of the drum has holes, *d*, through which air enters the ash pan below the grate.

An outer case, I, forms an annular space entirely surrounding the regenerator and drum. The upper part of the case conforms in shape to the plate, A, and closes up with the outer edge of the base, N, which carries concentric flanges that descend into the outside corrugations of the plate, A. These flanges and the outside case form a continuous air space, by which a current of air entering near the top of the cylinder is made to flow over the surface of the cylinder, the upper surface of the regenerator, the outside surface of the furnace case, G, and enter the ash pan through holes, *d*, to feed the fire as before mentioned. This is an entirely original feature, and has a series of remarkable functions to perform. The first effect of this current of cold air is to come in contact with the cylinder, keeping it cool; from this it passes to the somewhat warmer plate, A, keeping its temperature down also. After this it passes over the furnace casing, still warmer from the escaping furnace gases, and keeps its temperature down also, and finally enters the ash pan laden with heat, thus stimulating the fire by heat thrown off from the cooler parts of the engine. This constitutes a regenerating feature that can be carried to an indefinite degree of refinement.

We will now explain the duties performed by the other parts of the engine. A fire being built, the plate, A′, becomes quite hot in the center, the heat being less intense toward its outer edge. The lower part of the diaphragm also becomes heated, as do the lower layers of wire cloth and the upper layers to a less extent. If now the diaphragm be caused to move up, the air above it, which is cool, will be made to pass over the inside of the upper plate, A, and down through the wire cloth, becoming heated more and more as it passes through the more highly heated layers; thence over the outer part of the plate, A′, which is still hotter, and over its inside surface, gradually increasing in temperature until the greater part of the air reaches the center of the plate next to the fire. By these means the air is gradually but rapidly heated, causing the pressure to rise and force up the piston.

When the stroke is completed, as the crank turns the center, the diaphragm is made to descend, and the heated air is made to pass back again, coming in contact with the surfaces, and, being hotter, it gives off heat to them. As its temperature is reduced, it comes in contact with still cooler surfaces, and is thus gradually but rapidly cooled, until the pressure falls below the atmospheric pressure, by which the working piston will be driven down again.

These successive movements of working piston and diaphragm are produced by attaching each to a crank movement that is at right angles or nearly so with the other, so that while one is passing the center and moving slowly, the other is moving rapidly, and *vice versa*. As these operations are repeated upon the same body of contained air in the engine, and no air is supposed to escape or be introduced, there is no necessity for induction or eduction valves, and the only valve used is a small one operated by the governor, that keeps the speed uniform, by allowing a small quantity of air to pass in order to keep the engine down to a given rate of speed. It will be seen that, as the air passes back and forth in the regenerator, it gives up heat to the surface and in turn receives it back from the surface again.

It is a somewhat singular peculiarity that the change of the direction of the movement of the diaphragm changes at the same time the functions of the entire engine surface (except a very small portion of the extremes of the hot and cold parts) from heating to cooling, and *vice versa*; that is, when the movement is such as to cause the air to be cooled, then almost the entire surface of both plates, diaphragm, and all the regenerating surface becomes cooling in its effect; that is, the air brought into contact with any given surface is hotter than the surface it is in contact with, and is cooled by the contact, and a reversal of the motion brings about an exactly contrary state; that is, the air in every part of the engine is cooler than the surface in contact, and is consequently heated by the contact. The whole action is regenerative, and the only heat not converted into power is what escapes up the chimney and what radiates from the engine, which by proper means may be reduced to a minimum exceedingly small; but, owing to the surrounding current of cool air, the engine throws off but little heat.

The concentrically corrugated plates can be constructed in this form of any desired size, without danger of buckling or breaking from unequal expansion by the heat, as they can expand radially and the curves of the corrugations will stop the expansion at each turn, while, on the other hand, the plate is greatly strengthened laterally.

There is no regulation of water level or pressure to look after, and no possible danger of accident to the attendant.

The engine is entirely self-contained, and needs nothing but a stove pipe connection to a flue to make it ready for fire and work. The cost of running is that of 40 pounds of soft coal per day for a one horse engine.

The manufacturers of this engine—the McKinley Engine Co., of 17 Broadway, Cincinnati, O.—claim that its strong points are safety, cheap first cost, cheap running expense, no increased insurance rates, and ready adaptability to any kind of work.

THE LEMURS IN THE BERLIN ZOOLOGICAL GARDEN.

