

regard the aeroplane as the natural consequence of the dirigible balloon. Like the latter, the aeroplane should form a rigid whole, with the sole exception that it should be possible to slightly modify the inclination of the sails that replace the balloon. Like the dirigible balloon, it will have a car, and a network of suspension ropes more or less entangled. At the high velocities that form its *raison d'être* the displacement of this car and of these suspension ropes will absorb considerable motive power. For, if it is true, as Mr. Langley claims to have discovered a century after George Cayley, that the power necessary to sustain the system of sails is less in proportion as the velocity is greater, the power necessary, on the contrary, to propel all the rest of the aeroplane increases as the cube of the velocity, if there is no pitching; and more quickly than the cube if the opposite is the case. It must not be imagined, then, that the abolition of the balloon introduces into the resistance to headway a considerable economy, thus permitting of greatly increasing the velocity (say of quintupling it), and of making it possible to float the aeroplane with a relatively small spread of sails.

Dupuy de Lome estimated the resistance of the car and suspension arrangement of his airship to be two-thirds of the total resistance. The abolition of the balloon in this case gave, therefore, but a slight gain from the point of view of the resistance per unit of speed. But it might be objected that the Dupuy de Lome suspension is very complicated, and that the calculations of this eminent engineer appear too low for the resistance of the balloon, and too high for the resistance of the cordage and car. Let us place things in the most favorable light, and suppose a dirigible the suspension of which is so well arranged that the resistance of the non-sustaining parts shall be but one-eighth of the total resistance instead of two-thirds; let us replace the balloon by a system of sails capable of carrying at a certain velocity, V , the same effective weight and the same motor as the dirigible; and let us neglect the weight and the resistance to headway of the sails and the apparatus employed in the aeroplane for starting it, steadying it, landing it, etc. The motive power remains the same, and we have the following relation between the velocity, v , of the balloon and the velocity, V , of the aeroplane, which we substitute for it:

$$K v^2 = \frac{K}{8} V^2$$

$$V = 2 v.$$

whence

Thus, under such eminently favorable conditions for an aeroplane of the type considered, we double the velocity only. In reality we would obtain a much lower velocity. The reason is, it will be said, that the type is bad. Perhaps so, but not certainly, since if it be desired to improve it from the viewpoint of resistance to headway, we shall encounter difficulties of another nature. There is no doubt that, in order to reduce this resistance and obtain sufficiently great velocities to allow the use of relatively small sails, it would be necessary to have a closed car in the form of a cigar, rigidly connected with the sails. But then would reappear the phenomena of tilting that we escaped by the abolition of the balloon. If, in order to prevent this tilting, we spread the sails upon a frame forming the back of the cigar, we shall have a sort of large bird; but the stabilizing couple will be then much reduced, and this will prove a great inconvenience. The problem will be modified, but not simplified. This problem nature has wonderfully solved in the bird, under conditions, moreover, much less exacting than those imposed by the aeroplane ship. In the first place, in fact, the bird, which is a genuine animate aeroplane, as has been demonstrated by Penard, Drzewiecki, and myself without any possible doubt, weighs notably less than the aeroplanes designed to carry but one or two passengers. A moderate velocity suffices to give it a sustaining resistance equal to its weight. For analogous velocities, man requires much longer sails and also light and resistant ones, or else greater velocities if it be desired to reduce the sails to reasonable dimensions. And that is not the sole difficulty of the problem. The aeroplane is submitted to other exigencies, of which I shall recall but two—the slight inclination of the sails and the stability.

Law of Slight Inclinations.—An elementary calculation shows that, even with the lightest motors, the inclination of the sails should be maintained between very approximate limits. If the current of air strikes them above, there will be a rapid, almost vertical fall—a catastrophe such as put an abrupt end to the curious experiments of Otto Lilienthal; and if it strikes from beneath, but at an angle greater than a few degrees, there will be a slower fall according to an inclined trajectory. In order to solve the problem, it is necessary, then, to maintain the inclination with certainty between limits spaced by a few degrees solely. This is necessary in spite of the variations of the wind, pitching, tilting, and the flexibility of the materials composing the aeroplanes. To whom is it not evident that such a necessity is one of the great difficulties of the problem? This law of slight inclinations is not so hard on the bird, owing to the truly extraordinary sustaining quality of its wings, and to its instinct, which, according to requirements, surely and rapidly modifies the inclination, spread, and concavity of the said wings.

