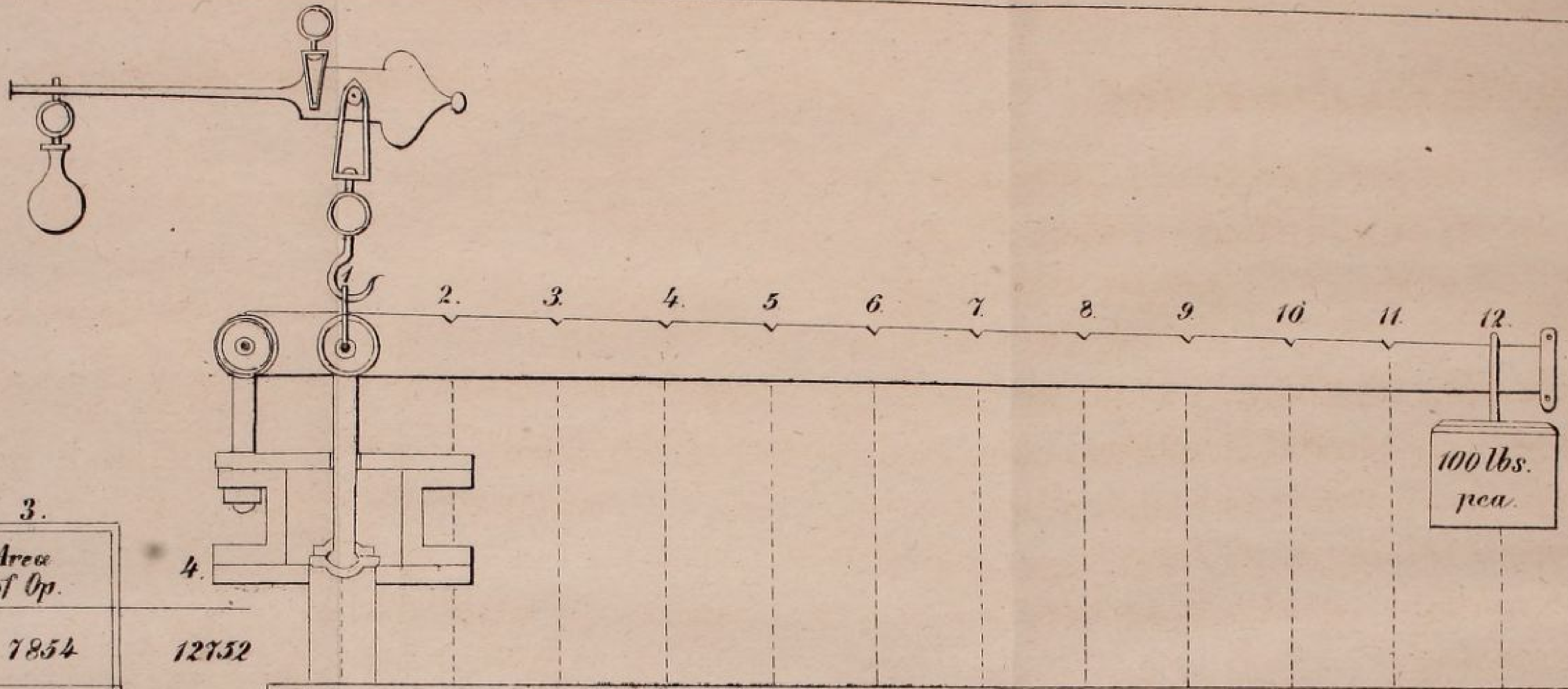
We would suggest an idea for the reflection and consideration of those whom it may concern, about the propriety of having the valve seats, into which they have to bed themselves on a dead level while the engine itself is on an incline plane. The valves falling into seats on an incline has a tendency to fall or bear hard on the lower side of the seat, while it is possible in some cases for the valve to be open on the high side of the seat, as the valve, owing to the incline of the seat and weight of the lever, inclines to slide downwards. Therefore we would suggest as the best, most natural, and only true plan for working puppet engines, is to have the valve seat on a dead level.



Scale.

1. Diameter of Valve.	2. Circumference of Op.	3. Area of Op.	4.	
1.	3.14	7854	12752	
3.	9.42	7.06	14.148	14.
3¼	10.21	8.29	12.056	21.
3½.	10.99	9.62	10.394	10.
3¾.	11.78	11.94	9.055	9.
4.	12.56.	12.56	7.958	8.
4¼.	13.35	14.18	7.050	7.
4½.	14.13	15.90	6.288	6.
4¾	14.92	17.72	5.643	5.
5	15.70	19.63	5.093	5.
5¼.	16.49	21.64	4.620	4.
5½.	17.27	23.75	4.209	4.
5¾.	18.06	25.96	3.851	3.
6	18.84	28.27	3.537	3.

