In calculating the strength of the arch, moving weights were considered.

The entire cost of the tunnel was about $5,964.00.—*Zeitschrift des Archit.*

Economy of Triple Expansion Engines.

The Coot is a vessel of 2,650 tons dead weight carrying capacity, is 270 feet long by 37 feet beam, and 18·5 draught above keel. Her triple engines have cylinders of 19½ inches, 32½ inches, and 53 inches diameter by 36 inches stroke, working on three cranks, and are all fitted with piston valves and dynamic valve gear. The Moorhen, a sister ship with which comparison of coal consumption and speed was made, is a vessel by the same builders, having a dead weight carrying capacity of 2,455 tons, is 260 feet long by 32½ feet beam and 19·3 draught above keel. She is fitted with ordinary compound engines by an eminent North Country builder, the cylinders being 33 inches and 62 inches in diameter, and 39 inches stroke.

On the completion of the voyage, Captain Croft, the marine superintendent of the Cork Steamship Company, reported that the Coot had steamed 8,258 miles on a consumption of 526 tons of coal, of which 320 tons were North Country coal of very inferior steaming quality, and 206 tons Welsh procured at Malta. The Moorhen steamed 7,555 miles on a consumption of 692 tons, the ship having still 703 miles to go to make up the distance covered by the Coot, and the 692 tons coal being made up of 552 tons of Welsh and 140 tons of West Hartley coal. Captain Croft further states that "there were exceptional circumstances telling against the Coot, head to wind for several hours going from Alexandria to Smyrna, through heavy rolling and the cargo getting adrift; and on homeward passage from Malta the Coot had strong head winds, while the Moorhen had fair wind and fine weather."

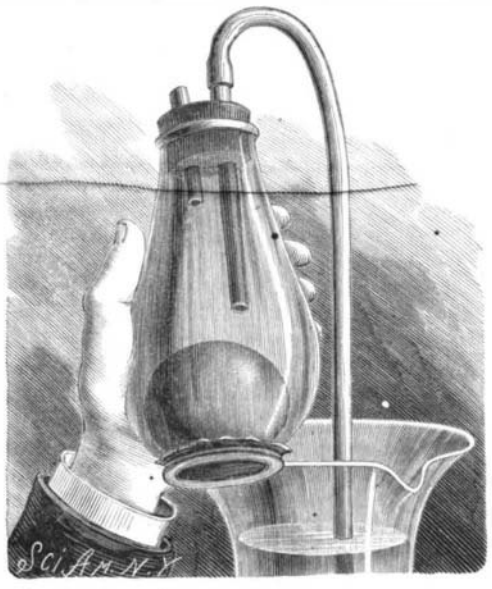
The average speed of the Coot in moderate weather is 9¼ knots per hour when fully laden.

Mr. F. C. Kelson, of Liverpool, the engineer superintendent to the owners, reported: "As far as we can at present make out, the Coot burns 25 per cent less fuel than the Moorhen for the same length of steaming, which is of course very satisfactory, considering that the Coot's average speed is quite equal to the Moorhen's, and also that the Coot has greater carrying capacity than the Moorhen."

EXPERIMENTS IN EQUILIBRIUM OF FLUIDS.

T. O'CONOR SLOANE, PH.D.

In the last issue was described a simple construction of the well known cup of Tantalus. In the cuts are shown two additional illustrations of siphon action, in which the expansion of thin India rubber is used to indicate the effect. A lamp chimney having a projecting flange around its lower edge is used. A piece of the thinnest pure gum India rubber sheeting is placed across and covering the opening of this end. A rubber band is sprung over it, so as to confine it to its place. As this connection must be very secure, a strong band is essential. A ring such as is sold for use on umbrellas for confining the ends of the rods is very good. This