Of Stability.—Aeronauts are persuaded that the question of stability will be solved by copying the arrangements employed by nature, and which are as follows: In full flight or in hovering flight, the wings of the

bird form a sort of dihedron, the angle of which is on the side toward the ground. If, then, the bird happens to lean toward the right and no longer sustains itself, it begins a fall which causes a stronger reaction under the right wing than under the left, and this brings it back to its natural position. Thus is found solved the question of transverse stability. As for the longitudinal stability, we know that the center of pressure, C , upon a sail approaches the edge of the sail the more closely in proportion as the sail makes a smaller angle with the air current. If, therefore, the inclination increases or diminishes, the center of pressure will be no longer upon the perpendicular of the center of gravity, G , but will retard and advance, and the sustaining force, applied at C , will form a couple with the weight of the aeroplane applied at G . This couple will bring the inclination back to what it was before. In reality, the phenomena are more complex. Thus, among other things, the longitudinal tilting would cause upon the keel formed by the bird's body disturbing effects analogous to those mentioned in the paragraph upon the tilting of dirigibles, were such effects not counteracted by a sort of air channel under the wings, by the instinctive displacement of the legs, and by the intervention of the tail.

And then, as a last resort, the bird might, at times at which the sustentation was accidentally inadequate, permit itself to fall and take on the necessary velocity. All those who have seen the swift fall of birds of prey, their great resources in the successive turns made by them to fasten upon and dispatch their victims, understand that the fall does not constitute a great danger to the bird. The same is not the case with the aerial ship, in which the automatic apparatus of most improved character serve to increase the weight, and are never equal to instinct. Moreover, by very reason of the purpose for which it is designed, such a ship can move only in horizontal or slightly inclined planes.

This rapid analysis shows us only the principal difficulties when under way, and to these may be particularly added those that result from starting and landing. These difficulties are such that the engineer who prides himself upon so many wonderful results accomplished in the last century, hesitates to say that there will be any end to them. He will succeed only by a methodical preparation, by delving deeper into the laws of aerodynamics, which is still disclosing so many secrets, and by instituting progressive experiments under conditions of acceptable security, say with mixed aeroplanes, that is, those provided with a safety buoy under the species of balloon. And since the conditions are very different with the ship aeroplane and the bird aeroplane, he will have to avoid servilely copying the latter, to demand for the study of flight only indications otherwise valuable, and to seek a solution of this great mechanical problem only in the judicious use of processes proper to mechanics, which, moreover, puts at his disposal parts that have an efficiency and power incomparably greater than those of animate ones. Thus it will be necessary for him before all else to proscribe the flapping of wings, which would greatly and uselessly complicate the maintenance of the slight inclination as well as the stability. Nature has recourse to it because an alternating motion is the sole means of bringing the muscular energy into play. But it would be as illogical to imitate the motion of wings in aeroplanes as it would to imitate the motion of legs in automobiles.

Among the means adopted for rendering the stability and the maintenance of inclination less precarious, there is one that consists in replacing the plane sail of wide dimensions by a system of plates properly curved and elongated like the wings of a bird. In the first place, with this arrangement, the reaction of the air per unit of surface is much greater for a given surface. Wenham, Phillips, and Lilienthal especially have made significant experiments upon this subject. On the other hand, the variations in inclination do not involve such marked variations in the direction of the resultant, and, consequently, in the value of the sustaining component. For these two causes, the pitching may have a greater oscillation without any fall resulting therefrom. Finally, the oscillations of a plane of given surface result in displacements, CC' , of the center of pressure which are less marked in proportion as the plane is more elongated in a transverse direction.

Mr. Phillips has, according to this principle, constructed an interesting aeroplane of which I gave an illustration in my memoir of 1897. Unfortunately the safety is null, and it would be necessary either to add to the plates a large sail forming a parachute in case of necessity, and which would destroy a part of the benefit accruing from the arrangement of the plates, or to combine the plate system in a different manner.

In conclusion, I may recall the fact that in 1897 I pointed out a means, a little heavy perhaps, of assuring the maintenance of the sails between the necessary limits of inclination, by utilizing the permanence of the axis of revolution of revolving disks.—Translated for the SCIENTIFIC AMERICAN SUPPLEMENT, from the French of Rudolphe Soreau in *La Vie Automobile*.

BRIQUETTING FUEL MATERIAL.*

By GEORGE E. WALSH.

