against 24 millions in the same months of last year, the average value per pound during the 10 months of 1906 being about three-fourths of 1 cent per pound below the average for the same months of 1905, thus accounting for the decrease in value of this one item of shipments from the noncontiguous territory to the United States. The figures for the 10 months indicate that the total commerce with the noncontiguous territories will amount to about 115 million dollars, exclusive of approximately 10 million dollars' worth of gold which will be received from Alaska during the full year, the gold figures for the 10 months ending with April having aggregated over 8½ millions.

Summarizing commercial probabilities for the fiscal year which ends with the present month, it may be said that both imports and exports will certainly exceed those of any preceding year, and that the aggregate of trade with the noncontiguous territories will also exceed that of any preceding year; that the increase in imports occurs in all the great groups except foodstuffs; and that the increase in exports occurs in all the great groups, but especially in agricultural products and in manufactures.

THE MUD-SKIPPER OR JUMPING FISH.

By RANDOLPH I. GEARE.

THIS queer-looking fish illustrates forcibly the power of Nature to adapt her products to their surroundings and requirements. She made them into a fish, but, having decided that they must eat land food, supplied them with the needed facilities for obtaining it. And thus, by the aid of their strong pectoral and neutral fins, and with the assistance of their tail, they can hop freely over the ground, and gather their food, which consists largely of little crabs. The eyes have

and seize one fish at the bottom of the burrow."

Dr. Francis Day, the eminent English authority on the fishes of India, gives the following account of their habits:

"It is most curious to see these little fishes along the side of the Burmese rivers. At a distance they at first appear stationary, contemplating all passing objects, or else snapping at flies or insects, or in the water they look like a flat stone or a piece of slate sent skimming by a schoolboy. They climb onto the trees and large pieces of grass, leaves, and sticks, holding on by their pectoral fins, exactly as if they were arms. Now and then they plant these firmly as an organ of support, the same as one places one's elbows on a table; then they raise their heads and take a deliberate survey of surrounding objects. They are not very timid; in fact, my interpreter captured several of them by means of quietly creeping up to them and knocking them over with a stick. Occasionally they crawled up to a boat's rope, when moored, and even onto its sides. Some looked light brown with dark bands, others darker, while a few were of a brilliant emerald green, probably due to the position of the body and the reflection of the light. One morning, when at anchor, I saw close to the side of my boat a snake in the water watching one of these fish, which was intently occupied capturing flies. With a stick I saved it from its reptilian foe, but its colors were so vivid I could not resist giving it a place in one of my collecting bottles.

"They are extensively used in Burma for live bait, a purpose for which they appear to be well adapted." Dr. Gunther says they are brought in considerable numbers into the Bombay markets.

These fishes, like many others, have several names, and the one by which they are most generally known

the Irishman, "Show me the building of to-day that has lasted as long as those of antiquity!" Surely a building material that has come down through more than four thousand years ought to be good enough for us dwellers in the twentieth century, who think a house that is a hundred years old a piece of antiquity, and calculate on replacing most of the buildings of to-day by others better (or at any rate different) within half a century.

If we go to the island of Crete—the inhabitants of which, according to the more or less lamented Bismarck, still deserve the reputation fastened on them by St. Paul, of being the prize liars of their time—we find the citadel of King Minos, to whom we assign a date "whereof the memory of man runneth not to the contrary," and this citadel is not only built with gypsum mortar but finished in colored gypsum plaster. Any one who has done much prowling around the ruins of North German "burgs" will note that the damp cold climate has had more deteriorating influence upon much of the building stone than on the gypsum mortar employed to bind the stones together.

There is a reason for most things; and for our low appreciation of the durable qualities of gypsum the principal reason is our own ignorance of the manner of preparing and applying the material in question.

As found in nature, gypsum is a hydrated lime sulphate, with the following chemical analysis (Seifer):

Lime	32.5 per cent
Sulphuric acid	46.5 per cent
Water of crystallization.....	21 per cent

By driving out the water by means of heat, the constituents are

Lime	41.2 per cent
Sulphuric acid	58.8 per cent

If we mix the anhydric gypsum with water, the two combine with evolution of heat, reduction of volume, and resumption of hardness.

But there are two processes of dehydrating gypsum, and these yield two widely-differing products; and general ignorance of this fact is the principal cause of the popular impression concerning the instability of plaster of Paris as a building material.

