DESCRIPTION OF A CLOSING TOW NET, FOR SUBMARINE USE AT ALL DEPTHS.*

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RECENT experiments with closing tow nets in submarine explorations have yielded so much accurate information concerning the vertical range of pelagic life, that the construction of the Tanner intermediate tow net in 1891† may be said to have inaugurated a new era in the study of the pelagic fauna, characterized by exact knowledge of the depth of the forms collected.

The vertical distribution of the pelagic life gathered with the open tow nets of the Challenger expedition has necessarily been conjectural, the nets employed having been dragged open at all depths. Since then European investigators have employed several devices for closing submarine tow nets, but direct evidence as to their reliability, so far as the writer is aware, seems to be lacking.

Open tow nets of different forms have long been employed by the United States Fish Commission, while a closing collector, although of very limited capacity (the Sigsbee gravitating trap), has done service on the Coast Survey steamer Blake; but it was not until 1891 that a closing tow net of large size was brought into use. The Tanner tow net, closing tightly at any depth desired, has proved its efficiency during recent explorations conducted by the Fish Commission and by Mr. Alexander Agassiz, but its large size and somewhat complicated construction have prevented its use except by steam power from large vessels.

While towing a light surface net behind one of the small boats of the Albatross in an Alaskan harbor in the summer of 1894, the idea of a very simple closing net presented itself, which was at once experimented upon and gave satisfactory results. I at first used it in moderate depths only, but subsequently, having made one of heavier form than at first employed, the principle was found applicable to deep sea work as well as near the surface.

This form of towing net is, on account of its lightness and simplicity, convenient for use by hand from all kinds of small sailing craft and open boats. It can be rolled into a small package with all its attachments and carried readily in one hand. With a light tow line passed through a pulley slung from one of the boat davits of the Fish Commission steamer Albatross, it has been hauled in from depths of 20 and 30 fathoms by one man with very little exertion, and has not failed to work in a single instance.

In the summer of 1895 this net, constructed in larger and heavier form, with a net ring 3 feet in diameter, was used successfully on board the Albatross during fishery investigations in Bering Sea, at depths varying from 20 to 200 fathoms.

Following is a description of a closing net of medium size constructed for use on the Fish Commission schooner Grampus (Pl. 1, Figs. 1 and 2). It consists of a tow net with a folding ring suspended by rope slings from a tripping arm attached to the tow line, and is operated at will by a messenger. The ring to which the net is attached is hinged to fold, for the purpose of closing the net, and is supported by two sets of slings of nearly equal length, one set attached near the hinges, supporting the net in an open position, the other attached at right angles to the hinges, supporting it in a closed position.

Closing is effected by means of a tripping arm, from which the slings are suspended, and which, being tripped by a messenger, shifts the weight from the opening to the closing slings, with the result of closing the net. The tow line is attached to the lower end of the tripping arm, the upper end of which is hooked to a ring on the tow line. The opening slings are secured near the upper end of the arm, the closing slings to the lower end. A light messenger (Pl. 1, Fig. 3) sliding down the tow line detaches the messenger ring from the upper hook of the tripping arm, shifting the weight from the opening to the closing slings. A spring catch in the upper hook of the tripping arm keeps the messenger ring from slipping out of place until struck by the messenger, while a heavy ring-shaped weight, released by the tripping of the arm, slips from the lower hook of the arm down the closing slings and keeps the jaws from opening after they have been closed by the messenger. The accompanying figures, showing the net in both open and closed positions, illustrate its workings clearly.

The tripping arm is merely a piece of half-inch brass, ordinarily about 2 feet in length and of the shape shown in the cut. The ring is 2 feet in diameter, made of ¾ by ¼ inch brass, and is essentially the same as that employed by Agassiz for use with his modified Chun-Petersen machine.* The messenger is a 2 pound bronze casting, in two parts, to lash around the tow line. A small lead sinker is lashed to the bottom of the net, of sufficient weight to carry it down clear of the ring, as it is, of course, lowered vertically and the vessel from which it is operated brought to a full stop. The net is light and of small mesh, preferably half inch. It is lined with bobbinet or mosquito netting, with a delicate inner lining of silk bolting cloth, the last being the real collector, to which the outer nets act as supports.

