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 (water-glass) 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 nitro-glycerin 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 nitro-glycerin 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 nitro-glycerin, 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 nitro-glycerin, 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 nitro-glycerin. 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.)

*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.

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."*

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

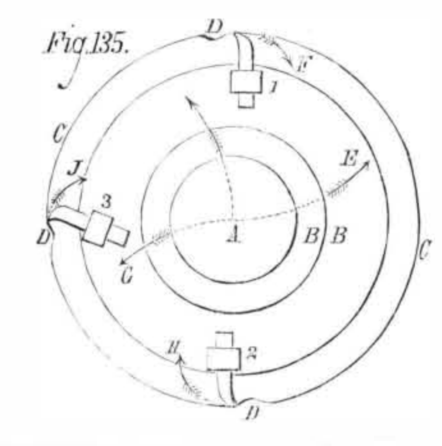


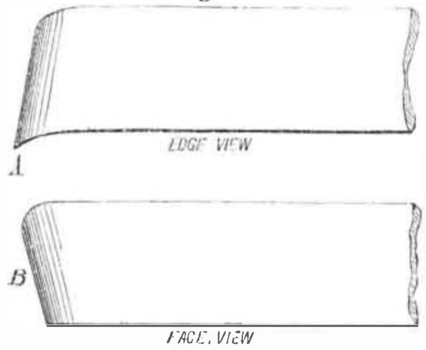
Fig. 135.

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 head is much less than that of the hole to be bored, this defect may possess importance, and then position No. 2 may be preferable; but it is an error to employ a bar of small diameter compared to that of the work.

To obtain the very best and most rapid result, there should be but little space between the sliding head and the bore of the work; the bar itself should be as stout as is practicable, leaving the sliding head of sufficient strength: and if the bar revolves in journals, these should be of large diameter and with ample facilities for taking up both the diametrical and end play of the boxes, since the one steadies the bar while it is performing boring duty, and the other while it is facing off end faces, as for cylinder cover joints. The feed of a boring bar, which is slight in comparison to its duty, will range at from 30 to 40 revolutions to an inch of travel; while that of a stout bar, held in large and closely fitting journals, may be about 20 revolutions per inch of tool travel for roughing-out cuts, and 4 revolutions per inch of travel for finishing cuts, which may be made to leave the work very smooth indeed.

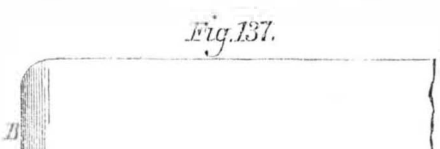
The tools employed for the roughing cuts should not have a broad cutting surface, and should have a little front rake, as shown in Fig. 136, A being the cutting corner. For the

Fig. 136.



finishing cuts, the same tool may be employed, the end being ground to have a broad level cutting surface along the edge, B, as shown in Fig. 137. These tools should be made

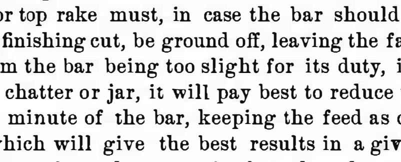
Fig. 137.



of the best quality of steel, and hardened right out, that is to say, not tempered at all.

The lip or top rake must, in case the bar should tremble during the finishing cut, be ground off, leaving the face level; and if, from the bar being too slight for its duty, it should still either chatter or jar, it will pay best to reduce the revolutions per minute of the bar, keeping the feed as coarse as possible, which will give the best results in a given time. In cases where, from the excessive length and smallness of the bar, it is difficult to prevent it from springing, the cutters must be made as in Fig. 138, having no lip, and but a

Fig. 138.



small amount of cutting surface; and the corner, A, should be beveled off as shown. Under these conditions, the tool is the least likely to chatter or to spring into the cut, especially if held in position No. 3, in Fig. 135; for a tool which would jar violently in position No. 1, would cut smoothly and well if held in position No. 3.

The shape of the cutting corner of a cutter depends entirely upon the position of its clearance or rake. If the edge forming the diameter has no clearance upon it, the cutting being performed by the end edges, the cutter may be left with a square, slightly rounded, or beveled corner; but if the cutter have clearance on its outside or diametrical edge, as shown on the cutters in Fig. 135, the cutting corner should be beveled or rounded off, otherwise it will jar in taking a roughing cut, and chatter in taking a moderate cut. The principle is that beveling off the front edge of the cutter, as shown in Fig. 138, tends greatly to counteract a disposition to either jarring or chattering, especially as applied to brass work.

