CHAPTER XII.

Aquarium Construction, Tools and Appliances

AQUARIUM CONSTRUCTION

In the construction of an aquarium the first consideration should be the comfort of the animal inmates, then the production of a pleasing form, with sufficient strength to insure against leaks or breaking of the glass by the water pressure. This latter, as previously mentioned, frequently occurs with all-glass aquaria, and has led to the more general adoption of brass and iron-framed aquarium tanks.

AQUARIUM PROPORTIONS. Surface aeration being necessary to the survival of all forms of aquatic life, the aquarium should be constructed to have large surface dimensions, greater than the depth of the water; even

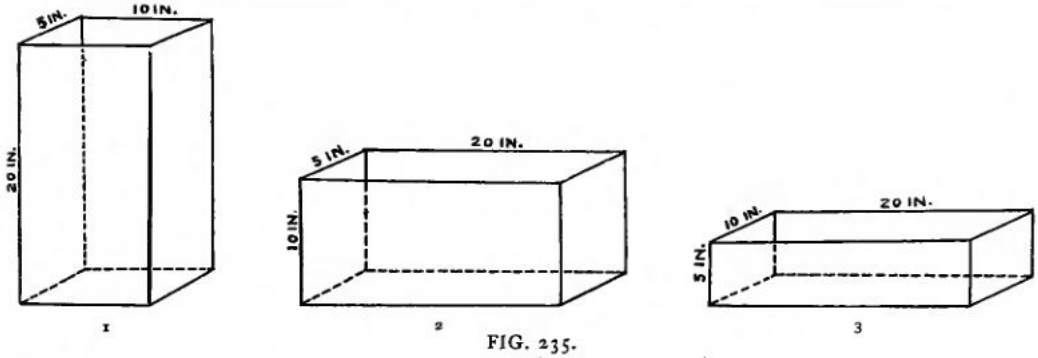

FIG. 235.

though its appearance may not be quite as pleasing as the usual high and narrow forms, designed to offer the largest field of view, to occupy the least space, and to restrict the weight of both the aquarium and its contents. To test the importance of surface aeration, a few freshwater fishes may be placed into a shallow dish of water and the same number into a high and narrow jar containing the same quantity of water, when it will be observed how soon those in the latter receptacle will come to the surface gasping for air. The diagram, Fig. 235, shows three vessels, each containing 1000 cubic inches of water, the first having a surface area of 50 square inches, the second 100 square inches, and the third 200 square inches. No. 3 will support at least twice as many fishes as No. 2 and four times as many as No. 1.

The length of an aquarium may be proportioned to the available space, but the breadth should not exceed 24 inches; when greater than this the contents will be somewhat obscured. The depth of water should not exceed 20 inches, because the pressure of the water would cause discomfort to the inmates and tend to confine their movements to the upper part of the aquarium. Large shallow tanks always give the best results. When space is available and the light is on the surface, a nearly

square aquarium may be adapted, but at a window with front light, the proportion should approximate a double cube, the length twice the breadth; but in either form the depth of the water should not be over 20 inches.

AQUARIUM BASES. A variety of materials may be utilized in the construction of a base or bottom for an aquarium. Heavy white pine, cross-battened on the under side and covered with zinc or glass; a plate of thick glass inclosed in a strong wooden or other frame, or slabs of marble or slate are all practicable; but wood will prove unsatisfactory for aquaria exposed to the weather. Slate is the best material and may be had of dealers in the desired sizes and thicknesses, with the edges either polished or marbleized. Slate bases one inch thick weigh 14 pounds per square foot. The required thicknesses are:

For aquaria to			15	gallons,	not	less	than	½	inch	thick.
"	"	"	40	"	"	"	"	¾	"	"
"	"	"	80	"	"	"	"	1	"	"
"	"	"	125	"	"	"	"	1¼	"	"

Aquaria with cast iron bases and frames may be obtained but should be thoroughly protected from rust on the surfaces in contact with the water by asphaltum varnish or other protecting covering.