In this combination of three nets all are of full width to the bottom, where they are closed by a lashing, the inner nets being secured rather slack, in order to avoid strain upon them in towing. As used on board the Albatross, by steam power at all depths, the net and its appliances have been constructed somewhat heavier and stronger. Additional weight is secured by passing the tripping arm through a 60 pound shot, of the ordinary pattern used for sounding, the shot being secured by a bolt to prevent its slipping when the arm is capsized. (See Pl. 1, Fig. 4.)

A deep sea tow net, closed, with the folded jaws protecting its mouth, offers little resistance to the water, and can be heaved in rapidly without the danger of being torn away from an open and widespread net ring, while the friction upon the contained organisms is reduced to the minimum.

The time gained in deep sea work, with a folding ring net which will permit of the steam winch reeling in at full speed, and the small stowage space required on shipboard for a net of this pattern, are matters of considerable importance. The readiness with which this net can be carried on deck by one man and attached to the wire dredge rope without complicated adjusting is perhaps the most important point of all in its favor, while its cost is less than that of any intermediate net hitherto employed.

This device has also been constructed in very light form, with a net ring 18 inches in diameter, for use in lakes or at very moderate depths, the heavier outside net being done away with, leaving merely the mosquito netting with its lining of silk bolting cloth.

In this form it will be useful in gathering the minute life, crustacea, etc., of the Great Lakes, a knowledge of which is essential in its bearing upon the food of young whitefish and other important fishes now being propagated artificially.

The folding ring tow net is also available for use as an ordinary surface tow net, without the employment of the messenger and the lead sinker.

The collections made by the Albatross during the past summer with the intermediate net were from depths of 20 to 200 fathoms, the net being lowered in one instance to 575 fathoms, when it accidentally touched bottom. The forms obtained consisted principally of minute crustacea, medusæ, annelids, and fishes, which have not yet been studied; but the ordinary surface tow net having been used at the same stations as the intermediate net, the contents of the two nets were usually found to differ somewhat in character and quantity. As a rule, the surface net contained a slightly greater quantity of material than the intermediate net, but at some stations the reverse was the case, while the intermediate net sometimes brought up forms not taken at all in the surface net. The towings, 18 in all, were made along the border of the submarine bank

