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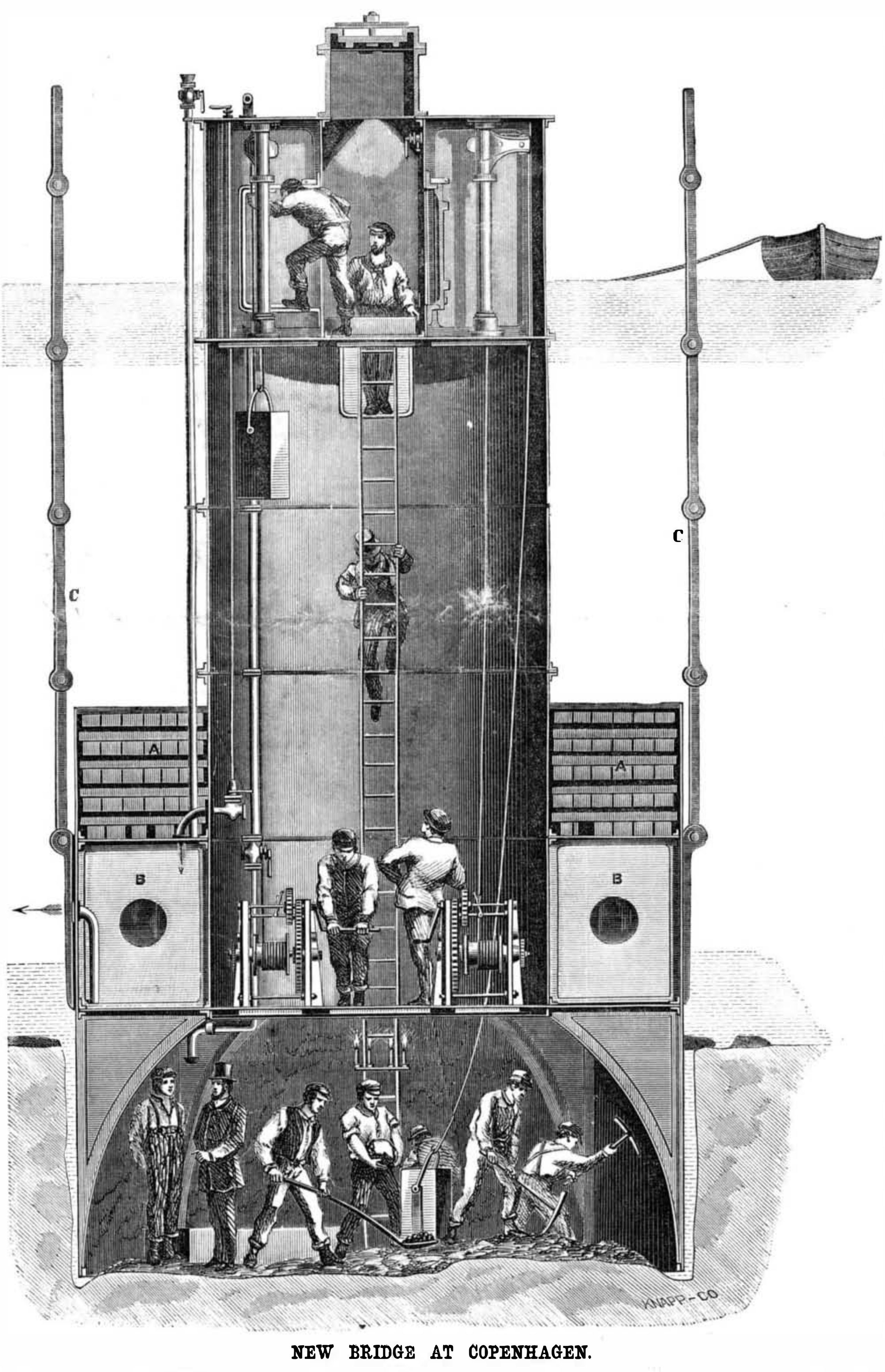
Caissons for Pier-Building.

Before more particularly describing the engineering illustration we give this week, taken from the London *Architect*, as showing a new and very clever method of building bridge piers, it may not be uninteresting to many of our readers to refer to one or two former contrivances which have been employed for that purpose.

