shaft. In the year 1769, the Duke of Hamilton, Kenneil, Scotland, got an engine made for his estate, by the Carron Iron Works, which was set going to manufacture those engines by Dr. Robuck, and Mr. Watt who obtained patents for their improvements, and received ⅓ of the savings of the coal, over the former engines. In the year 1773, Dr. Robuck withdrew, and Mr. Bolton joined Mr. Watt, who also made improvements and took out patents. The engine they erected for their own use, plainly told them that a crank, the throttle valve and governor, was wanting to regulate their engine that worked their own machinery, these were added although claimed to be invented by Mr. Hulls and Washborough of Bristol. In 1778, Mr. Bolton and Watt, improved the slide, or steam valve, so as to cut off the steam, before the end of the stroke; here it was made known that steam would expand, and form a cushion or spring, in each end of the cylinder, so that the crank may pass the centre easily; also they balanced the fly wheel to the weight of the crank, piston and rod; by this means they raised the steam to 30 lbs. in the boiler and sent it in with a blow on the piston, which pushed it up ⅜ of the stroke and then it was cut off, and the expansion of the steam took it to the end of the stroke; the momentum given to the fly wheel carried the crank over the centres. The next idea with Mr. Watt was to let off the steam in the air not condensed, but this idea seems to have taken some time to work out, for his mind was so much engaged in improving his tools, and workmanship while the high pressure or non-condensing engine was being improved, the mine or condensing engine was also being improved, the valve gear was also very much altered, and clockwork piece of machinery was also invented and fastened to the beam of the engine to count the number of strokes the engine made in a month. In some of the mines, the engines had to work faster in winter, than in the dry part of summer, which caused the cateract to be invented, and put to work by this pump, which allowed the water to escape from under the plunger pole, by opening and shutting a tap so much (I have made many of them,) that the engine could be made to work one stroke, or 20 in a minute. Such was the progress of the steam engine. In the year 1786, Oliver Evans of America, contrived to put a long round boiler with one flue and a beam engine into one of the reserve boats which drew much attention to altering the wagon boiler to its present shape. In 1801 Edward Cartwright made a portable engine and attached the cylinder to the boiler on wheels. In 1802 Trevithie and Vivian put their cylinders into the boiler (to keep it warm) of their first locomotive; (those men I knew). By this time quite a number of men, and plans were engaged to save coal, and burning the smoke, for it was plainly seen and felt that there was a tremendous and useful power in fire and water being brought together, economically. 1815 Mr. Woolf introduced his high pressure engine into the mines for drawing up the coal, and sending down materials, and a few years later for letting down, and drawing up the men and their tools (I, too, have enjoyed this ride). To such a perfection is the engine now-a-days brought, that we could not carry on our business without steam, railways, steamships, steam printing presses, steam heating, steam cooking, steam music, steam men, etc. (Barnum) we must not forget, that our faithful little engine has been pumping away all the time we have been running from place to place and date to date to see how the engine has grown, to what it is. It is now time to slack our fire, for we have nearly sent up, into the reservoir, our days 10 hours work 388,800 gallons of water. I want you now to push the burnt wood back off the bars into the bricks and throw a little ashes on it, close up all the doors and dampers, open the feed taps, check the engine, open the tap or screen, blow-off tap, now the bottom one, blow through the glass, and guage taps, safety valve, and steam guage tap, see all is working well; close the blow off's, the water is clear coming out, fill up the boiler to the water line, the steam is down, and the engine is stopped, clean off all the oil and dirt; feel every journal, and note every part, open the drain taps, draw her cover or duster over her, and wish her a good night's rest. Wipe the oil cloth with a damp cloth, also the windows and paint work; we will lock up the doors and go home to supper. If you will call at my studio at seven o'clock, we will talk over other subjects. At the appointed time my little room was filled with friends. One says, "what a beautiful view you have of Lake Ontario." Yes, I have been looking at that lake for 24 years past, and could tell many things about it, but cannot now spare the time. Here is a telescope to assist your eyes? another says "what a nice little air pump." Yes I could also say much on its wonders. "Is that a telephone?" Yes! I can speak to Mrs T—— in the kitchen quite plainly. I could tell you how it is made, and much in the laws of Nature here developed, but forbear for want of time. "Is this a magic lantern?" Yes, and here are a hundred