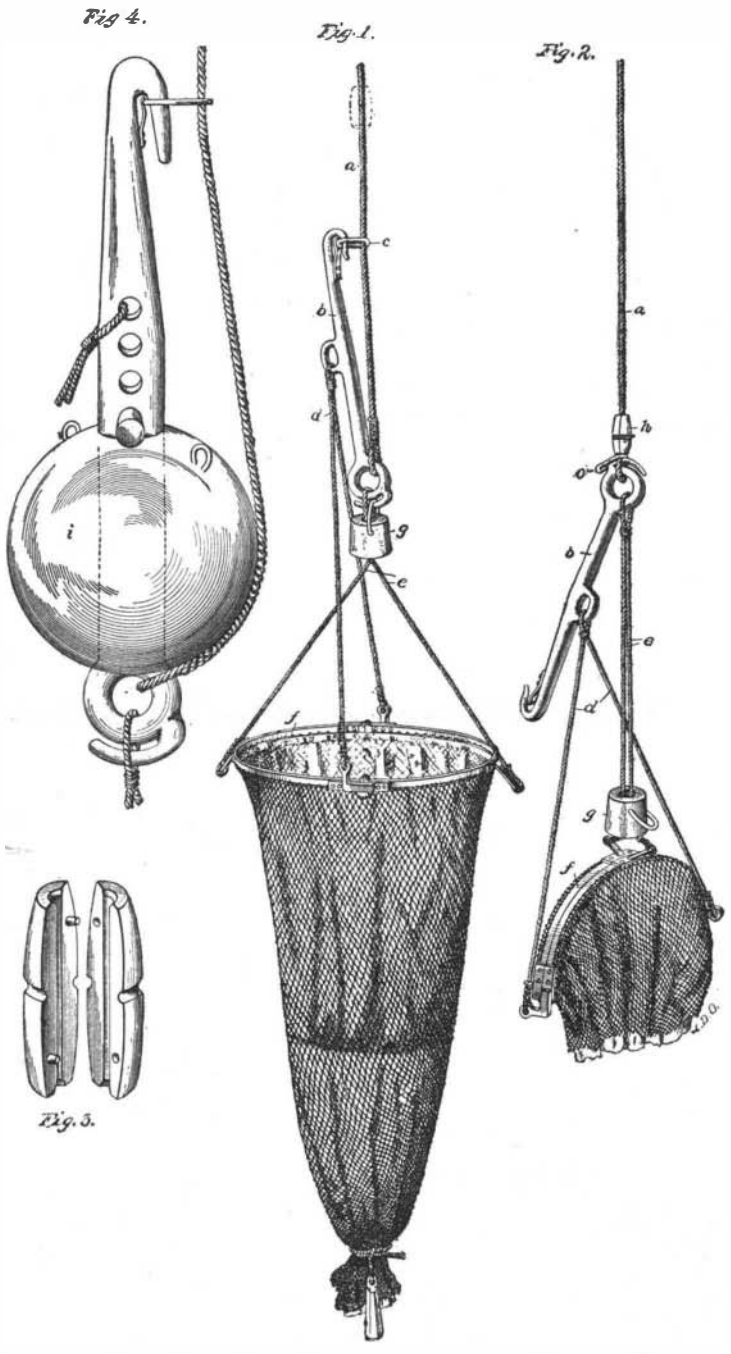


FIG. 1.—Showing net in position for lowering and towing: a, tow line; b, t ipping arm; c, tripping ring; d, opening slings; e, closing slings; f, folding net ring; g, closing weight; h, closing messenger (see also Fig. 3). FIG. 2.—Showing net closed for heaving in. FIG. 3.—Closing messenger. FIG. 4.—Showing heavy tripping arm used on steamer Albatross, with 60 pound sounding shot attached as sinker for proper strain on wire tow line in deep sea work: i, common sounding shot—60 pounds.

PLATE 1.—CLOSING TOW NET.

