

water is measured automatically by a proper apparatus. We have already referred to the meter pump, which regulates, measures, and samples the ventilating air currents. We have also referred to the cooling apparatus.

For each experiment, which usually occupies several days, a diet is selected such as has been found by previous experiments to meet, as nearly as may be, the needs of the person under experiment. Most of the materials, and specially the meats, are prepared in advance, and are kept in cans after sterilizing, if necessary. In putting up bread for use, the crust is removed and the crumb is cut in small pieces and likewise canned. The butter is carefully weighed and put in small cups, and everything else is done in the same way. Samples of everything are taken for analysis. The determinations made are in general for water, carbon, hydrogen, nitrogen, ether extract, ash, and heat of combustion. A careful measurement and analysis is made of the excretory products. In the first or preliminary period of four days these analyses are made, the data sufficing for a digestion and nitrogen metabolism experiment, and on the evening of the fourth day the subject enters the respiration chamber, although the actual respiration calorimeter experiment does not begin until seven o'clock on the morning of the fifth day. A night's sojourn in the apparatus suffices to get the temperature of the air in the apparatus and its content of carbonic acid and water in equilibrium, so that accurate measurements may begin with the morning of the fifth day and continue until seven o'clock on the morning of the ninth day, thus making the duration of this experiment exactly four days. The man weighs himself on a small Fairbanks platform scale specially made for the purpose.

The report of the Storrs Agricultural Experiment Station, and also the reports of the Department of Agriculture, are filled with most interesting tables giving the results of the various experiments, which we cannot reproduce here. In our SCIENTIFIC AMERICAN SUPPLEMENT, Nos. 1210 and 1212, further information on food experiments will be found.

The following is a summary of the results of certain experiments. The purpose of the preliminary period of four days was to bring the body into at least approximate nitrogen and carbon equilibrium with the food and to make the determination of the amounts of nutrients absorbed as nearly accurate as practicable. The income and outgo of the nitrogen were determined during this period, which thus amounted to a digestion and metabolism experiment. The metabolism of nitrogen, carbon, hydrogen and energy was determined during the final period of four days. In one of the two experiments the man had as little muscular exercise as he could well have with comfort. In the other he was engaged in quite active muscular exercise. The external muscular work was expended in driving a dynamo which produced an electric current. The latter was passed through a resistance coil, and the energy was transformed into heat which was measured with that given off from the body. The difference between the income and outgo of energy as measured in these two cases was 3.2 and 1.1 per cent, and averaged 2.2 per cent. The amount of energy as measured was in each case less than the theoretical amount of potential energy in the material consumed. On the whole, the theoretical amounts of energy transformed and those found in the experiments is as close as could be expected under the circumstances. The experiments do not demonstrate completely the conservation of energy in the normal organism. They do, however, approach very closely to such demonstration.

The study of human nutrition is very important, and it is expected that in time, with the aid of the experience thus far gained, apparatus may be planned for experimenting with small animals, as sheep and dogs. If in turn this effort should prove successful, the next step will be to devise apparatus and methods for experiments with larger animals, such as horses, oxen, and cows. It may be asked what is the advantage of such minute and painstaking experiments, which are, necessarily, carried out at great expense. There are really few problems of more importance than that of nutrition, either as relating to man or animals. A better knowledge of these laws with reference to animals is needed as a foundation for proper understanding of practical problems which the farmer has to meet in the feeding of his stock.

The work of Prof. Atwater and his able assistants is being watched with interest by those who appreciate the serious and important nature of economic problems.

ACCORDING to a recent Consular Report, there are eighteen locomotive factories in Germany; fifteen of them build full-sized locomotives, and three build engines for light railways, steel works, etc. The total output of the factories is 1,400 per year. The combined working force is more than 15,000 men. German locomotives are exported to nearly every country in Europe, and also to some extent to Asia, Africa and South America. Up to the present time no locomotive from the United States has entered Germany.

Correspondence.

Use of Scientific Terms.