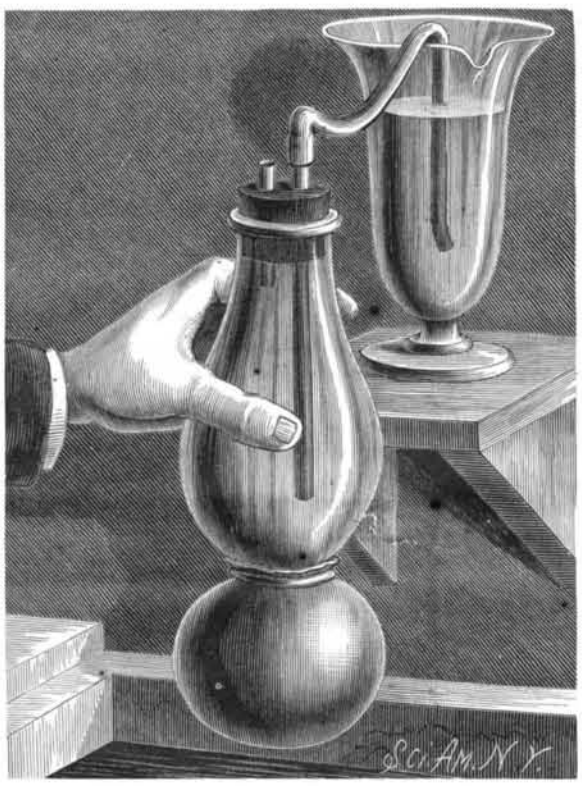


SUCTION OF A SIPHON.

will force the sheet against the glass and into all irregularities, so as to make a watertight joint. The rubber is not to be stretched in doing this, but is kept a little loose.

A tight cork of India rubber with one perforation, or if with two, one must be stopped, is provided that fits the upper end of the chimney. A tube of glass is inserted in the opening in the cork and is connected to a flexible tube of rubber. This forms the siphon. The chimney is filled with water. The rubber will bulge a little under the weight, but not very much. The cork is then inserted and the end of the flexible siphon tube is immersed in a vessel of water standing on the same level as that occupied by the chimney.

To illustrate suction, the chimney is lifted up until two feet or more of siphon tube depends from it. The rubber is now pressed in and upward. It expels air from the siphon and charges it, or fills it with water. Suction immediately begins to be felt, and the rubber curves inward. If the column is of a particular height with reference to the thickness of the rubber and diameter of the opening, nothing more than a slight inward bulging will thus be produced; but if the rubber is pressed further inward with the fingers, it will gradually yield to the pressure and rise up and in



PRESSURE OF A SIPHON.

more and more. After getting started, it will slowly rise up without assistance, growing thinner until so transparent as to be almost invisible. The way in which the pushing upward seems to help it is to be noticed particularly. This increases the area on which atmospheric pressure can be exerted.

To illustrate the pressure at the lower end of a siphon, the position of things must be reversed. The chimney is lowered and the vessel of water is raised up. The rubber immediately straightens, and begins to curve outward, and gradually assumes an almost perfectly spherical shape. Thus it also affords an illustration of the equality of hydrostatic pressure in all directons.

In both these experiments, the chimney should be held over a basin or pitcher, as there is danger of breaking the thin rubber.

The last experiment shown is one illustrating the mechanics of a drop of water, and incidentally some other laws of equilibrium of liquid bodies. A hoop of wood or metal, from fourteen inches to two feet in diameter, is required. This may be made from a cheese box, or a hooped section may be sawed off from a well-made barrel. A piece of the same thin rubber is spread over it, and tied on securely. To make it act well, the tension on the rubber must be just right. If too much or too little, a poor result will follow. For a fourteen inch hoop a slight tension is enough. A string wound tightly around it for five or more turns, and then tied, will secure it. This is then supported over a tub or receptacle for water, in case it should break.

Water is then poured into it. As it is introduced, the rubber takes the form of a portion of a sphere, and descends more and more as water is added. At last a point is reached when it is in unstable equilibrium, and the addition of a little more water causes it to suddenly descend two or three inches, and change its shape materially. These two conditions are shown in the drawing, the first by a dotted line. Sir William Thomson uses this in illustration of the equilibrium of a drop of water, as showing that it has two forms of rest. If the amount of water added is just right, the rubber will remain in either of the two positions indifferently. If added as just described, the withdrawal of a small amount will effect the purpose. The original paper of Sir William Thomson, published under the head of Capillarity, in the SCIENTIFIC AMERICAN SUPPLEMENT, Nos. 562 and 563, may be referred to here.

