

pose, so that each pipe may be blown through freely. You observe one pipe is just at the bottom of the upper row of tubes, the middle one is just at the top of the same tube, and the third one is four inches above, which makes the centre of the bottom pipe, to the top one just one foot, and our high water line is one inch above the tubes, which will give our glass three inches for steam and five inches for water, in sight. Our boiler being four feet diameter, our high water line, above the bottom of the boiler, is thirty-two inches of water and sixteen inches for steam, you can make good use of a little spare time in finding the number of gallons and pounds of water in the boiler, at 10 lbs. per gallon, before the engine goes to work, when we will spend a little time in calculating the water, steam, fuel, duty, power, &c., of the whole. On the top of the dome we have a 3 in. cast iron T bolt, the perpendicular flange is for the steam pipe, and the horizontal one is for the safety valve to be bolted to, so that it can be taken off and the valve ground without moving the steam pipes, or breaking the joint on the dome, which must be kept from leaking, because a little steam oozing out will soon eat away the boiler or dome plate. You cannot be too particular about this matter, which many men think nothing of. These flanges are all turned with rubber joints; wrought iron steam pipes are very good, they should be covered with felt and canvas, wood or anything else that will keep in the heat. Observe on the safety lever the figures are large and plain; the ball is screwed fast to the 50 lbs. figure; the valve lever is well fitted and works quite freely. You will observe we have no governor to this engine, because we do not want to keep in motion any more journals than we are obliged to. The steam or starting valve is not a globe, as many will have but a straight steam way slide valve, worked with a screw; it is easier to keep in good repair and no check to the steam. The cut-off tap on the steam pipe, close by the dome, is a straight cut-off tap, brass. Our cylinder drain traps are all of brass and screwed in. Oil cup to every journal with weeks inside. Some like the oil to be driven into the cylinder with the steam, but we will have ours screwed into the cover of the cylinder and another on the steam chest. Our heater for the feed water is a very simple one: a cast iron pipe, 1 foot diameter, with flanges, a shifting box in each end for a 1½ inch pipe, three lengths put together with return bends inside, so that the steam passes all round the outside of these pipes, the water being inside which makes it, to about 150° of heat, then the steam passes freely up the exhaust pipe, not into the chimney, but out through the roof of the house. The heater has a drain pipe to take away the condensed steam water. We will now fill the boiler with water from the well by a hand pump, as we have no other means. Our man hole joints we will make with platted hemp, four strands, four threads in each strand, the ends nicely sewed together, and hemmed smoothly all over, covered with thick red lead and linseed oil putty on both sides, the cover joint is cleaned off smoothly, no rough sand or iron skin left on it. The glands fit quite loosely across the boiler-hole, so that the screwing of the nuts do not bind the bolts in any, as each turn of the nut is made, the red lead squeezes out on every side. The man hole in the boiler is well faced and strengthened so that it will not spring with the pressure of the glands. If this joint is not good, we will make it with rubber and red lead putty, I think it will be good for six months or more we will now lower it over with the sheet-iron cover. Our chimney being finished by the bricklayer, 60 feet high, we will draw our damper, yes it works freely, a slide valve in a cast frame built into the walls just above the end of the boiler, the opening in our damper is 18 inches by 16 on 288 square inches, and the opening in the top of the chimney, is 18 inches square plastered all the way from bottom to top. This damper we will open or shut to suit the draft. Our four inch main water pipes, are all laid and connected with a tank 105 feet above the surface of the water, in the well. Our feed is connected with the main just behind the main check or foot valve, so that the full weight of the water in the main pipes shall be on the feed valves, one on each side of the heater, in this case we do not want a boiler check valve, having so far connected our pipe to the boiler and engine, we will put a fire of hard wood under the boiler to warm the water while we are pricking the stuffing boxes with cotton or hemp, and grease. As the water is increasing in temperature, a few brakes are seen at the tube ends and some of the seams; you say let us put into the boiler some oatmeal, horse-manure, or something considered by some men to be necessary for stopping leaks. Well I am not in favour of putting anything into the boiler, but the cleanest water we can get; be not alarmed about the leaks, but just watch them and you will see the iron in a well made boiler will use the best means to stop