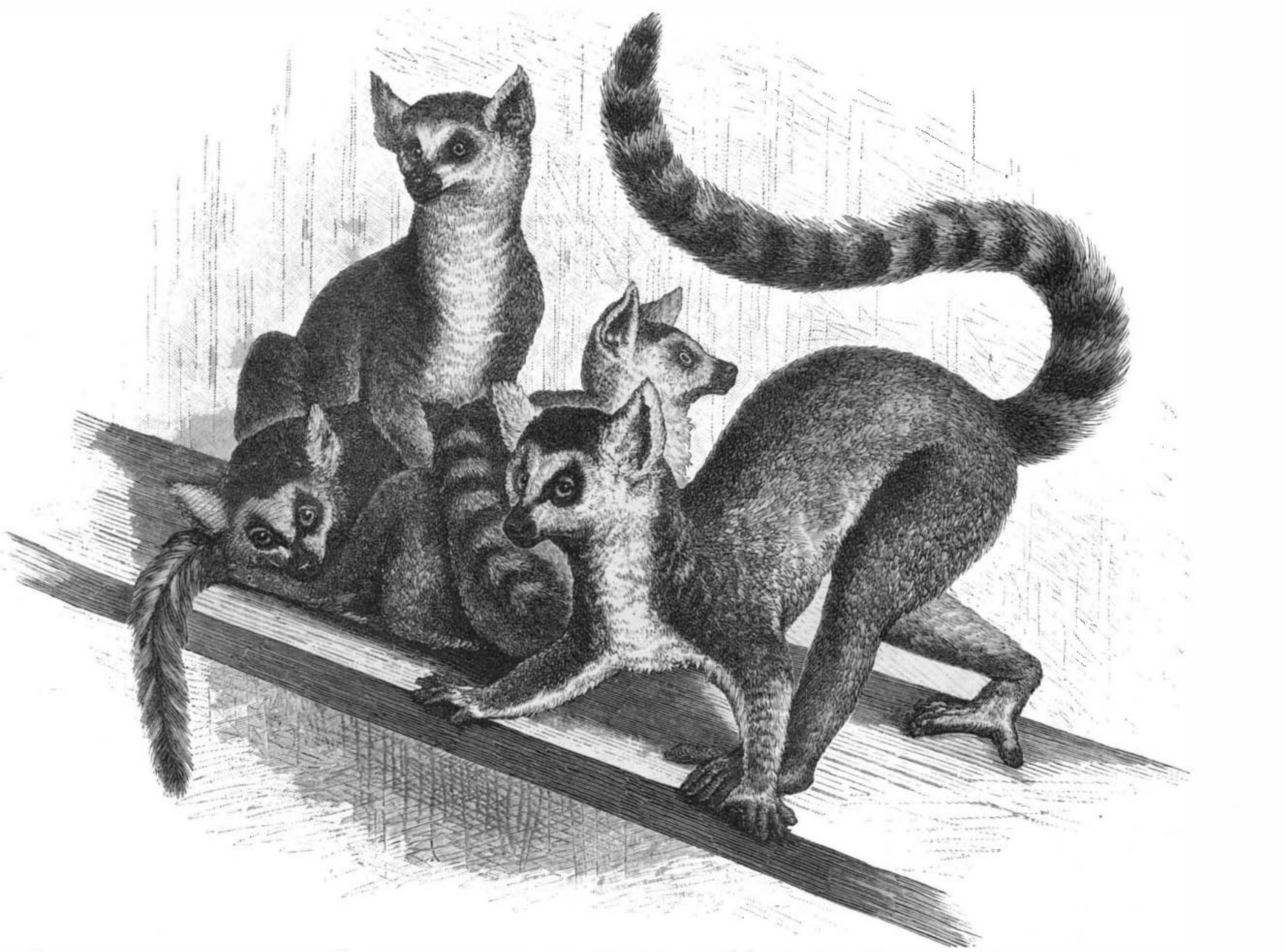
The Romans used to call the souls of the departed "Lemures," but they respected the good ones as household gods, or "Lares," while they feared the bad ones as restless, malicious ghosts and hobgoblins that wandered about in the night.

Science designates the lemur as the first family of half-monkeys, or that group of animals that can be considered as a connecting link between quadrumanous animals and gnawers.

The lemurs represented in this drawing from life are supple and bright creatures, and in their manners they remind one somewhat of monkeys, martens, and squirrels, but in certain positions they are very much like a kangaroo. The similarity is based upon the strongly developed extremities of the hind legs, which measure much more in size than the fore legs.

The *Lemur catta* has a length of from 85 to 90 cm., of which 35 to 40 is the body, and the rest is the tail.

