THE SILVERTOWN DYNAMO.

THE dynamo which we illustrate is of special interest as having been built to satisfy the Admiralty requirements with regard to heating. The machine is of the ordinary Gramme type, with inverted single horseshoe magnet, and, by the courtesy of the manufacturers, the India Rubber, Gutta Percha and Telegraph Works Company, Limited, we are able to give herewith some of its leading details. The machine shown in our illustration is intended for belt driving, but it will be easily understood that, by replacing the pulley by a coupling, and prolonging the bed plate, this machine can be directly coupled to a Willans engine, and it is this combination which has been supplied to the Admiralty. The armature core consists of naked iron wire thirty-one milles diameter, supported on a metal spider. The core is wound on a special lathe, in which the wire is guided by an adjustable feed motion, so that the different convolutions are placed close together with perfect regularity. During the process of winding, the intervening spaces between the arms of the spider are filled up with quadrant-shaped blocks, in order that the core may be perfectly circular. The armature conductor is wound by hand, and consists of 160 turns of 19 strand No. 16 cable, which is shaped on the outside into a rectangular or rather trapezoidal section, so as to completely fill the available space. The commutator has eighty sections, and the resistance of the armature when cold is 0·018 ohm. The magnets are of soft, annealed wrought iron, 100 sq. in. in section, and the bore of the pole pieces is $16\frac{9}{16}$ in. in the middle and $16\frac{5}{8}$ in. at the corners. The shunt winding is placed nearest the core, and consists of twenty layers 83 milles wire, each layer containing 74 turns. The total number of turns of shunt wire on both limbs is 2,960, and the resistance cold is 18·6 ohms, and after six hours' run 20·7 ohms. The exciting power of the shunt winding is 11,400 ampere turns. The series winding consists of copper strip $\frac{3}{4}$ in. by $\frac{1}{4}$ in. wide, there being fourteen turns on each limb. The resistance of the series coils is 0·006 ohm, and the exciting power of 5,712 ampere turns. This gives a total exciting power of 17,112 ampere turns. The machine is intended for an output of 200 amperes at 80 volts terminal pressure when running at 460 revolutions per minute.—*Industries.*

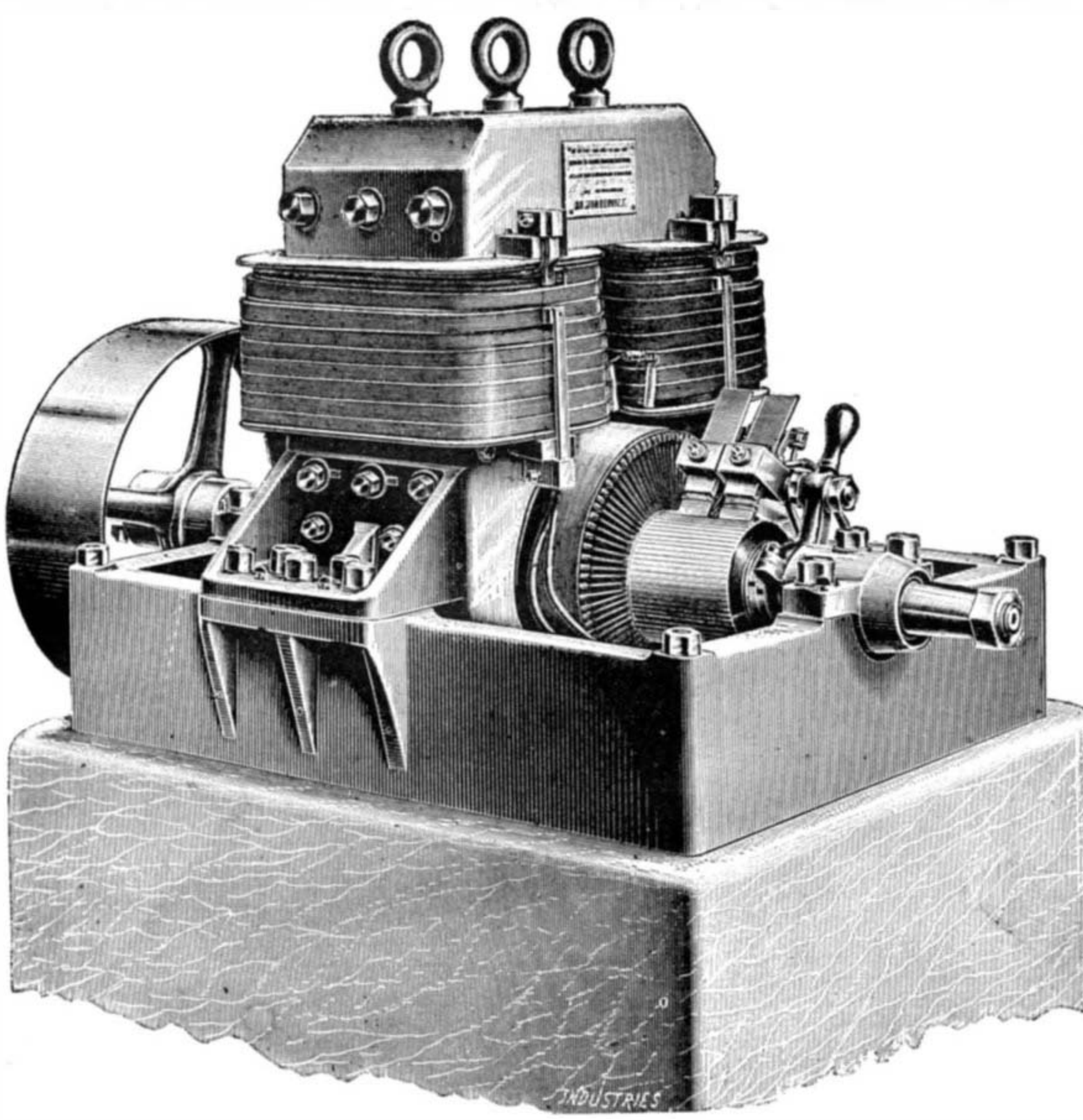


FIG. 1.—GENERAL VIEW.

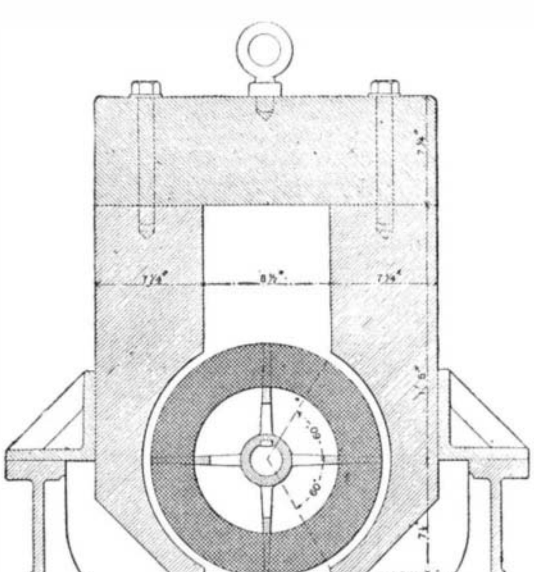


FIG. 2.