THE art of briquetting fine dust and loose raw material for fuel is of rather ancient lineage, but only in comparatively modern times has it entered the industrial field as an exact science, demanding the attention

of all users of fuel for power purposes, and promising to develop into a factor of no inconsiderable importance. The real object of modern briquetting of fuel is to recover some waste matter, or at least to utilize raw material which in its natural state could be of little use. In this broad comprehension of the science we find innumerable articles of raw material and waste matter teeming with unknown possibilities. On all sides of us there is waste material which contains sufficient burning properties to make it useful as a fuel if we could separate the foreign impurities from it, and compact the rest in a close mass so that it would ignite and burn steadily. The waste and sweepings of the city streets, the straw of the Western grain fields, the corn stalks of the great cereal belt, the leaves of the forest, the bogs and peat of the swamps, the soot and dust of blast furnaces, and the powdery dust of the coal mines, all present loose and insufficient fuel with fine possibilities for the experimental briquetting factory.

Briquetting any substance must necessarily depend for its success on the cost of the fuel when delivered for use, and on the relative efficiency of it in the furnace. Sundry other questions, such as that of economical handling and storage, and freedom from dust and dirt, or any impurities which might injure the furnace and boiler of a steam plant, enter into the problem; but these are more questions of detail than of anything else. They can be solved in time by different methods, applicable to each individual case. The quantities of raw material in different parts of the world suitable for burning when briquetted have always made this work attractive. We find very primitive people working up in brick form straw, leaves, and peat to burn in ovens and open fires. It is natural to compress any loose material into a solid brick for burning, especially where it is to be transported some distance to the furnace.

The effort has repeatedly been made in this country to utilize the waste stalks and straw of our corn and wheat crops by compressing them into solid, portable bricks, which would burn well and satisfactorily, and be easy to transport. Several factories have at different times started to manufacture briquets of this raw material, but their output does not seem to have passed much beyond the experimental stage. One method proposed was to cut the straw and stalks into short pieces, and then steam and cook them to a fluid mass. A mixture of earth, oil, and coal dust in different proportions made the paste of a heavier consistency. Then when pressed into bricks, and dried, they were ready for burning. The difficulty experienced in making these briquettes of straw and corn stalks seemed to be that they burned too freely, and their cost, even with straw and stalks plentiful on all sides, was altogether too high to make the experiment satisfactory from a commercial point of view. By adding a binder that tended to retard the rapid consumption of the briquettes, somewhat better results were obtained, but there has not been any commercial success in this direction yet. Meanwhile, the demand for western corn stalks and wheat straw for various other industries has increased so that this one-time worthless raw material has been steadily increasing in value. It is possible that this enhancement of price alone will be sufficient to make further efforts to briquet straw and corn stalks useless.

Forest leaves, sweepings of the city streets, and the peat bogs of New England have also attracted a good deal of attention, and different experiments have been tried to make use of this material for briquetting. The forest leaves are of little use to-day for burning, and they cannot be used to any good purposes at all unless they can be compressed into solid masses so they will burn slowly and steadily. Leaves are like bales of paper, however, which, if pressed too hard, will smolder a long time, but give forth very little heat and fire. It has been found necessary, therefore, to mix them with other materials of a coarser grain to separate the fine layers of leaves and enable the fire to penetrate to the interior. The ideal fuel is one like coal, which will give forth a glowing heat, and will remain so for a long time. It has been found that by mixing with the forest leaves certain proportions of dried forest mold or dirt, and using a binder which will hold the mass together firmly, better results are obtained than when it is attempted to compress the leaves alone. Another method that has been tried with fair success has been to mix leaves and good peat together, compressing the two under hydraulic power, and holding them in position by a good binder. The burning of such bricks is excellent from many points of view, and the results satisfactory under certain conditions.

Of all these experiments, however, the most interesting are those made with the sweepings of city streets, mixed with the waste gathered from the different households, stables, and ash barrels. The burning of this city waste in modern crematories to reduce it to an ash is a wasteful process. In many parts of England the city's waste is employed in operating electric light and power plants, and the saving to towns and municipalities in this way is considerable. This direct method of burning waste has its advantages, but it is proposed by others to establish large briquetting establishments to compress the waste in fuel bricks for common household and factory use.

