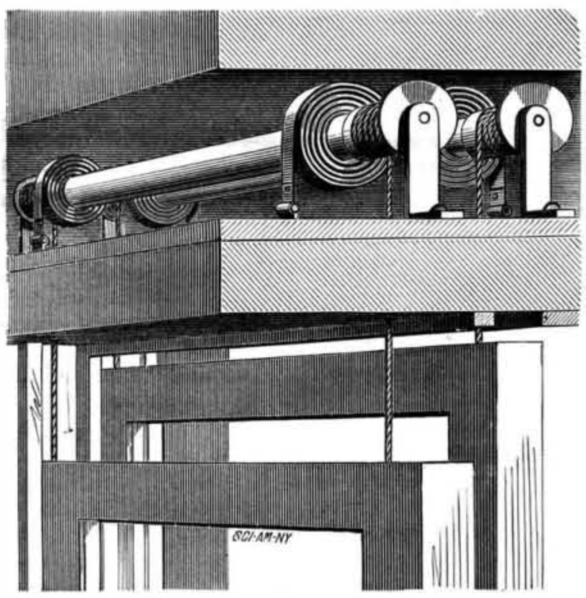
IMPROVED SASH BALANCE.

The novel sash balance shown in the engraving is the invention of Mr. George W. Arnold, of Knoxville, Ill. This device replaces weights and the ordinary springs, and provides a really mechanical device for balancing window sash. The invention consists of a miniature windlass provided with two coil springs, one near each end, the inner ends of the springs being fastened to the roller, and the outer ends secured to the top of the window frame. The bearings of the rollers are also secured to the top of the window frame, and cords extend from the ends of the rollers downward through holes in the window frame and are attached to the sash. The springs are put under sufficient tension to nearly



ARNOLD'S SASH BALANCE.

lift the sash. When the sash is raised the cords are wound upon the roller, and when the sash is lowered the unwinding of the cord winds the spring. All the parts of this sash balance are readily accessible for adjustment or repairs.

Men and Other Animals as Seed Carriers.

The "tick seed" (*Desmodium*) is a good example of a seed which the mother plant provides with means of clinging to almost any passing object. The pods of the "tick seed" are almost completely covered with small hooks, which catch hold of the clothing or the wool and hair of animals, and are carried away from the place where they were produced.

The genus *Bidens* of the sunflower family furnishes very familiar examples of seed distribution by animals. Each seed covering is provided with two stout prongs, which are barbed, with the points of the barb extending backward from the point. These prongs pass easily into clothing or the coverings of animals, but are not readily detached. These "pitch forks," as they are commonly called, have no other use for their barbed outgrowths than to aid in the distribution of the seed, and sheep, dogs, and other animals are employed in carrying the young Bidens from place to place. The burdock furnishes another fine illustration of a natural provision on the part of the mother plant for a distribution of her offspring by passing animals. The burr, containing many seeds, is surrounded by a multitude of sharp hooks, and by these the whole burr is closely fastened to man and beast. The reader will call to mind instances where cattle, sheep, dogs, and even horses have become partially covered with these closely clinging burrs. In this way the burdock seed may be carried from one State to another. Strange plants are frequently found near mills in which wool is carded and prepared for weaving. The wool comes in the fleece from various parts of the country, and perhaps from other countries, and the seeds clinging to the wool are separated, thrown out as refuse, and afterward, finding suitable ground, germinate and produce plants new to the locality. The smaller animals, and those not domesticated, as the rats and mice, act their part in this grand scheme for the spreading of the seeds of plants. Cotton is perhaps the most familiar vegetable product which is produced as a means of seed distribution. The human family is greatly blessed by this provision on the part of the cotton plant. Each cotton seed is completely inclosed in a tuft of fine hairs, by means of which the seed is easily and quite securely fastened to a person's clothing or to the coverings of animals.