slides to look at. How small to compare with those beautiful pictures I saw you put on the sheet in the schoolroom, yes and when this noble Scientific Magazine can afford room, I will give you 50 pages on those subjects. You see that barometer and thermometer, this desk and book-case, with an hundred volumes of books. All these things I have, instead of smoke, you say you have been smoking for 20 years past, and it cost about 25 cents per week equal to $13 × 20 = $260. I too have spent about 25 cents per week for 31 years, not in smoke but what you see = $400 worth what a difference. I believe, my dear friends, tobacco is causing more blindness, insanity, head and chest diseases, than any other thing besides; drunkeness, it also leads to it. Thousands of young children are cut off for want of pure air, but the house is full of tobacco smoke and smell, and so are our streets; every place, the smoke is let off in your face, without your permisson; be sure to keep brain cool and calm, free from any stimulating fumes or drinks, you need not be afraid to read or write a few hours every day in your own little room, with pure air. A well balanced mind, healthy body, a long night's rest, then you will be ready for your engagements in the morning. Good night. Meet me at the engine house, at 6.30 to-morrow morning; at the proper time, she is set going again for another day, and we will now talk about the nominal horse-power of our clean little engine. I told you that one of the mines employed 500 horses during one year to draw up the water in leather pails and the copper, tin, lead, iron, coal etc., in wood buckets attached to a rope passing over a pulley; the work of those horses, amounted to 16½ millions of pounds, divide this number by 500 horses it will give 33,000 pounds for each horse per day, 10 hours, one foot high; 33,000 lbs + 10 = 3,300 lbs. per hour + 60 = 55 lbs. per minute. The pails held about 55 lbs. of water or 5½ gallons, was drawn up every minute, this is what is called the nominal horse power by Mr. Watt or 33,000 lbs. drawn up one foot, in one minute is equal to the power of a horse in the 10 hours. Some of the mines were deeper than others, suppose the mine to be 150 feet deep, and if the horse draws up 220 lbs., 20 gallons will be equal to the day's work, or 33,000 foot pounds, or pounds one foot high per day, this was said to be (by Mr. Watt, and has not yet been altered) the power of the horse, a standard measure, like a foot a yard, a bushel a ton. This work performed, cost the mine company about five shillings, $1,25 per day. Mr. Watt offered to make an engine to do the same work for less money; he then calculated the size of the engine, the work required, or water to be drawn up, and called it so many horse power. An engine he made with a 50-inch cylinder, 10 feet stroke, 10 strokes per minute, 15 lbs. pressure of steam is called 178·5 horse power 50 × 50 ÷ ·7854 = 1963·5 square inches on piston + 14 lbs. steam on the piston + 290 feet, piston moves per minute = 5,890,500 lbs. power ÷ 33;000 lbs. = 178·5 horse power; this engine was low pressure. The exhaust steam discharged into another cylinder to be condensed by a stream of cold water in a vacuum, kept free from air by the pump, the difference of air between the atmosphere and the working of the pump is by this means given to the engine, which is considered to be about 11 pounds added to the steam. For you to clearly understand what the pressure of the atmosphere is on a vacuum, we will connect this little pump to the boiler, it is one inch square with a cover on the top. The piston and rod are balanced by this cord and weight over that pulley; the piston is now at the bottom, this little tap has let out the air that was under; now let on the steam. Close that little tap, you see its takes 15 lbs. (at the sea level), Toronto 350 feet above, to raise it up, and this is the pressure of the atmosphere on every square inch, you are now if the end of the exhaust pipe were open to the atmosphere, it would press into it the same, so that it would require a higher presture of steam to push the piston down and the exhaust steam out, this is the low pressure engine. But our own nice little engine, which has been working away, is a high pressure, see how she throws out her exhaust steam in balls and equally between each stroke. I told you her cylinder is 12 inches diameter 12 × 12 round inches = 144 × 7854 square area = 113·097 × 45 steam pressure (the safety valve, you know, we set to blow off at 50lbs.and the engine and pumps. We started with 5 lbs. which leaves us with 45 lbs. for work or power,) = 5089·365lbs. on the piston multiplied by the distance, the piston moves in the cylinder, 2 ft. up and 2 ft. down = 4 ft. = 20357·46 lbs. × 30 the number of strokes the engine makes in a minute = 610723·8 ÷ 23,000 lbs = 18·567 horse power, according to Mr. Watt's rule for his engine, but we have been working with only 30 lbs. (35 on the guage) which is only = 12·34 horse power, and in 10 hours we pumped up 388,800 lbs. of water, divide this by 33,000 lbs. = 11·782 horse power, you see by this the rule is good for one foot high, but we have pushed along