AQUARIUM FRAMES. Wooden frames may serve for small aquaria, but are not satisfactory. Contact with the water will cause warping and leaks. Zinc frames are too weak for aquaria of larger size. Angle brass frames are largely used and make handsome aquaria, either polished and lacquered or nickel-plated. For very large aquaria the angles, as rolled, are weak and should be reinforced by soft-soldering two together, as otherwise the resistance to the water pressure will depend too much on the strength of the glass plates. Angle iron is the most satisfactory for all sizes and may be obtained in different widths and thicknesses. The proper sizes and weights are:

For aquaria to			15	gallons,	½	to	⅝	inch, weighing	.56	pounds	per foot.
"	"	"	30	"	¾	"	"	"	.62	"	"
"	"	"	60	"	⅞	"	"	"	.87	"	"
"	"	"	80	"	1	"	"	"	1.50	"	"
"	"	"	125	"	1¼	"	"	"	1.75	"	"

AQUARIUM GLASS. Double-thick window glass may be used for aquaria under 20 gallons, or for the narrower sides of those under 30 gallons capacity; but its composition is such that its power of expansion and contraction is slight and it is liable to fracture from slight strains. Double-thick Crown or German-flint glass is preferable, and better resists pressure and danger from accidents. Plate glass is best for all aquaria, and may be had in two or more thicknesses, ¼ inch for aquaria under 60

gallons, and ⅜ inch for larger ones. Crystal plate is a beautifully polished, white flint glass used for the finest aquaria. It is softer in composition than the usual American plate glass.

AQUARIUM CEMENTS. The desired properties of an aquarium cement are insolubility, resistance to the action of water, strong adhesion, and absence of deleterious substances in its composition. It should "set," or become fairly hard, but not too quickly, nor become so hard that it will not permit of some expansion and contraction of the glass and frame. It should be sufficiently soft to be readily applied and to adhere closely to the surfaces. When its consistency is like that of stiff glazier's putty it is sufficiently thinned for use.

White and red leads form durable chemical combinations with linseed oil, but the acid substances which accumulate in the aquarium produce combinations with them which are injurious, so that when they are used they should be covered with a coating of paste composed of whiting and of shellac dissolved in naptha. Together with litharge, they may be used where the glass is set into grooves; but for all purposes, zinc white is more satisfactory and should be given the preference.

CEMENTS FOR WOODEN-FRAMED AQUARIA. For securing the glass into wooden-framed aquaria, either of two cements may be used. One is composed of 4 parts by weight of pitch and 1 part of gutta percha, boiled together and applied warm to the heated frame and glass. The other consists of 2 parts by weight of zinc white, 1 part of litharge, 3 parts of Portland cement, 3 parts of fine sand and 1 part of powdered resin, kept dry in an air-tight receptacle, and when used made into a thick paste with boiled linseed oil. It "sets" quickly and becomes very hard.

CEMENT FOR ZINC-FRAMED AQUARIA. The glass and frame are painted with "gold size" and permitted to dry. The cement is composed of equal parts of zinc white and red lead, rubbed into boiled linseed oil, to which sufficient litharge is added to make a thick putty.

CEMENT FOR BRASS AND IRON-FRAMED AQUARIA. A good cement for aquaria of thin glass, but not so well adapted for double-thick or plate glass, consists of 3 parts by weight of zinc white, 2 parts of litharge and 2 parts of Portland cement, mixed into a thick paste with boiled linseed oil, and an equal bulk of glazier's putty added. This "sets" hard and makes a very durable cement. For plate glass the following are extensively used: First, the frame, base and glass are painted with gold size. The cement is made of 1 part by weight of zinc white, 1 part of red lead, 1 part of litharge, 16 parts of glazier's putty and a very little ivory black, well kneaded together with a little boiled linseed oil and a small quantity of Japan drier. This "sets" slowly and never becomes perfectly hard, so as

to allow of the slight expansion and contraction. Second, a harder drying cement may be made of 2 parts by weight of red lead, 1 part of litharge and 16 parts of glazier's putty, mixed and applied similarly to the foregoing. Third, equal parts, by measure, of litharge, red lead, plaster of paris, powdered resin, boiled linseed oil and Japan drier; mixed and used at once. Fourth, one gill each of litharge, powdered resin, fine white sand and plaster of paris; mixed and cooked to a paste with boiled linseed oil and a little Japan varnish.