If the amount of water is a little less than is required to produce the lower position, and the hand is immersed in it, the same effect is produced as if water were added; as the hand is lowered, the rubber descends in the most curious manner, receding from the hand. If a coin is previously placed in the center, and an effort is made to extricate it, the effect is quite peculiar. A paradoxical aspect is given by the fact that apparently no weight is added. As everything immersed in water is buoyed up by a force equal to the weight of the water displaced, so the hand is pressed upward by this factor. But an upward pressure implies an opposite and downward one, and under this the water descends. Another way to treat the question is based on the fact that the pressure of water varies with the depth. By introducing the hand as described, the water is made to rise by the displacement. Hence a deeper column acts upon the rubber, and presses it down.

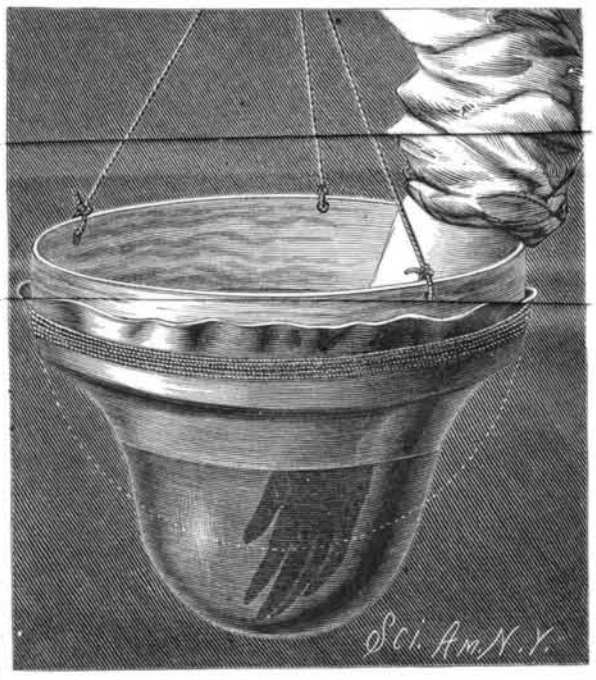
In constructing the apparatus, the thinnest rubber sheeting is the proper substance to use. Of course, no woven fabric, such as is used for waterproof cloaks, is available. If this and the question of tension are attended to, after one or two trials the apparatus will be successful. The tension will probably not work well on the first trial. The size of the hoop is important. It is not worth while to try it on a small scale. The sizes given really represent the minima from which a satisfactory result can be obtained.

Fireproofing Wood.

A mode of rendering wood incombustible not generally known is described as follows: Soak 27·5 parts by weight of sulphate of zinc, 11 of potash, 22 of alum, and 11 of manganic oxide in lukewarm water in an iron boiler, and gradually add 11 parts by weight of 60 per cent sulphuric acid. The wood to be prepared is placed upon an iron grating in an apparatus of suitable size, the separate pieces being placed at least an inch apart. The liquid is then poured into the apparatus and the wood allowed to remain completely covered for three hours, and is then air dried. The mode of application described is, we fear, a serious obstacle to the general use of this process for timber employed in building, especially as the rough timber, before being worked or framed, could only be conveniently treated in this manner. If joists, ceiling beams, and all joinery exposed to fire could be treated after being fixed with some chemical solution of proved resistance to the action of flame, we believe many architects would be found to employ it.

Longevity of Turtles.

In 1824 Mr. J. W. Warrington, one of the pioneer pedagogues of this vicinity, found a small *Testudo carolina* Linn., on the plastron of which he engraved, with his penknife, "J. W., 1824," and set it free near Albion, Ill. Some time during 1865 Mr. W. Hodson found it in the same vicinity where it had been set free forty-one years before. He engraved the letter "W" on the carapace and again set it free. Nothing more was seen of it until August, 1885, when it was found by Mr. Herbert Hodson (brother to W.), about one-half a mile from the spot where it had been set free twenty years before. He put it into his cellar, where it remained until this (1886) summer, when it by accident was poisoned by "Rough on Rats," and died from the effect. The engravings are all apparently as clear as when first made. The tortoise was below the medium size, and appears to have grown very little since the first engraving was done, sixty-two years



WATER DROP.

ago. The shell is darker and smoother than usual. On the back is a scar, which appears to be the remains of an extensive fracture. Mr. H. Hodson has three other tortoises that were engraved twenty-one, seventeen, and sixteen years since respectively. In illustration of the slow growth of these reptiles, I will mention that more than a year since, he broke open an egg in which was found a young tortoise. This he has since kept in confinement. It has made no perceptible progress in size during this time. Several years since, I kept a young *Pseudemys elegans* Wied. in confinement for more than two years. It made no perceptible increase in size, yet it partook quite freely of food.—*J. Schneck, Mt. Carmel, Ill., American Naturalist.*

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Bessemer Converters in the United States.

