a height nearly equaling that to which the heel is raised in walking causes the board to hit the head, or the head to strike the board, whichever you may call it.

Now in walking a mile, or 5,280 feet, on level ground, in 20 minutes (ordinary gait), and taking military regulation steps of 28 inches each, one lifts the body $5,280 \times 12 \div 28 =$ over 2,363 times in the 20 minutes. This means that the body is lifted $2,363 \div 20 =$ about 118 times per minute. If the rise of the center of gravity is but one inch, and the body weighs 160 lbs., there will be $118 \times 160 \div 12 = 590$ minute foot pounds, = nearly $\frac{1}{50}$ of a horse power, wasted just in lifting the body up and letting it come down again without any useful effect. In other words, the same amount of force expended in walking up 118 treadmill steps, each an inch high, in a minute, would develop $\frac{1}{50}$ of a horse power.

If, now, one were to walk so that the head and shoulders, as indicating the vertical position of the center of gravity, should not rise and fall with the steps, all this force would be saved; and if the muscles were of steel, and the motive power of the whole a spring, then walking on a level would resolve itself, very largely, into a question of overcoming the friction of the feet and joints, etc. But unfortunately (perhaps), the muscles are dependent, for their contraction and strength, upon the action of the motor nerves, and these last upon the mysterious chemistry, electricity, or whatever it be, of the brain and the nerves of volition. Thus, in holding the arm or the leg out steadily in any given position for even a short length of time, although there is no work being done, dynamically speaking, there is, to the muscular system, what amounts to the same thing, whether caused by action or by continued restraint—fatigue, followed by pain and by temporary paralysis if too prolonged—the limb dropping when the muscles refuse to perform their office.

There is thus much more physical fatigue caused by walking than corresponds to the 590 minute foot pounds, the foot pound account increasing arithmetically only, while the nerve tax mounts up in geometrical ratio. It is generally considered more "fatiguing" to come *down* a very long flight of steps, say those in Trinity Church spire, although lifting no weight, than to climb up, especially if one has taken no rest at the top.

We will now consider the work done by the velocipedist on a smooth and level mile course. Firmly seated, he causes the muscles of his leg to turn a wheel, and to do that only. His whole body is never lifted; and in one four-wheeled variety having treadle bars with reciprocating horizontal motion, even the weight of the legs is not raised, as in the common bicycle.

If an ordinary spring balance were fastened to the velocipede with rider in the seat, and the whole was hauled along, the spring would indicate in pounds the "draught," or the resistance due to the friction of the moving parts of the machine, and to that of the ground and the tires. A bicycle with driving wheel 3 feet in diameter would make $5,280 \div (3 \times 3.14) =$ about 528 revolutions per mile; and if we suppose the mile to be made in 20 minutes, the wheel has made $528 \div 20 =$ about 26 turns per minute. If the crank is 4 inches long, the vertical stroke of the foot is 8 inches, but the center of gravity of the limb, which is located in the thigh, has been raised only about half that, or say 4 inches. Supposing the legs to weigh 55 lbs., the work in lifting the legs is $55 \times 4 \times 26 \div 12 = 476$ foot lbs.

But every pound of this, less the ridiculously small amount lost in overcoming the friction of hip and knee joints, etc., has been utilized on the down strokes of the cranks as driving force; whereas, in walking, the fall of the whole body (which is utilized in treadmill work) is wasted.

We thus see that the velocipedist in traveling does less lifting than the pedestrian, and does not waste that force. He also strains the muscles less, and hence can keep it up longer and go further than if on foot; or he can "speed up" without getting fatigued by reaching the limit of endurance of the muscles and their motor nerves.

Furthermore, the velocipedist is apt to choose a better track than if walking.

A case in which the leg power is so employed that the velocipedist wastes the, say, 478 foot pounds used in lifting his legs, but expends none in lifting the body, is where he sits in a wheeled frame after the style of the baby go-cart, and propels himself and the vehicle by pushing with his feet against the ground. If he were to sit in such a frame and haul himself along by winding up, on a drum worked by foot cranks, a rope attached to a fixed point ahead, the power expended in lifting the legs could be utilized on the down stroke, as in the regular bicycle.

We think we have now answered our correspondent's questions, at least so far that he can readily "cipher out" for himself the entire interesting problem of locomotion.

CAPTAIN EADS' PROPOSED IMPROVEMENTS OF THE MISSISSIPPI AND ST. JOHN'S RIVERS.