them by expanding and throwing off some rust which will be better than we can put in, but if we find them too large, we will help the iron a little by caulking with a sharp tool but not cut the plates, as is frequently done. We will now clean up the engine room floor, fill up the oil cups, and make things look neat, and orderly, we will lay the oil cloth on the floor with this the engine pipes and room being finished painting, we will now clean up the floor and make things look neat, and clean, spread this oil cloth on the floor, lay this mat at the door, clean the glass in the door so that we may be able to see the engine working from the boiler-room. With a good lock on the door, it can be kept closed to keep out the dust. In the boiler-room we have a bench, a vice, a cupboard, and a few tools for daily use, hammer, chisel, two or three files, some rubber packing, a little hemp, and other things needed, our oil cans are made of copper, and nice and bright full of oil, we will now fill the cups and get ready for starting, for the steam is just beginning to rise, the air which is not required in the water for making steam. The heat is driving up to the surface of the water, the gauge now indicates four pounds, we will open the valves and let the air work the engine a few strokes, as well as blow through the gauge taps, for I like to get the air out of the boiler, first, because I have seen joints broken with it, that would stand the steam pressure. I have a very strong impression on my mind, that a tremendous power can be gained by a little steam and air brought together, the proposition has yet to be worked out. Nature's laws are what we want to apply to our use. Our gauge indicates five pounds per square inch. I will now start her, she will run awhile, as soon as the air pressure is removed, the steam will rise quickly, there you see she will not run over 300 revolutions, she is stopped, the gauge pressure is down again. Now while the steam is rising, I want you to assist me in finding out how many gallons of water we had in the boiler to begin with: Boiler 2-4 feet square $4 \times 4 = 16$ feet $\times 14$ feet long = 224 cubic round feet $\times 4,89474 = 1096'42176$ gallons the boiler will contain without the dome 2 flues and 19 tubes. Some of you say you are not well skilled in figures, so as to understand how I have worked that, or found those figures, well allow me and I will explain in a very simple way for I think it the duty of every speaker or writer to give what he knows in the simplest way, and no way is equal to the practical. Now mark out on the floor a square four feet, within these four lines mark three lines one foot apart from the side lines, which will make four divisions a foot each, now do the same the other way and then you will find within the four outer lines sixteen square spaces a square foot each or a foot each way, this shows you have sixteen square feet on the surface or area, suppose you now cut out the floor to those lines and dig down fourteen feet, then you will have a hole filled with air, 16 multiplied by 14 equal to 224 cubic square feet and each cubic foot contains $\frac{1000}{268}$ gallons of air or water, the meaning of these 268 decimals is, suppose one gallon was divided into one thousand parts, and we take 268 parts, you see it is a little over a quarter of a gallon; then 224 cubic square feet multiplied by $\frac{1000}{268}$ (gallons in one foot) gives 1086'42176 gallons, but you say the boiler is round, not square, true, we can have round cubic feet as well as square; with this difference, that a cylindrical foot has but 4.89475 gallons in it. These figures I have worked out purposely, to make easy way for you to find the number of gallons in a round vessel, and my future calculations, and to find the number of lbs, place the decimal dot between the 4 and 2 like this 10964'2176 or $\times 10$ lbs.. Our next process is to find half of the contents of the boiler, $1096'42176 \div 2 = 548'21088$ gallons, now we will find the number of gallons in the 8 inches above the centre line to those figures. The line across the front, above the centre line is just 45 inches and the line 8 inches below is the same, these to $45 + 45 = 48$ the centre line $= 138 \div 3 = 46$, here we have a rectangular fire 46×368 inches area or face near enough for our purposes $\times 168$ inches ($=$ to 14 feet long) gives $= 61824$ inches $\div$ by $277'274$ the number of inches a square gallon $= 222'97$; gallons of space in the 8 inches: add these to the half of the boiler $222'97 + 548'21088 = 771'18088$ gallons of space in the 32 inches of the boiler, out of these we will take the 2 flues 1 foot in diameter each $= 14 + 14 = 28$ cubic round feet $\times 4.89475 = 137'053$ gallons in the space of the 2 flues, now we have 19 tubes 2-4 inches diameter $= 16 \times 168 = 2688$ cubic round inches in each tube $\times 19 = 51072 \div 353'03$ (round cubic inches in a cylinder gallon) $= 144'664$ gallons of space, now add $137'053 + 144'664 = 281'717$ gallons to be taken out of the whole $771'18088 = 281'717 = 489'38388$ gallons of water in the boiler and by taking the 8 inch space out of the upper part of the boiler $548'21088 = 222'97 = 325'24088$ gallons of space for steam above water line. add to these the dome 2 feet diameter $\frac{1}{2} = 4 \times 2$ feet high $= 8$ cubic round feet $\times 4.89474 = 39'15792$ gal-