At a recent meeting of the Iron and Steel Institute, London, Mr. James P. Witherow, of Pittsburg, whose converter had been described by Mr. Hardisty, said that in America, within the past two years, considerable headway had been made in the development of the Bessemer process with the fixed or stationary type of converter. Up to the present, however, sufficient reliable data have not been obtained to enable the claims that might be advanced to be fully determined and demonstrated. The reason for this fact is twofold. First, because the year 1884 was consumed in experimenting with and remodeling the Clapp-Griffiths type of converter by Messrs. Oliver Brothers, of Pittsburg, to the type the speaker now recommends, and which he now has in successful operation; and, secondly, because in such experimental stages it is more difficult to obtain reliable data, and even when obtained it is often more difficult still to get those interested to credit the facts put before them. However, the results of the working of Mr. Oliver's new converter, which was substituted for that of the Clapp-Griffiths, were such that during the winter and spring of 1884-85 contracts were closed for seven distinct plants, about one-half of which were in use during the past summer, and all will be working in the coming winter. From this fact, the speaker thought, it would be seen that a fairly extended field was at command from which he could gather reliable information, the area of observation extending indeed from the Mississippi to the Schuylkill. Oliver's plant, the speaker continued, apart from being the pioneer in America, was constructed from very crude designs, sent over from England, from which the makers were forbidden to deviate or in any way change. This was unfortunate, as it led to failures in working at the commencement, and although the difficulties had been overcome and excellent work had been done by Mr. Oliver's plant during the past year, they found the first unfavorable impression very difficult to eradicate. Bessemer practice in the United States owed much to Mr. Oliver's experiments, for before that time, Mr. Witherow stated, they had no idea of being able to make boiler plate or flanging steel, and it was only after his investigations had been published that workers by the Bessemer process began to experiment on low silicon, and this was accomplished by blowing small or half charges in the converters. By dint of great care and attention, following Messrs. Oliver's practice, the Bessemer workers have been able to approach it in the matter of quality, but seem indisposed to carry it out to a successful commercial issue. The Bessemer works of the United States that have been built for the rail trade are of little use, the speaker thought, and of no benefit to the general iron and steel trade of that country. It was true that in times of depression they forced themselves into the market and sold blooms, billets, and plates. But consumers had to accept whatever qualities of steel the makers happened to be producing, no matter how irregular in quality it might be, or unsuitable for the purpose required. Consumers were never allowed to complain, as the steel makers considered their practice infallible. But the moment they fill up with rail orders the general consumer is completely ignored, and therefore it behooves the trade to seek other means of supply. It is for this reason that the small fixed converter seems destined to play an important part, and the speaker thought that, in the United States, such a description of plant will take the place of the more general type for supplying the smaller class of work.

Mr. Witherow had only been able to obtain practical data from two plants up to last August. These were that of Messrs. Oliver, and another of the Western Nail Company, of Belleville, Illinois. The first is one of Mr. Witherow's latest designed converters, but it is smaller than those more recently erected. It would blow from 3,500 lb. to 4,000 lb. of iron at a charge, while the latter will blow from 6,000 lb. to 6,500 lb. The Western Nail Company's plant is of the latter size, but there is one now in construction which will take over 8,000 lb.