Dr. Ure, in his "Dictionary of Arts," mentions what is considered to have been the first application of sinking cylinders through sand and water (quicksand). He says that a mining shaft formed of a series of large sheet-iron cylinders riveted together was sunk to a great depth through the bed of the riverLoire, near Languin. The seams of coal in this district of France lie under a stratum of quicksand, from 18 to 20 meters thick—equal to about 58 to 66 feet English—and they had been found to be inaccessible by all the ordinary modes of mining previously practiced. The difficulty of reaching them had been thought so entirely insurmountable that every portion of the great coal basin, which extends under these alluvial deposits, though well-known for centuries, had remained untouched. To endeavor, by the usual workings to penetrate through these semi-fluid quicksands, which communicate with the water of the Loire, was, in fact, nothing less than to try and sink a shaft in that river, or to drain the river itself.

This difficulty, however, was successfully grappled with by M. Triger, an able civil engineer. By means of the sheet-iron cylinders we have mentioned, he contrived with the aid of force-pumps to keep his workmen immersed in compressed air of sufficient density to force back and out of the bottom of the cylinder all the water which was there, and thus enabled the men to excavate the sand, gravel, and stones to such a depth that when the cylinder was sunk to a water-tight stratum, the compressed air was no longer necessary. An air-tight chamber at the top of the cylinder had a man-hole door in its cover and another in its floor; when the men had entered this chamber the upper door was closed, and compressed air from the cylinder was then admitted by means of a stop-cock. As soon as there was an equilibrium of pressure established between the chamber and cylinder, the man-hole door into the cylinder was opened and the men descended to their work. Here they had to work in air at a pressure of about three atmospheres, *i. e.*, equal to a pressure of, say, 44 lbs. per square inch. While the compressed air thus drives the water of the quicksand out of the shaft, it is said to infuse at the same time such energy into the miners that they can easily excavate double the work, without fatigue, which they could perform in the open air. Upon many of them the first sensations are painful, especially upon the ears and eyes; but they rapidly get accustomed to the bracing element. It is even said that old asthmatic men here become effective workmen, deaf persons recover their hearing, while others are sensitive to the slightest whisper. Much annoyance was at first experienced by the rapid combustion of the candles, but this was obviated by the substitution of flax for cotton wicks.



NEW BRIDGE AT COPENHAGEN.

The contrary principle to this of sinking cylinders was proposed by Mr. Potts, a medical gentleman of great inventive ability. His system was adopted in sinking the piers of the Black Potts Bridge, which crosses the Thames near Richmond. Each cylinder was lowered into the river in its proper vertical position, and then loaded sufficiently to make it sink when the greatest vacuum was obtained. The vacuum was produced by means of suction pumps, and then the external pressure of the atmosphere forced the mud, sand, or gravel and water from the bottom of the cylinder up inside of it, thus allowing the cylinder to descend as much as the displacement of the material at its base in the bed of the river would allow with the force of its own weight and load. The material thus forced up into the cylinder was scooped, or dredged, out as much as possible, the operation of creating a vacuum being again and again repeated until the cylinder was sunk to the supposed proper depth. It has been said that some of the cylinders sunk when the weight of the bridge and proving load came on them. This fault, however, cannot be charged to the mode of sinking, for in that case the cylinders could not have been sunk deep enough, or they were imperfectly filled in. At the same time, if the water had been forced or kept out by means of compressed air, there would naturally have been far greater facility for seeing and insuring a good and secure foundation.

The new cast-iron arched bridge over the Medway at Rochester is one of the first bridges built upon cast-iron piles sunk deep into the bed of a river by means of compressed air, used to keep out the water while the workmen were employed in excavating the material inside the piles, and allowing them to sink by means of their own weight and the load placed on them. This bridge is built near the site of the celebrated old bridge at Rochester, and consists of three spans (one an opening span). Each pier is formed of 14 cast-iron cylinders placed in a double row and sunk through the bed of the river into the hard chalk. All these cylinders were sunk by means of compressed air, to keep out the water while the men were at work in them, in a very similar manner to the method adopted by the French engineer, M. Triger, for sinking his shaft. Mr. John Hughes, Civil Engineer, was the first to adopt this mode of keeping the water out of piles while being sunk to form piers in the beds of rivers, and great praise is due to him for the thorough and practical way in which this system was carried out, in sinking seventy cylinders to a great depth in the bed of a strong tidal river like the Medway. The bed of the river was found to consist of strata of soft clay, sand, and gravel over the chalk, which was reached at a depth of 44 feet below average water line. Each cylinder was like an immense diving bell, always having its top out of the water, no matter at what depth the bottom was. They are formed of cast-iron pipes, 9 feet long and 7 feet diameter, with internal flanges, so that the external faces are free of any projections that would interfere with their free descent through the bed of the river. The access to and from the inside of the pile, while being sunk, was through two air-locks or chambers, made of cast iron, passing through the cover-plate bolted on the top length of the pipe forming the pile. The tops of these locks had openings 2 feet in diameter, and flap-doors which, when closed, allowed them to be filled with the compressed air from the cylinders. From each air-lock there was a vertical door opening into the air-chamber, which, when closed, was also air-tight, so that when the workmen had to pass in or out, or to take out the excavated material, they could do so without decreasing the pressure of the air very much. In coming out, they entered, through one of the vertical doors, into one or the other of the air-locks, and when this door was closed, the pressure of the air was reduced to atmospheric pressure by means of a small cock, opened to the atmosphere. As soon as there was an equilibrium of pressure, the top door was opened and the men came out. The operation of entering the pile or cylinder was the reverse of coming out. The only loss of the compressed air from the cylinder at each operation was the amount contained in the small air-lock.