To the Editor of the SCIENTIFIC AMERICAN:

Is it not a matter of some surprise that modern scientific writers still cling to the use of obsolete names? Take for instance the term "Carbonic acid," or as it is sometimes written, "Carbonic acid gas," for the compound now more properly designated as carbon-dioxide, whose symbol is CO_2 . Chemists have entirely discarded the use of the former names as being inaccurate, and now apply only the latter. There is, of course, another compound formed by the union of carbon-dioxide and water, which is the true carbonic acid. Its symbol is H_2CO_3 . While difficult or perhaps impossible to isolate on account of its extreme instability, it is as positively known to be an acid as nitric acid or sulphuric acid, since from it are formed the primary and secondary carbonates of the metals represented by MHCO_3 and M_2CO_3 .

Authors of late texts in chemistry all recognize this important distinction; but such writers as Gage, Hopkins, Carhart, Chute and others, in their works on physics, and Tarr, in his otherwise admirable text on elementary geology, do not seem to have paid much attention to it. Some, or it may be all, of them recognize the modern name carbon-dioxide, but they still cling tenaciously to the use of the old.

Would it not be better for all scientific men "to mind the same thing" and be strictly accurate? Science is nothing if not truth.

W. B. BONNELL.

Wesleyan College, Macon, Ga., July 11, 1899.

Protection Against Electric Storms.

To the Editor of the SCIENTIFIC AMERICAN:

At the present time there seems to be much said about tornadoes, or electrical storms, and their great destructiveness, and as I have given considerable thought to this subject for many years past, I believe that much can be done to lessen their disastrous effects.

As long ago as 1855 I began the study of atmospheric phenomena, and studied in various ways the atmospheric currents, electric and otherwise, for a number of years, with the view of establishing a weather bureau.

In the year above referred to, I was in Minnesota and observed one of these electrical storms in operation; it was on the west of the Mississippi River, and had evidently come from a long distance. It passed through a primitive forest of immense growth just before reaching the river, and every tree, for nearly 1,000 feet wide and as far as I could see, was leveled to the ground as completely and evenly as though felled by the woodman's ax. I also noticed that this storm did not cross the Mississippi, but when it reached the stream it disappeared, the timber on the other side of the river not being disturbed at all.

In my studies since that time I have been more and more convinced that whenever these electrical storms reach large bodies of water they become dissipated—the electric current being taken up in the water. I have known small streams to be entirely dried up, and the water taken from them, when the water was not in sufficient amount to take up the current.

Observation from that day to this has led me to conclude that partial, if not full, protection to cities and towns can be obtained by the erection on the west and southwest of large copper or other metal conductors, strung upon steel or iron poles, and at intervals sunk deep into the earth—where water can be reached—these heavy electric conductors preferably of copper. When an electrical storm strikes these conductors, it will be taken up, as is often the case in telegraph lines, where I have known dozens of poles to be torn to pieces by one flash of lightning, while if made of steel and occasionally connected deep into the earth with water, the current would have been carried away and the damage averted.

Another and perhaps more effective method of carrying off these great bodies of electric currents contained in what is known as "whirlwinds," which form the worst kind of cyclones, would be to bond the rails of railways with copper—the same as electric railways for return currents—and occasionally sinking hundreds of feet into the earth (if need be to reach water) large copper or other metal conductors. This could easily be done without injury to a railway, perhaps at the expense of the county or State. The railways running in a line nearly north and south would be the most likely to absorb these currents, as nearly all tornadoes come from either the west or southwest, and where crossing these lines would be absorbed and conducted silently and harmlessly into the earth. Scarcely any railway extends very long distances without crossing either bodies of water or points where water can be reached; and if the conductors from well-bonded rails reach water, even many miles from the point where an electric storm strikes, it would be absorbed and carried to that point; but the more frequently water could be reached, the more effective would be this method of carrying away surplus electricity causing these storms.

It will be noted that this is only on the principle of the lightning rod—too many of which are defectively installed.

In this connection it will be understood that it is just as important to sink large conductors deep into the earth along the line of railways or other metal used as an electric conductor, in order to reach moisture, otherwise such bonding would not convert the railway into a safety guard any more than the ordinary electric road of to-day, which seldom has and does not so much need deep ground connections.

Pasadena, Cal., July 7, 1899.