This table gives the weight of Steam car
of the Saftey Valve leaver: Valve & Valve s



Scale.

1. Diameter of Valve.	2. Circumference of Op.	3. Area of Op.	4.												
1.	3.14	.7854	127.52												
3.	9.42	7.06	14.148	14.1	28.3	42.4	56.6	79.7	84.9	99.0	113.2	127.3	141.5	155.6	169.8
3¼	10.21	8.29	12.056	21.1	24.1	36.2	48.2	60.3	72.3	84.4	96.4	108.5	120.6	132.6	144.7
3½.	10.99	9.62	10.394	10.4	20.8	31.2	41.6	52.0	62.4	72.8	83.2	93.5	103.9	114.3	124.7
3¾	11.78	11.94	9.055	9.1	18.1	27.2	36.2	45.3	54.3	63.4	72.4	81.5	90.5	99.6	108.7
4.	12.56.	12.56	7.958	8.0	15.9	23.9	31.8	39.8	47.7	55.7	63.7	71.6	78.6	87.5	95.5
4¼.	13.35	14.18	7.050	7.0	14.1	21.1	28.2	35.2	42.3	49.3	56.4	63.4	70.5	77.5	84.6
4½.	14.13	15.90	6.288	6.3.	12.6	18.9	25.2	31.4	37.7	44.0	50.3	56.6	62.9	69.2	75.5
4¾	14.92	17.72	5.643	5.6	11.3	16.9	22.6.	28.2	33.9	39.5	45.1	50.8	56.4	62.1	67.4
5.	15.70	19.63	5.093	5.1	10.2	15.3	20.4	25.5	30.6	35.7.	40.8	45.8	50.9	56.0	61.1
5¼.	16.49	21.64	4.620	4.6	9.2.	13.9.	18.5	23.1	27.7	32.3	37.0	41.6	46.2	50.8	55.4
5½.	17.27.	23.75	4.209	4.2.	8.4	12.6	16.8.	21.0	25.2	29.5	33.7	37.9	42.1	46.3	50.3
5¾	18.06	25.96	3.851	3.9	7.7.	11.6	15.4	19.3	23.1	27.0	30.8	34.7.	38.5	42.4	56.6
6.	18.84	28.27	3.537	3.5	7.1	10.6.	14.2	17.7	21.1	24.8	28.3	31.8	35.5.	38.4	42.4

This table gives the weight of Steam carried with a pea on the leaver of 100 lbs. exclusive of the additional weight of the Saftey Valve leaver: Valve & Valve stem. this additional weight can be got by a pair of Steelyards as here laid down.

Suppose the Leaver; Valve & Valve stem to weigh 50 lbs. which divided by 12½ the number of square inches in a 4 inch Saftey Valve would be 4½ lbs more, to add to each product in the Table.

TO PRACTICAL ENGINEERS.

This table is intended for the benefit of those who have not been sufficiently educated for the ascertaining, by calculation, the weight of steam they are carrying. It is well known that there are many skilful, trusty, and confidential engineers, whose perseverance and attention to duty have won for themselves the confidence of those by whom they are employed, and have elevated themselves to high standing as engineers, worthy of all trust, but who suffer from an imperfect knowledge of the principles upon which the safety valve calculations are made.

To this class of engineers, this table is intended, merely as a substitute for the advantages of an education, and will be found to contain all the necessary matter relative to making safety valve calculations of interest or importance to the practical engineer. And in addition to these calculations, to the uneducated engineers other considerations attach great importance to the tables and scales, of steam pressure and temperature in his hands; as they not only supply him with all necessary and useful imformation as to the state of steam in the boilers and at all times operating as a safety guard against explosions—but they also afford him a personal protection from any enactment by law with regard to his proficiency, as a practising engineer, requiring a qualification, which, in the absence of the safety valve calculator, could not be attained without the aid of an arithmetical calculation. As the chief object of this table is for the benefit and protection of the practical engineer alone, and to assist him in the attainment of useful knowledge in his business, it is hoped it will be cheerfully received by that class of men for whom it is designed.

THE USE OF THE TABLE EXPLAINED.

SCALE 1st gives the diameter of the opening in the safety valve seats. 2d—gives the circumference of the opening in seats. 3d—the area of the openings. 4th—contains the relative amounts in steam pressure to the square inch in steam as the load on the safety valve, for every notch that a pea 50 pounds pea, and for the diameters of the openings in safety valve seats from one to six inches in diameter. Each amount in the scale expresses the pounds and thousandths of a pound pressure to the square inch in steam, as the load on the safety valve for every notch that of a pea of 50 pounds will produce when moved on the long end of the beam.