Within the cylinder were two small cranes to lift the full buckets and lower the empty ones, which were worked by a two-handled windlass. As each pile was sunk 9 feet, the air-chamber was disconnected and a fresh length of pipe bolted on, and the air-chamber bolted on top of this. At each joint a floor or staging was fixed, with openings to allow of the ascent and descent of the workmen and the full and empty buckets, etc. These cast-iron pipes form part of the permanent structure of the piers, and when they were sunk to their proper depth they were filled in with concrete and brickwork.

The method of working was by setting the air-pumps in motion, having the top door of one of the air-locks and the bottom one of the opposite air-lock closed. The pumps were of such a size that in about five minutes 15 feet head of water was forced out through the bottom of the piles; and while the pumping continued the workmen passed through the air-locks to their various stations.

The engineering illustration which we give this week shows a more economical method of building piers in the beds of rivers, or under water. It shows a caisson or diving-bell, designed by Messrs. Burmeister and Wain, and adopted by them in building the piers of the new bridge in Copenhagen. The principal economy consists in having the caisson, or cylinder, of less cubic capacity than the finished pile of the piers, and in being able to take it away as each pile was built. When the excavation was made deep enough for a firm foundation, the building of the pile was commenced, and as it increased in hight the caisson was lifted accordingly until the pile was above water-line, when the caisson was removed to the required position of the next pile, and so on, until the two piers, each formed of two piles, were completed. This plan of lifting the caisson avoided leaving the whole of the piles of the piers encased in ironwork, as in the piers of Rochester and many other bridges. This caisson was made of wrought-iron, 18 feet diameter at the lower part by 8 feet high, and above this to the air-chamber out of the water it was only 10 feet diameter. Just above the 18-feet diameter chamber there were two annular rings, or chambers—one to contain iron ballast, A, and the lower one water ballast, B, so that in sinking the caisson the water chamber was filled with water for weight in addition to the iron ballast in the annular chamber above. When they had excavated to the solid strata, a bed of concrete 3 to 4 feet thick was formed, and on this the remainder of the pile was built with granite facing filled in with brickwork. As the building of the pile proceeded, the caisson was lifted by means of the suspension chains, C, connected with staging overhead, and by pumping air into the annular air-chamber, B, to displace the water. The finished piles are about 18 feet diameter at their bases, and 16 feet diameter at their tops, by 30 feet high. The whole of the work below water line was done in the 18 feet by 8 feet chamber at the bottom of the caisson. Between the time of lowering it to the bed of the river and the completion of the first pile to water line was only twenty-eight days, and then the apparatus was moved into position for the next pile. In lowering it for the second pile, it unfortunately got upset, and caused so much delay that it took thirty-six days to complete this pile. The third pile, was, however finished in sixteen days, and the fourth in seventeen days.

The air-chamber and locks on top of the caisson were very similar to those used for sinking the piles of Rochester Bridge.

OBJECTS OF INTEREST ON A GUANO ISLAND.

A recent writer from Baker's Island, in the South Pacific, off the coast of Peru about 2,500 miles, gives an interesting account of life on that little patch of *terra firma* which carries upon its bosom nearly a million tuns of guano.

He mentions that fish of remarkable size and beauty, weighing from fifty to sixty pounds, are abundant, and are easily taken with a hook. Sharks abound also—murderous sharks who swarm about the ship with greedy and persistent devotion. These sharks are, by hereditary proclivity, man-eaters; and the white man who comes within their reach is snapped at in an instant by a score of ravenous mouths. But, strange to say, a dark-skinned Polynesian will swim about in their midst and rarely be molested. I have seen a native of the Hawaiian Islands fearlessly jump from the bow of a ship into the midst of a "school" of these fellows, swim, with the end of a line in his mouth, to one of the buoys, and return to the vessel uninjured.