The fowls of the air are active seed bearers, especially those of small berries or pulpy fruits with small and hard seeds. The indigestible covering preserves the seed, while the exterior soft parts with their usual high color insure their being eaten. In this way the seeds of the blackberry, raspberry, currant, cherry, and a host of wild berry bearing plants have their seeds carried far and wide.

The Sparrow Nuisance.

The English sparrow, which has become so prevalent throughout the country, has demonstrated itself to be a first-class nuisance, fighting and squawking continually among themselves, and driving robins and other domestic birds from their usual haunts. How to get rid of the ubiquitous sparrow is now the question. In Germany and England the sparrow is a game bird, and is much sought after for pies, which are highly prized. By all means, says one of our contemporaries, put him on the list of game birds in this country, and make the season from January 1 to December 31. In addition to this it would be well, suggests the same authority, to offer rewards for methods of popularizing the sparrow as an article of diet.

Steam Whistles.

A correspondent of the *Railroad Gazette* recommends a steam horn instead of a steam whistle. He says that "as a general rule the steam whistle must be very powerful to be effective within half a mile. Now, if instead of a whistle a horn were to be used, the gain in useful effect would be great, while the disagreeableness of tone would be much, if not entirely, reduced. The form of such a horn with a mouthpiece or forcing tube would be extremely simple, of inconsiderable expense (less than that of the ordinary whistle), and instead of the screeching sound of the latter, it would yield the mellower tone of the modern tuba or cornet-a-piston, to which we suppose most persons will not object." There seems to be a good opportunity here for some ingenious person to exercise his inventive talents.

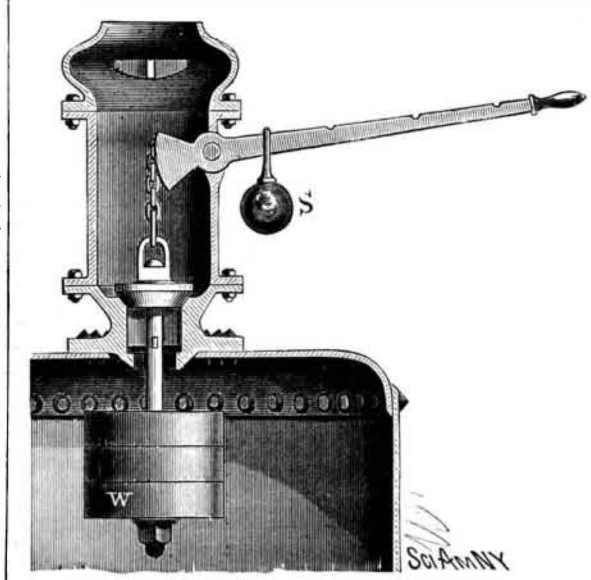
NEW SPANISH WAR STEAMERS.

Our engraving, from *La Ilustracion*, of Madrid, represents one of four new gun boats, all alike, and now in progress of construction in Spain. Their names are the General Concha, the Mgallánes, the Elcano, the General Lezo. The General Concha was launched last September, and is represented in our picture. These ships have a length of about 160 feet, beam 25 feet, displacement 524 tons, 600 horse power. Ordinary armament, three Hontoria guns; and on special occasions they will carry a large gun at the bow.

IMPROVED SAFETY VALVE.

The safety valve represented in the annexed engraving combines in one device both the lock form of valve and the open or adjustable one, with the advantage that, being the valve in ordinary use, it is not so liable to stick as is the ordinary lock valve, which operates only under excessive pressure, and in some cases fails to act altogether.