T. S. C. LOWE.

THE PEARL-BUTTON INDUSTRY OF THE MISSISSIPPI RIVER.

BY HUGH M. SMITH.

The business of making buttons from the shells of our native fresh water mussels is of quite recent origin, but has already reached comparatively large proportions and seems destined to have further growth. The fear is entertained, however, that, through indiscriminate fishing methods, the supply of mussels may be so seriously reduced that the continuance of the industry may be imperiled. The possibility of the early exhaustion of the mussel beds in that part of the Mississippi River which is in Iowa and Illinois led a number of interested persons to request the United States Fish Commission to make an investigation of the subject, as that is the section in which the business is more extensive and has been longest established. A comprehensive report* on the industry which has been prepared by the writer is about to be published by the Commission.

The manufacture of buttons from the shells of native fresh water mussels began in the United States in 1891, the inauguration of the business being made possible by the high duty on imported buttons imposed by the tariff bill of 1890. The first person to engage in this business was Mr. J. F. Boepple, who had for many years been similarly engaged in Hamburg, Germany. On account of an abundance of suitable mussels in its vicinity, Muscatine, Ia., was selected as the site of the first factory and has now become the leading center. Other towns on the Mississippi and its tributaries from time to time established works, until in 1898 there were twenty-one communities in Iowa and Illinois in which buttons were made. A remarkable development of the business occurred in 1898, no less than thirty-six factories being established during the first six months of that year. Button making has now become one of the principal businesses along a section of the Mississippi nearly 200 miles in length between Fort Madison, Ia., and Sabula, Ia. It gives employment to large numbers of people at what are considered good wages for such labor. It also supports a very important fishery, at which many hundred persons make a living. Another important feature of the Mississippi River button industry is the transformation of a hitherto useless product into a valuable commodity, which is placed on the markets at reasonable prices.

There are about 400 species of mussels found in the Mississippi River and its tributaries, but comparatively few are now utilized in or are adapted to button making. The requirements of a shell, from the button maker's standpoint, are sufficient thickness, a uniform color of the surface and various strata of the shell, and a degree of toughness that will withstand the necessary treatment without cracking or splitting. Thin-shelled mussels are absolutely useless for button making. Even if originally as thick as a button, the necessary grinding and polishing reduce them to mere wafers. The preferred color is white, but cream-colored shells are also employed. Shells with pink, purple, yellow, or salmon-colored nacre are not suitable, as the color fades with age and is apt to be not uniform. Certain shells that satisfactorily combine thickness and color are nevertheless useless, because they are soft or brittle and break easily during manufacture.

Coincident with the establishment of the button industry in Iowa and Illinois, there has arisen a new popular nomenclature for the mussels or "clams" utilized. The names applied by the fishermen and manufacturers have some reference to the color or shape of the shells. Originally quite local, they are now generally applied throughout the whole stretch of the river in which fishing is done.

By far the most important species of mussel used in button making is the "niggerhead." It has the general shape of the quahog or round clam, and is characterized by a very thick and heavy shell, with a black or dark brown outside skin and a glistening white interior, the latter color being uniform through the thickness of the shell. It is of relatively small size, the maximum being only $4\frac{1}{2}$ or 5 inches for the greatest outside diameter, and the average about 3 inches. It is often found in immense beds, preferring muddy sand and muddy gravel bottom, but also frequenting sandy bottom. About a dozen other species are utilized. The principal, in the vernacular of the region, are the "sand shell," the "mucket," the "deerhorn," the "butterfly," the "bluepoint," and the "pocketbook."

* The Mussel Fishery and Pearl-button Industry of the Mississippi River. Bulletin of the United States Fish Commission. 1898. 96 pages, 24 plates.