RULE *for finding the pressure of steam in a boiler by the load on the safety valve:* First—Take the diameter of the opening in the safety valve seat immediate below the level in which the valve seats itself. Next find the weight in pounds of the safety valve pea, which, for example, we will suppose weighs 50 pounds, and the opening in the valve seat to bc 4 inches in diameter. Our first operation in figures then, is to square the diameter of this opening, or to multiply it by itself. Thus, the diameter being 4 inches, 4 times 4 make 16, which is the square of the diameter sought. Next, in order to find the superficial contents in the seat, or its area, the decimals .7854 are employed, which are to be multiplied by the square of the diamter of the opening in the seat, which square was found to be 16. Out of the product arising of the decimals, by the square of the diameter, four right hand figures must be pointed off as decimals, and the figures to the left of the point in the product will express the whole number of square inches contained in the opening, and the decimals will express the ten thousandths of a square inch, which will be found as follows:

Rule—Multiply the square of the diameter by .8754, and the product will be the area:

Decimal, .7854
Square of 4 16
47124
7854
12.5664

Or multiply the square of the circumference by .09958, and the product will be the area.

Example.—What is the area of a circle whose diameter is 5?

Decimal, .7854
Square of 5 25
39270
15708
19.6350

The product of the multiplication just performed in example first, gives 12.5664 as the answer, then having pointed off the four right hand figures according to previous instructions, we have 12 inches and .5664 ten thousandths of an inch as the area of a circle or opening of 4 inches diameter. The first left hand decimal figure .5 in the product represents tenths of a square inch, and the two left hand figures ·56 represents hundredths, or .56 hundreths of a square inch, and the three left hand figures denote thousandths, or .566 thousandths of a square inch, and the whole four decimals express, as before stated, the ten thousandths of a square inch, so that we have an area of 12 inches and 5 tenths, or 12 inches and 56 hundredths, or 12 inches and 566 thousandths, or 12 inches and 5664 ten thousandths.

This explanation is essential to a clear understanding of the principle involved in the calculation of areas of circles. It is necessary, also, that the nature of decimals be understood: 5 tenths therefore is equivalent to one half, two-tenths are equal to one-fifth, four-tenths are equal two-fifths, six-tenths are equal to three-fifths, eight-tenths are equal to four-fifths, and ten-tenths are equal to a whole number. It must be understood also that not only ten-tenths make a whole amount, but one hundred hundredths, or one thousand thousandths, or ten thousand ten thousandths, are equal in value and equivalent to a whole; and that .5 (five-tenths,) .50 (fifty-hundredths,) or .500 (five hun-hundred thousandths,) and .5000 (five thousand ten thousandths,) are equivalent to one-half of a whole. So, also, .56, the two left hand figures in the above example expresses that the area 12.5664 contain 12 inches and 6 hundredths more than 50 hundredths, or one-half of a square inch; so, also, there are 66 thousandths in .566 more than a half inch, and in .5664 there are 664 ten thousandths of an inch more than half a square inch.

We will now find out by the load of a 50 pounds pea on the safety valve lever, the pressure of steam on the boiler for every notch on the lever, the opening to be covered by the safetv valve 12.6 square inches, and for all practical purposes it is unnececessary to consider fractions of a less denomination than one-tenth in what remains to be done to complete the operations on hand. With this understanding as a guide for future operations, our next object will be to take into view the proposed amount of weight intended as a load on the safety valve. We have supposed the weight to be 50 pounds, and the opening in the safety valve seat to contain 12.5 square inches, which when the weight is placed on the valve covering the opening will require a pressure of steam on the boilers equal to 4 pounds to each square inch to overcome the load, which will appear evident when we consider that the safety valve covers an opening of 12½ square inches, and that 12½ times 4 make 50.

Therefore every four pounds of 50 pea is the load on each square inch of 12 inches of the opening—making 48 pounds—and the remaining 21 pounds of the 50 pounds pea, being the half of 4 pounds, is the load on the remaining ½ inch of the opening of 12.5 area. The principle herein involved should be thoroughly understood by repeated revisions of the subject until it is well impressed on the mind. In order to arrive at a result by figures that we have just produced by mental calculation, it will only be necessary to divide 50, the weight of the pea, into pounds, by 12.5, the superficial contents of the opening in inches. This result will be produced by first reducing the area, 12.5, and weight, 50, to tenths by multiplying each separately by ten, thus—example:

$$\begin{array}{rcr} 12.5 & \quad & 50 \\ 10 & & 10 \\ \hline 125. & & 500 \end{array}$$