This improved valve employs a lever of a different order than the one ordinarily used, and there is a slack connection between the lever and the valve. The fulcrum of the lever is intermediate between the power applied and the weight to be raised, and the valve is inclosed within a lock-box or case, as also is its slotted rod or chain connection with the short arm of the lever. The valve itself is loaded, either



GREGORY'S SAFETY VALVE.

above or below, with a maximum weight, W, that corresponds to the extreme pressure the boiler should carry. Arranged upon the longer arm of the lever, which is exposed for control of the engineer, is an adjustable weight, S, for regulating the valve to blow off at any less pressure than the maximum one. Any extra weight put upon this arm of the lever eases the lift of the valve, which accordingly cannot be overloaded, and any propping up of the lever simply operates to slacken the connection between the lever and the valve, that is left free to act under its maximum load, W. This valve has never been patented, but was invented, as we are informed, by Mr. A. Gregory, of Newark, N. J., over thirty years ago, who has shown us a drawing made at that time which exhibits several modifications of the invention.

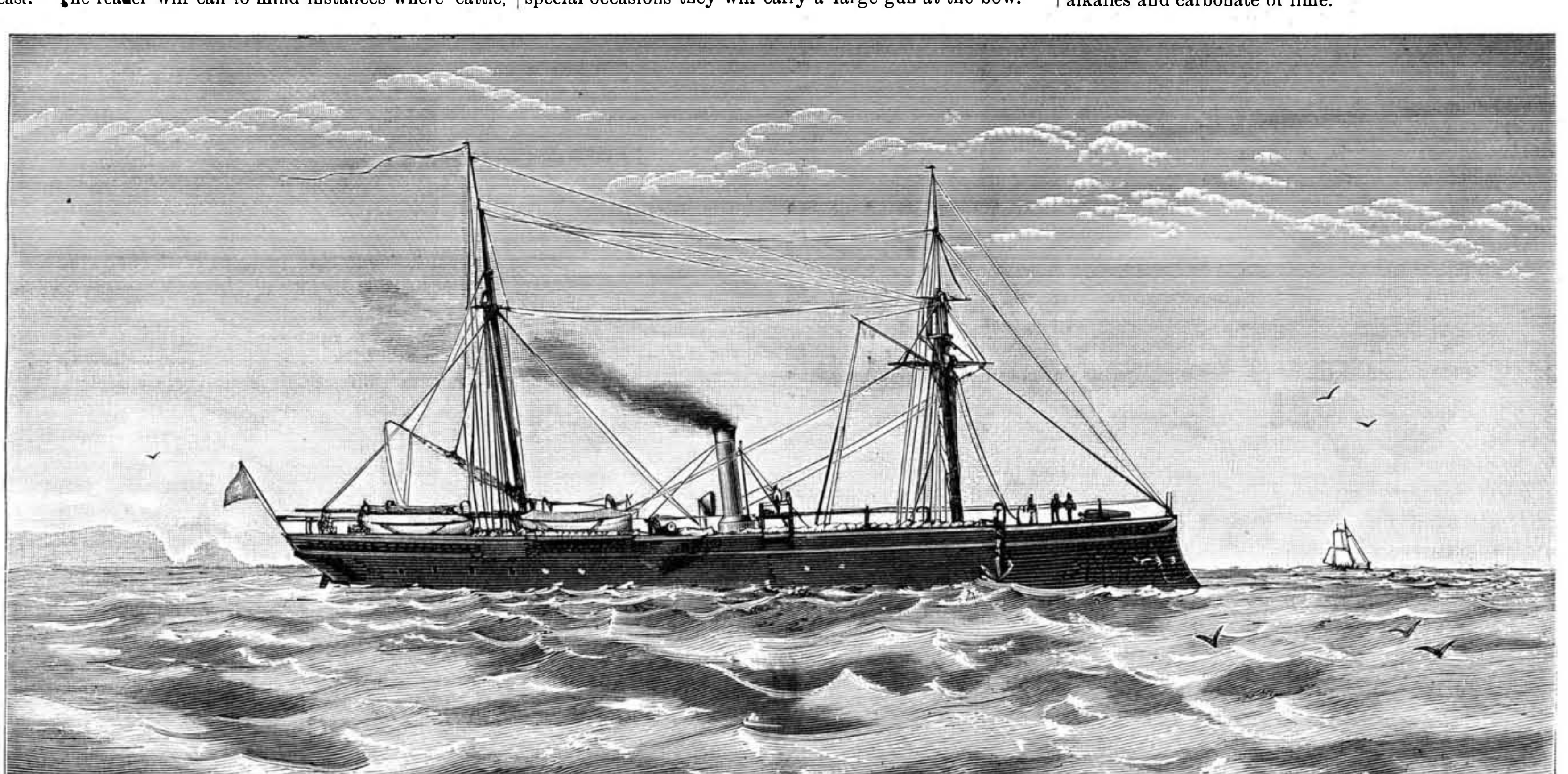
Steel for Cutting Tools.

