I may further remark that inasmuch as the change of strains in the material, and the attendant change of temperature is not uniform throughout the alteration of condition in the structures will be of the more importance in guns when the change is *per saltem* than in those when it follows a uniform law, and hence it is that in guns consisting of many hoops (and especially in wire-built guns), the matter is much less important than in guns consisting of only two or three rings.

Now in the gun of many coils, these alterations would be very much less, and the wire-gun, they would follow a uniform law which might easily be allowed for in the original construction, so that by firing a charge without a shot, the gun would at once be brought up to its maximum state of strength, or very nearly so, and subsequent firing would make little or no difference.

The effect of heating, therefore, may be fully provided against in a gun built according to formula, but might have very serious consequences in one built up hap-hazard.

Having thus laid down the general principles of construction, I will briefly refer to one or two systems of gun making in illustration.

I regret that I am not able to say anything beyond what I have already said with respect to Sir William Armstrong's system, owing to my not having received in time the information which Captain Noble has kindly sent me as to the dimensions and shrinkages employed at Elswick.

I must therefore confine my remarks to Sir Joseph Whitworth's and Sir William Palliser's guns, and I begin with Sir Joseph Whitworth's.

SIR JOSEPH WHITWORTH'S GUN.

Formerly Sir Joseph used to build up his guns of concentric rings or hoops, made slightly taper and forced one on the other by hydraulic pressure.

By the extreme accuracy of workmanship for which Sir Joseph's establishment has so long been justly famed, there can be no doubt that if the calculations are correctly made, a very excellent gun could be made in this way, though of course it would be costly; but Sir Joseph has such perfect confidence in his compressed steel that he does not now deem it necessary to avail himself of the additional strength which would be obtained by putting the successive hoops on under shrinkage, so that in fact his present gun, although built up of successive rings for the sake of convenience, is in the same condition relative to internal strains as would be a solid gun of the same dimensions and materials.

Admiring, as I do, Sir Joseph's material, I think he is not giving either it or himself fair play in thus abandoning the true principle of coil construction.

(To be Continued.)

Scientific Notes.

—The average velocity of light is 185,000 miles per second.

—A cubic foot of air weighs 535 grains Water is 825 times heavier than air. A cubic foot of water weighs 62½ lbs., a gallon 6 32-100 lbs.

—Platinum has been drawn into wires only one thirty-thousandth part of an inch, visible to the eye, and one mile's length weighing only one grain.

The speed of an electric spark, travelling over a copper wire, has been ascertained by Wheatstone to be two hundred and eighty-eight thousand miles in a second.

SOUND.—Is the effect produced upon the ear when air is set in motion within certain limits of rapidity. Audible sound begins when about thirty-two vibrations per second are made, and ceases when about 40,000 vibrations per second are reached. In an organ, the deepest note has thirty-two vibrations per second, the highest, 8192. The compass of the human voice is, on an average, about two octaves. Deep F of a bass singer has 87 vibrations per second; upper G of treble, 775.

The number of vibrations corresponding with the middle C of a musical instrument is 522 per second. An octave below, half the number; an octave above, twice the number.

Sound travels at the rate of 1100 feet per second in a still atmosphere The distance in feet between an observer and the point where a stroke of lightning falls, may be known by multiplying 1100 by the number of seconds that elapse after the flash is seen until the sound is heard.

The force of expansion of solids by heat is enormous. Thus iron, if heated from 32° F 212°, expands ·0012 of its length, to produce which change of length by mechanical means would require a force of 15 tons.

GUNPOWDER.—Composition:—75 saltpetre, 10 sulphur, 15 charcoal. Average specific gravity of the various sorts used in the Engineer Service to water as ·8985 : 1.

Average weight per cubic foot	=	56·42 lbs.
" " inch	=	·053 lb.
" " "	=	·5268 oz.
Cubic content .. .. .. 100 lbs	=	1·773 cubic foot.
" .. .. .. 1 lb.	=	·0177 "
" .. .. .. "	=	30·6374 cubic inches.
" .. .. .. 1 oz.	=	1·915 "

The heat developed at the moment of explosion is 4664° Fahr., and the resulting gas pressure, if the powder closely fills the chamber, is 40 tons or 80,000 lbs. to the square inch.

Careful experiment by De Saint Robert with rifled canon of 3½ inches bore, 8½ lbs shell, 1½ lbs powder, gives 1300 ft. velocity per second, or a little over 900 miles per hour, for the shell when it leaves the mouth of the canon, which is equal to a force of 219,000 foot-pounds, or a little less than seven horse power But the heat actually developed by the above amount of powder corresponds to almost thirty-two horse-power of work; *seventy-nine per cent.* of [illegible] the [illegible].