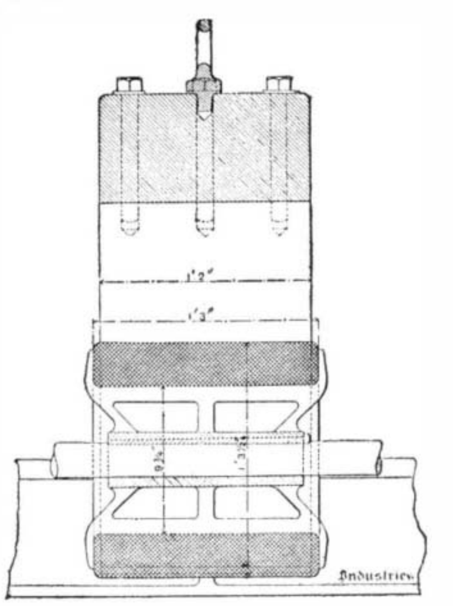


FIG. 3.

THE SILVERTOWN DYNAMO

PHOTO-LITHOGRAPHIC TRANSFERS.

By W. T. WILKINSON.

THERE are various ways of making photo-transfers, viz., upon paper direct and upon zinc, for subsequent retransfer to stone. The direct method is that most generally used, and for rough, ordinary work answers very well; but where fine work is wanted with absolute register, scale, and size, then the zinc method must be used.

Line transfers may be pulled from collotype plates, rivaling in sharpness and scale those pulled from zinc. But they require so much longer time preparing than the zinc plates that they are very seldom used for the purpose.

There are several ways of preparing the paper for the direct methods, each of which has its advocates. The paper may be coated with gelatine, chrome alum—a trace—and potassium bichromate, or with arrowroot and bichromate, thus making the paper sensitive with one operation. Paper so prepared is, after exposure, inked up dry and developed in hot water.

Another way is to coat the paper with plain gelatine, dry, then to sensitize by immersion in an aqueous solution of potassium bichromate, soaking the exposed print in cold water before inking up.

The ordinary transfer papers sold for carbon work, sensitized and developed in the same way, yield very good transfers.

Winstone, Shoe Lane, London, sells Husnik's transfer paper, which is sensitized in potassium bichromate dissolved in a mixture of water and methylated spirits of wine. This paper is inked up dry and developed in cold water. This paper is made by first coating with gelatine and chrome alum, drying, then floating upon albumen, which requires the methylated spirit to coagulate it and prevent its removal during sensitizing.

Bank post paper is usually recommended for photo-litho work, but it is too thin. The best paper is good wove, not laid, paper, from twenty-five to forty pounds per ream.

Inking up the Prints.—The old plan of inking up the prints involves the use of a litho-press in the dark room, and is at its best a clumsy and wasteful way of doing the work. The easiest and best way is to use a board like the back of a printing frame, one portion to be say 12x3 and the other 12x15, hinged together; the hinges to be sunk in the wood so that when the board is laid on the table it will lie quite flat. To use this board, raise the board in the middle, insert the edge of transfer in the joint, and the pressure at the hinges will hold it tight. Now on a clean inking slab thin a little photo-litho transfer ink with turpentine, charge a glue and treacle roller, then ink up the print, rolling from the hinges only, continuing the rolling until the turpentine has evaporated, when there should be a thin, even coat of ink, through which the image can be faintly seen. One of the points upon which a beginner stumbles is the inking up of dry transfers—the usual plan being to crowd on as much ink as possible, the consequence being that the print smears in development.

In inking up a wet transfer, place a piece of thick blotting paper on the board Place the wet transfer upon it face up, fix in the joint, blot the surface with either blotting paper or a soft cloth. Then having charged the glue roller with thin ink, roll the print one way only until the whites clear, leaving the lines forming the image standing out firm and black. A gentle rub with a pledget of cotton wool well charged with water will remove any scum left on whites, and the transfer is hung up to dry.

Photo-litho transfers should be dried at as low a temperature as is possible, else the gelatine coat will be made brittle, and the ink made too dry to give a solid transfer. For photo-litho transfers on zinc, thinner metal is used than for etching, as better contact is obtained over large surfaces, as well as being easier to handle.

The zinc must be well polished with very fine emery cloth and turpentine, then immersed in a weak bath of nitric acid, alum, and water, ten drops of nitric, ten grains of alum to a pint of water. This is put into a tray, the zinc immersed, and the tray rocked until the polished surface of zinc gives way to a fine matt. The plate is now removed and well washed, the scum being removed by rubbing gently with a pledget of cotton wool. The plate is now put into a whirler and coated with albumen, then whirled, coated again, whirled again, then dried over a small spirit stove. The albumen is composed of white of one egg, water eight ounces, saturated solution bichromate potash one ounce. Beat up the egg, add the water, mix, then add the bichromate solution. This mixture must be well filtered before use.

To get good prints on zinc, a whirler must be used. A film of albumen on zinc, well whirled, requires less than one-quarter the exposure of a film not whirled. Unwhirled films are uneven, one portion of plate having no film and another portion having a film too thick, through which the light, not having penetrated, washes off in development.

Inking up after exposure is effected with a glue roller, charged with thin ink, care being taken to get a very thin, even coat of ink all over the plate. From these prints upon zinc the transfers are pulled on litho-transfer paper and then retransferred to stone. The transfer to stone is best intrusted to a skilled lithographer, especially by beginners, as careless or ignorant transferring will spoil the very best photo-transfer.

Do not try photo-litho or any of the photo-mechanical processes with makeshift appliances, but get proper tools first, then the work will be easy and pleasant, and the results good.—*Br. Jour. of Photo.*

ON WOOL AND FUR, THEIR ORIGIN, STRUCTURE, CHEMICAL AND PHYSICAL PROPERTIES, AND COMPOSITION.*

By WATSON SMITH.

I.

WOOL and the different kinds of fur and hair covering certain classes of animals, such as sheep, goats, rabbits, and hares, we may generally discriminate from one another in that wool differs from fur and hair, of which we may regard it as a variety, by being usually more elastic, flexible, and curly, and by possessing certain peculiarities of surface structure conferring upon it the property of being more easily matted together than are fur and hair. Yet this attempted definition needs to be cautiously advanced, for the fact is, as Dr. Bowman, our greatest authority, observes in his work on the wool fiber: "The difference between wool and hair is rather one of *degree* than *kind*, and all wool-bearing animals have the tendency, when their cultivation is neglected, to produce hair rather than wool. Wool and hair, fur being intermediate, are simply modifications of the same root substance, and the scales of the wool fiber have a much larger free margin than is the case with hair, being only attached to the stem for about one third of their length, and in many cases the free ends are more or less turned outward, so as to present a much more serrated edge than is the case with hair. The interior portion of the fiber, however, does not differ in the least from that of hair, and can neither be distinguished from it chemically nor microscopically."