The reason for multiplying the area in inches, and weight in pounds by 10, is because the area contains fractional parts, whilst the weight of the pea is in whole numbers, and because it is necessary to preserve their equality of value in fractional parts in calculating that existed before having been reduced to fractions; and when we divide 500 by 125, the quotient will give the steam pressure in the boiler in pounds to the square inch, for one notch on the beam of a safety valve covering an opening of 125 square inches which beam carries a weight of 50 pounds, we proceed in figures as follows—example:

125) 500 (4 quotient.
500

In the last example we find the quotient to be 4, then the product arising from the multiplication of the pressure for one notch by any number of notches on the beam, will give the steam pressure in the boiler when the pea hangs in the notch for the number computed. Suppose for example, that at 4 pounds to the notch, it be required to find the pressure of steam for 9 notches of the 50 pounds pea on the beam, the multiplication of one by the other would give 36 pounds to the inch as the pressure of steam, and in the same manner the pressure of steam for any number of notches may be found.

For philosophical or experimental purposes, when the pressure of steam in a boiler is to be determined with nicety and precission, recourse must be had to scale 4 and 5, which scales are calculated with mathematical accuracy: scale 4 giving the steam pressure for 1 notch, and for any diameter or opening between 1 and 6 inches of a safety valve carrying on a beam of a pea of 50 pounds weight, and scale 5 contains the pressure of steam for one notch in the same manner for a safety valve carrying a pea 100 pounds weight on the beam. From the preceeding explanations and examples, it will be obvious the product arising from the multiplication of any pressure found on scale 4 by any number of notches on the beam, will give the presrure of steam in the boiler in pounds and in thousandths of a pound to the square inch. However, precaution must be taken to point off three right hand figures in the product for decimals, as the pressure in the scales contain three decimals.

The same course is to be pursued with reference to scale 5, except it must be observed the pressure in scale 5 contains 4 decimal places, and that the right hand figures in the product of every multiplication must be pointed off, and the result will give the pressure in pounds and ten thousandths of pounds to the square inch of steam in the boiler for a safety valve loaded with a pea on the beam weighing 100 pounds.

NOTE.—When 25 or 75 pounds, or any other pressure of steam, greater or less, is desirable, by adopting a method of calculation based upon these principles, the load on the safety valve may be easily adjusted to produce any required pressure of steam on the boilers.

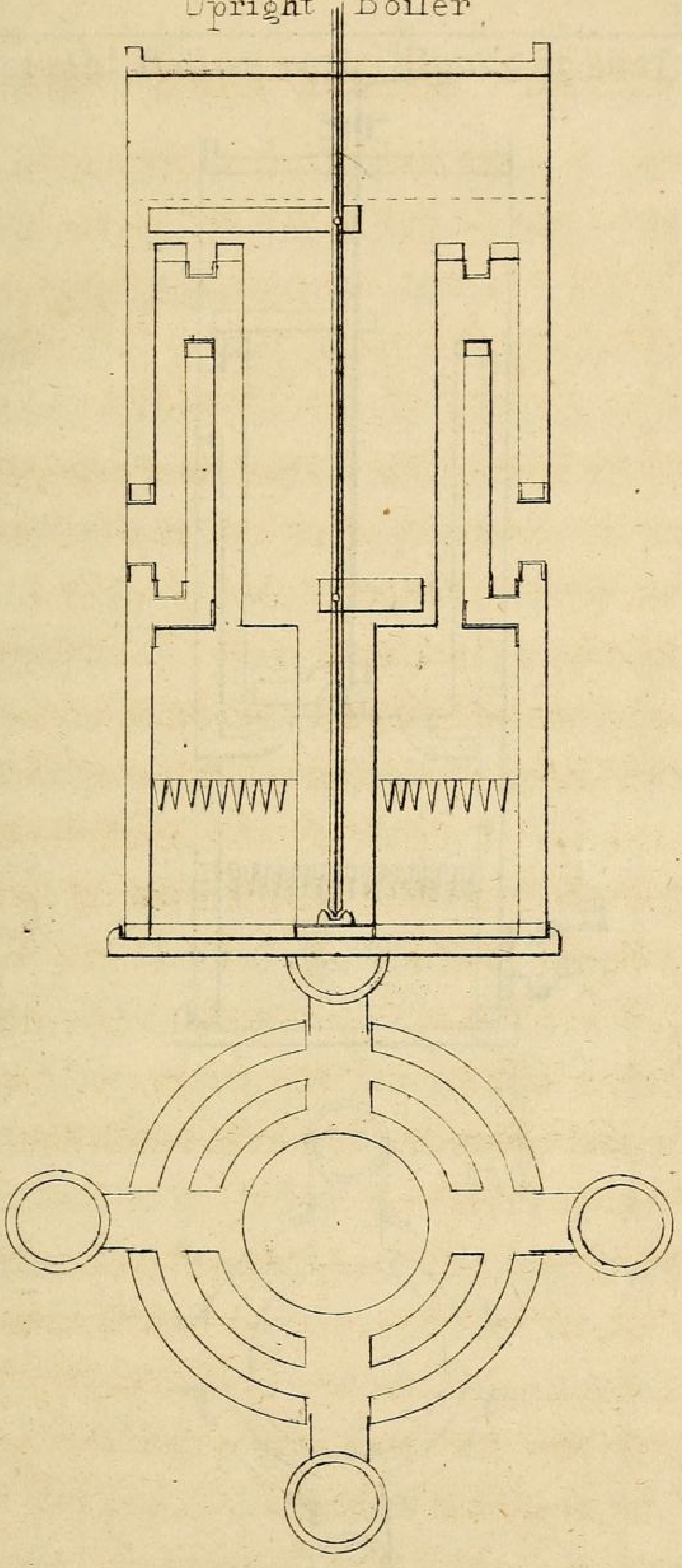
JOHN WALLACE'S VERTICAL STEAM BOILER.