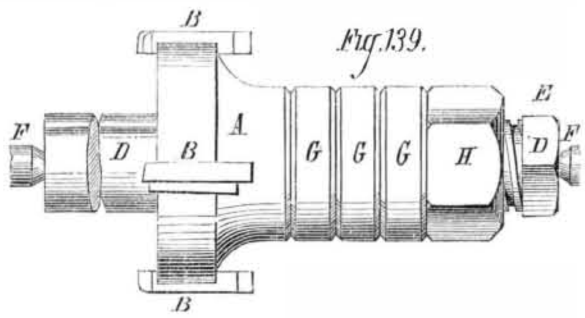
The only other precaution which can be taken to prevent, in exceptional cases, the spring of a boring bar is to provide a bearing at each end of the work, as, for instance, by bolting to the end of the work four iron plates, the ends being hollowed to fit the bar, and being so adjusted as to barely touch it; so that, while the bar will not be sprung by the plates, yet, if it tends to spring out of true, it will be prevented from doing so by contact with the hollow ends of the plates, which latter should have a wide bearing and be kept well lubricated.

It sometimes happens that, from play in the journals of the machine, or from other causes, a boring bar will jar or chatter at the commencement of a bore, and will gradually cease to do so as the cut proceeds and the cutter gets a broader bearing upon the work. Especially is this liable to occur in using cutters having no clearance on the diametrical edge; because, so soon as such a cutter has entered the bore for a short distance, the diametrical edge (fitting closely to the bore) acts as a guide to steady the cutter. If, however, the cutter has such clearance, the only perceptible reason is that the chattering ceases as soon as the cutting edge of the tool or cutter has lost its fiberous edges. The natural remedy for this would appear to be to apply the oilstone; this, however, will either have no effect or make matters worse. It is, indeed, a far better plan to take the tool (after grinding) and rub the cutting edge into a piece of soft wood, and to apply oil to the tool during its first two or three cutting revolutions. The application of oil will often remedy a slight existing chattering of a boring bar, but it is an expedient to be avoided, if possible, since the diameter or bore cut with oil will vary from that cut dry, the latter being a trifle the larger.

The considerations, therefore, which determine the shape of a cutter to be employed are as follows: Cutters for use on a certain and unvarying size of bore should have no clearance on the diametrical edges, the cutting being performed by the end edge only. Cutters intended to be adjusted to suit bores of varying diameter should have clearance on the end and on the diametrical edges. For use on brass work, the cutting crown should be rounded off, and there should be no lip given to the cutting edge. For wrought iron, the cutter should be lipped, and oil or soapy water should be supplied to it during the operation. A slight lip should be given to cutters for use on cast iron, unless, from slightness in the bar or other causes, there is a tendency to jarring, in which case no lip or front rake should be given.

SMALL BORING BARS.

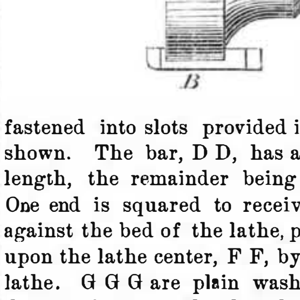
In boring work chucked and revolved in the lathe, such, for instance, as axle boxes for locomotives, the boring shown in Fig. 139 is an excellent tool. A represents a cutter head, which slides along, at a close working fit, upon the bar, D D, and is provided with the cutters, B B B, which are



fastened into slots provided in the head, A, by the keys shown. The bar, D D, has a thread cut upon part of its length, the remainder being plain, to fit the sliding head. One end is squared to receive a wrench, which, resting against the bed of the lathe, prevents the bar from revolving upon the lathe center, F F, by which the bar is held in the lathe. G G G are plain washers, provided to make up the distance between the thread and plain part of the bar, in cases where the sliding head, A, requires considerable lateral movement, there being more or fewer washers employed according to the distance along which the sliding head is required to move. The edges of these washers are chamfered off to prevent them from burring easily. To feed the cutters, the nut, H, is screwed up with a wrench.

The cutter head, A, is provided in its bore with two feathers, which slide in grooves provided in the bar, D D, thus preventing the head from revolving upon the bar. It is obvious that this bar will, in consequence of its rigidity, take out a much heavier cut than would be possible with any boring tool, and furthermore that, there being four cutters, they can be fed up four times as fast as would be possible with a single tool or cutter. Care must, however, be exercised to so set the cutters that they will all project true radially, so that the depth of cut taken by each will be equal, or practically so: otherwise the feeding cannot progress any faster than if one cutter only were employed. For use on bores of a standard size, the cutters may be made with a projecting feather, fitting into a groove provided in the head to receive it, as shown in Fig. 140, which shows the boring bar and head, the nuts and washers being removed. A A A A represent the cutters, B the bar, C C the sliding head, and D D D D the keys which fasten the cutters in the head. The cutters should be fitted to their places, and each marked to its place; so that, if the keyways should vary a little in their radius from the center of the bar, they will nevertheless be true when in use, if always placed in the slot in which they were turned up when made. By fitting in several sets of cutters and turning them up to standard sizes, correctness in the size of bore may be at all times insured, and the feeding may be performed very fast indeed.