Fig. 1 shows a section of the skin with a fiber of wool rooted in it. Here we see that the groundwork, if we may so term it, is fourfold in structure. Proceeding downward, then, we have, 1st, the outer skin, scarf skin, or cuticle; 2d, a second layer of skin called *rete mucosum*, forming the epidermis; 3d, the papillary

* Read before the Chemical Club, December 4, 1888.

layer; 4th, the lowest or corium layer, forming the dermis. The peculiar globular cellular masses below in the corium are termed *adipose cells*, and these throw off perspiration or moisture, which is carried away by the sudoriparous glands, which pass independently off to the surface. Other glands terminate under the skin in the hair follicle, which follicle or hair socket contains or incloses the hair root. Now the complex glands referred to, terminating in the hair follicle, secrete an oily substance, which bathes and lubricates as well as

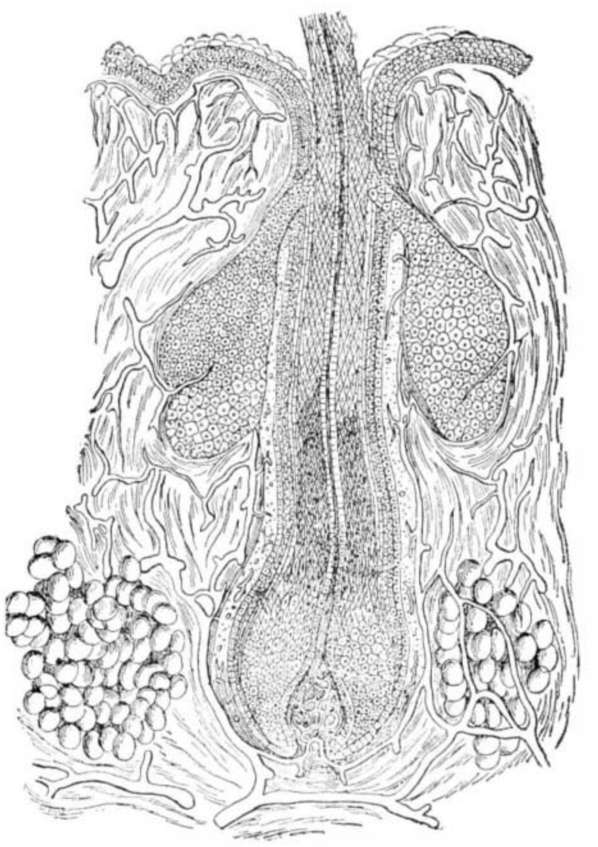


FIG. 1.

nourishes the hair. As regards its origin, this hair or wool fiber is formed inside the follicle by the exuding therefrom of a plastic liquid or lymph, and this gradually becomes granular. It is then formed into cells, which, as the growth proceeds, become elongated into fibers, and form at length the central portion of the hair. Just as with the trunk of a tree we have an outside dense portion, the bark, and an inner less dense and more cellular, and then an inmost portion, which is most cellular and porous, so with a hair the central portion is loose and porous, the outer more and more dense. Glancing at the figure (Fig. 2) of the longitudinal

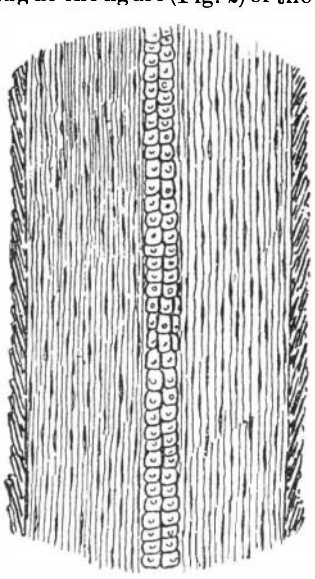


FIG. 2.

section of a human hair, we observe first the outer portion like the bark of a tree, consisting of a dense outer sheath of flattened scales, then comes an inner lining of closely packed fibrous cells, and frequently an inner well marked central bundle of larger and rounder cells, forming a medullary axis. The transverse section shows this exceedingly well (Fig. 3). The end of a hair

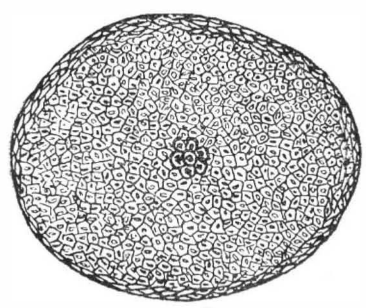


FIG. 3.

is generally pointed, sometimes filamentous. The lower extremity is larger than the shaft, and terminates in a conical bulb or mass of cells, forming the root (Fig. 1).

In the next figure (Fig. 4) we are supposed to have separated these cells, and above, A, we see some of the cells separated from the central pith or medulla, and fat globules; between, B, some of the intermediate elongated or angular cells, and below, C, two flattened, compressed horny scales from the outer portion of the hair. Now these latter flattened scales at the surface are of great importance to the textile manufacturer. Their character and mode of connection with the cortical substance below makes all the dif-

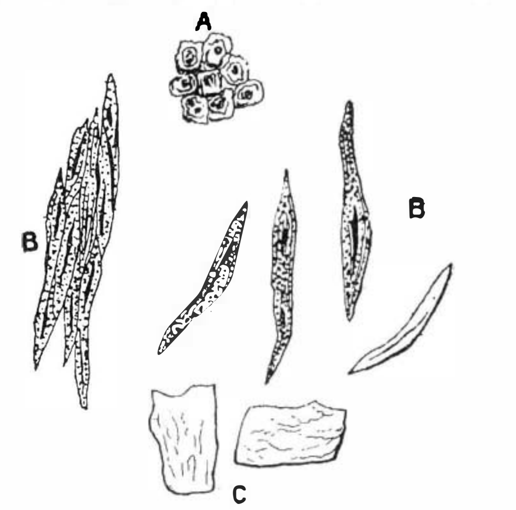


FIG. 4.

ference between wool and hair, and so determines the extent and degree of that peculiar property of interlocking of the hairs known as felting (Fig. 5). We observe that the very structure described indicates the very considerable porosity of wool and fur fibers, and their capacity for being cleansed by proper agents from all greasy and other matters between scales and pores.

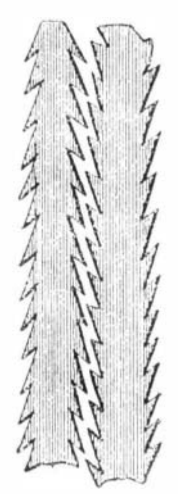


FIG. 5.

Let us now look at the general external structure of a hair, say a human hair. The upper or free edges of the scales are all directed toward the end and away from the root; in fact, in the case of some of the more perfect wool fibers the appearance under the microscope is almost like that of a number of minute cups inserted and piled up within each other. The fact of the peculiar serrated structure is easily proved by a simple mechanical test. Take a human hair, place it between finger and thumb, and gently rub it by the alternate motion of finger and thumb together. The hair will then invariably move in the direction of the root quite independently of the will of the operator.

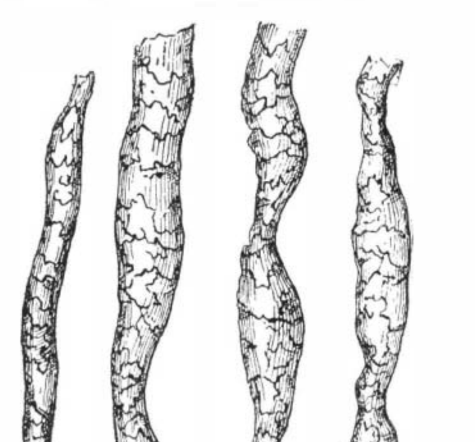


FIG. 6.