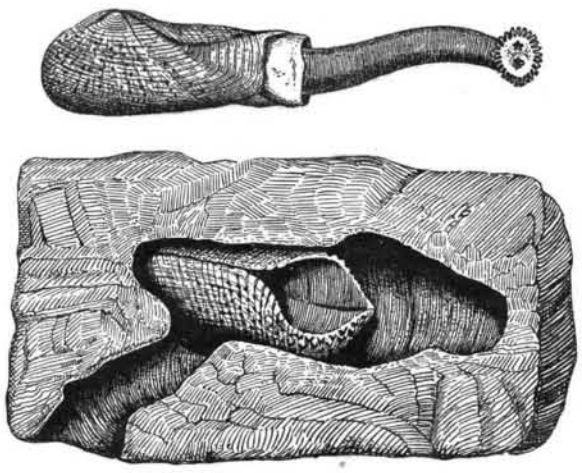
At Messrs. Oliver's, with two small converters working alternately, *i. e.*, following each other instantly on blast and charging, there has often been made 125 tons in a day of 24 hours, and over 75 tons has been made in a single turn. When working up to this output Mr. Oliver states that he can make his ingots at a cost of five dollars per ton, including waste, labor, ferro-manganese, and refractories, everything, in fact, but pig iron. The allowance for waste is two dollars, and it averages from 12½ per cent to 14 per cent. All the cinder in slag from the converter and all collections of shot about the platform are remelted in the cupola, and by this plan the waste is said to be reduced by at least two per cent.

Experiments have been made at Oliver Brothers' works with phosphorus pig, ranging in mixture up to from 0·34 per cent to 0·44 per cent. of phosphorus, and from this excellent cut nails were made. At the Western Nail Company's works, last July, similar experiments were made under the direct inspection of Dr. T. M. Drown, professor of chemistry of Boston, Massachusetts, and his observations were embodied in a paper he had prepared on the "Little Bessemer Process," and read before the American Society of Arts. In conclusion, Mr. Witherow said that no doubt his unpretending type of the Bessemer process has to contend against great odds, and as it is in the beginning of its development, it is impossible to obtain complete data to support the claim made by the few friends it possessed. If, however, positive proof of his claims could not be submitted in a year's time, then metallurgists and steel makers would have sufficient grounds for treating his statements with indifference.

ROCK BORERS.

According to the usual course of things, we would hardly look into the class of mollusks—the very name of which is derived from *mollis*, soft—to find an animal fitted for drilling holes in solid rock. Yet, nevertheless, it is here we find the rock borers. They are bivalves, the shells being thin, but brittle and hard, more or less open at both ends, and armed anteriorly with rasp-like spines. The animal itself is either club-shaped or worm-like; the mantle is closed in front with the exception of an orifice through which the truncated foot is passed; and the siphon tubes are long and united nearly or quite to the ends. The species are rather numerous, and inhabit most parts of the world.

The question as to how these mollusks bore out their dwelling places in the rocks has been a subject of much discussion. The supposition that the shell is the instrument of perforation originated with Bonanni, in 1684, and in the present century most naturalists have favorably entertained it. M. Cailliaud is a great upholder of this theory, and thinks he has clearly proved



ROCK BORERS.

by numerous experiments that such is the case. Geffreys says it is easy to scrape with the edge of a limpet-shell a cavity in chalk or shale, such as the rock limpet occupies; but can it be imagined that in this case the shell instead of the foot is naturally employed for that purpose? The fine and regular striæ or grooves, which are plainly marked on the sides of the cell or hole of the rock borer, are unquestionably caused by the friction of the spinous ridges that ornament the shell. These grooves are wanting at the bottom of the cell, and are replaced there by a far more delicate elaboration, which is, without doubt, produced by the sucker-like motion of the foot. Prof. Owen attributes part of the process to the action of the foot, which is sucker-like, and enables the animal to fix itself to the substance which it intends to perforate. The softness of the foot offers no obstacle, for it is certain that the perpetual renewal of a softer substance will render it capable of wearing away a harder one, subject to the friction of a softer surface, and, not like it, susceptible of being repaired. Lewis says the soft muscular disk is perpetually renewed, and the hard limestone has no self-renovating power; and thus, just as falling water wears away granite by the incessant repetition of gentle blows, so do these mollusks excavate rocks or wood by the incessant repetition of muscular friction.

Some writers have affirmed that the foot is armed or studded with silicious particles, thus forming a perfect boring instrument, on the principle of a "diamond drill." Others, again, declare that no such instrument exists in any of the species.

It has been generally supposed that the rock borer does not secrete an acid. However, both Thorrent and Cailliaud have discovered that they, at least some species, do secrete an acid, which may assist them in perforating the rocks they inhabit.

The work of boring into such rocks as gneiss must be extremely slow. It takes about a year and a half for a *pholas* to arrive at maturity; by that time it has made a hole five or six inches deep.

