DEEP SEA SOUNDING BY PIANOFORTE WIRE.

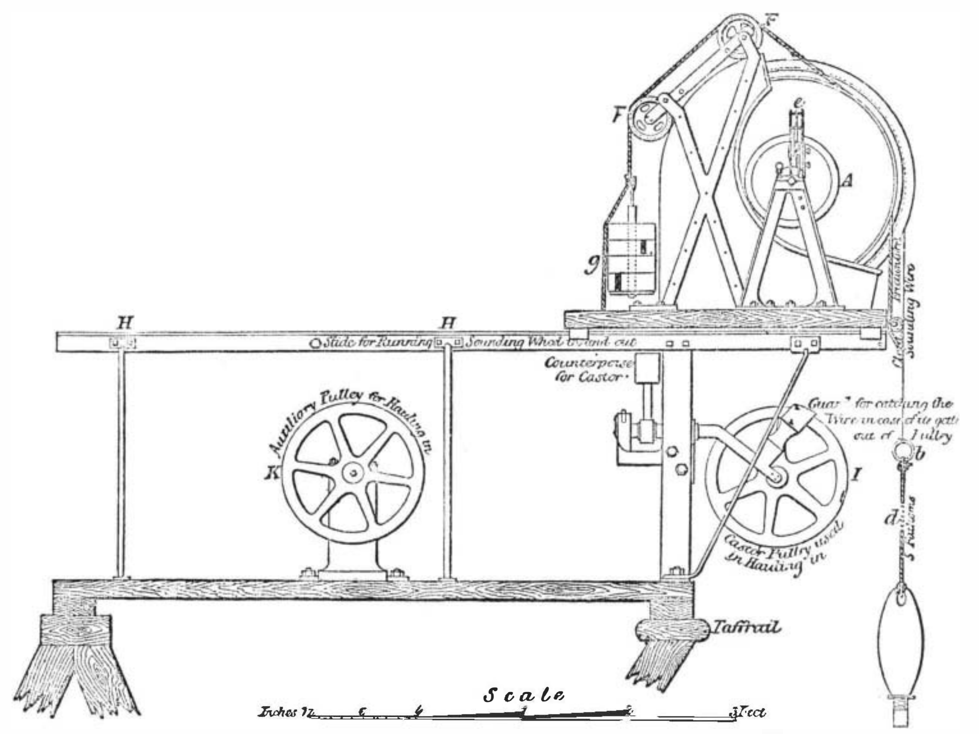
The use of piano wire for deep sea sounding was first successfully carried out by the celebrated physicist and electrician, Sir William Thomson, to whom belongs the merit of its introduction.

Since that first attempt, the pianoforte wire has done excellent service on submarine cable expeditions in various parts of the world; among other places, across the Atlantic, across the Pacific—where Captain Belknap, U.S N., found depths exceeding 500 fathoms—and in South American waters, from Cuba to the River Plate.

The sounding apparatus, as it is now finished and sent out by Mr. White, of Glasgow, Scotland, and as it is has been used by the steamer Faraday on the Direct United States (Messrs. Siemens') Cable expedition, is represented in the accompanying engraving, which we extract from *Engineering*. It consists of a large light drum, A, of galvanized sheet iron, on which the wire is carefully coiled. The free end of this wire terminates in a stout galvanized iron ring, *b*, and to this ring the sinker, *c*, is attached by a hemp line, *d*, several fathoms long. The interposition of the line between the wire and sinker prevents the wire from reaching the bottom, and the ring is heavy enough to keep the wire tight—thus kinking of the wire is avoided. The circumference of the drum is one fathom, and an indicator, *e*, is fixed to the axle to indicate the number of revolutions of the drum. A slight correction, due to the thickness of wire on the drum, has therefore only to be applied to the indicated number of turns in order to give the amount of wire paid out, or depth of the sounding in fathoms.