The color of the fine wooly fur on the back is a grayish brown, with a tinge of red here and there, while the face, ears, and front part of neck are almost white; the only coal black coloring is seen around the eyes, on the nose, and on the forehead.



THE LEMURS IN THE BERLIN ZOOLOGICAL GARDEN.

The black and white curved tail is quite graceful in its shape, and it is by no means a useless appendage, for in springing and jumping it serves as a rudder and balancing pole, while it serves as a stool in sitting.

When the animals huddle together at night, they twist their tails around each other, forming a sort of net about those who are sleeping.

The hands are nicely formed; the inside is deep black, while the outside corresponds to the color of the body; the fingers are exceedingly dexterous, for they pick up the smallest insect or piece of straw with great ease; they turn fruit over on all sides with the greatest rapidity, and eat it gracefully, always dropping out the unsavory portions.

Sociableness is a life necessity of our lemurs. Left alone, they become cross and soon die, while company makes different creatures of them. Then they are always merry, and chase each other around in the cage, springing among each other like monkeys, with their roguish tricks.

Most of the varieties of lemurs live in the woods of Madagascar that are the fullest of insects and fruits; they are also seen on neighboring islands, and go around nights after prey, screeching like our house cats when they mew very loud.

Modifying the Climate by Closing the Straits of Belle Isle.

A suggestion was made by me, and published in the SCIENTIFIC AMERICAN of October 31, 1885, that the climate of the North American coast could be modified by shutting off a great portion of the "cold wall"—that southerly current which now washes our shores, and flows between us and the warm currents of the Atlantic, and reduces the normal temperature of our coast.

In this article we intend to refer briefly to some of the objections that have been raised against this plan.

It is conclusively shown by our charts that the great body of the cold wall comes down to us through the Straits of Belle Isle. Newfoundland deflects the remainder of the Arctic current to the southeast. Here, pressing against the Gulf Stream, it veers it southward in the form of a loop, and, finally, running under it, goes on toward the equator.

The Gulf Stream flows through the Straits of Florida; the main body—the portion that passes our shores—has a course directly north and a little west, is deflected slightly to the east by the coast of South Carolina, then North Carolina; it thence turns more to the north again, when it is deflected by the cold current returning from the pole. When this cold current is of least strength, as in August and September, the Gulf Stream comes within 10 miles of Barnegat; at other times it is distant 120 miles, changing with the amount of this cold current and the wind.

The location of this Gulf Stream in the Atlantic Ocean varies by 300 miles.

One branch of the Stream passes to the east, and, circling the Saragessa Sea, forms the great equatorial current.

It has been stated the Gulf Stream cannot be changed, because the difference in the specific gravity of the polar and tropical oceans causes this mighty flow of water.

In changing this current we take it as we find it, and have little to do with its first cause; but as the specific gravity theory is used against us, let us consider whether it is true. Lieut. Maury advanced that theory in his very interesting "Physical Geography of the Sea." Later, he stated that the sea was held in exact equilibrium by this same specific gravity, and still later that it was the great retarding force that prevented the currents from flowing with "milltail velocity toward the pole, covering the intervening sea with a mantle of warmth as a garment." His disciples should have followed him to the end.

Let us consider this question of specific gravity.

The water is much more salt, and consequently heavier, at the equator than at the pole. Provided both were at the same temperature, the water at the equator, being the heavier, would sink to the bottom of the ocean, and the fresher water of the northern sea would then flow down over its surface. The water would then obtain an equilibrium, and remain without current. In arriving at this condition of things, it is evident that the surface current would go toward the equator, and the under or salt current would go toward the pole. The under (salt) current becoming freshened by melting snow and ice would rise, and we have the surface current going south and the under current north.

But we have another element to consider, viz., heat. The waters about the equator are heated to a temperature of about 84° Fah. This is the equatorial surface current.

Now, we know that salt water when heated expands, has less weight per cubic foot than fresh water has when cold, and that the fresh water, which would have a tendency to flow on the surface toward the equator, by the sinking of the salt water in that region from its greater weight, by the action of heat is prevented from doing so by the expansion of the salt water at the equator. This would cause equatorial waters to flow toward the pole, if any motion was caused at all, and these two forces oppose each other.

Comparing the soundings as given by Captain Nares with the tables of the expansion of sea water under different temperatures as experimentally determined by Professor Munch, and as given by Professor Croll, of Edinburgh, in "Climate and Time," the amount of expansion from heat, we have only 4 feet 6 inches as "the height to which the level of the water at the equator ought to stand above that of the poles, in order that the ocean may be in static equilibrium."