The amount of burning material found in a varied collection of this nature is sufficient to justify one in undertaking to briquet it for fuel purposes. A large percentage of this waste is of woody fiber, ground paper and cloth, pulverized soot of coal and wood, vegetable fiber of all kinds, and general miscellaneous rubbish that will easily burn. All of this material

* From *Power*.

when saturated with moisture in a steaming vat, mixed with a small percentage of coal dust gathered from the local coal bins and yards, and then compressed and held together with a good binder, makes a fuel which gives a strong and continuous heat whether used in the factory or mill furnace, or in the stoves and heaters of the private houses. This waste to-day is towed out to sea and dumped overboard, or burned in crematories which produce very little good. The question of briquetting it and making it of commercial use is one that must continue to grow in importance until something definite is accomplished in utilizing the material. At present the material could be obtained for the mere asking, and in some cities the waste would actually be gathered and carted to the briquetting establishment free of cost.

Our fuel problem is bound to assume a more acute aspect from now on, and it may not be many years before coal and oil will no longer monopolize the whole field as they practically do to-day. The gas engine is rapidly becoming a formidable competitor of the steam engine, but unless used as an auxiliary to a steam plant this engine must consume coal for generating its fuel. Numerous coal-saving devices are on the market, and also inventions for saving the gas and escaping heat up the flue. In fact, the modern trend of science and invention is toward the discovery of new methods to economize in fuel consumption. It seems as if the limit of these inventions was pretty near at hand, and that in order to make further improvements the inventors must turn their attention to the fuel itself. If no new fuel can be discovered in the earth's surface, it may be that new methods of utilizing the waste will make up for this. One of the best-known methods of economizing in the use of coal in parts of Europe is to briquet the pulverized portions of the fuel which could not otherwise be easily transported and burned. For years past, Germany and England have engaged very largely in the use and manufacture of coal briquets. The dust and waste of coal mines have always been enormous, and for years past much of this material has been allowed to accumulate at the mouths of the pits. It was not more than a decade ago that thousands of tons of culm went to waste near the coal mines. We have learned to use this waste to-day, and year by year we find new material to utilize in the same way. The briquetting of bituminous coal robs it of all its unpleasant smoke and soot, and makes it as easy of transportation as anthracite. In Germany the coal briquets are rendered almost smokeless and odorless, even when made of soft Silesian coal, because there is a preponderant amount of coke mixed with it.

Briquets of coal and coke in Germany are used extensively on the railroads, steamships, and in factories and private houses, and one rarely sees trailing clouds of smoke issuing from the chimneys. In 1901 the total output of the briquet factories of that country amounted in round numbers to about 1,643,416 tons. The average selling price was \$3.16 per ton, and the year before that \$2.92. Most of this amount was used at home either by railroads, mills, or German steamers, and a small proportion exported. The industry is one that has steadily increased, having doubled itself within five years. Most of these briquets in Germany were made from coal screenings, with a binder of pitch and inflammable material which cost three or four times as much as the coal screenings. In fact, it has always been found that a suitable binder is the most expensive part of the briquetting industry, and unless good supplies of the right materials are within reach it is useless to attempt the work.

From official sources it is learned that the total output of coal briquets of all the European countries averages nearly 20,000,000 tons. England and France are large consumers and makers of the briquets. French, English, and German steamships use it partly because of the economy of storage. When made in convenient sized bricks, the briquets can be stored away in the coal bunkers of the ships so compactly that there is little waste of space. That is of the utmost importance in ships which have a long journey to make, and in the case of men-of-war it frequently increases their radius of action from 10 to 20 per cent by virtue of their larger coal supply stowed away in the bunkers. A considerable number of the German and English steamers on the Asiatic stations have tried burning coal briquets, with perfect satisfaction to the companies. German capitalists have already negotiated to construct a briquet factory on the China coast, where they intend to furnish German ships with fuel made from the coal dust and screenings that are to-day practically wasted.

Coal briquets have only in recent years been manufactured in this country. There are several factories now in operation, but the demand for this form of fuel has been small and the popularity of it comes slowly. Inevitably, however, briquets must be used extensively here as in Europe, because economy in fuel is growing more urgent every year. We cannot afford to waste fuel as in the past. Business competition is surely making it apparent to all that the concern which ignores the small economies in fuel is paving the way to failure. Not more attention is given to machine inventions to-day in the industrial world than to the question of securing greater results from fuel. It is the study of the engineering profession to make each ton of coal yield a greater amount of work. Fuel economizers and feed-water heaters are but other names for saving the cost of producing power. "Slack coal," brown coal, peat and coal screenings, culm, and cheap grades of bituminous coal can be compressed into briquets, when the proper binding

material is obtained, which will furnish power and heat equal to the best anthracite. The only question that remains to be settled is whether the cost will enable the manufacturers to sell at a reduction. The coal-briquet plants so far established have adopted machinery for compressing the bricks that shows a decided improvement on the type in use in most of the European factories. It is admitted that most of the German briquet factories use from 8 to 10 per cent of binding material, and in some instance as high as 12 and 15 per cent; but the plants in the western part of this country have reduced the quantity of lime in the binder to 2 per cent and the pitch to 5 per cent. The presence of lime in the briquets in any large quantity is bound to have a deleterious effect on the furnace and flues, but it has been found to be necessary in order to harden the bricks so as to prevent rapid disintegration.