In order to stop the drum immediately on the sinker reaching the bottom, the brake, F F, is employed. It consists of a friction cord attached at one end to the framework of the apparatus, and passing over a secondary groove on the circumference of the drum, A, the other end being weighted at *g*. By means of this break the increased pull on the wire, due to the amount of it paid out, is to be more than counteracted, so that the drum will revolve by a pull on the wire due to something less than the weight of the sinker. For, in this case, when the sinker is supported by the bottom, there will be a friction on the drum, bringing it to rest. The weights, *g*, have, therefore, to be applied gradually, as the wire runs out. The rule adopted in practice is to apply resistance, always exceeding by 10 lbs. the weight of the wire out. Then, the sinker being 34 lbs., we have 24 lbs. weight left for the moving force. This is amply sufficient to give a very rapid descent, so that in the course of half an hour the bottom will be reached at a depth of 2,000 or 3,000 fathoms. The person in charge watches a counter (the indicator, *e*), and for every 250 fathoms (that is, every 250 turns of the wheel) he adds such weight to the brake cord as shall add 3 lbs. to the force with which the sounding wheel resists the egress of the wire. That makes 12 lbs. added to the brake resistance for every 1,000 fathoms of wire run out. The weight of every 1,000 fathoms of wire in air is 14½ lbs.

In water, therefore, the weight is about 12 lbs.; so that if the weight is added at the rate indicated, the rule will be fulfilled. So it is arranged that, when the 34 lbs. weight reaches the bottom, instead of there being a pull, or a moving force of 24 lbs. on the wire, tending to draw it through the water, there will suddenly come to be a resistance of 10 lbs. against the motion. A turn or two and the drum comes to rest. The instantaneous perception of the bottom, even at so great a depth as 4,000 fathoms, when this rule is followed, is very remarkable. The sounding apparatus is best fixed so as to project beyond the bow or stern taffrail. In order to take a sounding, the drum, A, is run out to the end of the rails, H H, where it admits of the sinker dropping sheer into the sea. The sinker is then gently lowered by turning the handle of the drum until it touches the water, when the indicator is set at zero. Everything being ready and the ship at rest, the handles of the drum are then unshipped, the check pawl of the drum is unlocked, and the wire runs rapidly out. When bottom is reached, the indicator is read off, and the hauling up is set about at once. The wire is first supported from the framework by a yarn stopper, or is held by a couple of men with canvas or leather protection for their hands. The drum is then run inboard again, and the wire is led over ½ circumference of the caster pulley, I, then passed over the auxiliary hauling-in pulley, K, so as to make ¾ or 1¾ turns before it is coiled on the drum.



WHITE'S DEEP SEA SOUNDING APPARATUS.

The tube in the end of the sinker, if fitted with a valve door, brings up a specimen of the bottom. As the wire comes in, it may be partially dried by rubbing it with a piece of canvas; and as it is being coiled on the drum, to preserve it from rusting it is drenched occasionally with oil. When not in use the drum is kept in a bath of oil. It was formerly the custom to apply a solution of caustic soda in the same way, but the oil has superseded it.

This is the complete apparatus for deep sea sounding, but a simpler affair will suffice for soundings of even 1,000 fathoms, and especially for flying soundings from telegraph or mail steamers approaching land. With the wire three men can do the work in a small fraction of the time; the sounding is surer, for the wire goes down very sheer; and difficult manœuvering of the ship in rough tides, to keep her over the line, is avoided during hauling in, because the lateral friction of the wire to its passage through the water is so small compared to that of the hempen line. A sounding in 2,500 fathoms, which would engage several men and a donkey engine, require very alert handling of the ship, and occupy from four to five hours, can now be done by three men in the space of about forty minutes.

Breaking of a Fire Ladder.

By the breaking of a patent fireman's ladder machine in this city, during a recent drill of the fire department, three men lost their lives. The machine consists of a combination of ladders, which, by the turning of winches, are quickly elevated to an angular or perpendicular position, the ladders sliding out one beyond the other. The unfortunate men were on the upper ladder, ninety feet from the ground, when one of the lower ladders gave way, and they were precipitated to the pavement. Cause—bad material and bad workmanship.