The property the rock borers possess of giving forth phosphorescent light in the dark is remarkable. This property is not confined to the skin or outer membrane, but every part of the body, and when a pholas is cut into pieces each portion is luminous, and much of the water that drops from them sparkles brilliantly. Out of fifteen living specimens obtained by Cailliaud, at the end of April and in December, ten or twelve only gave out phosphoric light. In none of these did the foot exhibit any luminosity. Geffreys says: "I am disposed to believe that this light is caused, *not* by the rock borer itself, but by extraneous microscopic organisms; but," he adds, "the subject ought to be further investigated."

The rock borers have been found inhabiting new red sandstone, slate rocks, coal shale, hard rocks, chalk, marl, and submarine wood.

A curious little boring mollusk, the *Martesia cuneiformis*, is sometimes found in the oyster shell along our coast. In a large shell from the Chesapeake Bay, Md., I counted six excavations made by this little borer. None of the holes, however, went entirely through the shell. There was no mistake as to what animal drilled the cavities, for each of them contained a *Martesia*.

C. FEW SEISS.

The Dreams of the Blind.

A paper read before the biological section of the American Association for the Advancement of Science was on "The Dreams of the Blind," by Dr. Joseph Jastrow. The object of the paper was to determine the extreme age at which a child may become blind and yet lose all memory of the visible world, so that it no longer sees in its dreams.

Almost all dreams of normal persons are sight dreams, and a dream is often spoken of as a vision. The blind are deprived of this most important sense; but if they have not been born blind, they may remember enough of what they have seen to enable them to imagine how things look, and when the imagination has free play in sleep, to picture themselves as in full possession of all their senses. Physiologists would explain this by saying that during the years in which they saw, a certain part of the brain has become educated to receive and interpret all these messages which the eye sends, and that when this part of the brain acts spontaneously in sleep, the person dreams of seeing. Such a portion of the brain would be called the sight center.

If now we find out the latest age at which blindness may set in and yet the person keep on dreaming of seeing, we shall find out the time it takes for this sight center to develop. For this purpose about 200 blind persons of both sexes were questioned at the institutions for the blind in Philadelphia and Baltimore, and it was found that those who became blind before their fifth year never dreamed of seeing; of those whose sight was lost between the fifth and the seventh year, some did and some did not see in their dreams; while all whose eyesight was destroyed after the seventh year had quite as vivid dream visions as seeing people. The fifth to the seventh year is thus shown to be the critical period. This period corresponds with the age which authorities assign as the limit at which a child becoming deaf will also become dumb, and also with the age of one's earliest continuous memory of one's self.

It is interesting to note that blind persons dream quite as frequently as normal people, and that with those who do not see in their dreams, hearing plays the principal part. When dreaming of home, for instance, they will hear their father's voice or their sister singing, and perhaps will feel the familiar objects in the room, and thus know they are at home. We, in such a case, would see it all.

Cold and Tobacco Smoking.

Dr. Chudnovski publishes in the *Russkaya Meditsina* an account of a series of observations made on twelve soldiers in a military hospital, who were perfectly healthy with the exception of slight injuries, with the object of determining the effect of cold applications to the epigastrium upon the rapidity of digestion. The stomach tube was of course freely used, and the completion of digestion was taken to be marked by the disappearance of solid particles in the gastric contents, as revealed by drawing them up through the tube. The author found that when ice bladders were applied next the skin over the region of the stomach, digestion was retarded in nine out of the twelve cases. Six of the men were smokers and six non-smokers. In the former the time required for digestion averaged seven hours, while in the case of the non-smokers the mean period of digestion was only six hours.

An Interesting Monument.

M. Clermont-Ganneau has communicated to the Academy of Inscriptions and Belles Lettres a note relative to a discovery made by him in an old building at Jerusalem. It was a block of stone, with a Greek inscription signifying that any stranger who should have passed that limit would be condemned to death. It is evidently a fragment of one of the posts which formed, in the temple built by Herod, a dividing line between the exterior inclosure of the Gentiles and the inner precinct reserved for the Jews. It will be remembered that St. Paul barely escaped stoning when he was accused of having introduced Greeks into the inner circle with himself. The stone has been removed to Constantinople, but a cast has been taken, which will be preserved in the Museum of the Louvre.—*Cosmos.*

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