C. Reichel, of Berlin, gives the results of many years of observation on the preparation of steel for tools in the *Zeitschrift für Instrumentenkunde:*

First, the steel must only be heated to dark red, which is the temperature at which a film of soot burns off.

Secondly, the heated article must be carefully protected from oxidation, hence a flame rich in carbon must be used, and the immersion be done as quickly as possible, so as not to keep it long in the air.

Thirdly, water used for hardening must be free from alkalies and carbonate of lime.



THE NEW GUN BOAT GENERAL CONCHA, OF THE SPANISH NAVY.

Petroleum as Fuel.

Since the discovery of the oil springs in America, various efforts have from time to time been made to introduce petroleum as a fuel for steam boilers and general heating purposes; but notwithstanding that the subject has been taken in hand by both British and foreign governments, as well as by private individuals of considerable influence and ability, it is a fact that not only has no practical progress been made in the use of liquid fuel, but that in those cases where it has been tried and experiments carried out with the best results as regards evaporative efficiency, the installation has been abandoned, and a return made to our old and much abused friend coal. The reason for this is not far to seek, and consists in the fact that the cost of evaporating a given quantity of water by means of heat produced by the combustion of petroleum so far exceeds that when coal is used, as to much counterbalance any advantages that may be gained; always excepting those few countries where from scarcity of coal and wood, and abundance of petroleum, the latter fuel is found to be the cheapest.

One of the earliest investigators into the merits of liquid fuel was Sainte-Claire Deville, who carried out a series of very extensive experiments with a couple of locomotives on the Paris and Strasbourg Railway, which were specially fitted up under his direction with appliances for burning the oil. The results of these experiments were published in the *Journal* of the French Academy of Sciences for 1868 and 1869; the average evaporation being given as about 11 pounds of water per pound of fuel. In the United States, commissioners were appointed to specially consider the value of petroleum as fuel on board steamers, a sum of $5,000 being appropriated for making the necessary tests; but after long and careful trials, the Secretary of the Navy finally reported against its use, on the grounds that convenience, comfort, health, and safety were against it, the only advantage shown being a not very important reduction in bulk and weight of fuel carried. As far as our own country is concerned, the whole subject was brought before the Institution of Civil Engineers in 1878 by Mr. Harrison Aydon, in a comprehensive paper dealing with the matter historically, and in which the results of a great number of experiments made with different forms of boilers under various conditions, and with several kinds of burners, were given. In this paper the use of liquid fuel was strongly advocated, and it was shown that with burners on Mr. Aydon's system, in which superheated steam was used for evaporating the oil previous to combustion, and in which a jet of steam was associated with the burning fuel, perfect combustion without smoke was obtained, with an evaporation almost identical with the full calorific power of the oil. Other burners, on somewhat different plans, but all employing the use of steam in combustion, gave almost similar and equally satisfactory results. In view of this it is somewhat surprising to read in a pamphlet recently published in order to puff up the value of "water gas," produced by the process of Dr. C. Holland, to which our attention has been directed, that "how to use petroleum or mineral oil in a direct manner as fuel with good economy and effect has never been discovered." Further, "that if such a direct way to burn petroleum had been discovered, we should have been much later in learning, if at all, how to make the most effective and economical fuel ever known, by using petroleum as a resolvent of water, and thus reproducing the enormous heat which the constituents of water—oxygen and hydrogen—create in reuniting. The effective power of the combustion of oxygen with hydrogen has been shown by the experiments of various standard authorities to be 50 per cent greater than that of the combustion of the same quantity of oxygen with the equivalent of carbon required for its separation from the hydrogen of the water." This, as is afterward stated, has been learnt and applied by Dr. C. Holland, whose process is thus described: "Not a particle of oil or of oil vapor is burned in this process after its operation is fairly started. The oil is entirely combined with the oxygen of the water—steam—within the retorts, without a single atom of atmospheric oxygen. The constant temperature of the fire chamber keeps the retorts hot enough for the disengagement of the oxygen of the steam in the presence of the carbon of the oil. The chemical affinity of these two elements at such temperature causes them to unite, and so releases the hydrogen of the steam, which issues at the burners in the most powerful combustion, producing, instead of smoke, only the purest aqueous vapor."