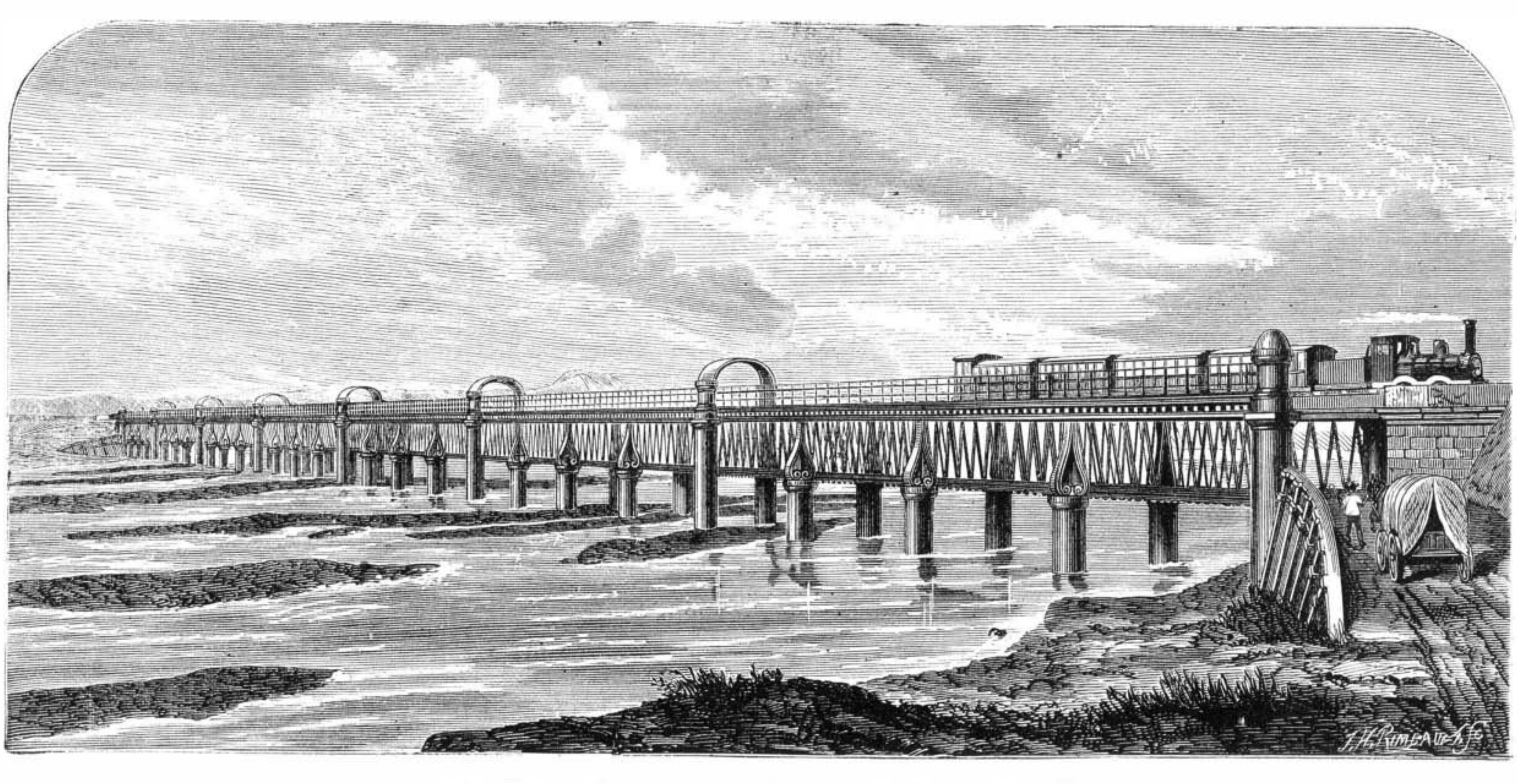
Dietetic Effects of Water.