The first process consists in heating the raw gypsum at a comparatively low temperature, with the intention of driving out only a portion of the chemically-contained water. The object of this process is to get a quick-setting plaster, one that will harden in half an hour at most, and that can be used for making casts where delicacy of outline and fidelity of reproduction are the main desiderata.

The other process, carried on at a red heat, has for its object the production of a hydraulic plaster, which shall possess high resistance to the disintegrating influences of moisture and general weathering. Such plaster is much slower setting and much harder than that for stucco and casts, and is purely constructive in its application. It furnishes mortar, flooring, beton mass, and even building-blocks.

A plaster that is dehydrated at a temperature lying between those necessary to produce the "stucco" and "hydraulic" plasters, is neither one thing nor the other, and will not even set when mixed with water.

The burned stucco plaster has in a loose condition a specific gravity of between 0.65 and 0.85; when well shaken down it reaches 1.2 or even 1.4. But in a fully compressed condition the specific gravity is about 2.6.

The hydraulic plaster weighs loosely about as much as water, or ten per cent more; shaken down in a measure, the figures are 1.5 to 1.6; and its proper specific gravity is about 2.85.

The non-hydraulic gypsum remains only a few minutes in a fluid condition, when mixed with the proper proportion of water, and develops considerable heat. The right proportions of water and plaster vary with the quality of the latter material, from say 10 per cent more weight of gypsum, to 60. The plaster is to be strewn in the water and not stirred until the proper quantity has been added; this avoids lumps. Long stirring is not advisable.

Hydraulic gypsum takes less water and is not to be mixed to a thick cream, but rather to a thin dough. The color should be rather yellowish than bluish—the latter color being a sign of over-burning.

Although the analysis of the uncalcined plaster shows only about one-fifth its weight of combined water, the mixture for stucco purposes contains from 90 down to at least 70 per cent. This extra quantity does not remain in the stiffened mass, but gradually evaporates, and in fact often is thrown out in part by sweating. The disappearance of the superfluous water naturally leaves the mass porous. But to get good sharp casts it is desirable to use as much water as possible; particularly because this retards the hardening process. In making molds for porcelain this porosity is desirable, as it facilitates the drying of the creamy mass which is poured in; ceramic work, however, which is molded under pressure, should be made on or in molds which have been made of a stiff mass, as this stands the pressure of molding better.

Plaster should be kept as dry as possible, and dirty water should never be used in mixing, as this reduces the binding property.

A great mistake is adding more water to the mass when it has once got stiff. The stiffness is not the result of lack of water, but is caused by the presence of exactly the right quantity to enter into chemical combination.

In working with hydraulic plaster the strength of the resulting structure depends more on the proper proportion of water than on any other one cause. The great danger is toward excess. The proper amount is

A PECULIAR SPECIES OF JUMPING FISH.

the appearance of being pushed forward out of their sockets. They can see on land as well as in the water. When drawn back into their natural position, the eyes are protected by a membranous covering.

During the ebb tide these fishes leave the water and hunt for crustaceans, sometimes climbing up on trees or old pieces of timber. The group here shown has been prepared from specimens captured on the mud flats at the mouth of the Sungei Bulu, on the Selangore seacoast in India, by Mr. William T. Hornaday, now director of the New York Zoological Society. He found them exceedingly hard to capture, and the difficulties he met are best described in his own words:

"Although apparently stranded they seemed to feel perfectly at home, and went jumping around over the mud. In reality they were feeding upon the tiny crustaceans left on the bank by the receding tide. . . . There were probably a dozen in sight, hopping spasmodically about, or lying at rest on the mud, but when we made for them they developed surprising energy and speed, and made straight for their burrows. They progressed by a series of short but rapidly repeated jumps, accomplished by bending the hinder third of the body sharply around to the left, then straightening it very suddenly, and at the same instant lifting the front half of the body clear of the ground by means of the arm-like pectoral fins which act like the front flippers of a sea-lion. These fins are almost like arms in their structure and use, the bones being of great length. They were so rapid, and the mud so very deep and our progress so slow, that the fish always succeeded in getting into their holes before we could reach them. By digging a big hole two feet deep, and standing on one's head in the bottom of it, we were able to reach an arm down two feet farther

by naturalists is the "goby." They belong to a group which is found in the seas and along the coasts and large rivers of India, Burma, the Andaman Islands, Malay Archipelago, and beyond. They do not occur on either the Pacific or Atlantic coasts of America. One species appears on the west coast of Africa. The body is usually olive brown, with white or blue dots, although, as already intimated, they sometimes appear to assume a bright green hue, which Dr. Day thinks may be due to the reflection of the light.