HORSE-POWER.—When Watt began to introduce his steam-engines he wished to be able to state their power as compared with that of horses, which were then generally employed for driving mills He accordingly made a series of experiments, which led him to the conclusion that the average power of a horse was sufficient to raise about 33,000 lbs. one foot in vertical height per minute, and this has been adopted in England and this country as the general measure of power.

A waterfall has one horse-power for every 33,000 lbs. of water flowing in the stream per minute, for each foot of fall. To compute the power of a stream, therefore, multiply the area of its cross section in feet by the velocity in feet per minute, and we have the number of cubic feet flowing along the stream per minute. Multiply this by 62½, the number of pounds in a cubic foot of water, and this by the vertical fall in feet, and we have the foot-pounds per minute of the fall; dividing by 33,000 gives us the horse-power.

For example: A stream flows through a flume 10 feet wide, and the depth of the water is 4 feet; the area of the cross section will be 40 feet. The velocity is 150 feet per minute—40× 150 = 6000 = the cubic feet of water flowing per minute. 6000 × 62½ = 375,000 = the pounds of water flowing per minute. The fall is 10 feet; 10 × 375,000 = 3,750,000 = the foot-pounds of the water-fall Divide 3,750,000 by 33,000, and we have 113 21-33 as the horse-power of the fall.

The power of a steam-engine is calculated by multiplying together the area of the piston in inches, the mean pressure in pounds per square inch, the length of the stroke in feet, and the number of strokes per minute; and dividing by 33,000.

Water-wheels yield from 50 to 91 per cent of the water. The actual power of a steam-engine is less than the indicated power, owing to a loss from friction; the amount of this loss varies with the arrangement of the engine and the perfection of the workmanship.

MOLECULES.—A molecule is the smallest mass into which any substance can be subdivided without changing its chemical nature.

All substances are aggregations of isolated molecules.

A piece of gold having six plane surfaces, each one inch square is called a cubic inch of gold, and looks as if it solidly filled that space But it is not solid, for it is composed of individual molecules, which are separated by comparatively wide intervals.

Molecules are, to use the language of Sir William Thompson, "pieces of matter of measurable dimensions, with shape, motion, and laws of action" A molecule of glass, as measured by this philosopher, is one five hundred millionth part of an inch in diameter.

Equal volumes of Substances, when in a state of gas, and under like conditions, contain the same number of molecules.

The number of molecules in a cubic inch of any perfect gas, at 32° F. and 30 ins. barometer pressure, is one hundred thousand millions of millions of millions, or 10^{20}.

The molecules of bodies are never at rest, but have a constant motion. The molecules of a gas confined in a vessel have great energy, are always flying about at a high velocity but in straight lines. They strike against each other and rebound, they drive against the inner walls of the vessel, and the force of this impact against the walls we call the pressure of a gas.

At a barometer pressure of 30 inches, or 15 lbs. to the square inch, temperature 32° F., the molecules of hydrogen have a velocity of 6097 feet per second, or over 4000 miles per hour. The energy of a pound of hydrogen, under the above conditions, is equal to that of a cannon-ball of the same weight having the same velocity.

A cubic inch of water may by heat be expanded into gaseous form, or steam, occupying the space of a cubic foot. In both forms the same number of molecules of water are found; but in the gaseous condition, the molecules are much more widely separated than in the liquid; so widely, in fact, that a cubic foot of alcohol vapor together with a cubic foot of either vapor may be introduced into the vessel—or, apparently, just as much of the alcohol, and just as much of the ether, as if there were no water vapor present. All these vapors remain separate; they do not chemically unite.

A Big Score.

The Toronto Field Battery' Figures Eclipsed—Big Work by the Montreal Field Battery.

QUEBEC, Sept. 27.—The Montreal Field Battery fired to-day in the Dominion competition, and succeeded in making the highest score of the season, if not on record, in the Dominion, being a total score of 555, therefore beating the Toronto battery by 73 points Lieutenant-Colonel Stevenson, in command of the battery, is highly delighted at beating the score of the Toronto boys. The firing party of 16 men, commanded by Lieutenant-Colonel Stevenson and Capt. Oswald; arrived here yesterday morning and went to the citadel, where they were most hospitably received and entertained by the officers and men of "A" battery. Contrary to the usual custom here, they found that they had to take their guns and targets down to the Island of Orleans, and when there, to put the latter in position previous to firing. All of which was formerly done in advance while Col. Strange commanded here. The weather was heavy and rainy nearly all day, there being only two or three hours of sunshine in the forenoon, but nevertheless the shooting was excellent throughout. The three highest scores were:—Sergeant Hastings, 43; Sergeant Ma..h, 42; Gunner Moffat, 41.
Toronto Mail.