Certain experiments made by a French *savan*, with the view of ascertaining how far the phosphate of lime in bone may be replaced by other phosphates, have been used by Mr. W. J. Cooper to illustrate how profoundly the bodies of animals are influenced by the waters they drink. This is an aspect of the water question which will be new to most people; but there is no doubt that the composition of the body is materially influenced by the mineral constituents of the fluids we habitually drink. The active effects of several mineral waters upon the functions are well known; it is not so generally known that water from artesian wells, so pure from organic pollution, sometimes contains sulphate of magnesia and other salts to such a degree as to be positively injurious. On the other hand, in some districts in Holland where there is only rain water to be obtained for drinking purposes, softening and distortion of the bones are frequent. That, as shown by the experiments referred to by Mr. Cooper, the use of natural waters may tend to alter the structure of our bodies, introduces another element into the much vexed question as to the proper source whence to draw the supplies of potable water for towns, by showing that the inorganic impurities of water are of more importance to health than they have been usually considered; while it lends support to the opinion that the same conditions have something to do with the goitre and other glandular affections endemic over certain regions.

ENGINEERING IN NEW ZEALAND.

We publish herewith a view of a bridge, designed by Mr. J. Millar, of Dunedin, New Zealand, to carry the Otago Great Northern Trunk Railway over the Waitaki, a river of great width, and liable to considerable variation in depth of water. The bridge consists of 28 bays, each of 132 feet from center to center of piers. On one side an extra span of 45 feet leads the general road traffic upon the bridge, as shown, the rail level being on the top, and the road level at the bottom, of the Warren girders, which compose the long structure. The river, which is, in times of low water, reduced so much in volume that the bed is exposed in banks of shingle, as shown in the engraving, is greatly flooded at the season when the snow melts from the mountains, and passes down in torrents. At such times the width of the river is increased to a mile, and the water rises to a level within 5 feet of the level of the bridge.

HAIR should never be put in mortar until a few days before the material is used, as the lime will soon destroy it.



BRIDGE OVER THE WAITAKI NEW ZEALAND.

Nitro-Glycerin Explosives.

Nitro-glycerin is the most powerful explosive in use. In difficult blasting, where very violent effects are required, it surpasses all others. In spite of the many accidents that have occurred with it, it has been found to be so valuable that its use has steadily and largely increased.

Its liquid form is a disadvantage, except under favorable circumstances, as when made at the place where it is to be employed. It, however, forms the essential ingredient in a number of solid mixtures, which will be taken up farther on. When used in blasting or similar work, it is usually put in tin cans or cartridge cases.

Since nitro-glycerin is so readily detonated, it has the advantage of not requiring strong confinement. Even when freely exposed, it will exert violent effects, such as breaking masses of rock or blocks of iron. So, in blasting, it requires but little tamping. Loose sand or water is entirely sufficient.

The relative force of nitro-glycerin is not easily estimated, since the effect produced depends greatly on the circumstances. Thus, a charge of nitro-glycerin in wet sand or any soft material will exercise but a slight effect, while the same charge will shatter many tuns of the hardest rock. In the former case much more sand would be thrown out by a slower explosion, which would gradually move it, than by the sudden violent shock of the nitro-glycerin, which would only compress the material immediately about it. But in the hard rock, the sudden explosion is much more effective than the same amount of force more slowly applied. Roughly, it may be said that nitro glycerin is eight times as powerful as gunpowder, weight for weight.

Products of decomposition: On explosion, nitro-glycerin is resolved entirely into the gases carbonic anhydride, water, nitrogen, and oxygen, the last named appearing only in small quantity. If explosion is imperfectly accomplished, oxides of nitrogen are formed, and the total quantity of gas is lessened. If fully exploded, no disagreeable or poisonous gases are given off.

NITRO-GLYCERIN PREPARATIONS.

The explosive preparations containing nitro-glycerin will be taken up in this place, since they are but forms in which nitro-glycerin itself is presented for use. Their explosive power is derived from the nitro-glycerin in them; so that they are not explosive mixtures in the sense in which that term has been employed in these pages.

In all of them nitro-glycerin is present as nitro-glycerin, but it is mixed with some absorbent substance or vehicle. In this way a solid or semi-solid substance is obtained, which is much more convenient and safer to use than the liquid itself.

DYNAMITE.

In dynamite, the absorbent is usually a natural silicious earth. Deposits of this silicious earth are found in many places, notably in Hanover. From the Hanover earth, the original dynamite was made. This silicious earth, or *Kieselguhr*, is a fine white powder, composed of the skeletons of microscopic animals (infusoria). It has a high absorptive power, being capable of taking up from two to three times its weight of nitro-glycerin without becoming pasty.