The distance from the equator to the poles is 90°—say 5,400 geographical miles, or 6,20) statute miles. Experiments of M. Bubuat show that where the fall is less than one in one million, no motion in water can occur. This would require a height of 32 feet at the equator before the slightest motion in the form of a current could take place. But the facts are, as given by the Challenger expedition, that at the equator the water is 3½ feet lower than it is at 38° north latitude.

If this be true, can gravitation drive the water from the equator to the North Atlantic?

Sir John Herschel limits the gravitation theory to the possibility of a trifling surface drift.

Maury says: "Some currents of the sea actually run up hill, while others run on a level. The Gulf Stream is of the first class." He also says that "the greater density of the waters of the Gulf of Mexico over those of the Polar Sea is the cause of the Gulf Stream," and that "the difference in temperature between the tropical and polar regions assists as a cause."

As this difference in temperature tends to make the tropical waters lighter, it practically annuls the effect of the difference in saltness; it must retard, not assist.

As we go toward the equator, the water becomes warmer, and at the same time salter and heavier; the increasing temperature compensating for the increasing specific gravity.

The theory also maintained, that the diurnal motion of the earth is the cause of the Gulf Stream and the cold Labrador current, as stated by Maury, is as theoretical as his statement that water runs up hill or that railroad trains are in the habit of selecting particular points of the compass when they run off the track.

If the Gulf Stream is caused by gravity, or weight, it must be running down hill; and the higher center, "roof shape," as Maury describes it, indicates that the mass is impelled by a *vis a tergo*.

Water forced into an estuary or through a narrow channel is higher in the middle than on the sides, but on the falling tide its surface is concave; the same is true of a rising or falling river, or of the mercury in a barometer.

That the Gulf Stream itself, and particularly its southern branch, which joins and returns as a portion of the great equatorial current, force their way squarely against the effect of this diurnal motion is well known. We have abundant record that the climates of the earth and the currents of the ocean have seen many changes since the creation of the world; and that the changes have been largely due to changes in the great ocean currents seems evident.

One other point about which doubt is expressed is that of the heating power of the Gulf Stream.

The estimate of the volume of the Gulf Stream as given by Maury is that it is 32 miles wide, 1,200 feet deep, going at the rate of 5 knots an hour, or 6,165,700,000,000 cubic feet per hour.

Sir John Herschel's estimate was 30 miles wide, 2,200 feet deep, going 4 miles an hour, or 7,359,900,000,000 feet per hour; Dr. Golding's, 5,760,000,000,000 feet per hour.

Prof. Croll took the stream as 50 miles broad, 1,000 feet deep, and 4 miles per hour. In order to bring his estimate beyond any possible objection, he reduced it one-half. He assumed the entire mass of the Stream started at a temperature of 65° and returned at 40°, making the loss of heat 25°; and this he claims to be an underestimate.

Each cubic foot of water, in this case, carries for distribution 1,158,000 foot pounds of heat.

According to the above estimate, 2,787,840,000,000 cubic feet of water are conveyed from the Gulf Stream per hour, or 66,908,160,000,000 cubic feet daily.

The total quantity of heat thus transferred per day is 77,479,650,000,000,000,000 foot pounds.

This amount of heat equals all that falls upon the earth within 32 miles of each side of the equator—a belt 64 miles wide around the earth.

Comparing the quantity of heat conveyed by the Gulf Stream with that conveyed by the atmosphere, the density of air to that of water is as 1 to 770; the specific heat to that of water is as 1 to 4·2. The amount of heat that will raise one cubic foot of water one degree will raise 770 cubic feet of air 4·2° or 3,234 cubic feet 1°. The Gulf Stream, therefore, is the equivalent of a constant current of air at a temperature of 65°, over 600 feet deep, blowing from every part of the equator at the rate of over 20 miles an hour.

We have another element in the heat abstracted by our littoral current, known as the "cold wall."

Taking the mass of this cold wall to be 10 miles in width by 150 feet in depth, running at 2 knots an hour, for 24 hours, will give us 2,280,960,000,000 cubic feet per day.

Supposing the water in passing from the Straits of Bell Isle to Cape Hatteras is raised 20°, the amount of heat absorbed by it would be 7,376,624,640,000,000 cubic feet of air lowered 20°—equivalent to a belt 1,000 miles long, 50 miles wide, and a mile high raised 20° above the freezing point every 24 hours.

One other statement made was that a change in the location of the Gulf Stream would not affect our climate, because our cold weather comes from the west and northwest.