Should any of these cements not set sufficiently hard, as may happen in warm weather, Portland cement will remedy the difficulty. The bright-red color of these cements may be modified to any desired shade by the addition of ivory black.

Cements for Marine Aquaria. A cement composed of 2 parts of litharge, 3 parts of Portland cement, 3 parts of fine sand, 1 part of powdered resin, mixed to a thick putty with boiled linseed oil, is most generally used. Another cement is composed of litharge made into a stiff putty with glycerine and sets very hard. It may be also used to stop leaks.

Cement for Frameless Aquaria. Powdered sulphur is added to melted beeswax to form a very thick fluid, and poured into the corner posts after the aquarium is assembled. Another cement for aquaria, having the base grooved to dispense with a lower frame, consists of zinc white, and spar varnish, to which any coloring substance may be added, and made into a thick paste or putty.

Cement for Rockwork and Tuftstone. Equal parts of Portland cement and sharp white sand are the best for these uses. Mineral and animal oils should never be used in aquarium construction.

Aquarium Paints. Asphaltum varnish is the best coating for all frames, over which oil paints of an desired color may be used; but not where it will come into contact with the aquarium water. Bronze, silver or aluminum powders in gold size make a handsome finish. Surfaces in contact with the water, or in moist places, are best protected with asphaltum varnish. Decalcomania decorations on the frames, covered with varnish, make handsome embellishments.

Constructing Aquarium Frames. To facilitate comprehension of the construction of angle-framed aquaria, the parts will be described as the lower and upper frames and the corner posts. The greatest accuracy must be observed to have all the parts of exactly the same size, true, plumb and at right angles. The angle iron, which constitutes the upper and lower frames, must be marked of exactly the right lengths and the mitre-pieces sawed or filed out at the corners so that the frames when bent will be true in all directions, prior to which the bolt holes in the lower frame should

be drilled and countersunk to take in the flat heads of the bolts. A rivet hole is drilled through the frames on each side of the corners, to exactly correspond with those in the corner posts, which are countersunk for the rivets. that they may be hammered flush on the inside of the frame.

The base is usually 3 inches greater in length and breadth, so as to extend 1½ inches beyond the frame on all sides. The frame is set upon the base and the bolt holes marked; which are then drilled through the slate and opened on the under side to accommodate the nuts. Stove-bolts of the exact required length are the best for this purpose.

Assembling the Aquarium. When assured that all the parts are true and in perfect alignment, and the bolt holes in the lower frame and in the base exactly plumb, the lower frame and the base under it should be coated with zinc white, and after this dries, aquarium cement spread over this part of the base and the frame evenly and securely drawn tight by the bolts, the number of which depends upon the size of the aquarium; but one should be placed very near each side of the four corners, with one, two or three between, at even intervals, on both the long and the short sides, to make the frame rigid and to prevent subsequent leaks. The bolt holes and the space about the nuts should be filled with aquarium cement. A method of construction is to use separate corner pieces to unite the lower and upper frames with the corner posts, usually adopted for large aquaria, which has the advantage of making all the inner sides flush; but riveting them together and filling the space between the frame and the glass with cement is quite as neat and strong in construction.