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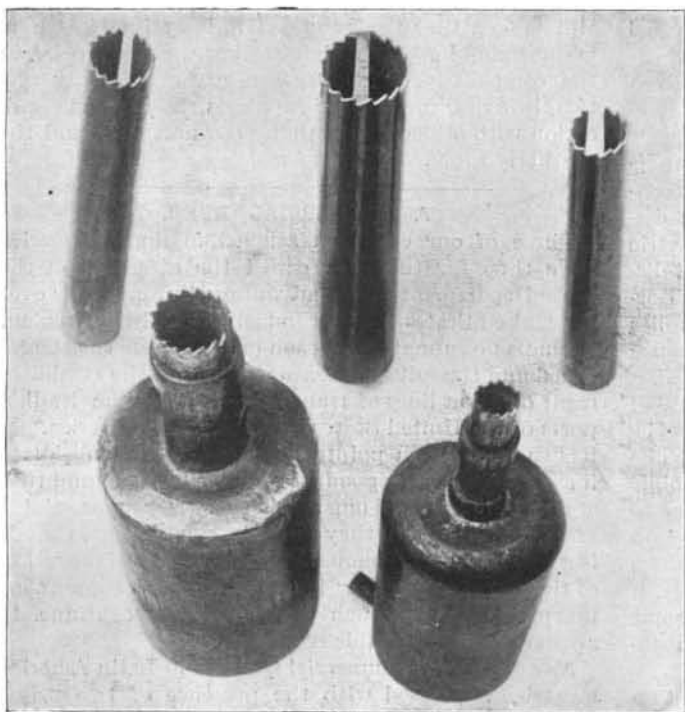
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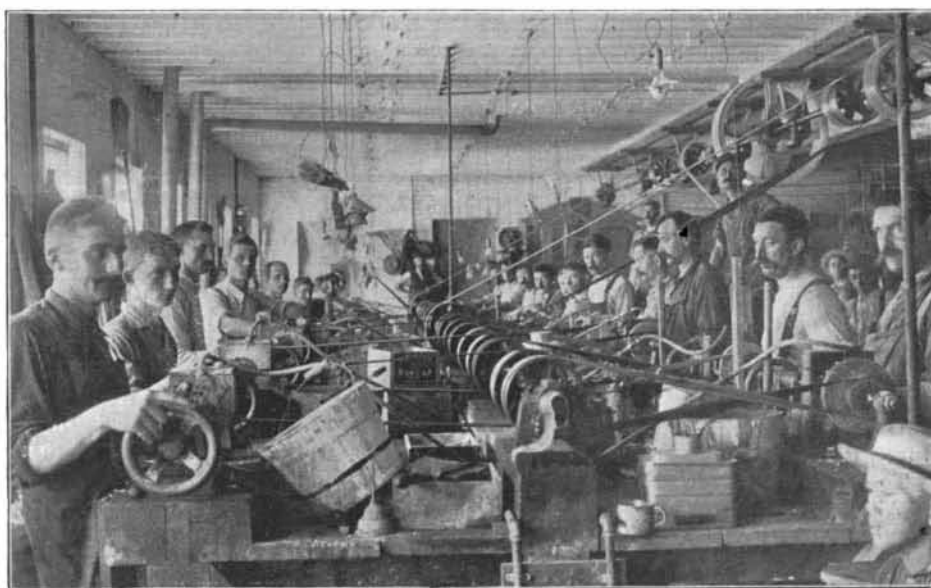
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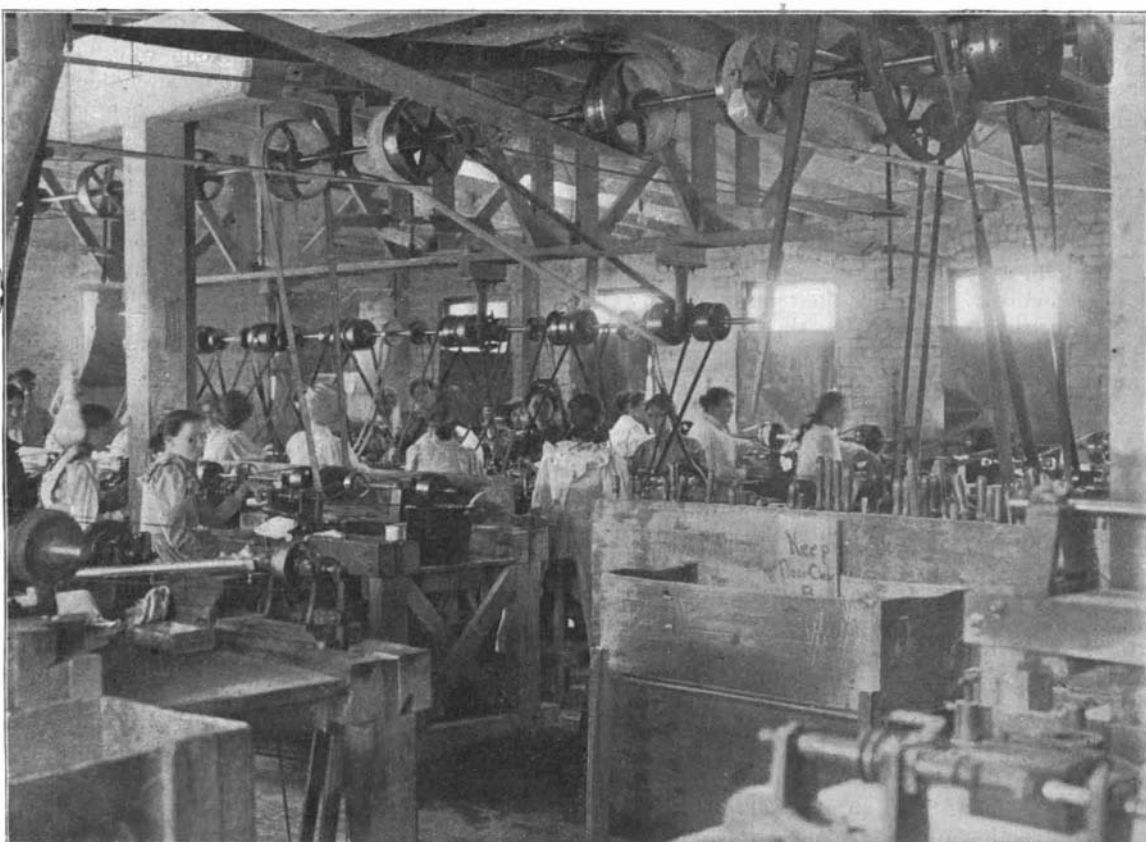
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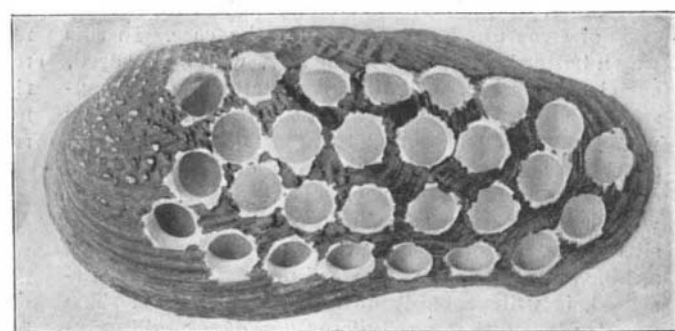
Mussel Fishing through the Ice, Mississippi River.