When a hair or wool fiber is in its natural state, and hence with its pores full of natural grease and its surface more or less lubricated, it feels smooth and soft, also on looking at it through the microscope its scales are not always easily discernible as scales, but look like lines or markings. There are several ways of making this scaled surface perceptible to the touch, and the scales, as scales, perceptible and plain under the microscope. Moreover, since this development of the scaly structure is an important condition for the milling and felting processes, in which it is of equal importance that the integrity of the surface (the smoothness and polish of the scaled surface, the smoothness, too, of the edges of the scales, etc.) be preserved as much as possible, so that that final quality of the woolen or felt goods known as a good finish may be obtained in the highest possible degree, we have to inquire as to the most harmless means of attaining the one without imperiling the other. It is clear that the use of a solvent to remove the grease, oleates, and natural salts, without dissolving or corroding the fiber, is the first natural step.

In the case of wool for spinning and weaving it is the only step necessary, previous to bleaching; for, as we shall now see, the natural development of well cultivated wool is such that the scales project quite sufficiently for this purpose, whereas in the case of fur for felt hats the fullest development and projection of the scales is necessary to encourage the intimate approach and interlocking needed for a close and hard felt (Fig. 5). This felting is simply a contraction and condensation of the looser fibers to a compact mass by reason of an ever-increased interlocking of inverted fibers, in-

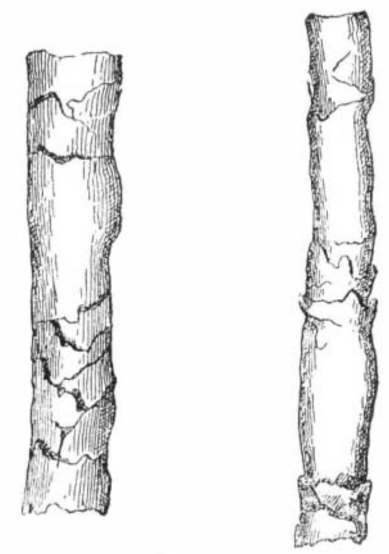


FIG. 7.

duced by processes of beating, "bumping," vibrating under pressure, etc., and the fuller projection of the scales is brought about by treatment preferably with acids, since alkalies exert a too considerable solvent and corrosive action. I will now show you on the screen samples of the finest merino wool fiber (Figs. 8, 9, and 10), and of various specimens of fur.

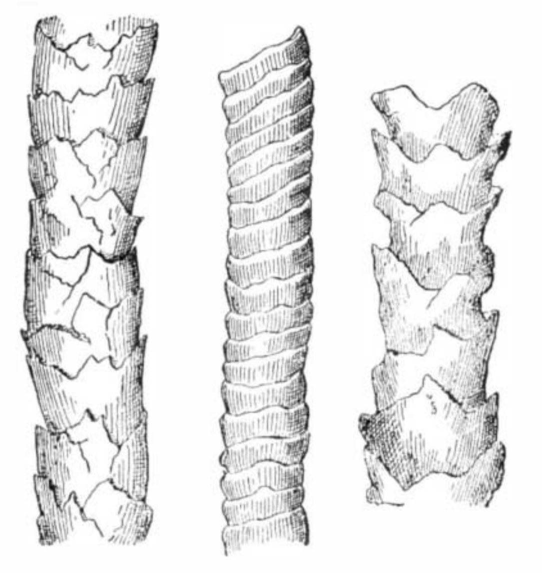


FIG. 8.—Finest Merino Wool Fiber. FIG. 9.—Wool Fiber Showing Typical Structure. FIG. 10.—Wool Fiber from Chinese Sheep.

There is a saying among felt manufacturers that "Dead wool won't felt." By this I understand wool from animals that have died of disease. It is now interesting to observe how diseased wool appears under the microscope, and this I will show you on the screen (Fig. 6). You see there the mystery revealed and solved. The fibers are attenuated, irregular, the scale markings and edges almost disappeared in some places, and generally scanty and meager in development, and hence felting with such fiber must be imperfect. (*See* Fig. 6.) Such diseased wool is nearly as bad as "kempy" wool, in which malformation of fiber has occurred. In such kemps, as Bowman shows, scales have disappeared and the fiber has become in part or whole a dense non-cellular structure, resisting dye penetration and felting. (*See* Fig. 7.)

Let us now consider the chemical composition of wool, fur, and hair. We shall best do this by considering apart: (1) the composition of the pure fiber itself and (2) that of the substances, fats, saline compounds, and grease associated with it.

Pure fiber of wool has something like this composition in 100 parts: carbon = 49·25 per cent., hydrogen = 7·57 per cent., oxygen = 23·66, nitrogen = 15·86, and sulphur = 3·66 per cent.

As regards the sulphur, it is difficult to look upon this as an integral constituent of pure wool fiber, since it is removed to a greater or less degree by most solvents, and in different wools the variation has been found to be from 0·75 to 3·8 per cent.

Based on the fact of the presence of sulphur is a method for discriminating wool fiber or fabric from those of silk or cotton.

Plumbite of soda, when boiled with wool, at once blackens it, while silk and cotton are not blackened.

Based on this fact, moreover, are the old methods of dyeing the hair black with lead solutions, though at the risk of introducing lead into the system, followed by colics and contractions of the limbs.

For the quantitative determination of wool in presence of silk and cellulose fibers, a useful reagent is basic zinc chloride, made by dissolving 100 parts of fused zinc chloride with four parts of zinc oxide in 85 parts of water, at a boiling heat, until a clear solution is obtained. This solution dissolves silk slowly in the cold, quickly if hot, and forms a thick, gummy liquid. Wool, fur, and vegetable fibers are not affected by it. But another solvent is required for removing wool or fur, and that is caustic soda solution, especially if hot. Vegetable fibers remain undissolved.

Vegetable fibers are easily removed from silk and wool by a mere soaking in dilute sulphuric acid of about 3° Tw., followed by drying. The cellulose fibers are destroyed and converted into mere dust, which can be removed by shaking or beating out the dust. In strong sulphuric acid, cotton and cellulose fibers are dissolved, especially on gently warming; wool is but little affected, and certainly not dissolved; silk is at once dissolved, even in the cold. Addition of water to the cellulose and silk solutions causes only dilution of the clear liquid; but addition of tannic acid, while leaving the cellulose solution unaffected, precipitates in a curdy form the fibroin from the silk solution. A solution of oxide of copper in ammonia dissolves cotton and silk, but not wool, and from the cellulose solution a solution of sugar or gum precipitates the cellulose, while no precipitation is effected in the solution of the silk. The following solvent finally is efficacious for silk, while leaving cellulose fiber and wool undissolved. Sixteen parts of copper sulphate (cryst.) are dissolved in 150 parts of water, and to the mixture are added 16 parts by weight of glycerol. The mixture is then treated with a solution of caustic soda until the precipitate first formed is just redissolved.

From these data, schemes for quantitative estimation in mixture of cellulose fibers, wool, and silk can readily be constructed.

In dyeing certain shades and colors on wool, it is sometimes necessary to remove as much of the sulphur as possible from the fiber, and Chevreul, I believe, introduced the method of steeping in milk of lime, washing with water, weak hydrochloric acid, and water again, with several repetitions of the process. Silk differs from wool, among many other things, in containing no sulphur, but it contains about 18 per cent. of nitrogen. Hummel gives the amount of mineral matter in wool, free from yolk, as 0·08 to 0·37 per cent. This consists chiefly of phosphates and silicates of lime, potash, iron, and magnesia.