GYPSUM—A MUCH MISUNDERSTOOD MATERIAL.*

By ROBERT GRIMSHAW.

THERE are some materials, used in the arts, which are too little understood of men, and among these we may reckon gypsum, or plaster of Paris, which is not only too little understood, but in some connections exactly wrongly understood. In the line of building construction, for example, the word "gypsum" immediately suggests "staff" and temporary structures and decorations, designed and expected to last out at most two winters in a temperate climate. Now as a matter of fact some of the oldest buildings in the world owe their long preservation not merely to favorable climatic conditions and the fact that no great battles were fought about their bases, but to the use of gypsum in their construction. They have not come down to us through the centuries in spite of the fact that their builders used plaster of Paris in their construction, but because of that fact. As a tolerably well-known building of rather accurately attested age I may instance the pyramid of Cheops, built with gypsum mortar, and which may well recall the bull of

*Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

determined by experiment; but in general it may be said that only half as much is needed as for stucco work. Care must be taken that during the hardening process no water is drained or absorbed from the mass. It is advisable to have a bed of wet sand on which to work. In order to get the maximum strength, too rapid drying must be avoided; that means avoidance of drafts and of high temperatures.

Stucco plaster swells at the moment of hardening; the increase of volume being about one per cent. This is a great advantage which it possesses in common with cast iron; it gives sharp castings. But if ordinary stucco plaster be employed instead of the hydraulic, the results of this swelling property will be disastrous.

Once hard, neither of the two varieties of gypsum loses its size or shape; but the hydraulic kind differs from the stucco plaster in that it does not swell at the moment of hardening. This is a very desirable property from the point of view of making floors and other large surfaces required to be fully free from drying cracks.

Gypsum which has set is soluble in 400 parts of water. In order, therefore, to protect it from the injurious effects of moisture, the surface of casts, cornices, etc., may be filled with oil paint. Attempts to secure the same advantages by the use of alum, or borax, have proved in the long run futile. There are in Berlin, according to Segar and Cramer, who have collected a mass of material in favor of gypsum for the German Society of Gypsum Manufacturers, façades of stucco which have, by reason of a coat of oil paint, resisted the weather for sixty years.

Hydraulic gypsum, being unaffected by absorption of water into its interior, is indicated for places where weathering is to be expected.

In inspecting ancient buildings where gypsum has been used as mortar between the stones or bricks, the observant investigator will see how much better it has stood the gnawing tooth of time than the lime mortar exposed under similar conditions to the same disintegrating influences.

It will be seen, therefore, that the expression "much misunderstood material" at the head of this article, is particularly applicable to gypsum; and it is to be hoped that our architects and builders will give the old-new building a fair show. To be sure the experiment may remind one of the Irishman who, having heard that a crow would live a hundred years, bought one to try; but it is worth going over the ground which such old master builders as those of the pyramids in the dry climate of Egypt, and the burghs and abbeys of cold and damp Northern Germany, trod with such sureness and success.

DEVICES FOR DETERMINING THE ENERGY LOSSES IN IRON SHEETS.*

By DR. ALFRED GRADENWITZ.

WHILE some amount of energy is expended in magnetizing iron, the magnetical condition once produced is maintained therein without any consumption of energy, the energy recovered in demagnetizing being smaller than that expended in magnetizing by that part of the molecular energy of the iron which has been converted into heat. Outside of this hysteresis loss some other loss of energy due to what is called Foucault currents will be observed in iron in case of

sheets. The intensity is proportional to the density of the lines of force (B) and number of periods, while the loss of efficiency is proportional to the square of the current intensity and to the ohmic resistance of

means of wattmeters on samples of at least 10 kilogrammes derived from at least four sheets, and should be stated for $B_{\max.} = 10,000$ and 50 periods in watts per kilogramme for a given temperature. This fig-

Fig. 7.—Plant Using Epstein Apparatus for Testing Energy Losses in Iron Sheets.