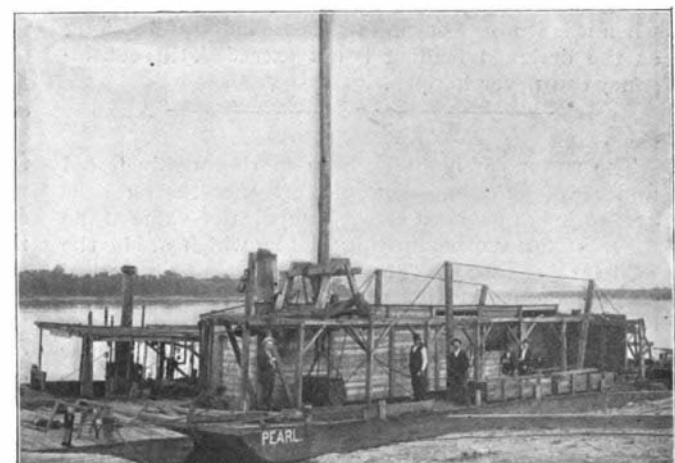
Sawing Rough Blanks for Buttons.



Drilling Holes in the Buttons.
THE PEARL-BUTTON INDUSTRY OF THE MISSISSIPPI RIVER.—[See page 86.]



"Deerhorn" Mussel with Blanks Cut Out.