Backed by the prestige of his magnificent success in opening the mouth of the Mississippi, Captain Eads has now no difficulty in securing the whole people as his audience when he comes forward with two more great projects for national improvements. One of these is no less important than the work already accomplished, for it aims directly at the saving of the enormous expense of constructing the new levees along the Mississippi by a means as simple, and without doubt as efficient, as the famous jetties themselves. This means is, briefly stated, to narrow the wide and shallow places of the river so as to confine its current to a uniform channel. The river naturally scours its bed out in the narrow parts and drops the sediment in the wider portions along its entire length, and wherever there is a widening there are the shoals, the islands, the snags, and the stumps which impede navigation.

To bring the wide parts to the uniform width Captain Eads proposes to cover the sand bars with brush and stone dams. These obstructions would cause a deposit of sand between them and force the waters to deepen the channel. The work should go on annually, the obstructions being gradually built higher, and finally, when the river had been brought to a uniformity of width, there would be a uniformity in depth, in current, and in transportation of sediment. This work could be much more easily accomplished than could the rip-rapping or mattressing of the banks, because it needs only to be done in shallow water. Levees are objectionable, it is argued, not because of the present amount needed for absolute protection from the near floods, for four or five millions would insure this, but it is because they must cave in at the wide places. Instead of diffusing the water by outlets and raising high levees at these points, as proposed by the United States Engineers, Captain Eads advocates its conservation—every drop of it—in one channel of uniform width, and the abolition of all the wide places, the closure of the outlets, and, if necessary, the closure of the island chutes. The United States Engineers propose to attack the bank of the river with shovels and wheelbarrow, to accommodate its anticipated elevation ten or a dozen feet higher than ever before. Captain Eads proposes to set the river to work in the bottom of its bed, as he did at the jetties, and, while deepening it for the benefit of commerce, to lower its haughty crest forever. They provide for a river carried threateningly above the land, a constant source of terror and anxiety, while he proposes that its vast volume, "in all the grandeur of its mightiest floods, shall be viewed with an admiration devoid of fear from happy homes safe above its surface."

Captain Eads' other project is the deepening of the channel through the bar at the mouth of the St. John's River, Florida. Here he suggests a system of jetties analogous to those used at the mouth of the Mississippi. He finds that there exists from Jacksonville to the sea a river basin 25 miles long and averaging one mile in width. At one end of this basin the average rise of the tide is nearly 1 foot, and at the other end 5½ feet. The average quantity of tidal water passing into and out of this basin twice a day is equal to nearly 2,000,000,000 cubic feet. This would produce an average rate of current equal to 2 miles per hour, through a channel having a cross section of 30,000 square feet, or a maximum current during average flood and ebb tides of about 4 miles an hour. With such a tidal basin, even without the additional advantage of the river current resulting from a large annual rainfall upon 7,500 square miles drained by the river, Captain Eads thinks that there would be no question of parallel jetties acting otherwise than as a certain means for deepening the channel through the bar. The inflowing waters, now nearly 3 miles wide, would be caused to traverse a channel only three or four tenths of a mile wide. The frictional resistance would thus be greatly decreased, and higher tidal oscillations would occur at Jacksonville. The river channel would, therefore, not only be deepened over the shoals in the river by a higher plane of water at high tide, but the increased flow of tidal waters through the river would deepen the bottom likewise and materially improve the navigation of the river.

THE CONFECTIONER REGARDED IN THE LIGHT OF A COLORMAN.

Should the dealer in paints for decorative purposes, tiring of his vocation, suddenly conceive the idea of exposing for sale bucketfuls of brilliantly colored, ready mixed paints as newly discovered but extremely toothsome and healthful substitutes for our present articles of dessert, as well as harmless and delicious offerings to the candy-loving maiden and child, it is quite probable that the public, with its own convictions as to "the eternal fitness of things," would promptly spurn the proffered products of this new-fledged industry, and look with extreme pity, if not contempt, on the chemist who should rashly lend his name to testimonials asserting their harmlessness. And yet, if we are to believe the testimony of "experts" recently given in the Supreme Court of Massachusetts, at Boston, the trade of the confectioner would seem, in some cases, to be separated by but few removes from that of the colorman; the paints of the latter being mixed with linseed oil, while those of the former—identical in composition—are prepared for "internal use" with the more palatable materials, sugar and starch. This, of course, is a distinction; but, as far as the health and safety of the public are concerned, with very little difference.