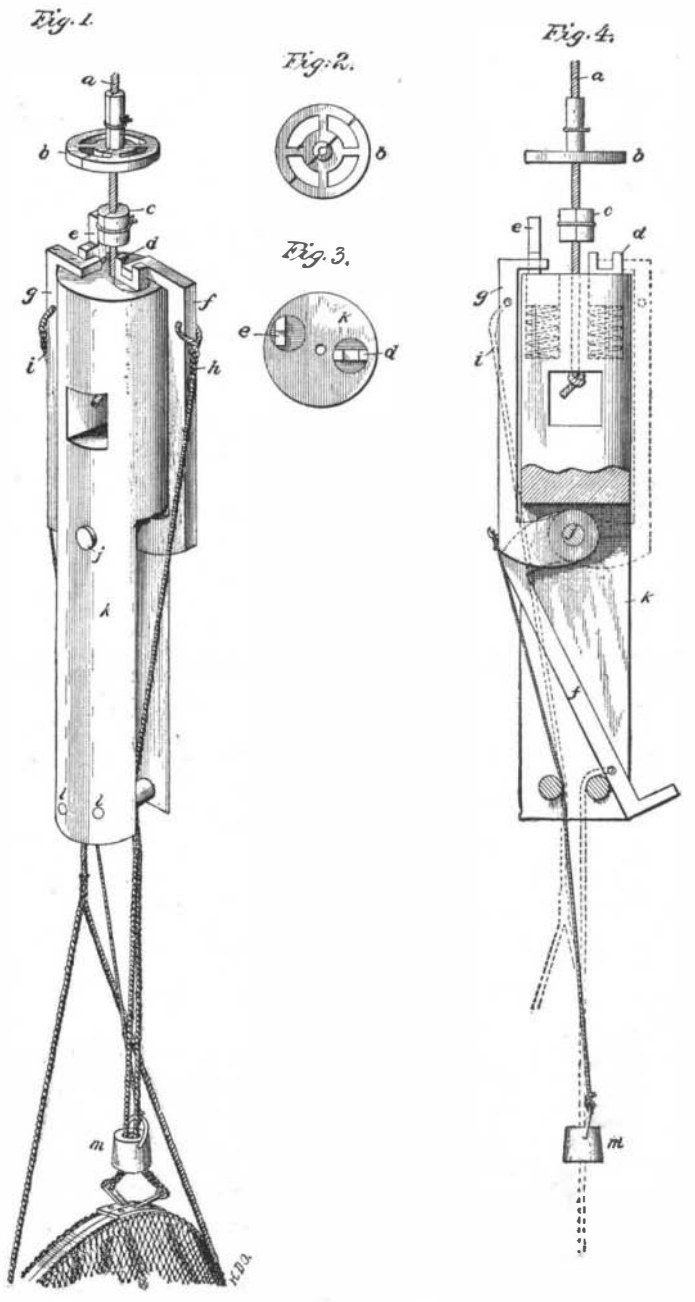


FIG. 1.—Showing net in position for lowering: a, wire tow line; b, second messenger—to close; c, first messenger—to open; d, plunger securing right arm; e, plunger securing left arm; f, right arm; g, left arm; h, closing slings; i, opening slings; j, bolt securing tripping arms; k, body of machine (2 ft. 3 in. long); l, bolts holding net lines on center of gravity; m, closing weight. FIG. 2.—End view of second messenger. FIG. 3.—End of machine, showing position of plungers. FIG. 4.—Showing right arm tripped, springs to plungers, and knot securing tow line.

PLATE 2.—CLOSING TOW NET.

* From a pamphlet issued by the U. S. Fish Commission.

† Tanner, Rept. U. S. Fish Com. 1889-91, pp. 259-260. Bull. U. S. Fish Com., 1894, pp. 143-151.

* Agassiz, Bull. Mus. Comp. Zool., 1892-93, vol. xxiii, p. 45, etc.

south of the Pribilof Islands during the month of August, from lat. 54° to 56° N. and long. 167° to 172° W. Soundings were from 75 fathoms, on the bank, to 1,901 fathoms beyond it. There can be no doubt that there is an abundance of pelagic life at 200 fathoms in this part of Bering Sea.

After some experience with the single tripping arm described, I designed a machine for opening as well as closing the jaws of the tow net, which worked satisfactorily (Pl. 2). It is a combination of two tripping arms, for operating which two messengers are employed on the same tow line, the second striking a separate detacher from the first. A rough experimental machine, constructed on board the Albatross, was used successfully in port, but did not have strength to withstand the strain of towing at sea. Experiments indicate, however, that a properly constructed machine of the same pattern would accomplish the desired result. Its use in place of the single tripping arm permits of the folding ring tow net being lowered in a closed position, the closing slings being attached to the right arm, the opening slings to the left. The arms are bolted to a bar of brass about 2 feet long, suspended from the tow line, and in position for use are hooked upright to detachers released by messengers. The first messenger tripping the right arm, the jaws of the net fall apart for towing. The second messenger, in turn, tripping the left arm, the weight is thrown back on the slings of the right arm, closing the jaws. A ring-shaped weight around the right slings, and suspended from a hook on the left arm, holds the jaws together for lowering. It is released upon the tripping of the left arm, and slips again to its position upon the right slings, holding the jaws together for heaving in.

The net being closed tightly in going down, it is not necessary to stop the vessel and lower it vertically.

UNDERGROUND PHOTOGRAPHY.*

THE value of photographs in a mining report is evident to everyone, and there are few engineers who have not wished at various times that they could illustrate their papers by means of the camera. I will endeavor to show how, with the simple appliances that can easily be carried into a rough country, photographs can be secured which will much more than repay the slight cost and trouble in taking.