This boiler having for a long time engaged the attention of the inventor, (who has applied for Letters Patent to secure his invention,) is now before the public. It has been thoroughly tested, and, we think, proved to be superior to all the other boilers now in use. It will raise steam faster than any other boiler, consume less fuel, and is less liable to explosion. It is so constructed that with a full head of steam, and while the engine is in motion, the sediment can be dislodged, and then discharged through the mud valve, thus relieving it from the the danger of choking up with mud and sediment, to which small flue and tubular boilers are so liable.

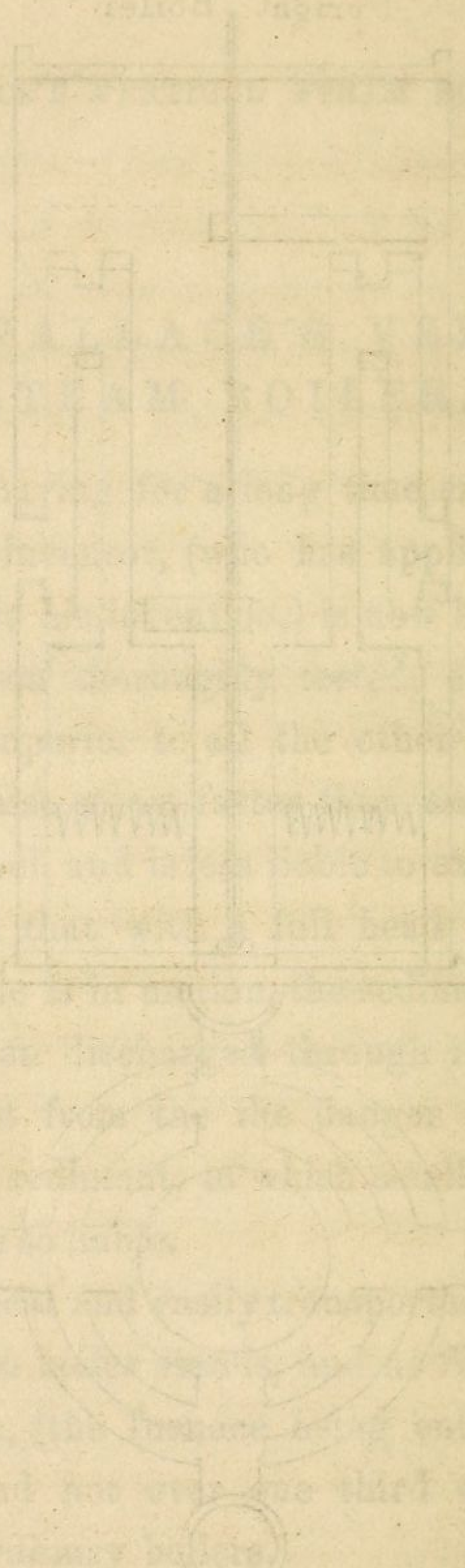
It is cylindrical and easily transported. It requires no fire front, no boiler stands, and no furnace of brick or mason work, (the furnace being entirely inside of the boiler,) and not over one third the grate bars requisite for ordinary boilers.