Wool that has been fully cleansed from foreign matters has a chemical composition very similar to that of feathers or horn. The name keratin has been given to such substances. Dr. Knecht, of Bradford, has been endeavoring to isolate from wool the substance which unites so readily with coal tar dyes and other dyestuffs to form apparently beautiful lakes in the fiber. This substance, he argues, is a basic one, since acids and acid coal tar colors and color acids are all absorbed and retained after washing. Moreover, by treatment with sulphuric acid, he has apparently removed this substance by solution. This solution he filtered and found that it forms, with most of the acid coal tar colors, richly colored lakes, or precipitates. By neutralizing the sulphuric acid solution with NaOH, he obtained a curdy precipitate of the substance.

But we have been speaking of the purified fiber. Let us now ask what proportion this bears to the impurities associated with it in the raw wool. With such a structure as that which we have seen wool possesses, it can be no matter of surprise if the greasy matters, natural oily substance, saline matters, etc., stowed away behind and around those numerous scaly envelopes, should amount to a very considerable proportion. Such is indeed the case. When dry sheep's wool is treated with very dilute hydrochloric acid (0·13 per cent. HCl), ether, water, and alcohol successively, and then again exhausted with alcohol and ether, all the soluble ingredients are removed and the insoluble matters left can only be separated mechanically. The ether dissolves the fat, the water the wool sweat, principally consisting of the potassium compounds of oleic and stearic acids, etc., and the alcohol, what of the preceding the other solvents leave.

In some cases the loss thus obtained amounts to from 20 to 50 and up to 70 per cent. of the air-dried wool.

Again, another surmise may be very properly grounded on the peculiar structure of the wool fiber, viz., that such fiber is very likely to absorb moisture readily and retain it persistently. This is the case, and little attention has been paid to it in England, as Dr. Bowman and Professor Hummel point out. On the Continent a manufacturer will not buy water as wool, and official public testing establishments are situated in all the principal centers in Germany and France.

According to Bowman, the water in wool is there in two conditions: (1) As moisture; and (2) as water of hydration, or water really belonging to the fiber in its natural state.

He has determined the latter by drying wool at 38 C., and then exposing it to the air at from 10° to 16° C. He then found that the amount of moisture regained was about 8¼ per cent. However, though mentioning that the amount of water absorbed depends on the amount in the air, Bowman does not here state the hygrometric condition of the air at the time. I understand that the condition of the atmosphere is so critically considered by practical men, that some wool staplers in Bradford will not sell after an east wind has been blowing for some days. However, the average loss at 100° C. is 14 per cent., but it is not unattended with some decomposition, and the fiber is turned yellow. This means a further loss of 5¾ per cent. in addition to the 8¼ per cent. This wool exposed to the air regained much of the loss, but not all, showing that injury to the fiber had commenced.

On the Continent it has been found that if exposed to a temperature verging upon that which would cause scorching of the fiber, it will regain 18 to 18½ per cent. of the moisture.

J. Persoz finds that while at 130° to 140° C. wool fiber is completely disintegrated, when moistened with a 10 per cent. solution of glycerol, it remains unaffected at this temperature (*Monit. Scient.*, July, 1887).

Chevreul, after determining in wool dried at 100° C. the earthy matter, suint, and neutral fats, found that only 31¼ per cent., or less than one-third, of pure textile fiber remained. Dr. E. Knecht finds a similar amount of fiber in a sample of greasy Russian wool.

Chevreul's analysis of raw merino wool, after drying at 100° C., gave him of—

	Per cent.
Earthy matter deposited by washing the wool in water	26·06
Suint or yolk, soluble in cold distilled water	32·74
Neutral fats (soluble in ether)	8·57
Earthy matter adhering to the fat	1·40
Wool fiber	31·23
	100·00

Generally, it may be said, the finer qualities of wool (merino) contain more yolk ("suint") than the coarser kinds.

Now, as regards this yolk and the part it plays in the nourishment and growth of the wool, Youatt says: "The filament of the wool has scarcely pushed itself through the pore of the skin, than it has to penetrate another and singular substance, which from its adhesiveness and color is called *yolk*. It is found in greatest quantity about the breast and shoulders, the very parts that produce the best, healthiest, and most abundant wool; and in proportion as it extends in any considerable degree to other parts the wool is then improved." The fineness, strength, and luster of the fiber depend upon this natural defense, lubrication, and nourishment combined.

In a determination of the constituents or analysis of raw wool, Hummel, in his "Dyeing of the Textile Fibers," gives the following outlines:

(*a.*) *Moisture* is determined by drying at 100° C. in a stream of hydrogen (inert gas).

(*b.*) *Wool fat* by extraction with ether, thereby removing also the oleates, subsequently removed by shaking the ether solution with water. The ethereal solution contains the *wool fat*, the aqueous the *oleates*.

(*c.*) Residual wool is repeatedly washed with cold distilled water; more oleates are thus extracted. They are mixed with those from the ether; see (*b*). The wool is then washed with alcohol. More oleates are thus extracted, and their weight is added to those from the aqueous solution. Earthy oleates left in the wool are decomposed by weak hydrochloric acid. The acid is removed by water, the wool dried and treated with ether and alcohol. On evaporating the solvents named to dryness, residues are obtained from which the amount of earthy oleates can be reckoned.

(*d.*) The wool is finally dried and well shaken, and teased out over paper, to remove dirt, sand, etc. When washed on a fine sieve the wool is dried and weighed, and the sand and dirt taken by difference.

Marcker and Schulz, using the method sketched above, obtained the following results:

	Wool of Lowland Sheep.	Wool of Full-bred Rambouillet Sheep.	Pitchy Wool.
	Per cent.	Per cent.	Per cent.
Moisture	23·48	12·28	13·28
Wool fat	7·17	14·66	34·19
By successive treatment:			
Soluble in water (wool sweat)	21·13	21·83	9·76
Soluble in alcohol	0·35	0·55	0·89
" in dilute HCl	1·45	5·64	1·39
" in ether and alcohol	0·29	0·57	.....
Pure wool fiber	43·20	20·83	32·11
Dirt	2·93	23·64	8·38
	100·00	100·00	100·00

Wool fat is not a compound of glycerol, and consequently is not a true fat. It is separable into two portions by treatment with boiling alcohol; the lesser soluble and the larger insoluble. The soluble part contains chiefly the at once alcohol-like and fat-like body *cholesterin*, which is a carbinol, along with *isocholesterin*, while the insoluble part contains principally these latter bodies combined with oleic acid, and in small quantity with stearic and other fatty acids.

So-called "pitchy wool" contains much wool fat, which is difficult to remove by scouring with mild alkalies.

A method issued by the Fab. Chem. Prod. Acte. Ges., of Berlin, of separating the constituents of commercial wool fat (C. D. Abel, Eng. pat. 326, January 8, 1886) is based on the fact that the raw product is soluble in carbon bisulphide, benzine, benzol, xylenes, toluene, isobutyl, alcohol, or amyl alcohol, but from its solution in these all the soaps (*sic*) are completely precipitated by addition of acetone. The fatty acids of commercial wool fat can be separated from the wool fat by converting them into alkali soaps by adding alkalies, and then treating the whole with ethyl or methyl alcohol. With the aid of heat all is dissolved, but on cooling the wool fat separates, leaving the soaps in solution. The easiest plan is to treat the raw wool fat with ammonia and then with alcohol. The ammonia soaps dissolve and leave the wool fat, which, after emulsifying with water, forms *lanolin*.