Steam Dredge for the Mussel Industry.

Owing to the comparatively shoal water in which mussels are found, they may be gathered with less difficulty than is ordinarily encountered in takings shellfish. Furthermore, the shoalness of the Mississippi makes every part of it accessible to the fishermen and renders the exhaustion of the beds more certain, speedy and complete.

Mussels are obtained with various kinds of apparatus. Those which have been or are now in use are the hand rake, the tongs, the rake hauled by means of a windlass, the dredge operated by steam, and the bar with hooks. The last named, a very ingenious contrivance, came into use in 1897 and has largely superseded other appliances. It consists of a circular iron bar, 6 to 8 feet long, with from thirty to fifty-four pronged wire hooks attached at regular intervals in strings of two or three hooks. This apparatus, which is used from a small boat and is hauled over the bottom by means of a rope, depends for its action on the habits of the mussels. They rest on the bottom, or partly buried in the mud or sand, with the free margin of their shells turned up cream and with their shells separated to admit the water, laden with oxygen and food. When touched they quickly close their shells, and if a foreign body is interposed between the valves, it is tightly grasped and retained. Anyone who has not witnessed the use of this apparatus can scarcely realize how remarkably effective it is. Often when the mussels are abundant, almost every prong will have a mussel on it, and two or three are sometimes caught on one prong. When the beds of mussels are compact, one man can take 800 to 1,000 pounds of "niggerheads" in a day, and a case is reported where 2,200 pounds were obtained by one man in ten hours. The average daily catch at present, however, is probably not over 500 pounds.

After sufficient ice forms on the river, there is considerable mussel fishing through the ice with "shoulder rakes" and "scissor rakes." For the use of these appliances, under such circumstances, a hole two to six feet square is cut through the ice.

Throughout the river section mentioned, mussels are found in varying abundance. The natural tendency of some of the species is to form more or less dense beds, while others seem to be generally distributed. Considered as a whole, this part of the Mississippi River is undoubtedly one of the most favored sections of the United States, as regards abundance and variety of mussels adapted for buttons. The mussel beds are sometimes of great length, although usually quite narrow. One of the most productive beds was discovered near New Boston, Ill., a few years ago. It was about 1½ miles long and 60 rods wide, with the shells very thickly disposed. It is reported that fully 10,000 tons of shells, chiefly "niggerheads" and "muckets," with a few "sand shells," were taken therefrom during the past three years. The number of mussels represented by this enormous quantity was probably not less than 100,000,000. On some grounds, practically all of the mussels are of one species, while on others several species may be mixed in varying quantities. The largest and most compact beds are formed of "niggerheads" and "muckets."

It is estimated that in 1898 about 1,000 persons were engaged in taking mussels to sell to the button manufacturers along the Mississippi River, between Fort Madison, Ia., and Sabula, Ia.

The factories at which buttons are made are, as a rule, specially constructed two-story brick buildings, of considerable size, having a cost value of \$5,000 to \$30,000, which sum includes land, buildings, machinery, and general equipment. A few of them occupy parts of mills or machine shops. Some of the plants, at which only blanks are sawed, are also in special brick or wooden buildings, but most of the "saw works" are in connection with machine shops or in improvised out-buildings of private residences, some of the smaller ones being in simple sheds. A single room is sufficient for the mere sawing of the rough blanks, but the various steps in the manufacture of the complete buttons necessitate a number of rooms and make the factory a rather elaborate establishment, with the heavier machinery and rougher work on the first floor, and the different finishing processes on the upper floor. The daily capacity of the largest factories is 700 to 1,000 gross of finished buttons.

The essential work at all the factories is done by machinery. At all the larger and many of the smaller establishments, steam or electricity is employed; some obtain their electric power from the city electric plant, some have independent dynamos, some have steam engines, and some use the power of adjoining machine shops or mills. A gasoline engine, of two or three horse power, furnishes the motive power for the saws at several of the small works, and foot power is also employed in a few places.

Preparatory to being used, the mussel shells, as purchased from the fishermen, are sorted into sizes. Another preliminary step is the soaking of the sorted shells in barrels of fresh water for three to six days to render them less brittle. Even when only a few hours out of the river the shells become dry and brittle, and crumble or split under the saw.

