Measures of Length.

Metric denominations and values.		Equivalents in denominations in use.
Myriameter.........	10,000 meters.	6·2137 miles.
Kilometer......	1,000 meters.	0·62137 miles, or 3280 feet 10 inches.
Hectometer...	100 meters.	328 feet 1 inch.
Dekameter..	10 meters.	393·7 inches.
Meter........	1 meter.	39·37 inches.
Decimeter......	$\frac{1}{10}$ of a meter.	3·937 inches.
Centimeter..........	$\frac{1}{100}$ of a meter.	0·3937 inch.
Millimeter..........	$\frac{1}{1000}$ of a meter.	0·0394 inch.

Weights.

METRIC DENOMINATIONS AND VALUES.			EQUIVALENTS IN DENOMINATIONS IN USE.
Names.	Number of grams.	Weight of what quantity of water at maximum density.	Avoirdupois wt.
Millier, or tonneau.	1,000,000	1 cubic meter..............	2204·6 pounds.
Quintal................	100,000	1 hectoliter................	220·46 pounds.
Myriagram...........	10,000	10 liters........................	22·046 pounds.
Kilogram, or kilo...	1,000	1 liter	2·2046 pounds.
Hectogram	100	1 deciliter....................	3·5274 ounces.
Dekagram............	10	10 cubic centimeters	0·3527 ounce.
Gram	1	1 cubic centimeter.	15·432 grains.
Decigram..............	$\frac{1}{10}$	$\frac{1}{10}$ of a cubic centimeter..	1·5432 grains.
Centigram	$\frac{1}{100}$	10 cubic millimeters.......	0·1543 grain.
Milligram.............	$\frac{1}{1000}$	1 cubic millimeter........	0·0154 grain.

Recent Progress in the History of proposed Substitutes for Gunpowder. By Prof. F. A. Abel, F.R.S., V. P. C. S., Chemist to the War Department.

From the London Chemical News, No. 344.

The changes which have been effected in the composition of gunpowder, since its first application as a propelling agent, have been limited to small variations in the proportions of its constituents. But the modifications which have from time to time been introduced into the details of manufacture, *e.g.*, the preparation of the ingredients, their incorporation, and the conversion of the mixture into compact masses (grains, &c.) of different size and density, have been sufficiently important and successful to secure the fulfillment by gunpowder, in a more or less efficient manner, of the very various requirements of military science and of different branches of industry.

The characteristics of gunpowder, as an explosive material of permanent character, the action of which is susceptible of great modification, are mainly ascribable to the peculiar properties of the oxidizing agent—saltpetre. Frequent attempts have been made to replace this constituent of gunpowder by other nitrates, (such as those of sodium, lead, and barium;) but, although materials suitable for blasting operations have been thus prepared, (such as soda-gunpowder, and barytic powder, or *poudre saxifragine*,) all mixutres of this class hitherto produced have exhibited important defects, when compared with gunpowder manufactured for propelling purposes.

The well-known oxidizing agent, chlorate of potash, which differs from saltpetre only in containing chlorine in the place of nitrogen, is far more energetic in its action upon oxidizable bodies than any of the nitrates. Thus, a mixture of chlorate of potash with charcoal alone deflagrates as violently as gunpowder, and is far more readily inflamed by percussion than the latter; while a mixture analogous to gunpowder, containing chlorate of potash in place of saltpetre, detonates violently when struck with moderate force, and acts far too destructively, on account of the rapidity of its explosion, to admit of its safe employment in fire-arms.

Many years ago, a mixture known as German, or white, gunpowder, and consisting of chlorate of potash, ferrocyanide of potassium, and sugar, was proposed and tried without success as a substitute for gunpowder; and since then many preparations of a similar character have been suggested for employment either as blasting and mining agents, or for use in shells, or even for all the purposes to which gunpowder is applied. The most promising of these, claimed as discoveries by Mr. Horsely and Dr. Ehrhardt, are mixtures of chlorate of potash with substances of permanent character and readily obtained, containing both carbon and hydrogen, such as tannic and gallic acids, and some kinds of resins. These mixtures are much less violently detonating than most of the explosive mixtures containing chlorate of potash, while, if well prepared, they are decidedly more powerful as explosives than gunpowder. For blasting purposes some of these mixtures probably possess decided advantages over ordinary blasting powder, and possibly they may also be susceptible of employment for sporting purposes; but they are not applicable to fire-arms used for war purposes, because, in order to ensure the requisite uniformity of action, the ingredients must be submitted to proper processes of incorporation, &c., such as are applied to the manufacture of gunpowder; and this treatment would render the mixtures far more violent, and consequently destructive, in their action upon fire-arms, than if used in the form of crude mixtures.

A comparatively very safe application of chlorate of potash to the production of a substitute for gunpowder was made about six years ago by a German chemical manufacturer, M. Hochstädter. Unsized (blotting) paper was thoroughly soaked in, and coated with, a thin paste consisting of chlorate of potash, finely divided charcoal, a small quantity of sulphide of antimony, and a little starch, gum, or some similar binding material, water being used as the solvent and mixing agent. The paper was rolled up very compactly and dried in that form.