A more recent method by Langbeck and Ritsert (Eng. pat. 6,210, May 7, 1886) is to treat raw wool fat, freed from water and dirt, with boiling alcohol containing about 10 per cent. of ether, the warm alcoholic solution of the free fatty acids, free cholesterin and isocholesterin and volatile ethers of the fatty acids containing also a small quantity of cholesterin fats are separated from the undissolved cholesterin fats. The alcohol is removed and the cholesterin fats distilled off by superheated steam. Another way was to dissolve the whole wool fat in ether and precipitate the cholesterin fats alone by addition of alcohol. This method is applicable direct to the lyes from wool-washing works.

I understand in these methods that raw wool fats which have been already separated from other matters are taken, but I also think the fact called attention to by Hummel, p. 92 of his "Dyeing of Textile Fibers," has been much overlooked by chemists, and inventors too, viz., the soaps (oleates) are not perceptibly soluble in the volatile agents proposed, CS_2, ether, and petroleum spirit, etc., but only bodies of the nature of fats. Hence washing with water must always follow.

Wool Sweat.—The portion soluble in water has been shown by Chevreul, Vauquelin, Hartmann, etc., to contain principally the potassium salts of oleic, stearic, hyenic, and other fatty acids, along with others in smaller quantity of potassium with valerianic and acetic acids, and also phosphates, sulphates, chloride of potassium, etc. Ammonium salts are, moreover, present in small quantity.

It is not necessary to call attention to the great value of the constituents of the suint and salts. 1st. As regards the potash. 2d. The possibility of making ferro- and ferri-cyanides from them. 3d. As a source of lanolin and cholesterin—for this has already been done in papers published in this *Journal* by Ivan Levinstein, 1886, 578–580, and W. Bott, 1883, 123–124. Hummel also gives a useful account of it in his Dyeing of Textile Fibers, pp. 40–43.

Quite recently (*Compt. Rend.*, 107 (20), 789–792) A. and F. Buisine have discovered in *suint*, and isolated from it, glycollic acid and normal pyrotartaric acid, COOH.CH_2.CH_2.CH_2.COOH (normal propylene dicarbonic acid) a higher homologue of succinic acid (COOH.CH_2.CH_2.COOH). They are contained in the portion of suint soluble in water. These savants have already isolated benzoic, succinic, and malic acids. The following list of acids is given as derived from fermented suint: The fatty acids from acetic to capric; the hydroxy acids of the foregoing, glycollic and lactic acid, and their acid amides, glycocol, leucin, the bibasic acids, oxalic, succinic, and normal pyrotartaric, a hydroxy acid of one of the preceding bibasic acids, malic acid, with some others, as hippuric, benzoic, and uric, etc. These acids exist principally as potash salts. Acetic acid amounts to 60 per cent. of all the other acids present, and Buisine hopes to recover it industrially. In northern France alone 1,000,000 kilos. should be obtained annually.

Action of Acids.—Dilute acids have little effect on wool, *i. e.*, sulphuric and hydrochloric acids, whether hot or cold. The scales on the fiber are, however, opened out, and hence felting promoted. The feel also becomes harsher; harshness of feel is often alleged as a criterion of damage to the fiber, but it may not be so at all, for if you cleanse the fiber with CS_2 or benzol perfectly, and then with cold water, you get a certain degree of harsh feel simply because the oils and fats are completely removed from the surface of the fiber, and the scale edges become more sharply developed. A microscopic examination, however, clearly shows when serious modification of the fiber has taken place.

Furriers use as a stimulant to the fiber scales acid solution of mercuric nitrate, but they often use it so strong that the fur is stained yellow and made excessively harsh. In such cases it is undoubtedly injured, and no good finish can be got upon felt made from such fur. Figs. 11 and 12 respectively illustrate fur fibers

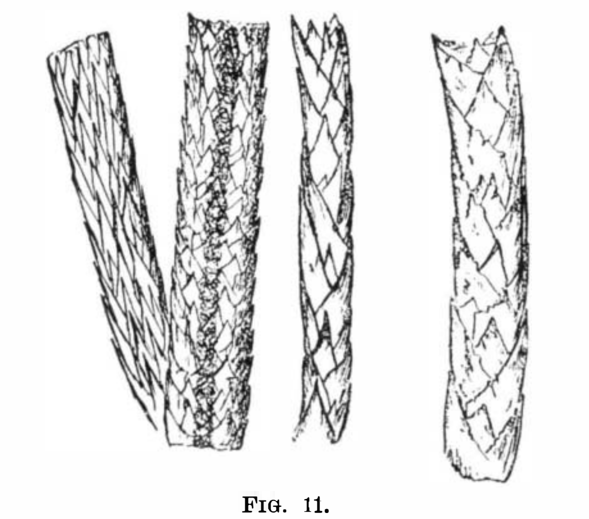


FIG. 11.

from different parts of the same animal (hare) *before* and *after* the treatment described. The figures, of course, represent the microscopic appearances.

Cellulose is, of course, very sensitive to sulphuric acid, which disintegrates it. The felt manufacturer removes cellulose particles or burrs from his felt by steeping in dilute sulphuric acid, drying, and then

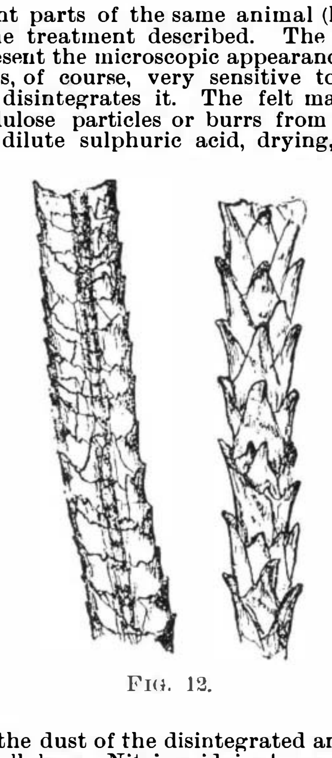
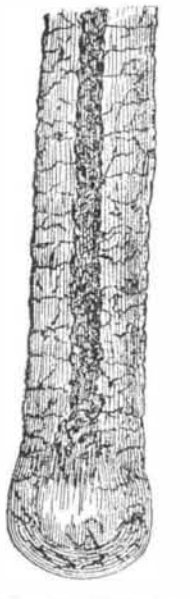


FIG. 12.

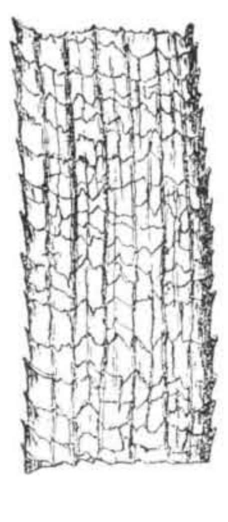
beating out the dust of the disintegrated and partially carbonized cellulose. Nitric acid is also used for stripping wool of its color previous to redyeing. Thus indigo-dyed wool may be "stripped" with nitric acid of 3°–4° Tw. Sulphurous acid is the best bleaching agent for wool, removing its natural yellow color. Dr. Knecht has shown that when boiled with dilute sulphuric acid, wool absorbs from 2 to 3 per cent. SO_4H_2, which are only removed by long continued boiling with renewed quantities of distilled water. Part is removed as ammonium salt.