The next step is the cutting or sawing of the rough

blanks. The shells are usually held with special pliers while being cut; these grasp the circumference of the shell and enable cutters to retain it fast while holding the shell at right angles to saw. Some sawyers have the hand gloved or mittened, and use no pliers or pincers. At the more extensive plants a fine jet of water plays on the shell, as the saw revolves, in order to prevent the formation of dust and to keep the shell cool. The dust is very irritating to the respiratory passages and eyes of the cutters, and at some of the factories the dust is drawn into a tube by a current of air. The cutters in the smaller works often cover the mouth and nose with a cloth.

The saws are of flat steel strips about two inches wide, and of various lengths corresponding to the sizes of the buttons. These strips, after being provided with fine teeth along one of the sides, are accurately bent into a cylindrical form and fitted into heavy iron holders; the latter are adjusted to a lathe in which they revolve on a horizontal axis. As the blanks are cut they pass back into the saw and holder and drop into a box beneath the saw.

The next step is the dressing or grinding of the back of the blank, to remove the skin and make an even surface. To accomplish this, each blank has to be held with the finger against a revolving emery wheel.

Turning or facing is the next step. This, which is similar to the preceding, gives to the front of the button its form, including the central depression. This is followed by the drilling of two or four holes for the thread.

The button is now complete, with the exception of the polishing process. This brings out the natural luster which has been lost in grinding and which gives to these buttons their chief value. The buttons are placed in mass in large wooden kegs, known as tumblers, in which they are subjected to the action of a chemical fluid at the same time that the tumblers are revolving on a horizontal shaft. By mutual contact, combined with the effect of the fluid, the buttons become highly lustrous, while the fluid is churned into a milky froth. After being washed and dried, the buttons go to rooms where they are sorted into sizes and grades of quality, and then sewed on cards and packed in pasteboard boxes.

In all branches of the button industry a gross is considered as consisting of 14 dozen, in order to make allowance for the imperfect or defective buttons that are liable to be produced at every stage of the business from the cutting of the rough blanks to the sewing of the finished buttons on cards. The unit of measure of the size of buttons is the line, which is one-fortieth of an inch. The buttons manufactured on the Mississippi are from 12 to 45 lines in diameter. The largest buttons (40 to 45 lines) are made from "niggerheads." Following are the quantities of various-sized blanks that may be cut from 100 pounds of average-sized "niggerheads": 16-line, 28 to 34 gross; 18-line, 30 to 32 gross; 20-line, 24 to 29 gross; 22-line, 15 to 20 gross; 24-line, 12 to 15 gross.

A large number of persons are employed at the button factories at wages generally regarded as good. Besides men, who have the more arduous and important duties, many boys and girls are given employment. At factories in which finished buttons are made, from 30 to upward of 200 people are employed, the males and females being in about equal numbers. The factories which simply produce the "rough blanks" employ only males, the number of whom averages only 14. The total number of factory employes in 1898 was about 1,450, to whom the amount paid in wages was approximately \$260,000.

It was apparent in 1898 that the button industry was being overdone by the establishment of numerous small factories at which rough blanks were sawed. Many persons engaged in the business without proper equipment or experience, and the very short life of some of the factories shows that the remarkable increase in the business in 1898 was not a healthy growth. Some of the output was not of standard quality, and a general lowering of prices was a result.

The prices received for rough blanks range from 10 to 20 cents a gross, depending on size and quality. The prices correspond rather closely with the sizes, an 18-line blank, for instance, bringing 18 cents a gross; but as a rule the prices are less than the figures representing the sizes of the blanks, being 1 to 3 cents "under the line." The average size of the rough blanks is 18 or 20 lines, and the average value per gross is 16 or 18 cents. The wholesale prices received for the finished buttons have been a little over double those of the rough blanks of the same sizes, or about 40 cents a gross.

The quantity of mussels utilized in button-making in 1898 was about 7,000 tons, having a cost value of \$72,000. The manufactured output consisted of about 2,250,000 gross of buttons and rough blanks, with a market value of more than \$500,000.