Artificially prepared silica has been proposed by the writer as a substitute for the natural earth, and has been used at Newport with good results. This silica is prepared by precipitating it from a solution of sodium silicate (waterglass) by sulphuric acid, washing, and drying. Its absorbent power is a little less than that of the natural earth, but it retains the nitro-glycerin very well.

The process of making dynamite is very simple. The nitro-glycerin is mixed with the dry, fine powder in a leaden vessel with wooden spatulas.

Dynamite has a brown color, and resembles in appearance moist brown sugar. It usually contains from sixty to seventy-five per cent of nitro-glycerin. In this country, dynamite is made and sold under the name of giant powder.

The explosive properties of dynamite are those of the nitro-glycerin contained in it, as the absorbent is an inert body. It freezes at the same temperature as its nitro-glycerin, to a white mass. If solidly frozen, it cannot be fired; but if loose and pulverulent, it can be exploded, although with diminished violence. It can be thawed by placing the vessel containing it in hot water.

The keeping qualities of dynamite are those of the nitroglycerin it is made from. It is safer because it avoids the liquid condition, and from its softness it will bear blows much better. Exudation must be guarded against. Therefore, it must not contain too much nitro-glycerin, especially if it is liable to be exposed to comparatively high temperatures, which tend to make the nitro-glycerin more fluid, and consequently less easily retained.

The firing point of dynamite is the same as of its nitro-glycerin. If flame is applied to it, it takes fire and burns with a strong flame, leaving a residue of silica. It is not sensitive to friction or moderate percussion.

Mode of firing: Dynamite is fired by a fulminate fuse. Gunpowder will fire it, but not with certainty, and the effect obtained is much less than when the stronger agent is employed.

Use and relative force: Dynamite is the best of the nitroglycerin preparations, and is indeed the best form in which nitro-glycerin can be used. It has earned a good reputation for safety, in spite of the horror usually excited by nitroglycerin, or anything connected with it. It contains more of the explosive agent than the other nitro-glycerin preparations, and is therefore stronger. Safer than the liquid nitroglycerin, from its mechanical condition, it is not complicated by the admixture of substances which may exercise injurious effects.

It is used for blasting and other purposes instead of nitroglycerin. It is now extensively employed in mining and quarrying with excellent results, and its use is constantly increasing. Much more effective than powder, it is practically safer, since it is not liable to explosion by sparks or flames. Carelessness is therefore less likely to be followed by accident. For military purposes, also, it is largely employed. The explosive force of dynamite is, of course, that of the nitro-glycerin contained in it. If it contains seventy-five per cent, its comparative force may then be approximately stated at six times that of gunpowder, weight for weight.

DYNAMITE NO. 2.

Dynamite proper contains only nitro-glycerin and the silicious absorbent. Mixtures containing other substances are sometimes included under the same name. The true dynamite is often called dynamite No. 1, and the others dynamite No. 2, etc., or receive fanciful names. All these mixtures contain less nitro-glycerin than the No. 1, so that they cost less per pound, but of course they are proportionately less powerful. Possibly they may sometimes be of use.

The following are varieties of No. 2 dynamite made in England, according to the report of the Select Committee of House of Commons on explosive substances, June 26, 1874:

	Per cent.		Per cent.
Nitrate of soda	69·00	Nitrate of potash	71·00
Paraffin	7·00	Paraffin	1·00
Charcoal or coal dust	4·00	Charcoal	10·00
Nitro-glycerin	20·00	Nitro-glycerin	18·00
	100·00		100·00

It is hard to see any advantage in these mixtures except that they are cheaper, and might be applied to uses where the great violence of the larger amount of nitro-glycerin is not needed, and yet a sharper explosive than powder is wanted. It is improbable that any useful effect is obtained from any other ingredient than the nitro-glycerin. Those containing deliquescent salts (nitrate of soda, for example) are objectionable from their liability to exudation. All of them will be injured by water, which dissolves the salts, which are the principal ingredients.

It is easy to see that the number of such mixtures that might be made is very great, for almost any dry salt or powder may be taken as an absorbent.* No special value would attach to any of them. The only requisites would be that the absorbents should not exert any injurious action, and that no more nitro-glycerin should be present than could be perfectly retained at the highest temperature that would probably be experienced.