The camera is the most important part of the outfit, and this should be the best obtainable, and in most cases where portability is an object, carrying not larger than a 5 × 7 in. plate. It should be folding, self-containing and, where necessary, focusing by a scale in front, without the aid of the ground glass. The camera should have double swing-backs and sliding front. The tripod, as in surveying, should be adjustable to different heights, and is much steadier by having its legs in only two sections. One should have two lenses, wide angle and rectilinear, for underground and surface work, and these should be able to cover a larger plate than the camera carries, so that the image is sharp when both sliding front and swing-backs are used. The best lenses are none too good, as great rapidity is almost always an advantage. The most useful shutter is probably the automatic Bausch & Lomb, with iris diaphragm. I use a 4 × 5 in. folding Kodak, sliding front and double swing-back, Bausch & Lomb lens and shutter. The Poco, Premo, Wizard and some other cameras, when fitted with wide angle lenses, are admirably adapted for underground work, and are very portable.

The plates used should be the quickest possible to obtain. Seeds 27 and Carbutts, also the quick plates of some other makers, work nicely, but little or nothing can be done with a slow plate. Films rarely give complete satisfaction, but where great portability is required cut films seem to work fairly well. The lamp is very important. I have found the "Perfection" lamp (Fig. 2), while not perfection, perhaps the nearest to it of any lamp. The "Perfection" is a magazine lamp, and will serve for from 5 to 15 exposures without refilling. An admirable lamp is made by taking a clay pipe, wiring on to it a lamp wick. The magnesium powder is put in the bowl and the wick, previously soaked in alcohol, is lighted. The magnesium is blown up through the flame by means of a rubber tube or a bulb such as is used with the shutter of the camera. This outfit, costing about 1½ cents, will make as good a picture as the best lamp in the market, but has to be filled each time it is used. This, however, is perhaps an advantage, as it enables the photographer to control the intensity of his flash by the amount of magnesium used, which has to be guessed at with a magazine lamp. Fig. 1 shows the contrivance ready for use.

Blitz-pulver may be used without a lamp, and simply ignited on a rock or shovel. It is easier to regulate the amount of light and much quicker, but it is harder to direct the light and makes more smoke. Magnesium powder with a lamp is, in my opinion, far nicer, less expensive, and in most cases better than blitz-pulver. A box to contain the instruments, plate holders, etc., together with a flask of alcohol for the lamp, is useful. At all events, they should be carried in such a way as to be easily found in obscure light.

In taking the picture it is not necessary to focus very carefully, as the wide angle lens is very nearly universal focus. The best way is to focus with the ground glass on some object about 20 feet away, make some kind of a mark and use this where the light is obscure underground. The camera must be leveled carefully, as the wide angle distorts somewhat, even under the best conditions. This operation is quickened by having a level or a pair of levels on the swing-back. If the swing-back is level, the picture will not be distorted, but the plates must be perpendicular, no matter where the lens is pointing. A ball and socket joint aids in leveling, but makes the camera less steady. By moving candles or lights in front of the camera one can tell exactly how much ground the lens covers and just what the photograph will include. There is rarely enough light to see the image distinctly on the ground glass. Everything being ready, the slide is withdrawn from the plate holder, the shutter opened, unless it was left open in the beginning. The lamp is set going from behind or to one side of the camera a few inches back of the lens. The flash must never get in front of the lens, though candles or lights may be left burning if they are not moved. The exposure lasts according to the size of the workings, and the length of the flash can only be learned by experience. Perhaps three thimblefuls of pure magnesium, or about twice the quantity of blitz-pulver, would light an ordinary sized drift or stope. If the photographer stands behind the camera and causes the lamp to move in an arc from one side over the top to the other, blowing slowly all the while, to throw the light in all directions, the best results can be obtained. A reflector is sometimes useful.