Whether there is a sort of freemasonry between the sharks and the Kanakas, or whether the tastes of the shark are too fastidious, and not sufficiently cannibal to relish cannibal flesh, has not been satisfactorily explained. But the shark and the Kanaka are on the friendliest terms imaginable.

The flying fish abounds in these waters. When pursued by the dolphin, their foe, whole schools of them may frequently be seen to leap out of the water and fly for several hundred yards, skimming along quite near the surface, and now and then gaining new velocity by striking the crest of a wave with their long, ray-like, pectoral fins. But this beautiful fish has enemies in the air as well as in the sea, and frequently its aerial flight is cut short by some fleet sea bird that is ever on the alert to seize its prey.

THE FEATHERED INHABITANTS.

Among the chief objects of interest on the Island to a visitor are the birds; and they are well worthy of study. The sea-fowl are at all times a noisy set, but at night, while the older ones are engaged in the quarrels of love-making, and the young are complaining over their scanty rations, the Babel of their chattering is destructive to the sleep of one unused to such disturbance.

During the first night of my stay on this forlorn spot, it seemed at times as if the house were besieged by innumerable tom-cats; then the tumult resembled the suppressed bleating of goats, and I heard noises as of bats grinding their teeth in rage; again it was the querulous cooing of doves, and soon the chorus was strengthened by unearthly screams, as of ghouls and demons in mortal agony. But on going forth into the darkness to learn the cause of this infernal serenade, all was apparently calm and serene, and the radiant constellation of the Southern Cross, with the neighboring clouds of Magellan, looked me peacefully in the face, while, from another quarter of the heavens, the Pleiads shed their "sweet influence" over the scene.

The most quiet time of night with the birds is about daybreak, when they seem to subside into "cat-naps," preparatory to the labors of the day.

By day many of the birds range on tireless wing, over leagues of ocean, in quest of fish. But still the number of those that remain about the island is so great as to defy computation, and as you pass through their haunts, in some places they rise in such clouds as actually to darken the air above you.

The eggs of some of the birds are of fine quality, and are much esteemed by the Americans as well as the Hawaiians on the island. Those of a bird called the *nu-e-ko* are most valued. This name is an imitative word, derived from the cry of this restless creature, and is applied to it by the Hawaiians, who have quick intuitions in onomatopoetic matters.

The *nu-e-ko* is a bird of moderate size bearing a strong resemblance to the piping plover. It is less phlegmatic and stupid than most of the other birds, and does not waste so much of its time in droning and crooning and love-making.

Yet it is not undomestic in its habits. While the father is engaged in the business of the island, providing for the wants of the family by fishing, the mother is ever hovering near her half-fledged young, now invitiug them to try their wings in flight, and now hustling them out of sight under some clump of brown grass, and teaching them to lie close in order to escape observation.

The *nu-e-ko* does not make its home on the guano fields, but prefers the sandy shingle nearer to the ocean. The plumage of its back is brown, spotted with gray, a color so nearly resembling that of the sand upon which it makes its nest, that it might almost escape detection. But, when danger approaches it rises on the wing, uttering its shrill, peculiar cry of "*nu-e-ko! nu-e-ko!*" and leaves its egg or its young to the tender mercy of the intruder. As it spurns the ground it shows its throat, breast, and wings, lined with sheeny feathers, that glint in the sun like flakes of silver, while it whirls and curvets in the air. This bird is plain in its tastes, and for a nest is content with a simple hollow, scooped out of the sand, the warmth of which assists in the incubation of its speckled egg.

The gannet (*Sula bassana*) is a bird of great power and beauty. The color of the grown bird is white, with wings that are tipped with black. It has a long sharp beak which is serrated and slightly curved at the end, a formidable weapon of attack as well as of defense. Its wings are of immense strength, and when fully spread, they span about seven feet from tip to tip. In their fishing expeditions they range for hundreds of miles from their nesting places, and late in the day ships in mid-ocean often see long files of them returning home like heavy laden treasure vessels speeding to port. This sight is regarded by seamen as a sure indication that land lies in the direction of their flight, though it may be scores of leagues away.

In regard to moral character, the birds may be divided into two classes—those which make an honest living, and those which are robbers. The gannet stands at the head of the respectable birds, and is a thrifty and honest citizen of the air.

The representative of the thievish class is the frigate-pelican, or man-of-war hawk, (*Tachypetes aquilus*). This bird has a dense plumage of gloomy black, a light wiry body, that seems made for fleetness, and wings of even greater spread than the gannet's. Its tail is deeply forked, its bill is long, sharp, and viciously hooked. Audubon regards the frigate bird as superior perhaps, in power of flight, to any other. It never dives into the ocean after fish, but will sometimes catch them while they are leaping out of the water to escape pursuit. It is often content to glut itself on the dead fish that float on the water, but it depends mostly, for a subsistence, upon robbing other birds. It is interesting to watch them thus occupied.