Many of these mixtures have been proposed and made, but it is undesirable at the present time to touch upon more than a few of the most prominent, which will serve as examples.

LITHOFRACTEUR.

Lithofracteur is a mixture which, according to Trauzl, has the composition:

	Per cent.
Nitro-glycerin	52·00
Infusorial earth	30·00
Coal	12·00
Soda saltpeter	4·00
Sulphur	2·00—100

Sometimes, instead of the sodium nitrate, the potassium or barium salt is used, and variations made in the quantity of nitro-glycerin present. Like all the nitro-glycerin preparations, lithofracteur has no necessarily definite composition, being merely a mixture made according to the caprice of the manufacturers, as shown by experiments with lithofracteur in England by a special committee. Experiments in 1872 with a lithofracteur containing 66·7 per cent of nitro-glycerin showed great liability to exudation. In 1873 the manufacturers submitted another sample of 47·5 per cent, which, of course, retained the nitro-glycerin much better.

This preparation is made by Krebs Brothers & Co., in Cologne, and has been used to some extent in Europe. It is claimed by the makers that the other substances (coal, saltpeter, and sulphur), mixed with the nitro-glycerin, increase the quantity of gas delivered, and, therefore, the explosive force. This is not, however, correct. Nitro-glycerin is so sudden in its explosion that nothing can be added to it from the slower burning of any of the other combustible ingredients, which are present in comparatively small amount, and in bad proportions. Neither does the presence of these substances add anything to the safety of the mixture. They tend to lower its firing point, and render it more easily exploded.

Lithofracteur must be regarded as inferior to dynamite proper, especially for military purposes. It is much more liable to exudation.

The mixtures known in this country as giant powder No. 2, rend-rock, etc, and those already spoken of under the head of dynamite No. 2, are similar to lithofracteur; but in them the silicious earth is generally omitted.

DUALIN.

Dualin is a mixture made by Carl Dittmar, a Prussian, of nitro-glycerin, sawdust, and saltpeter, in about the proportions:

	Per cent.
Nitro-glycerin	50·00
Fine sawdust	30·00
Saltpeter	20·00
	100·00 (Trauzl.)

This preparation is also inferior to dynamite. The sawdust and saltpeter have much less absorptive power than the silicious earth, and retain the nitro-glycerin comparatively feebly. Its firing point is said to be considerably lower than that of dynamite. Also, its lower specific gravity is a drawback.—*Professor Hill's "Notes."*

* During the siege of Paris, in 1870, nitro-glycerin and dynamite were made in the city in considerable quantity for military purposes. The glycerin was obtained from the candle factories, but of course the silicious earth was unattainable. Many experiments were made to discover a good absorbent. Pulverized brick, tripoli, charcoal, magnesia, chalk, lampblack, and others were rejected as not possessing sufficient absorptive powers. Finally, the ash of the coal used for gas-making was hit upon. This was a white powder mainly composed of aluminum silicate, and capable of taking up twice its weight of nitro-glycerin, without becoming plastic. The mixture so made was called dynamite.

PRACTICAL MECHANISM.

BY JOSHUA ROSE.

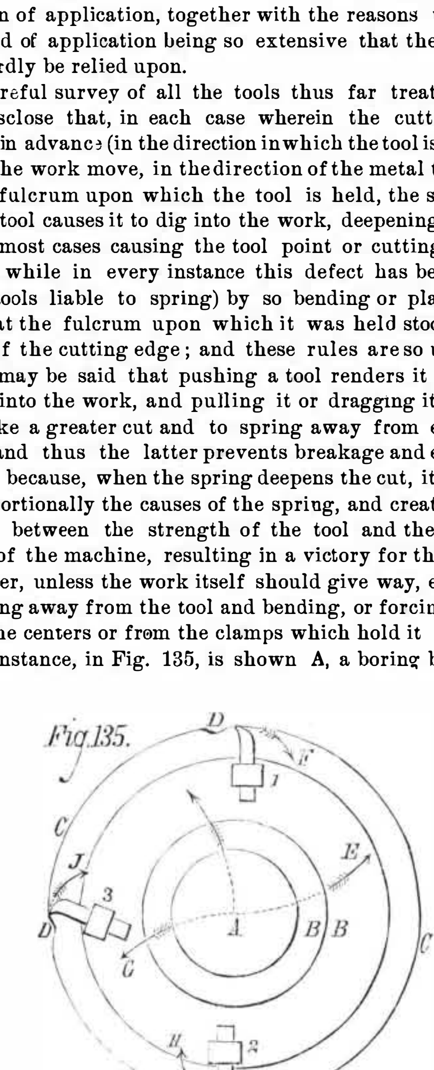
NUMBER XXXII.