The furnace in this boiler being entirely surrounded with water, there is but little danger from fire, and insurance companies have insured factories where these boilers have been used, for 25 to 40 per cent less than

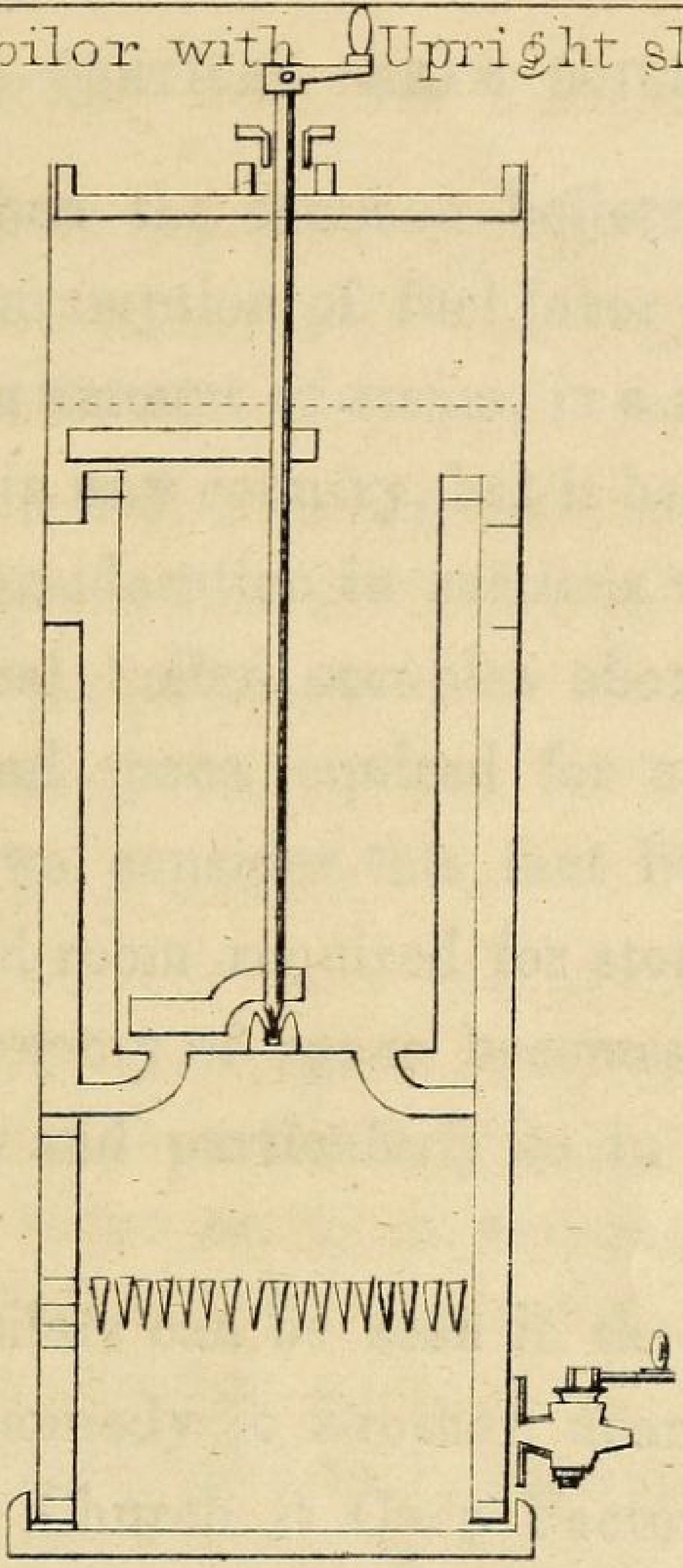
Upright Boiler

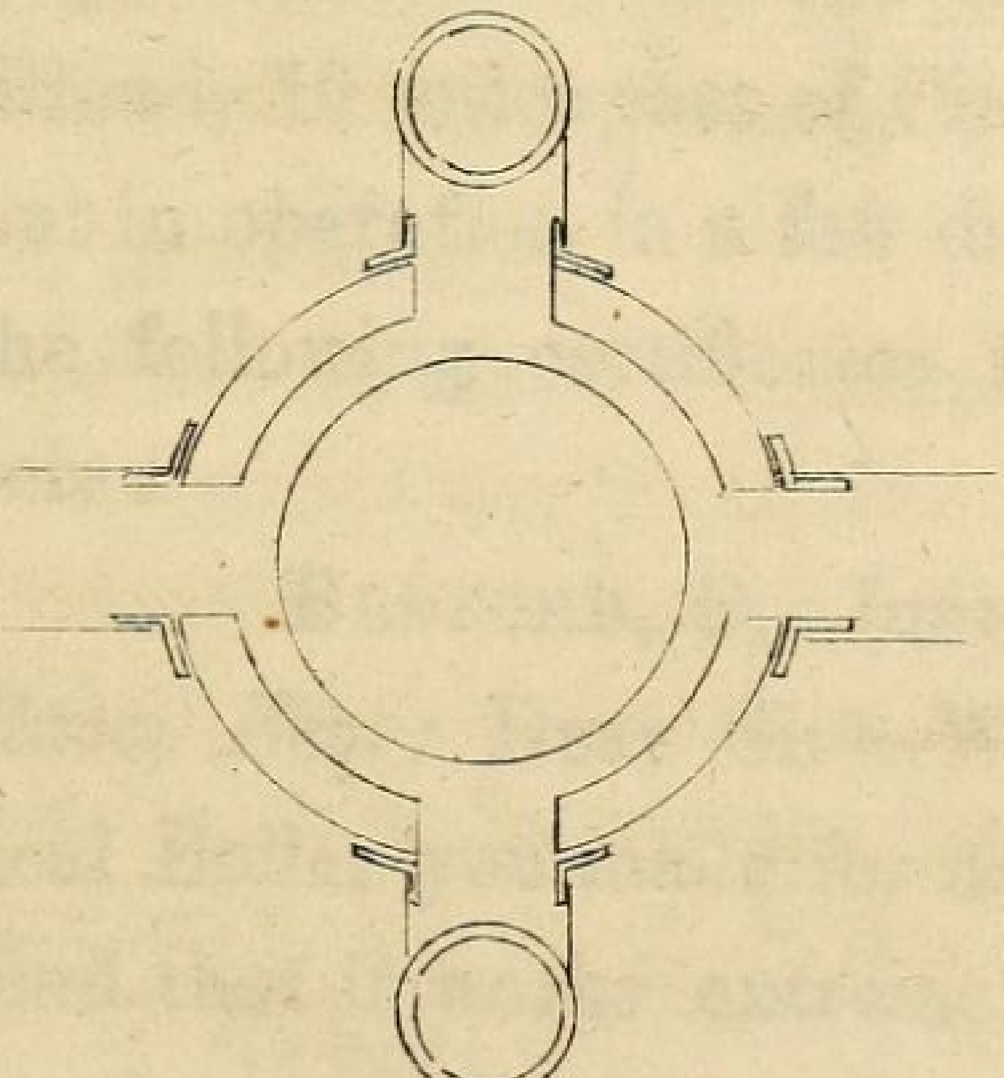


Upright Boiler.



Upright Boiler with Upright shaft in





Ground View of Upright Boiler

they would do when the common boilers were used. The decreased consumption of fuel (over 33 per cent) to produce a given amount of steam, is a matter of no small importance in any country, but it becomes a subject of the first consideration in sections where fuel is dear. The vertical boiler occupies about one-tenth only of the ground space required for a horrizontal boiler, and when we consider this fact in connection with the decreased room required for storage of fuel, and ashes, the economy of space becomes a matter of great importance, and particularly so in large towns and cities.

One of these boilers can be seen in the printing establishment of Kennedy & Brother, near Pittsburgh, one at Wheelock, Church & Co.'s Factory, Bedford, Cuyahoga County, O., another at the Hillsboro' and Cincinnatti Railroad, 10 miles east of Cincinnatti, and others will be put in operation in a few days.

We annex the following certificates from persons using these boilers:

BEDFORD, O., June 28, 1853.