Fig. 2.—The Möllinger Type of Testing Apparatus.

the conductor, being dependent to a large extent on the shape of the cross-section.

In all kinds of electrical apparatus in which variations in magnetism are produced (e.g., in dynamos and transformers) thin iron sheets are used in building up the iron bodies in order to reduce as far as possible the losses in efficiency due to the phenomena above referred to. Now, since the quality of the iron

Figs. 5 and 6.—Sliding Bar for Introducing Iron Sheets in Richter Apparatus.

as regards its electro-magnetic behavior is mainly responsible for the efficiency and the heating of the electrical apparatus, a thorough investigation of the iron used in manufacturing sheet iron for electrical machinery should be of the highest interest.

The importance of a magnetic examination of the

ure, as reduced to the sinuoidal behavior of the tension curves, is called the 'loss-coefficient' at the temperature in question." The types of apparatus especially recommended by the association are the Epstein (Fig. 1), Möllinger (Fig. 2), and Richter (Fig. 3) apparatus. These three iron-testing instruments are based on the common principle that the iron sample is conveniently shaped to a magnetic circuit, containing exclusively iron of the quality to be tested. The iron sample is next magnetized, winding it with wire and passing an alternating current through it. The effect produced by the alternating current in the windings is measured by means of a wattmeter, in addition to which the current intensity and tension are read by means of instruments of precision, whence the loss coefficient is determined, taking account of the loss of energy in the copper windings and other corrections.

Fig. 4 shows an iron-testing plant recently installed in a metallurgical works in which the Richter apparatus is mainly used. This apparatus enables four complete iron sheets of 1,000 x 2,000 millimeters area to be tested without any loss of metal. The iron sheets are introduced into the drum all together by means of a sliding bar (Figs. 5 and 6) and are thus bent to a cylindrical sleeve surrounded by the magnetizing windings that are drawn out freely through the air. The direct current-alternating current transformer visible in Fig. 4 is used as source of current; this is operated from a special accumulator battery so as to obtain a constant number of turns throughout each test. The frequency and pressure of the alternating current are readily altered within wide limits so as to separate the ascertained losses into those due to hysteresis and Foucault currents respectively. Any necessary apparatus for inserting and regulating the transformer (switches, fuses, ammeters, voltmeters, frequency meters, and regulation resistances) are installed on the marble switchboard. The readings proper of the intensity, tension, and output on which the determination of the loss coefficient is dependent, are made on the instruments of precision installed on the table and which, independently of the displacement in phase, record the number of periods and shape of current curve; they are of the dead-beat type. The precision wattmeters have been so designed as to reach the terminal deflections with full current and tension load for $\cos \phi = 0.5$, thus considerably increasing the accuracy of the reading.

In Fig. 7 is shown a similar testing station of another rolling mill in which the Epstein apparatus is exclusively used. In this apparatus the sheet to be tested should be cut into strips of given length and breadth, which strips are insulated from each other by wrapping them with silk paper and are combined in a substantial package by winding them with insulating tape. The four packages are next introduced into the four magnetizing coils and the magnetic circuit closed by tightening the wooden jaws. Any immediate contact of the side joints is prevented by inserted pieces of fiber. The transformers and instruments used in connection with these iron-testing plants are so designed and provided with such ranges as to allow the measurements to be carried out both with the Richter and Epstein apparatus.

The third testing apparatus referred to above, viz., the Möllinger instrument, comprises an iron core made up of punched iron rings. This apparatus requires no joints which might permit leakage, as the continuous core is surrounded by a detachable coil. The apparatus is used to special advantage in connection with the current iron tests made in electrical works, employing sheet rings as used in the current types of dynamos. As these sheet rings can be put to service

Fig. 8.—Dubois Magnetic Balance.

Fig. 3.—The Richter Testing Apparatus.

Fig. 4.—Iron Testing Plant Using Richter Apparatus.

Fig. 1.—The Epstein Apparatus.

DEVICES FOR DETERMINING THE ENERGY LOSSES IN IRON SHEETS.

variations in the magnetism. These currents are due to variations in the flux traversing the iron and go in a direction at right angles to the flux, thus being unable to develop to any considerable extent in thin iron

sheet iron used in armature disks has been fully appreciated by the Association of German Electricians, which, at its last meeting in 1905, enunciated the following regulations:

"The total loss in iron should be determined by

*Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.