In this manner, very firm rolls of an explosive material are obtained, which burns with considerable violence in open air, and the propelling effect of which, in small arms, has occasionally been found greater than that of a corresponding charge of rifle powder. Moreover, the material, if submitted in small portions to violent percussion, exhibits but little tendency to detonation. But as no reliance can be placed on a sufficient uniformity of action, in a fire-arm, of these explosive rolls, this alone sufficed to prevent their competing with powder. The same description of explosive preparation, differing only from that of M. Hochstädter in a trifling modification of its composition, which is certainly not likely to lead to its greater success, has recently been brought forward in this country by M. Reichen and Mr. Melland.

One or two other much cruder explosive preparations, containing chlorate of potash, alone or in conjunction with saltpetre, have met with some application to blasting purposes. One of these consisted of spent tan, in small fragments, which was saturated with the oxidizing agent, and afterwards dusted over with sulphur. When flame or a red-hot iron is applied to this preparation, it deflagrates very slowly and imperfectly; but when employed in blast holes, where it is confined within a small space, it develops sufficient explosive force to do good work. In addition to comparative cheapness, the great advantage of safety was claimed for this material by its inventor, a claim which was substantiated by the partial destruction by fire, on two occasions, of a manufactory of the substance near Plymouth, without the occurrence of an explosion.

The accidental explosions of gunpowder which are occasionally heard of, occur, in most instances, at the manufactories, and in the course of some operation (especially that of incorporation) to which the explosive mixture is submitted. The only means of guarding against, or reducing as much as possible, the liability to the occurrence of these accidents, consist in the strictest attention to the precautionary measures and regulations, which experience has proved to be essential to safety, and which, in spite of the strictest supervision, are unquestionably sometimes overlooked or imperfectly carried out by workmen. Explosions of gunpowder, generally of a serious character, do occur, however, though very rarely, during the transport of the material, or in magazines where it is stored. The great explosion of a gunpowder magazine at Erith in September, 1864, specially directed the attention of government and the public generally to the necessity of adopting measures for reducing, as much as possible, the risk of occurrences of such disastrous accidents. Hence, much interest has recently been excited by a well-known method of rendering gunpowder less dangerous in its character, which has been brought prominently before the public by Mr. Gale, and which consists of diluting powder, or separating its grains from each other, by means of a finely powdered non-explosive substance. Attempts have several times been made in past years to apply to practical purposes the obvious fact, of which nobody acquainted with the nature of gunpowder could be ignorant, that, by interposing between the grains of powder a sufficient quantity of a finely divided material, which offers great resistance to the transmission of heat, the ignition of separate grains of the entire mass may be accomplished without risk of inflaming contiguous grains. In 1835, Piobert made a series of experiments with the view to apply this fact practically to reduce the explosiveness of gunpowder, and similar experiments of an extensive character were carried on by a Russian chemist, Fadéiff, between 1841 and 1844. These experimenters found that the object in view might be attained by diluting gunpowder with any one of its components; they also employed very fine sand, (a substance closely allied in its physical characters to the powdered glass which Mr. Gale now proposes to use;) but the preference appears to have been given to a particular form of carbon. It was not attempted altogether to prevent the burning of a mass of gunpowder when a spark or flame reached any portion, but to reduce the rapidity of combustion so greatly as to prevent the occurrence of a violent explosion. No more than this is accomplished by the employment of powdered glass in the proportions directed by Mr. Gale. Indeed, as the quantity of diluent required to give to different kinds of gunpowder the character of equally slow burning materials, increases with the explosiveness of the particular powder and with the size of its grain, the proportion of powdered glass with which the gunpowder employed in rifled cannon would have to be mixed to render it only slow burning, would be about double the quantity required for almost altogether preventing the ignition of fine grain powder, or of the comparatively weak blasting powder with which Mr. Gale's public experiments appear generally to have been instituted. Although a sufficient dilution of gunpowder may secure such comparative safety to the neighborhoods of large magazines, or to the crews of merchant vessels in which gunpowder (for blasting purposes, &c.) is transported, as to compensate fully for the inconvenience attending the great increase of volume of the powder, there is no doubt that such a treatment of gunpowder actually issued for military and naval service would be attended by more than one serious obstacle—such as the tendency of the powder, unless very largely diluted, to separate from the glass, during transport by land or sea, to so considerable an extent as very greatly to diminish the degree of security originally aimed at; the very great addition which would have to be made to the arrangements for carrying the necessary ammunition in active service; the necessity for introducing, in the field or on board ship, the operations of separating the powder from the glass and transferring it to cartridges and shells, (which, whatever sifting and other arrangements were adopted, would be time-taking and very dangerous,) instead of preserving the ammunition ready for immediate use; and, above all, the incalculable mischief which would inevitably result from the establishment, in the minds of the soldier and sailor, of an erroneous feeling of security in dealing with gunpowder, which, however harmless it may for a time be rendered, must finally be handled by the men in its explosive form. The extremely rare occurrence of accidents with gunpowder, on board ship or in active land service, is mainly due to the strictest enforcement of precautionary regulations, some of which may appear at first sight exaggerated or almost absurd, but which combine to maintain a consciousness of danger and a consequent vigilance indispensable to safety.