The trial referred to was that of a Boston firm of confectioners on the charge of manufacturing and selling candy adulterated with chrome yellow, or, more accurately speaking, chromate of lead. In view of the poisonous nature of this pigment, to which we shall presently refer, the evidence elicited from the witnesses was remarkable. A former member of the firm, who had been in the confectionery business for twenty-five years, stated that he had made a specialty of the lozenge department and had never known a case of injury to a person arising from chromate of lead, and had never heard of any complaint against it. He had always been in the habit of eating lozenges freely, and although he should probably not relish a grain and a half of chromate of lead, yet at the same time he should not consider it dangerous. One of the workmen testified that chrome yellow was used in nearly every large establishment in New York, and he, together with other workmen, had been in the habit of eating the raw article. He had no doubt that he had eaten between one and two grains at a time and never considered it dangerous to the extent it was used in making lozenges. One of the members of the firm testified that he was familiar with the confectionery business both in this country and in Europe; he had always taken the greatest precautions to have lozenges made pure (?), and, to the best of his knowledge, chrome yellow was very extensively used in this country; it was used to produce a harmony of color. By inquiry and observation he had taken pains to ascertain if chrome yellow was injurious, and among the chemists he had consulted was Dr. Liebig, in Europe.

The object of the defense in this trial seemed to be to prove that not only is chromate of lead (which includes "chrome yellow," "chrome green," "orange chrome," and the "American vermilion" of some manufacturers) not poisonous, but that, even if it were so, the small quantities in which it is used would render it harmless. In regard to the first proposition we may refer to a very recent case reported in the *Boston Medical and Surgical Journal* under the head of "Toxicology," where we find the following cases of poisoning by the inhalation of dust containing chrome yellow. The *Journal* says:

"Leopold reports five cases of this form of poisoning, one of which proved fatal. The patients were employed in weaving cloth, colored with chrome yellow (chromate of lead), which was quite loosely applied to the thread, so that a portion of the pigment was easily detached and became diffused throughout the air of the room. The patients were affected with a yellow-coated tongue, yellow sputa, loss of appetite, malaise, in some cases vomiting, pain in the region of the stomach and umbilicus, obstinate constipation, and debility. The fæces were yellow. These symptoms disappeared in a few weeks after the removal of the cause, except in the case of an infant nine weeks old, who died in six or eight days after the beginning of the symptoms, which, however, did not appear until three weeks after exposure to the infected atmosphere. The symptoms in this case were fever, restlessness, shrieking, several yellow fluid stools daily, redness of the skin over the chest and abdomen, parched lips, and, just before death, short respiration.

"After death there were found inflammation and perforation of the stomach, the same appearances which were seen in the two cases previously reported by Dr. Von Linstow, caused by ingesting the chrome yellow. None of the poison could be detected in any of the organs except the lungs, in which 3·6 milligrammes (0·055 grain) were found."

As to the second proposition, the small quantity used: there are but two to three salts of lead that as medicines are adapted for internal administration; and, when it becomes necessary for the physician to employ them in this manner, he uses them cautiously, and in what are called "medicinal doses," for it is well known that continued doses of exceedingly small quantities are the very ones that produce all the dangerous constitutional effects of the lead.

Familiarity with poisons, as with other things, is apt to breed carelessness in handling, if not contempt for their effects; and, because the worker among them testifies to their innocuousness to his own system when self-administered, it by no means follows that the practice is a safe one to recommend to the public. At all events, no such testimony as we have referred to above will serve to remove the prejudice that exists in the minds of parents against allowing their children to be fed on substances that are known to be injurious.

The vegetable kingdom yields such a large number and variety of harmless coloring matters, exactly suited to the requirements of the confectioner, that there is no necessity for resorting to the use of either colored earths or metallic salts, and their employment, therefore, being not only inexcusable, but criminal, should be promptly punished by the arm of the law.

CONGRESS TO BE MADE A PATENT MILL.

If that portion of the new patent bill is passed which provides for the lapsing of a patent in event of the non-payment of an auxiliary fee a few years after its issue, one result will be to convert Congress into more of a patent manufacturing concern than it already is. Every Congressman knows now that not a session passes but that legions of inventors, who have failed or who think they have failed to realize as much as they should during the lifetime of their patents, fill the records with applications for extensions. It was to relieve Congress from this increasing burden that the duration of the patent was lengthened from fourteen to seventeen years, the object being to afford the inventor more time to gather his profits. Under the provisions of the proposed new law, however, it must be obvious that Congress will be besieged by applications to revive patents which have lapsed because poor inventors may not have had the means to pay the additional fees required at the time fixed by law, and for a great variety of other reasons which will be urged. We have already pointed out other objections to this enactment, but the above in its results is by no means one of the least serious, as the consequence will be to engender an immense amount of special legislation, to take up the time and materially augment the work of Congress, and to hinder the progress of measures of public importance.