I grant that sometimes that will occur. The same cause that chilled Bermuda and made South Florida a frozen region during the winter of 1885-86 would at certain seasons bring us cold weather; but it is known, and fully stated by Lieut. Maury, that, during the intense cold on our coasts, ship masters should make their course directly east for the Gulf Stream; that across this the ordinary cold winds do not blow, and for the reason that the atmospheric pressure is higher on that portion of the Atlantic.

If we had not the cold wall between our shores and the Gulf Stream, it is fair to presume that we should have a less stormy coast, as the juxtaposition of these two currents with their difference in temperature must from that circumstance tend to an unstable condition of atmospheric equilibrium. Our cold northwest winds would then sweep to the north of us, and become westerly and southwesterly winds.

Air and water go to the points of the least resistance. An examination of the winds of the globe, now so fully described by Coffin and others, indicates that the great currents of the ocean, without which the earth would not be habitable, are caused by atmospheric currents; and that these currents are deflected and diverted by the coast lines is plainly shown by every coast line on the earth.

With the cold wall cut off, we would have along our sea coast the year round the fine fish that now come straggling up to us late in the season, which would be ample compensation for the codfish which would then be found, as now, on the Newfoundland Banks; and we should lose the occasional visits of whales that now follow the cold stream, and, hemmed in by our shores and the warm waters of the Gulf, become a prey to our Long Island fishermen.

The Straits of Belle Isle may never be closed. It is England's territory, and she will not pay the cost for the benefit of her Canadian provinces and the United States. But I advance the theory that our climate can be modified by closing the Straits of Belle Isle as a problem in physical geography capable of an engineering solution. JOHN C. GOODRIDGE, JR.

The Audubon Society for the Protection of Birds.

"The moment a bird was dead, however beautiful it had been when in life, the pleasure arising from the possession of it became blunted." So wrote the great student of birds, John James Audubon, and such is the adopted motto of the society for their protection, which bears his name. In answer to the appeal of the American Onithologists' Union for the protection of our native birds, not used for food, from destruction for mercantile purposes, the Audubon Society was founded in New York city in February last.

We have already called attention to the indiscriminate slaughter of the innocents—"the very St. Bartholomew of birds"—which is the result of the present unfortunate fashion of using the stifled singers for personal decoration, but to make the appeal still stronger, we are tempted to repeat some of the statistics collected by the society. A single taxidermist in this city handles annually 30,000 bird skins; a single collector brought back 11,000 skins as the result of a three months' trip; one small district on Long Island furnished about 70,000 birds to the metropolis in four months' time. These figures amount in the aggregate to very large totals. One New York firm had on hand 200,000 birds on the first of February.

But large as this destruction is, it is not limited by domestic consumption. Many birds are sent to the foreign markets. In London there were sold from one auction room, and in a space of only three months, 404,464 West Indian and Brazilian birds and 356,389 East Indian birds. In Paris 100,000 African birds have been sold by one dealer in a year. The depletion of our own fields and woodlands has been quite as large in proportion to their riches. A New York firm had recently a contract for supplying 40,000 American birds to one Paris firm.

The protection of these little visitors is not a matter of sentiment alone, though if it were we should still urge it, for the sentiment is one which it is highly creditable for every one to entertain, but it has also a utilitarian aspect. The interests of agriculture are also involved. The food of the smaller birds consists largely of the insects destructive to growing crops. If nature's militia, the army of birds, be killed, it will be impossible to find a substitute for their faithful guardianship.

The Audubon Society invites co-operation in carrying out its purpose all over the country, and will furnish copies of the Audubon pledge and other printed matter on application. Its address is 40 Park Row, New York. Membership is open to any one who will sign the printed pledge, but it involves no other responsibility. There are no dues or expenses of any kind. We are glad to see that the most influential women's club in New York—Sorosis—has become interested in the work of the society, and is largely represented in its membership.

Birds Killed by Electric Light.

The latest strike in Chicago is that of the birds. When the watchman of the Board of Trade building made his rounds some days ago, he found the sidewalks and streets in front of the tower covered with numbers of dead birds of all sorts. They had evidently been killed by striking the electric lights at the top of the tower, for the roof of the building was found to contain numbers of them, and each of the lamps in the big circle of light had its full share, one globe containing eight. It is reported the birds were of many varieties, some of them being unfamiliar to the local ornithologists. The theory advanced is that the birds belonged to flocks migrating northward, and being attracted by the great light, were killed the moment they came in contact with it.