W. W. Wallace, Esq.: Dear Sir—We have been using the Vertical Boiler you made for us, for the last ten days, and find that it works extremely well. We use shavings, saw-dust, and in fact anything at all for fuel, and find no difficulty in raising steam with any kind of fuel. In fact, the more we use it, we feel better satisfied that it is superior to the old horrizontal boiler, and feel safe in recommending it to any who want a boiler that requires little fuel and less attention. We have tried it with cord wood, and find that it requires ½ of a cord of wood to keep up a hot fire for one day. Respectfully your friends,

WHEELOCK, CHURCH & CO.

PITTSBURGH, Aug. 3, 1853.

W. W. Wallace: Dear Sir—We have now in use in our Printing Establishment, Manchester, one of your new Vertical Boilers, for which you have applied for letters patent. It gives entire satisfaction, and we cheer fully recommend it as being more safe, econonical and useful, than any other boiler with which we are acquainted. Our machinery is kept running constantly, and we do not consume more than *three* bushels of coal per day. KENNEDY & BRO.,

Publishers "Kennedys' Bank Note Review," 3d st.

PITTSBURGH, July 16, 1853.

W. W. Wallace: Dear Sir—I have used tho Vertical Boiler I bought of you for over three months, and am well satisfied with it. It occupies less space, consumes less fuel, and raises steam faster than any other boiler that I am acquainted with. I would confidently recommend them to those who want a first rate boiler.