Action of Alkalies.—Alkalies, which have little effect on cotton, have to be used very dilute and with great caution on wool. Alkaline carbonates in solution and dilute, also at a temperature not above 50° C., have little action on wool. Soap and carbonate of ammonia have less injurious action still. If a soda ash with causticity in it be used, the damage is certain. The temperature of any solution used in the case of wool is an important matter, for even hot water is injurious. Dr. Bowman finds that "wool which looked bright when well washed with tepid water became duller when kept in the water some time at a temperature of 71° C., and the same wool, subjected to boiling water at 100° C., became quite dull and lusterless." "When the water at 71° contains only very small quantities indeed of alkali," adds Bowman, "the whole of the surface of the wool, and indeed its substance, is dissolved into a jelly-like mass." Dr. Knecht finds that wool will dissolve in a solution containing less than five per cent. of its weight of NaOH at boiling temperature. I have here micro-sketches of a human hair before and after treating with warm dilute alkali (Figs. 13 and 14).



Before treatment with alkali.

FIG. 13.



After the treatment.

FIG. 14.

You will observe the projecting and jagged edges of the scales (Fig. 14), indicating corrosion and injury. The same fibers that carried before boiling with water alone 500 grains without breaking, broke after boiling with 480 grains.

In the drying of wool in chambers in the carbonizing process, 121° C. may be used provided the vapors escape, for the rapid evaporation cools the wool, heat becoming latent in the steam at the expense of the fiber.

We see then that pitchy wools and rich merinos, richest, respectively, in wool fat and yolk, *i. e.*, the very finest wools, will be those needing most care in scouring with alkalies or soaps. Yet they are just the wools requiring most and strongest treatment to rid them of the extraneous matters of the yolk. Thus manufacturers have looked about for other scouring agents.

Carbon Bisulphide.—Among them are what are termed the *volatile scouring agents*, such as carbon bisulphide, fusel oil, ether, petroleum spirit, benzol, etc. However, these volatile bodies are solvents for fatty matters, and not for alkaline oleates and soaps. Hence, in conjunction with them, a washing with water must be combined, so as to follow the treatment with volatile liquid.

Bisulphide of carbon has, so far, among these agents received the most favor, as it so very readily dissolves the wool fat, even in the cold.

Bowman says: "Bisulphide of carbon dissolves the suint and fat of wool very easily and completely, without injury to the fiber. The bisulphide may then, when removed from the wool, be driven off at a steam heat, leaving the unchanged fats behind as a residue." However, lime soaps are not removed, and it is a fact that bisulphide of carbon, if hot, leaves the wool yellow, and bleaching will not remove that yellow color, for it is due to sulphur deposited in the fiber.

Hummel (p. 101, "Dyeing of Textile Fibers") says the use of volatile liquids has not yet met with much acceptance, but that the difficulties attending their use have been more or less overcome by Da Heyl, Van Haecht, and others, more especially by T. J. Mullings, yet the process of the latter, who employs throughout a low temperature, is not an unqualified success. A friend of mine who has witnessed and inspected it in operation, tells me that the water run off into the river after the washing which followed the CS_2 treatment had a dreadful odor, and made the river smell for some distance. However, if properly purified by rectification from half-slaked quicklime in powder, it has little or no odor.

Benzol and petroleum spirit have the serious objections that they are specifically lighter than water, and so can neither be so easily displaced by water from the fiber, nor be sealed by a layer of water kept above their surface. Combined with this great mechanical and statical advantage of CS_2, we have the additional one of its volatility, though this, as we shall shortly see, is by no means an advantage under some circumstances.

I have in this paper endeavored to explain the physical and chemical structure and properties of wool fiber and its natural accompaniments, so as to prepare the way for the consideration in the next of the advantages of a rational treatment of the raw wool with a volatile and inert solvent in the cold, along and alternately with water, over the treatment at present in vogue with warm dilute alkalies in the process known as scouring, and I hope to be able to prove to you that a new process just invented and patented by my friends, Messrs. Singer and Judell, fulfills all the demands made by such a rational treatment. The apparatus for this new process is now being constructed by Messrs. Mather & Platt.

(*To be continued.*)

A CORRESPONDENT of the *British Medical Journal* tells of a drunken doctor in the Alleghany Mountains, who, when in a state of semi-drunkenness, took a piece of ammoniæ carb. out of his surgery bottle and chewed it. The effect was almost magical. The contents of the stomach were quickly ejected, the usual depression not following, so that he was able to at once resume his debauch. The remedy has been tried many times since with great success. The drunkard can generally be roused and got to swallow ½ drachm of ammon. carb. dissolved in a wineglass of water, which drunk off will prove immediately effective as an emetic and restorer.

PRINCIPLE OF FORCE AND DEMONSTRATION OF THE EXISTENCE OF THE ATOM.

By HUDSON MAXIM.

CO-EVIDENT with consciousness of our existence are certain truths.

Truth is the exact accordance with that which is, has been, or shall be.

Self-evident truth is that accordance with being which is too simple to require demonstration.

Complex truth is that accordance with being whose evidence requires demonstration.

A complex truth established upon self-evident truths is a concomitant certainty with the primary truths themselves.

There is no difference in truth. Self-evident truth is what, with all conditions necessary to its determination as absolute, is at once within consciousness of certainty. What truth is self-evident to one mind may not be so to every other. The greater the mind, the greater the truths that become self-evident. Some truths that are self-evident to the mind of a Newton, a Darwin, a Spencer, may be far beyond the comprehension of ordinary mortals. An axiom is any self-evident truth.

SELF-EVIDENT TRUTHS.

Axiom 1.—A thing cannot, at the same time, be and not be.

Axiom 2.—That which exists as a composite whole, its parts, as units of the whole, also exist.

Axiom 3.—The whole is greater than any of its parts.

Axiom 4.—Every whole is equal to all its parts taken together.

Axiom 5.—If any part be taken from a whole, there remains such a part of the whole as has not been taken.

Axiom 6.—Division of a body is not annihilation of the body.

Axiom 7.—Nature extends without limit in all directions and contains all bodies, all space, all causes, and all effects.

Axiom 8.—No two solid bodies can occupy the same space at the same time.

Axiom 9.—An absolute solid completely fills the space occupied by its dimensions of extension.

Axiom 10.—No absolute solid can occupy more space than is equal to its dimensions of extension.

Axiom. 11.—No absolute solid can occupy less space than is equal to its dimensions of extension.

Axiom 12.—An absolute solid cannot pass through the same space at the same time that it is occupied by another absolute solid. (Axiom 8.)

Axiom 13.—If an absolute solid be taken from a given space, there remains an absolute void of dimensions of extension equal to the solid body taken.

Axiom 14.—Motion is alteration of position or changing of place.

Axiom 15.—Force is any action between bodies which changes, or tends to change, their relative condition as to rest or motion.

Axiom 16.—There exists a certain something which we call matter.

Axiom 17.—There exists an attractive force between different portions of matter which we call gravitation.

ARGUMENT.