One of the most remarkable materials recently employed to replace gunpowder as a destructive agent is nitro-glycerine. This substance was discovered by Sobrero in 1847, and is produced by adding glycerine in successive small quantities to a mixture of one volume of nitric acid of sp. gr. 1·43, and two volumes of sulphuric acid of sp. gr. 1·83. The acid is cooled artificially during the addition of glycerine, and the mixture is afterwards poured into water, when an amber-colored, oily fluid separates, which is insoluble in water, and possesses no odor, but has a sweet, pungent flavor, and is very poisonous, a minute quantity placed upon the tongue producing violent headache which lasts for several hours.

The liquid has a sp. gr. of 1·6, and solidifies at about 5° C., (40° Fahr.) If flame is applied, nitro-glycerine simply burns, and if placed upon paper or metal, and held over a source of heat, it explodes feebly after a short time, burning with a smoky flame. If paper moistened with it be sharply struck, a somewhat violent detonation is produced. Alfred Noble, a Swedish engineer, was the first to attempt the application of nitro-glycerine as an explosive agent, in 1864.

Some experiments were, in the first instance, made with gunpowder, the grains of which had been saturated with nitro-glycerine. This powder burnt much as usual, but with a brighter flame in open air. When confined in shells or blast holes, greater effects were, however, produced with it than with ordinary gunpowder; its destructive action is described as having been from three to six times greater than that of powder. The liquid could not be employed as a blasting agent in the ordinary manner, as the application of flame to it from a common fuze would not cause it to explode. But Mr. Noble has succeeded, by employing a special description of fuze, in applying the liquid alone as a very powerful destructive agent. The charge of nitro-glycerine having been introduced, in a suitable case, into the blast hole, a fuze, to the extremity of which is attached a small quantity of gunpowder, is fixed immediately over the liquid. The concussion produced by the exploding powder upon the ignition of the fuze effects the explosion of the nitro-glycerine.

The destructive action of this material is estimated, by those who have made experiments in Sweden and Germany, as about ten times that of an equal weight of gunpowder. Therefore, although its cost is about seven times that of blasting powder, its use is stated to be attended with great economy, more especially in hard rocks, a considerable saving being effected by its means in the labor of the miners, and in the time occupied in performing a given amount of work, as much fewer and smaller blast holes are required than when gunpowder is employed. The material appears to have recently received considerable application in some parts of Germany and in Sweden; but in England its employment has been confined to one set of experiments instituted in Cornwall last summer, upon which occasion a wrought iron block, weighing about three hundred-weight, was rent into fragments by the explosion of a charge of less than one ounce of nitro-glycerine placed in a central cavity.

Nitro-glycerine appears, therefore, to possess very important advantages over gunpowder as a blasting and destructive agent, but the attempts to introduce it as a substitute for gunpowder have already been attended by most disastrous results, ascribable in part to some of its properties and the evident instability of the commercial product, but principally to the thoughtlessness of those interested in its application, who appear to have been induced, either by undue confidence in its permanence and comparative safety, or from less excusable motives, to leave the masters of ships or others who had to deal with the transport of the material, in ignorance of its dangerous character.

The precise causes of the fearful explosions of nitro-glycerine which occurred at Aspinwall and San Francisco will, in all probability, never be ascertained; but they are likely to have been due, at any rate, indirectly to the spontaneous decomposition of the substance, induced or accelerated by the elevated temperature of the atmosphere in those parts of the ship where it was stored. Instances are on record in which the violent rupture of closed vessels containing commercial nitro-glycerine has been occasioned by the accumulation of gases generated by its gradual decomposition; and it is, at any rate, not improbable that a similar result, favored by the warmth of the atmosphere, and eventually determined by some accidental agitation of the contents of the package of nitro-glycerine, was the cause of those lamentable accidents. The great difficulties attending the purification of nitro-glycerine upon a practical scale, and the uncertainty, as regards stability, of the material even when purified, (leaving out of consideration its very poisonous character and its extreme sensitiveness to explosion by percussion when in the solid form,) appear to present insurmountable obstacles to its safe application as a substitute for gunpowder.

(To be continued.)

FRANKLIN INSTITUTE.

Proceedings of the Stated Monthly Meeting, September 19th, 1866.

The meeting was called to order with the Vice-President, Prof. Fairman Rogers, in the chair.

The minutes of the last meeting were read and approved.

The Board of Managers presented their minutes and reported the following donations to the Library:

From the Royal Astronomical Society, the Royal Geographical Society, the Society of Arts, the Chemical Society, the Statistical Society, and the Institute of Actuaries, London, England; Thomas Oldham, Superintendent of the Geological Survey of India, Calcutta, India; la Sociétié d'Encouragement pour l'Industrié Nationale, l'Ecoles des Mines,