JOHN D. DAVIS, JR.

All orders promptly attended to.

W. W. WALLACE,
319 Liberty-st., Pittsburgh.

MISCELLANEOUS.

STEAMBOAT DISASTERS.—Investigations made by a Congressional Committee, show the following loss of property and life on the rivers and lakes of the United States, in each of the following four years:

Years.	Amount of property destroyed.	Number of lives lost.
1848,	420,512	65
1849,	368,171	34
1850,	558,826	395
1851,	730,537	79
Total 4 years,	$2,078,046	563

The number of lives lost in 1850 was mainly occasioned by the explosion of boilers on board two steamboats, and the burning of a third, crowded with emigrant passengers.

LIFE BOAT STEAMERS.—A new plan for building steamers has been brought out in England, and an experimental boat built to run from London to Boulogne. This boat is 235 feet long, 20 feet beam, of 250 tons burden, and has an engine of 50 horse power. The bow and stern are filled with fixed air, like a life boat. If it meets the expectations of the inventor and builders, two immense vessels of 10,000 tons and 100 horse power will at once be built on the same plan; they will run from London to the east Indies in thirty days, without stopping on the way.

GARDNER'S ROCK DRILL.—G. A. Gardner, of Boston, has obtained, in 1852, a patent for a Rock Drill, designed for drilling blasts and wedge holes in rock, which we think worthy special notice.

It drills horrizontally as well as perpendicularly, or at any angle. The drill is drawn back six inches by cams rotated in a shaft, and projected against the rock by an india rubber spring, similar to the rubber car springs, repeating the blow from 120 to 150 times per minute. The patentee guarantees the machine to drill five lineal feet of 3 to 6 inch blast holes per hour, or fifty feet per ten hours in granite. The rate of advance when actually working, is $\frac{1}{4}$ to 2 inches per minute. In soft rock the advance is much faster. In limestone or mica slate, the rate of 3 to 4 inches per minute can be attained.

This machine is peculiarly adapted to tunneling—4 to 6 drills being combined in one machine, being equal to 150 or more men working at one section.

Navies of the World.—Great Britain has 136 vessels afloat, or, in ordinary or building, carrying 17,681 guns; France has 346, carrying 8,928 guns; Russia has 179 afloat, carrying 5,896 guns; Holland has 134, carrying 2,600 guns; the United States has 77, carrying 2,245 guns.

Diving Boat.—A new diving boat is now exhibiting at Cherbourg, France. Dr. Payerne is the inventor, and he has discovered means to descend to the bottom of the sea, and to remain there with a body of operatives as long as he pleases, replaceing, by chemical means, the oxygen absorbed. He also found a mode of directing the boat under water, by steam, as if it were on the surface. He engages to reach the English coast from any harbor in France. This invention is promised the patronage of the Prince President.

Whirlpools and Whirlwinds.—If in the bottom of a pond, or other reservoir of water there be an aperture through which the fluid is allowed to flow, there will be formed, immediately above the outlet, a whirling vortex, which is called a "whirlpool." It is formed by the currents from opposite directions meeting each other at the aperture; the meeting of these currents gives rise to a circular motion, which extends to some distance; this motion imparts to the water a centrifugal force, by which it is thrown from the center, leaving a funnel-shaped hole from the surface to the outlet. The Mælstrom, a large whirlpool in the ocean, off the coast of Norway, has a vortex sufficient to swallow up the largest ships.

Precisely analagous to the whirlpool is the "whirlwind;" the heated air at any portion of the earth's surface being caused to rise by the pressure of the surrounding colder and heavier air, the meeting currents produce a whirlwind. Whirlwinds are also frequently produced by contrary winds. The partial vacuum, caused by the ascending whirl, is commonly filled with dust, leaves, straws, and other light bodies, which it takes up in its course. It is sometimes sufficiently powerful to uproot trees and uproof houses. If the current of air from any rarticular quarter be of greater force than the other, the whirlwind then acquires a progessive as well as a rotary motion.

NOTE.—Page 145 and 153, inclusive, alludes to a table, (gotten up expressly for the uneducated engineer,) embracing all the different sizes of safety valves, from one to six inches, including all the one-eighth inches between one and six inches, having two separate tables, one for 100 pounds pea, and one for 150 pounds pea, and a third table showing the different degrees of heat at the various numbers of pounds to which the steam may be carried. This table having been lost or mislaid, and as it would require much time and labor to get up another, the author deemed it best not to delay the publication of the present volume, and offers, as a substitute, a smaller one. The sizes of valves in the substitute will be from 3 inches up to 6 inches, including the one-fourth inches. The second volume of the work will contain the large table.

THE AUTHOR.