The briquetting of iron flue dust is a more recent enterprise than any of the foregoing, and it represents an industry that may have a far-reaching effect on the operation of our blast-furnace plants. The experimental work in this direction has more distinct promises for the future than it has in a record of past achievements. It has not yet arrived at the stage where it may be called an exact science, but on the other hand it has accomplished results sufficiently important to justify the erection of a number of briquetting plants. The manufacture of flue-dust briquets is an economical recovery of waste material, and the blast furnaces where the operation is carried on show an increased saving and profit. The amount of iron contained in the flue dust and the amount of lime required in the bonding agent, necessarily determine to a considerable extent the value of the briquets. The fine flue dust of the blast furnaces is very difficult to handle, except by means of improved machinery and methods of manipulation. It has been found necessary to install good dust catchers in the flue, and then by an endless chain system carry the hot material through a revolving screen to hoppers below. The briquet plant should be located near the large blast-furnace mill, so that the dust can be delivered promptly either while hot from the flue or in cars that can back straight up to the receiving bins. The flue dust is separated from the coke by means of the screens, and the latter is run back in the furnace, while the former goes to the briquetting plant.

When the flue dust is deposited in the receiving hopper of the plant it is thoroughly mixed by revolving blades, and carried by them to an inclined belt conveyor. The thorough screening and mixing of the dust prepare it for immediate contact with the bonding agent. There is a wide experimental use of bonding agents for iron flue dust, and different compositions of lime, soda ash, and salt and other ingredients are employed. Most of the bonds used are patented, and are kept secret by the briquetting companies. The first of the bonding agents put in a tank above the flue-dust bins consists of a certain proportion of salt and soda ash. After this mixture has been boiled, lime is poured in and allowed to slake, and the whole stirred continually for some time. This bonding agent must be made of the right thickness and consistency, and the success of the operation depends largely on the skill of the operator in securing the desired result in this direction.

The flue dust and the bonding mixture are allowed to flow together in a conveyor mixer, where through machine manipulation the two become a mass of stiff, sticky substance. Machinery then rolls, stirs, plows, and twists around this mixture of flue dust and bonding material until it is woven and mixed evenly throughout. It is absolutely necessary that the bonding agent should be manipulated so thoroughly that it is worked into every part of the flue dust, and this can be accomplished only through fine machinery invented for this purpose. After mixing it in this way, the machinery catches up the material and passes it through rolls under a pressure of 6,000 pounds. Once more it is stirred and plowed up, and passed through rollers again.

When it finally emerges from the last set of rollers, it is deposited in the big press pan, and then conducted as needed to the big presses. The material is cut up and pressed into molds by heavy pressure and then carried on a conveyor belt to the cars or storage yard beyond. The drying ovens are located not far off, and the green briquets are carried to them on specially prepared cars or by conveyor belts. The drying ovens are sometimes heated by the waste furnace gases, which are employed with considerable economy in this way. After the briquets are dried, they are ready for immediate use, and they are carried direct to the furnace. The machinery for conveying them to the furnace and loading them on transfer elevators for feeding the fires, is all of the ordinary type, and represents nothing new in the way of invention.

Briquetting fine flue dust is a peculiarly difficult work unless carefully handled. It is so fine that it will blow out of the hoppers or conveyor belts with the least gust of wind, and consequently it has to be protected continually throughout its entire course. The dust is hard and grinding, and its effect on machinery is much like powdered emery. The machinery made for handling it must consequently be of the best, and designed for the particular purpose. The mechanical points involved in the manufacture of the dust briquets can be better solved as more experimental works are established and operated for the commercial manufacture of the product. Where the blast-furnace mills are large, and their capacity sufficient to warrant the erection of a briquetting plant, the saving is quite

important. The larger the tonnage of the plant the less expense is involved in the process of manufacture.