Let us take the word nature, as best suited to our use, and consider the term as embracing in its meaning all space, all matter, all causes, and all effects.

It is self-evident that nature must be either all an absolute void or an absolute solid, or consist of both, perfect solids and void spaces.

Nature cannot be all an absolute solid, for in that case all motion were impossible. (Axiom 12.)

Nature, therefore, must be either all an absolute void, or consist of perfectly solid portions of matter and void spaces where matter exists not. (Axioms 9, 10, and 11.) One of these two alternatives must be true. (Axiom 1.)

Nature cannot be all an absolute void, for in that case all force and all motion were impossible; for if nothing existed, there would not be anything to move, or anything for force to act upon, or between. And motion and force are as stated in Axioms 14 and 15.

Hence the only alternative left is that nature embraces spaceless solid units of substance and absolute void where substance exists not. For to demonstrate existence impossible except as claimed, of what is known to exist, proves the truth of the claim.

But let us argue this point a little further.

Let us take at the ordinary temperature of the air, what is termed a *solid* iron ball or sphere.

Now, it is self-evident that the sphere in question must be either all an absolute solid, or all an absolute void, or consists of both absolute solids and void spaces.

If we heat the sphere, we find that it expands, increasing its dimensions of extension in all directions; and on cooling again, we notice that it contracts to its former dimensions as it reaches its former temperature.

During these alterations in size we find that the weight or gravitative force of the sphere toward the earth remains unchanged. Hence the quantity of matter contained in the sphere is neither increased nor diminished. And, as an absolute solid could neither expand nor contract in size (Axioms 8, 9, 10), we know that the sphere in question cannot be all an absolute solid, but must contain void spaces.

We know that it cannot consist wholly of spaces, or else it would be nothing but void. (Axioms 1, 8, 9, 10.) Hence the sphere must consist of both void spaces and spaceless solids possessing certain dimensions of extension in length, breadth, and thickness.

And the dimensions of extension of all the solid atoms plus the dimensions of extension of all the vacant spaces of any body are exactly equal to the dimensions of extension of the whole body; for the whole must be equal to all its parts (Axiom 4), and must require all its parts to complete the whole.

But it is argued that as we know nothing of matter except through force, force may be either a property of matter or matter be but a property of force.

It is self-evident that force is what it is claimed as being in Axiom 15, and hence cannot have being except in being what it is (Axiom 1)—the action or power of something exerted upon something, or action between two or more things or objects.

Therefore, as force can exist only as a condition of more than one thing, if we take away from the ultimate whole wherein force is considered, all of the parts except one, between which the exertion of force exists, we have one part left (Axiom 5), but no force. What, then, must that part be which is left?

The certainty that it exists (Axioms 1 and 5), the certainty that it cannot be force, the certainty that it can be nothing else, demonstrates that it must be absolutely solid substance. (Axiom 4.)

Let us now conceive of but one of these ultimate solid atoms as existing entirely alone in all space, assuming that it alone be all the matter or substance in existence.

It could have no motion in any direction, for space of itself without limit is without direction, and no place in space could have position relative to the rest of space—hence position and place as relative to but space are impossible, therefore, a single ultimate atom existing alone in space could have no motion, as it could not alter its position, having no position or place to change.

Hence, direction, distance, position or place are terms which relate to conditions of existence of more than one unit of existence or atom, excepting as relates to points within its own dimensions, and being an absolute solid, no point within itself can change its position relative to other points. Hence all motion were impossible with an ultimate atom existing alone in space.

The ultimate solid could have no axillary motion, as no point within its dimensions could alter its position relative either to other points in the solid unit or to space.

The conception of a centrifugal force from an axillary motion, as tending to separate the ultimate atom into parts, is untenable, for the ultimate atom being a perfect solid must also be absolutely unbreakable, as well as absolutely incompressible, as will be more fully shown further on.

A single ultimate solid existing alone in space could possess no attracting or repelling force or power—as there would be nothing for it to attract or repel.

Therefore position, place, force, and motion are conditions of existence of more than one ultimate atomic solid.

If we now conceive of another like ultimate solid atom as existing along with the first, an attracting force, or a repelling force, or both, according to distance, and the concomitant conditions of position and motion are possible.

But it is self-evident that as no change can take place in the ultimate solid, the only effect force is capable of producing, and the only force that is possible to exist, is the changing, or tending to change, the condition of the atoms as to rest or motion relative to one another.

Now, if a single ultimate solid existing alone in all space can possess no force, and in itself is incapable of undergoing any change; and if the addition of another ultimate solid along with it adds force, and the conditions of position and motion being the only conditions possible, if we add an infinite number of atoms we have an infinite force, and by infinite combinations of atoms we have infinite manifestations of force, but necessarily of the same force; as the only possible manifestation of force is in the change of the relative condition of atoms as to rest or motion, as all changes must occur outside of the atom, for the atom is of itself unchangeable.

ANSWERS TO ARGUMENTS AGAINST THE EXISTENCE OF THE ATOM.

The principal arguments against the existence of the atom which I have seen are those advanced by Herbert Spencer and by Boscovich. Spencer, in his "First Principles," page 51, says: "Were matter thus absolutely solid, it would be what it is not, absolutely incompressible, since compressibility, implying the nearer approach of constituent parts, is not thinkable, unless there is unoccupied space between the parts. Nor is this all. It is an established mechanical truth, that if a body, moving at a given velocity, strikes an equal body at rest in such wise that the two move on together, their joint velocity will be but half that of the striking body. Now it is a law of which the negation is inconceivable, that in passing from any one degree of magnitude to any other, all intermediate degrees must be passed through. Or in the case before us, a body moving at velocity 4 cannot, by collision, be reduced to velocity 2, without passing through all velocities between 4 and 2. But were matter truly solid—were its units absolutely incompressible and in absolute contact—this "law of continuity," as it is called, would be broken in every case of collision. For when, of two such units, one moving at velocity 4 strikes another at rest, the striking unit must have its velocity 4 instantaneously reduced to velocity 2, must pass from velocity 4 to velocity 2 without any lapse of time, and without passing through intermediate velocities; must be moving with velocities 4 and 2 at the same instant, which is impossible."

Spencer here bases his argument on what he supposes to be an immutable law of nature: that a moving body cannot pass from velocity 4 to velocity 2—that is, from a given velocity to a velocity half as great at the same instant.

Let us conceive of a body being projected perpendicularly from the earth in such wise that it shall ascend and descend in the same line. It certainly must stop at the point whence it begins to descend, and as it must move at some velocity until it stops, it must pass instantly from velocity something to velocity nothing, which is as great as from velocity 4 to velocity 2.

For, suppose the force of gravitation were instantly removed at the same instant that the ball was moving at its last degree of velocity, the ball would continue to ascend, and however slowly it moved, would travel a given distance, say twelve feet, in sufficient time, and if it moved with only half that velocity, it would travel six feet in the same time.

Now, a velocity of twelve feet in a given time is to a velocity of six feet in the same time as velocity 4 is to velocity 2. Therefore, to stop at all, a moving body must pass instantly from some velocity to some other equally less as from velocity 4 to velocity 2.

Again, suppose we were to project a body perpendicularly from the earth at the rate of a thousand feet per second.

From the moment it leaves the earth, the attraction of gravitation acting upon it, continually retards its