Although the mussel fishery is under ten years old, and in most places began within the past two or three years, it has already had a pronounced influence on the productivity of the mussel beds and bids fair to lead to serious consequences to the capital invested in

the button industry. Throughout this stretch of river, wherever fishing has been at all regular or active, there has been a more or less marked reduction in the abundance of mussels of all kinds utilized in making buttons and in some localities the depletion of the grounds has been almost complete. The many persons financially interested are very desirous that appropriate measures be taken to insure the existence of a substantial business of this kind. Suspension of the industry—which is not a remote contingency—would prove a calamity to many communities.

The history of the fishery up to this time shows the disregard for the future which has come to be regarded as characteristic of fishermen. The decrease in the mussel supply has been brought about by several practices, chief of which is the activity of fishing operations. Not only have large quantities of mussels been taken from the beds at one time, but the fishing has been so incessant that no opportunity has been afforded the beds to recuperate. The shoalness of the water has made it possible to thoroughly scour almost every foot of ground. The failure of the fishermen to suspend their operations immediately prior to and during the spawning season of the principal species of mussels has undoubtedly had a serious effect on the supply.

Not the least injurious feature of the fishery is the gathering of small mussels for market and the incidental destruction of small shells that are not utilized, but left on the banks or the ice to die.

The testimony of the button manufacturers, and the evidence afforded by their shell heaps, indicate that there are comparatively large quantities of immature mussels taken. This practice depends to some extent on the depletion of the grounds of the larger mussels, necessitating the gathering of the smaller ones to make a fair catch, but also on the indifference of the fishermen to the great injury thus done the mussel supply. The manufacturers are, of course, equally indiscreet in continuing to purchase lots of small shells, and a few of them refuse to do so, but it is generally not feasible to exclude the small shells mixed with the larger ones.

The effects of natural enemies and physical agencies on the mussel supply become more important when combined with the fishing operations. Animals which are known to prey on the mussels are muskrats, minks, raccoons, and hogs, the first and last being especially destructive. The freshets to which the Mississippi is periodically subject undoubtedly do great damage to the mussel beds, burying them under sand and mud. Shifting sand-bars are also known to cover up beds. The fishermen sometimes find extensive beds of dead shells which appear to have been recently uncovered by the current. During freshets, when the stream finds new channels, many mussels are carried from their beds and left dry when the water subsides. Droughts also are liable to expose mussel beds and cause much destruction. However, pollution of the water by refuse from cities and manufacturing establishments is perhaps the most serious menace to the mussel beds, next to the operations of the fishermen. Certain kinds of refuse are very injurious and are capable of killing practically every mussel with which they come in contact.

If, therefore, the button industry of the Mississippi is to be maintained, it seems essential that the States interested should promptly take joint action to prevent the gathering of small mussels, to give some protection to the principal mussels immediately prior to and during the spawning season, and to prohibit the running of factory and other refuse on the mussel beds.

Melting Babbitt Metal.

In many shops it is customary to melt babbitt metal in the smith's forge—a very wasteful and vicious method, when it is considered that the forge gives too intense a heat for properly melting babbitt, and that babbitt metal injures the working of the forge whenever any of the metal finds its way into and remains in the tuyere. Lead there will effectually prevent the welding of iron as long as it is exposed to the action of the vapor of the lead. A much better way, and a cheaper one, is to rig up a little gas bench for the melting of small lots of babbitt. When a quantity of it is to be handled, a furnace similar to that used for melting out—and melting in, too—the lining of axle and motor boxes will do. But the gas bench is made of one or two heavy gas burners similar to those used in kitchens for cooking. They are placed in an iron bench, and proper iron bearers rigged for holding the ladles in place. With this rig the heat can be regulated at will, and there is no danger of melting out the bottom of the ladle before the workman is aware it is even red hot and before the babbitt is fairly warmed through.—James Francis in Street Railway Journal.

At the State camp, Peekskill, N. Y., it is stated that light portable furnaces in which almost any substance can be cremated in a few seconds will be tried, instead of latrines. No sinks will be dug. It is thought that if the experiment is successful, it will revolutionize military camps and obviate the outbreaks of typhoid fever which are so prevalent in military camps.