These modest statements practically amount to a claim for producing perpetual motion; for it is proposed to acquire heat energy by continually separating water into its constituents, oxygen and hydrogen, and by again combining these two gases, their separation, it is alleged, absorbing less heat than is given out in their combination, so that there is a surplus which may be utilized for raising steam or for any other purpose. The absurdity of such a claim will, of course, be apparent to any engineer who gives the matter a moment's serious consideration; but as there are doubtless many to whom the whole subject is strange, we propose to briefly consider the circumstances attending the combustion of mineral oil, and to make a concise comparison between its calorific power and other properties and those of coal.

A pound of petroleum may be taken as consisting of 0·85 pound of carbon and 0·15 pound of hydrogen, which, if burnt direct to carbonic anhydride and water with the exact equivalent of atmospheric air, would produce 22,700 heat units, with an elevation of temperature of 5,484° Fah., always supposing that combination could take place at this temperature, which is doubtful. This supposes a thermal value of 17,000 units per pound of carbon, and 55,000 units per pound of hydrogen, the former being somewhat higher than is generally allowed for carbon in the solid state, and the latter a little lower than is taken for gaseous hydrogen. Assuming now that instead of being burnt directly with air, the petroleum is first heated in a chamber in contact with steam, to such a degree that partial combustion takes place, the oxygen of the steam combining with the carbon of the oil to form carbonic oxide, while the hydrogen of the steam, as well as of the oil, is set free. In this case the 0·85 pound of carbon will combine with 1·13 pounds of oxygen from 1·27 pounds of steam, giving out 5,950 heat units, and setting free the 0·15 pound of hydrogen in the oil as well as 0·14 pound with which the oxygen was associated in the form of steam. The separation of this steam into its constituent gases is only effected by the expenditure of heat, as much heat being absorbed as is given out in its formation, so that to supply the 1·13 pounds of oxygen, 8,680 units must be communicated from the outside. After this partial combustion there remains 1·98 pounds of carbonic oxide and 0·29 pound of hydrogen, which on issuing from the retorts through suitable nozzles and meeting a proper supply of air would be burnt to carbonic anhydride and water, producing 25,430 heat units. Adding to this the 5,950 units from the formation of carbonic oxide, and deducting the 8,680 units required for the dissociation of the 1·28 pounds of steam, there is left a net total of 22,700 units as the result of the complete combustion of 1 pound of petroleum, which is precisely the same value as was found in the case of direct combustion with air. It will thus be seen that no advantage as regards increase in heating power is obtained by the use of steam. In practice, however, there seems to be an advantage of another kind, inasmuch as the steam is found to promote the combustion by bringing about a proper intermixture of combining particles, so preventing the formation of the smoke which nearly always accompanies combustion with air alone, and which is the cause of considerable loss from waste of carbon and reduction in the efficiency of the heating surfaces. Steam also promotes the draught, and so permits of a lower temperature of escaping products than when the draught is entirely dependent on the chimney. Taking this temperature at 300° Fah., and assuming the temperature before combustion at 60° Fah., each pound of petroleum will give 21,460 available units of heat, which is equivalent to an evaporation of 22·21 pounds of water from and at 212° Fah.