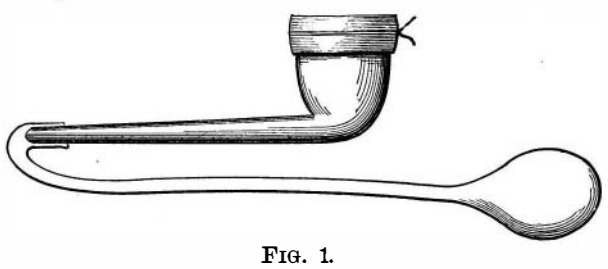


FIG. 1.

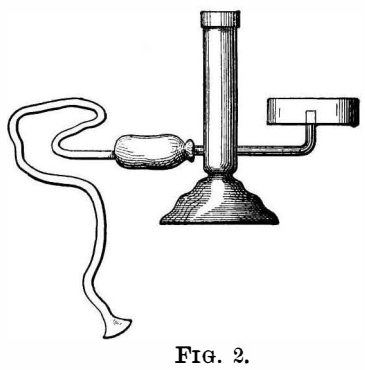


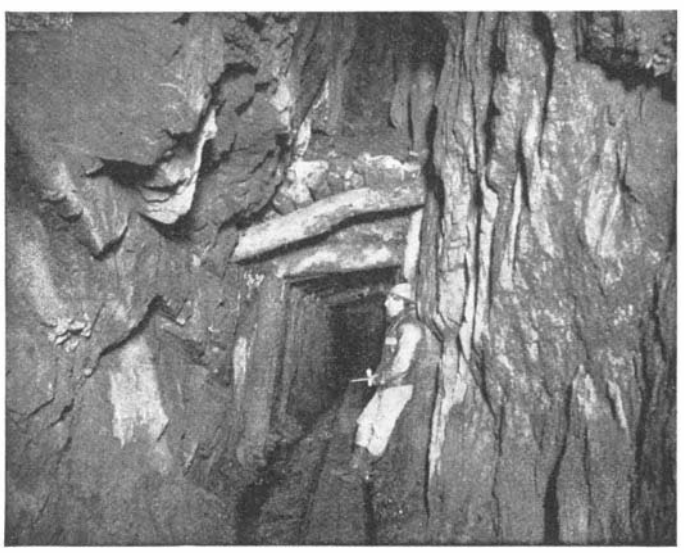
FIG. 2.

Care should be taken not to let the smoke get in front of the camera, as this fogs the picture. This is very difficult in taking low drifts and upraises. In such places it is usually necessary to use blitz-pulver where the plate is exposed and the flash finished before the smoke really gets started. In all cases it is well to study the direction of air currents, both while making the flash and also when a good exposure is desired. I have found it almost impossible to take a second good picture within a reasonable time, even in well ventilated mines. After flashes as well as after blasting, even when the smoke is gone, there seems to remain a practically invisible gas which throws the objects in the picture all on one plane and makes the photograph look like a bass-relief. In taking pictures of shaft houses and mills even in daylight it is often advisable to give one or more flashes to bring out more detail in obscure places. The contrasts otherwise are liable to be too great.

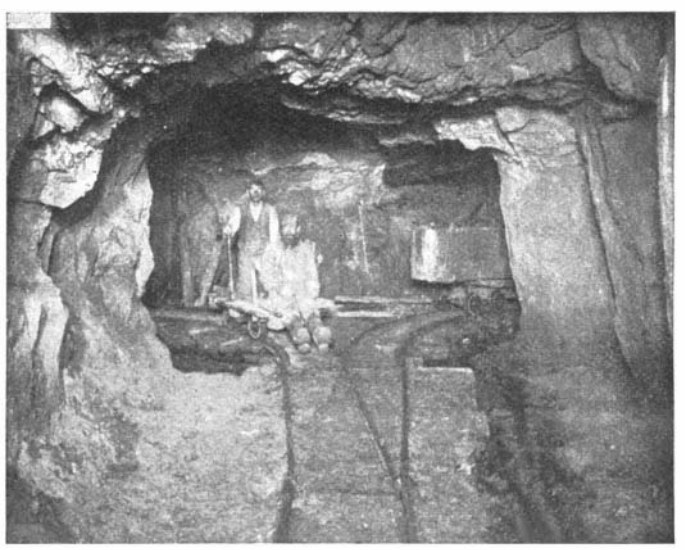
A few words should be added on the subject of developing and printing. Underground flashlights, having so little contrasts, need a good light in developing. They should be developed slowly, and will often be improved by intensifying later on. The author prefers negatives bordering on dense, and thinks that it is difficult if not impossible to over-develop a properly exposed or an under-exposed plate. In the boxes with the plates will be found formulas from the makers for developer, intensifying and reducing solutions, and these are usually best suited to the particular brand of plates. Eastman's eikonogen powders and Dr. Anderson's eikonogen cartridges are very useful in traveling. They are cheap, take up little room and do very good work. In developing in tents and the like, starlight or indirect moonlight does little or no harm.