BORING BARS AND TOOLS.

A very important consideration with reference to boring bars is the position which the cutters should occupy towards the head or the body of the bar. We have already been over the same ground with reference to parting or grooving tools for lathe work, cutting tools for planing work, and cutters for cutting out holes of a large diameter in boiler plates; but there are so many principles involved in the shape and holding position of cutting tools, so many variations, and so many instances in which the reasons for the adoption or variation of a principle are not obvious, that it is of vital importance to specify, in the case of each tool, its precise shape and position of application, together with the reasons therefor the field of application being so extensive that the memory can hardly be relied upon.

A careful survey of all the tools thus far treated upon will disclose that, in each case wherein the cutting edge stands in advance (in the direction in which the tool is moving or, if the work move, in the direction of the metal to be cut) of the fulcrum upon which the tool is held, the springing of the tool causes it to dig into the work, deepening the cut, and in most cases causing the tool point or cutting edge to break; while in every instance this defect has been cured (upon tools liable to spring) by so bending or placing the tool that the fulcrum upon which it was held stood in advance of the cutting edge; and these rules are so universal that it may be said that pushing a tool renders it liable to spring into the work, and pulling it or dragging it enables it to take a greater cut and to spring away from excessive duty; and thus the latter prevents breakage and excessive spring, because, when the spring deepens the cut, it increases proportionally the causes of the spring, and creates a contention between the strength of the tool and the driving power of the machine, resulting in a victory for the one or the other, unless the work itself should give way, either by springing away from the tool and bending, or forcing it from the lathe centers or from the clamps which hold it

For instance, in Fig. 135, is shown A, a boring bar; B B



is the sliding head; C C is the bore of the cylinder, and 1, 2, and 3 are tools in the positions shown. D D D are projections in the bore of the cylinder, causing an excessive amount of duty to be placed upon the cutters, as sometimes occurs when a cut of medium depth has been started. Such a cut increases on one side of the bore of the work until, becoming excessive, it causes the bar to tremble and the cutters to chatter. In such a case, tool and position No. 1 would not be relieved of any duty, though it spring to a considerable degree; because the bar would spring in the direction denoted by the dotted line and arrow, E, while the spring of the tool itself would be in the direction of the dotted line, F. The tendency of the spring of the bar is to force the tool deeper into the cut instead of relieving it; while the tendency of the spring of the tool will scarcely affect the depth of the cut. Tool and position No. 2 would cause the bar to spring in the direction of the dotted line and arrow, G, and the tool itself to spring in the direction of H, the spring of the bar being in a direction to increase, and that of the tool to diminish, the cut. Tool and position No. 3 would, however, place the spring of the bar in a direction which would scarcely affect the depth of the cut, while the spring of the tool itself would be in a direction to give decided relief by springing away from its excessive duty. It must be borne in mind that even a stout bar of medium length will spring considerably from an ordinary roughing-out cut, though the latter be of an equal depth all round the bore and from end to end of the work. Position No. 3, in Fig. 135, then, is decidedly preferable for the roughing-out cuts. In the finishing cuts, which should be very light ones, neither the bar nor the tool are so much affected by springing; but even here position No. 3 maintains its superiority, because, the tool being pulled, it operates somewhat as a scraper (though it may be as keen in shape as the other tools), and hence it cuts more smoothly. It possesses, it is true, the defect that the distance from the cutting point stands fur ther out from the holding clamp, and the tool is hence more apt to spring; and in cases where the diameter of the sliding