Turning now to coal—which we may take as being composed of 83 per cent of carbon and 5 per cent of hydrogen, the remainder being chiefly ash, with a little oxygen and nitrogen—and taking thermal values of 14,500 and 50,000 units respectively for 1 pound of solid carbon and hydrogen in the condition in which it exists in coal, we find that the combustion of 1 pound to carbonic anhydride and water will give 14,535 units, while if only the exact proportion of air be admitted, the rise in temperature would be 4,845° Fah. Allowing an initial temperature of 60° Fah., and a temperature of 500° Fah., for the escaping products, this represents an evaporation of 13·5 pounds of water from and at 212° Fah. The evaporative efficiency of 1 pound of coal to 1 pound of petroleum is, therefore, as 1 to 1·64 under the conditions taken; but as with petroleum the admission of air to the combustion chamber can be controlled with much greater exactness than with coal, there is less loss from the cooling effect produced by more air entering than is really necessary to support combustion, and allowing for this, we are disposed to place the possible actual efficiencies as 1 to 2. With this as a basis it is easy to arrive at the relative cost of the two fuels. Taking coal at 15s. a ton, the value of 100 pounds weight will be $8\frac{1}{28}$ pence. Crude petroleum is at present worth 6d. a gallon, but is not fit to be used as a fuel without distillation. We will, however, take it at 6d., and as the specific gravity is 0·800, water being 1·0, 100 pounds weight will occupy 12½ gallons, and will cost 75 pence. The relative costs of coal and petroleum, weight for weight, are, therefore, as 1 to 9·3; but as we have admitted the evaporation efficiencies to be as 1 to 2, it makes the actual cost of evaporating a given quantity of water with petroleum to be 4·63 times as much as it is with coal.

One of the chief advantages alleged in favor of petroleum is that it would occupy much less space than coal, and that ships could therefore take away a much greater supply of fuel than at present, which would enable them to remain longer at sea, and obviate the necessity for coaling depots. This advantage has been very much overrated, for with petroleum of specific gravity 0·8 equal spaces would be occupied by equal weights of coal and oil. This allows 50 pounds weight to the cubic foot, which is about correct for north country semibituminous coal when heaped, Welsh and Scotch being heavier, and therefore making the comparison less favorable to petroleum. It would appear, then, that taking into account the calorific power of the two fuels, a given amount of storage room would be just twice as efficient if petroleum was used as in the case of coal. In addition to this there must be reckoned the reduction in the number of stokers, which is no doubt a very important feature, especially at sea. Against this, however, the highly inflammable nature of the oil must always be considered a source of great danger, as well as the difficulty in storing it in vessels sufficiently away from atmospheric action. There is also the difficulty which may arise from the clogging up of the apparatus, and its destruction from the intense heat. The high furnace temperature is also exceedingly apt to produce priming, though this could be guarded against to some extent; but we believe it is entirely owing to excessive priming that such absurd reports have been made as to the evaporative power of petroleum, some experimenters having recorded as much as 35 pounds of water per pound of fuel, whereas we have seen that 22·21 pounds is the maximum amount attainable, even when only the exact supply of air required for combustion is admitted.