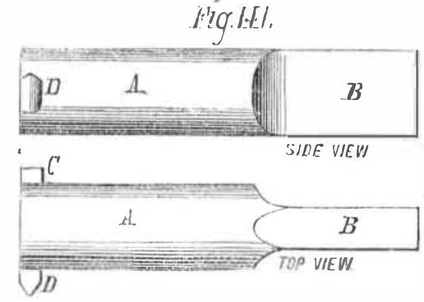
Fig. 140.



BORING TOOL HOLDERS.

For use on holes too small to admit of a bar having a sliding head, which are usually bored with a slide rest tool, a boring tool holder may be employed to great advantage. Such an appliance is shown in Fig. 141, A representing a round bar shaped at the end, B, to fit into the tool post of the slide rest, and having a groove across the diameter of the end, C D, to receive a short tool. The slot and tool may be either square or V-shaped, the tool being locked by a wedge. It is obvious that, instead of shaping the end, B, as shown, the bar may be held (if the slide rest head is provided with clamp instead of a tool post) by two diametrically opposite flat faces. For use in holes of from two to eight inches bore, such an appliance is invaluable, especially if the hole to be bored is of unusual depth; because the bar may be made very stout in proportion to the size of the hole, and will, therefore, stand a depth of cut and a rate of feed totally impracticable with an ordinary boring tool, and will not spring away towards the back end of the hole, as boring

Fig. 141.

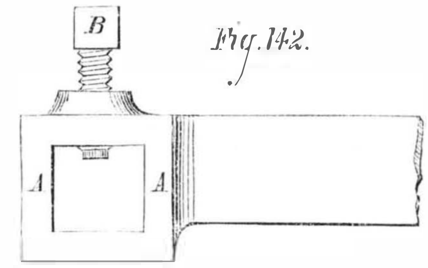


tools are apt to do. Furthermore, the cutting tools, being small, are easily forged, ground up, and renewed when worn out; and the bar maintains its original length, which may be made to suit the depth of hole required to be bored: while a boring tool becomes shorter each time it requires reforging.

The shape of the cutting tool may be as shown at D, Fig. 141, or such other as the nature of the duty may require. For truing out broad recesses in large work, the slot in the end, C D, may be made large enough to receive two tools, one to turn the inside and the other the outside of the recess.

For use upon holes of a large bore, or upon outside work, in which the tool requires to stand out far from the slide rest, the tool holder shown in Fig. 142 should be employed,

Fig. 142.



the tool box, A A, being long enough to receive two of the set screws, B.

The Value of Vivisection.

While the practice of vivisection cannot be defended when the torture is inflicted on lower animals, simply to exhibit truths already fully settled and demonstrated, its utility in original investigation cannot be contradicted. This is amply proved by the results to which it has lead. In summing up the benefits to practical medicine accruing from vivisection, in a speech recently delivered before the British Medical Association, the president of that body, Sir Robert Christison, noted among others the following:

By means of the most extended series of vivisection on record, Orfila placed toxicology on a scientific basis, and gave to the world a knowledge of the action of poisons which has been directly instrumental in saving thousands of lives. To experimentation on animals as to the nutritive value of non-nitrogenous substances, the goodly fellowship of anti-vivisectionists who have a tendency to gout or gravel owe the accurate dietetic treatment of their ailments. Sir Robert himself discovered through vivisections the mode in which oxalic acid poisons, and the means of counteracting its effects; determined the rapidity of action of prussic acid; ascertained by experiment, first upon himself and subsequently upon animals, the physiological and toxic effects of Calabar bean, now largely and usefully employed in medicine; in an important medico-legal case he established the guilt of the accused by proving upon animals the fatal action of laburnum bark, the substance administered, the effects of which had not previously been investigated.

To Sportsmen and Hunters.

The editor of the *Forest and Stream* announces the establishment of a most interesting exhibition at the Centennial Exposition, to be held in Philadelphia next year, where he intends to show a genuine camp in the forest, with a running stream—shelter tents, a veritable Indian birch wigwam, canoes, etc., etc. Every department will be complete, and genuine Indians and trappers have already been engaged to superintend each one. Anything that comes within the province of his interesting journal will be welcome to a place, whether old relics or new inventions, things useful or ornamental, boats, guns, rods, dog collars, camp utensils, life preservers, bear traps, snow shoes, lariats, wigwams, buckskin suits, wampum belts, portable stoves, Indian scalps, pelts and horns, jack lamps, moccasins, tents, rubber goods, stable furniture, rare birds and animals, fruits and plants, trolling tackle, bats and balls, billiard tables, aquariums, and cartridge belts.

RECENTLY, off Wicklow, Ireland, the British ironclad Iron Duke ran into and sunk the ironclad Vanguard. Cause, fog. Both ships were of 6,000 tuns burden, plated with 6-inch iron, and carried 14 guns each. No lives were lost.