As evening comes on these pirates may be seen lying in wait about the island, for the return of the heavily laden fishing-birds. The smaller ones they easily overtake and compel them to disgorge their spoils; but to waylay and levy blackmail upon those powerful galleons, the gannets, is an achievement requiring strategy and address. As the richly laden gannet approaches the coast of his island home, he lifts himself to a great hight, and steadily oars himself along with his mighty pinions, until he sees his native sands extending in dazzling whiteness below. Now sloping downward in his flight, he descends with incredible velocity. In a moment more he will be safe with his affectionate mate who is awaiting his return to the nest.

But all this time he is watched by the keen eye of the man-of-war hawk, who has stationed himself so as to intercept the gannet in his swift course.

With the quickness of thought the hawk darts upon him, and, not daring to attack boldly in front, he plucks him by the tail, and threatens to upset him, or he seizes him at the back of his neck and lashes him with his long wings. When the poor gannet, who cannot manœuvre so quickly as his opponent, finds himself pursued, he tries to buy his ransom by surrendering a portion of his fishy cargo, which the hawk, swooping down, catches before it has had time to reach the earth. If there is but one hawk this may be a sufficient toll, but if the unwieldy gannet is set upon by a number of these pirates, he utters a cry of real terror and woe, and, rushing through the air with a sound like a rocket in his rapid descent, he seeks to alight on the nearest point of land, well knowing that when once he has a footing on *terra firma* not even the man-of-war hawk dare come near him.

The man-of-war hawk is provided about its neck and chest with a dilatable sack, of a blood-red color, which it seems to be able to inflate at pleasure. On calm days, about noon, when the trade-wind lulls, giving place to a sea-breeze that gently fans the torrid island, these light, feathery birds may sometimes be seen at an immense hight balancing themselves for whole hours without apparent motion on their out-stretched vans.

Whether they are able to increase their specific levity by inflating their pouches with a gas lighter than the atmosphere, or whether they are sustained by the uprising column of heated air that comes in on all sides from the ocean, is a question I am unable to answer. While floating thus, this bird has its pouch puffed out about its neck, giving it the same appearance as though it had its throat muffled in red flannel.

The most unique and novel bird on the island is the tropic-bird or marlin-spike (*Phaëton phœnicurus*).

Its wings are long and its flight very rapid. It is distinguished by two slender, tapering feathers, of rare beauty, which project like a long steering oar from its wedge-shaped tail.

I cannot resist the temptation of alluding to one other bird that abounds here. It is the Mother Carey's chicken (*Thalassidroma Wilsonii*)—an ocean butterfly—the pet and favorite of every true sailor. This bird is about the size of a chimney swallow. Its pretty ways and seemingly innocent affectations, are enough to win the heart of almost any one. The society and study of these birds are not without an inspiration.

(From the Waltham Watch Papers.)

EFFECT OF MAGNETISM ON TIME-PIECES.

The intention of the present paper is to point out a defect in the construction of time-pieces of every description in which balances are used, and at the same time a source of error in their performance, which has been hitherto little, if at all, suspected, but which, where it occurs, completely defeats all the ends intended to be answered by the application of the above-mentioned ingenious contrivances; and that it does occur very frequently will be made sufficiently obvious by a simple detail of facts supported by actual experiments.

It has been suspected by some and denied by others that the balances of watches when manufactured of steel, as they mostly are, might be in a small degree magnetic, and consequently be disturbed in their vibrations, but that a circular body, such as a balance is, should possess polarity—that a particular point in it should have so strong a tendency to the north, and an opposite point an equal tendency to the south, as to be sufficient to materially alter the rate of going of the machine when put in different positions, has never, I believe, been even suspected. If it had, the use of steel balances would have been laid aside long ago, particularly where accurate performance was indispensable, as in time-pieces for astronomical and nautical purposes. Though I have frequently examined with great care watches that did not perform well, even when no defect in their construction or finishing was apparent, and suspected the balance to be magnetic, yet I never could have imagined that this influence, operating as a cause, could produce so great an effect as I found upon actual experiment; for I did not expect to find that a balance, even when magnetic, should have distinct poles.

Happening to have a watch in my possession of excellent workmanship, but which performed the most irregularly of any watch I have ever seen, and having repeatedly examined every part with particular attention, without being able to