That petroleum can under some circumstances become an efficient and economical fuel is a proposition we are not disposed to dispute; for instance, in Russia, where, from the scarcity of wood and other fuel, mineral oil has been very advantageously used. What we do contend is, that excepting under such special conditions as are not likely to obtain in England and other principal countries in Europe, or even in the United States, which is comparatively close to the oil wells, petroleum is a much more expensive fuel than coal. It is well for us also to state again, that there is no difficulty in burning mineral oils, notwithstanding what may be said to the contrary by anxious inventors. It is too late in the day to claim any very special advantage in the use of superheated steam. This has been done over and over again, and though we do not pretend that one form of burner may not give somewhat better results than another, there is certainly little prospect of any startling discovery being made which is at all likely to enable petroleum to compete commercially with coal as a general fuel for raising steam. What is really wanted is a reduction in the price of the oil, but we think that not even the prospective new sources of supply, when made available, will effect much in this direction.—*The Engineer.*

Variation in Oils of the Same Density.

In the study of mineral oils it is customary to classify them, in part, according to their specific gravity, yet it must have occurred to every one that two oils which have the same density are not necessarily identical. The various oils are prepared by distillation, and none of them are simple compounds of definite composition, but each is a mixture of, we know not how many, different oils. As the distillation proceeds the gravity increases, and as dangerous oils are succeeded by safe oils, so illuminating oils are followed by lubricating oils, with no well marked boundary or separating line between them.

R. Krause has introduced a new factor into the problem of testing and distinguishing oils, viz., their viscosity or consistency. He finds that oils which have the same specific gravity at the same temperature may differ widely in viscosity. The author determined the time required by the same quantity of the different oils to flow out of fine tubes, and compared this time with that required for the same quantity of rape seed oil to flow from the same tube.

The experiments were made upon four samples of oil, each having the specific gravity of 0·883 at 60° Fah., but from four different places, viz., Sachs-Thuringen, Oelheim, Scotland, and Pennsylvania. The first named is obtained by distilling a light brown, friable, bituminous brown coal; the Scotch oil, by the distillation of a bituminous shale; while the oil from Oelheim, like that from this country, is obtained by the distillation of crude petroleum. The method of preparing each of these is well known.

The time required for 25 c. c. of each oil to flow from the viscosimeter, at 60° Fahr., was as follows:

Sachs-Thuringen paraffine oil	2 m.	50 sec.
Oil from Oelheim petroleum	5 "	55 "
" " American petroleum	9 "	10 "
" " Scotch shale	9 "	45 "
Rape seed oil	32 "	25 "

From this we see that the German oil is twice as thick, and Scotch oil more than three times as thick and viscid as the paraffine oil of Saxony.

If we take rape seed oil (specific gravity 0·912) as unit, the viscosity of the mineral oils will be represented by the following decimal fractions:

Sachs-Thuringen paraffine oil	0·088
Oelheim petroleum	0·189
American petroleum	0·282
Scotch paraffine oil	0·301

That a mineral oil should be equal to rape seed oil as a lubricant it should have a specific gravity of 0·910 and a viscosity equal to 1; *i. e.*, it should require as long for 25 c. c. of this oil to flow from the viscosimeter* as for the same quantity of rape seed oil.

The greatest viscosity observed in any oil was 2·45, in a thick mineral oil from Russia, having a specific gravity of 0·910. This oil is superior as a lubricator to cotton seed and rape seed oil for nearly all purposes.—*Chem. Zeitung.*

Aurora Photo Plates.

Photographic plates are now so sensitive that the flash of the lightning's stroke may be caught, the flight of the cannon ball, the spokes of the rushing locomotive wheel, the feet of the fleetest horse, and even the dim gleams of the nebulæ. But there is one subject, it seems, that is too fine for the most sensitive of the best plates—the aurora borealis. Dr. Tromholt, the famous Norwegian philosopher, who makes it his special study, has made many attempts to obtain a negative of the aurora, but without success. An exposure of seven minutes on the most sensitive dry plates gives him no trace of an impression. It will never do for the photographer to be beaten in this shabby manner. Plates more sensitive than the aurora are now wanted, and we doubt not will soon be forthcoming.

* For description of the viscosimeter, see *Dingler's Journal*, ccxix., 163.