As in coal briquetting, the binder is the most expensive material used, and the question of reducing this cost to the lowest medium is now in course of investigation. It is essential that the brick should be hard and compact enough to stand transportation and avoid rapid disintegration. When the right proportion of lime and salt is used the briquets are hard and solid, and break with a clean cleavage; but when lime alone is employed, or a large excess of salt, the briquets tend to break apart and crumble in dust, thus destroying their chief value. The salt must be added in sufficient quantity to prevent this crumbling.

In drying the dust briquets, the surface must be hardened by a gradual application of heat, or otherwise the outside shell hardens, and the inside remains more or less green and soft. If thoroughly and properly dried in the ovens, they can be stored indefinitely for use, and though the outside gets a coating of rust, no harm is done to them. This rust is due to the action of the air and salt in combination with the iron in the briquets. Briquets completely coated with this rust can be used without any apparent change in their general usefulness.

The value of all fuel briquets must be ascertained by actual tests in furnishing a steady and continuous heat in the ordinary furnace. Experimental tests which do not take into account the modern furnace conditions of mills and factories are of little practical value. The use of briquets only in specially-prepared furnaces will hardly prove of sufficient importance to warrant their commercial manufacture. The briquets must be able to take the place of coal or other fuel, so that a change from one to the other will not presuppose a change in the burning apparatus. In the case of oil fuel, the changes demanded in the grates are imperative, and are necessary to the proper use of this liquid as fuel; but the plant which has once had its grates fixed for oil burning can easily change back to coal within a short time. This installation of coal and oil burning grates marks one of the changes of the day, and tends to give plants a better assurance of sufficient fuel in the event of strikes or delays in transportation of oil fuel. It would hardly be considered economical to make any further changes in the burning apparatus to suit another fuel, and briquets of any kind must therefore accommodate themselves to the conditions of the present grates. This they seem to be able to do, and the various plants are gradually increasing their output and the quality of their briquets.

LEATHER FROM WALRUS SKINS.*

By CHARLES H. STEVENSON.

FORMERLY the principal use of walrus hides in Europe was for the rigging of vessels, for which it is especially adapted. For many years nearly all the rigging of vessels on the north coast of Norway and Russia was made of this article. The skins were also employed for protecting the rigging of vessels from chafing. Later came their use in northern Europe for manufacture into harness and sole leather.

Then the thick, heavy leather was adopted by silversmiths and other manufacturers of bright metal objects, for removing marks and scratches and to polish fine metal surfaces. The hide is particularly desirable for this purpose because of its peculiarly tough grain. It is usually cut into circular shape, forming a wheel of solid leather, but sometimes a ring of leather is cemented to a wooden center by which it may be attached to a revolving head or mandril. Other than that made from bull-neck, buffalo, or sea-lion hides, there is no satisfactory substitute for walrus leather for these purposes. The thickest parts of the hide are the most valuable, and the demand at the present time is quite large, the principal silver works of the United States and Europe making use of it. The London value of an average hide suitable for polishing purposes is in excess of \$100.

About 30,000 pounds of tanned walrus hides are imported into the United States annually. The import value is about \$25,000 and the selling value after it is cut in the form of wheels is from \$40,000 to \$50,000. The quantity used in Europe is probably double the amount of the importations into this country. A small quantity of walrus hide has been tanned on the Pacific coast of the United States, but the quality of the output is reported as inferior to that prepared in Great Britain. As shipped from the tanneries, the "sides" weigh from 30 to 200 pounds. The cub sides weigh from 30 to 40 pounds, measure from 1/4 to 1/2 inch in thickness, and are worth about 30 cents per pound. The largest sides weigh from 180 to 200 pounds each, are 1 1/2 to 2 inches thick, and sell for \$1 to \$1.25 per pound. The average sides weigh 80 or 90 pounds, are 3/4 to 1 inch thick, and sell for 60 to 70 cents per pound. Of course, when cut into circular shape these are sold at very much higher prices. The average price paid by metal-workers in this country is probably between \$1 and \$2 per pound, and for the very thick hides as much as \$5 per pound has been paid.

Another use to which tanned walrus hide is put is as covering for the rollers used in ginning long-staple cotton, such as Sea Island or Egyptian. This is a comparatively recent use, yet probably 6,000 pounds are consumed in the United States annually in this manner. The tanned hide is cut into thin strips and attached to the surface of the roller, entirely covering

* Extracted from United States Fish Commission Report for 1902.