The engineer rarely does his own printing, but he will be rewarded as a rule when he does. Platinum paper gives the best results, as it tones down the sharpness of the ordinary flashlight negative. It is the easiest and quickest paper to handle, though somewhat more expensive than the gelatine papers. Bromide paper, except for very thin negatives, is not as good as platinum, as it is likely to intensify the faults of the negatives. It is admirable, however, for enlargements, and most negatives taken by flashlight can be enlarged with good results.

The accompanying illustrations are reproductions of underground photographs taken in mines in the vicinity of Clear Creek and Idaho Springs in Colorado. They show what can be done with the camera in a mine.



BEGINNING OF A STOPE.



JUNCTION OF TWO VEINS.

PHOTOGRAPHS TAKEN IN THE PRUSSIAN MINE, COLORADO.

*Written for the Engineering and Mining Journal by James Underhill.

MOISTURE IN COAL.

THE characteristics of different coals with reference to their ability to absorb moisture vary between wide limits. Anthracites are almost wanting in this property. The surfaces of the lumps of anthracite coal become wet when exposed to rain; but there is scarcely any penetration of the moisture into the structure. The semibituminous coals, of which the Cumberland and Pocahontas are examples, absorb some moisture because a considerable portion is usually in the condition of dust; but the part which consists mainly of lumps absorbs little more water into the body of the fuel than does anthracite coal. If a small pile of Cumberland coal which has been wet by the rain is left in the open air, the moisture will quickly and almost wholly disappear after one or two days' drying. The percentage of moisture which these coals contain when subjected to the ordinary exposure of transportation and storage in an unprotected pile seldom reaches as high a point as 5 per cent. The bituminous coals have different properties in this respect. Their power of absorbing moisture is much greater. Some of these coals, which have all the appearance of being practically dry, will, when tested for moisture, shrink 5 per cent. or more. The water enters the structure, and becomes in some degree hydroscopic. The surface indications fail to reveal it. These coals sometimes contain no less than 15 per cent. of moisture, and yet they appear no more moist on the surface than Cumberland coal, which holds but 5 per cent.

It is a matter of some concern how to treat the moisture in the case of wet coal used on an evaporation test. It is agreed that the basis of computation should be the weight of dry coal; but the point at issue is whether the boiler should be given credit for the evaporation of the moisture in the fuel. The subject does not have the importance with the higher grades of coal, because these seldom contain much moisture. As it happens, the coals which contain the large quantities are the ones which are often of the poorest class. With an evaporation, for example, of 5 to 1 and 15 per cent. moisture in the coal, the credit to which the boiler is entitled for evaporating this moisture is 3 per cent.; whereas, in the case of the high grade coals giving, perhaps, 10 to 1 evaporation, with 5 per cent. moisture, the percentage is only one-half of 1 per cent. It would appear, then, that the subject might in some instances be of great importance.

How this should be decided is a question depending upon the object in view. If the commercial value of the coal is the thing desired and the moisture is one of its usual characteristics, then no allowance of any kind should be made for it. The moist condition is the state in which it is purchased, and that is the condition on which the results should be based. If the efficiency of the boiler as a steam generator is desired irrespective of the coal used, it seems certain that the boiler should have the benefit of every advantage to be derived from the use of dry coal, and, under those circumstances, it should have the credit of evaporating the moisture