Setting the Glass. The glass should be carefully cleaned with whiting to remove grease. The frame having been filled with a smooth coating of cement, the glass should be carefully pressed against it, the longer sides being first inserted and kept in place by wooden strips at the top and bottom, and then those of the shorter sides inserted; all done by very gentle pressure and supported in place by the wooden strips, acting as braces. After a day, the lower and upper edges of the glass at the frames and the corners, where front and side meet, may be covered with aquarium cement, and this left to harden or covered with slender strips of glass. Filling the aquarium with water will tend to exert an even pressure on all sides and cause the glass to press evenly on the cement. The cement however will take longer to become hard. When taking an angle-framed aquarium apart, there will be less likelihood of breaking the glass if the cement is softened by running a knife-blade between it and the glass and pouring in coal oil.

SOME AQUARIA DATA

231 cubic inches of water are a gallon, which weighs 8⅓ pounds; a cubic foot of water contains 7½ gallons, and 268 gallons weigh a long ton of 2240 pounds.

The weight in pounds of the water in an aquarium may be obtained by multiplying the number of gallons by 8⅓.

The pressure on the bottom of an aquarium is obtained by multiplying the height, in inches, by 0.43, the result being pounds per square inch of bottom; the pressure on the sides by multiplying the length by the breadth, in inches, and this by one-half the pounds pressure per inch on the bottom, obtained as above. The result is the total pressure in pounds.

The number of gallons in a rectangular aquarium is obtained by multiplying the length, breadth and depth, in inches, and dividing by 231. The result is in gallons. Should the sides be sloping, the mean of the upper and lower diameters, (the diameter in the middle,) is taken.

The capacity of a sphere is obtained by multiplying the cube of the diameter, in inches, by 0.5236 and dividing by 231. The result is in gallons.

The capacity of a cylinder is obtained by multiplying the square of the radius (one-half the diameter,) in inches, by 3.1415; multiplying this result by the depth, in inches, and dividing by 231. The result is in gallons.

For ready reference, data is given of the usual sizes of household aquaria. The weights are in pounds, the pressure in pounds per square inch.

Length.	Breadth.	Depth.	Gallons.	Weight of water.	Pressure per square inch on bottom.	Total pressure on sides.	Total weight of aquarium and contents.
20	12	12	12	100	5.16	625	150
24	12	12	15	125	"	740	185
30	12	12	18	150	"	925	225
30	14	14	25	210	6.02	1250	290
30	16	16	33	275	6.88	1825	375
36	18	18	50	415	7.75	2450	550
40	18	18	56	465	"	2675	610
48	18	18	67	550	"	3275	715
48	20	20	80	665	8.60	4125	880
54	20	20	90	750	"	4640	985
60	20	20	100	835	"	5100	1110

A number of methods have been devised to construct aquaria without frames, some of which have been successful and of handsome appearance; but a neat frame appears more structural, and for sizes over 24 inches is essential to both strength and safety.

AQUARIUM TOOLS AND APPLIANCES.

The experienced aquariist avails himself of a number of simple tools and appliances to facilitate the manipulation of the aquarium. Of these a brief description follows:

NETS. The knotted-mesh twine nets sold by dealers are usually of poor form and too rough for handling goldfishes. It is preferable to employ very shallow ones of Brussels netting. The simplest construction of frame is one piece of wire, first turned into the circle and the end twisted upon the shank. A neater one may be made of a wire ring soldered into the head of a brass wood-screw, and fastened to a light wooden rod. The most practical size for the aquarium is about 4½ to 5 inches in diameter, rounded in form at the back and straight in front; and for the tank a solid brass wire-framed rectangular net about 8 by 12 inches.

FORCEPS. One of the handiest aquarium tools is the forceps. The simplest construction is of one piece of brass wire bent into equal legs, crossed and slightly flattened at the rivet holes and the ends serrated. Pressure applied anywhere above the rivet closes the jaws and even the smallest particles can be removed or plants forced into the pebbles by grasping the roots. Another form may be made of two straight pieces of wood screwed to a light block and long enough to be operated without putting the hand into the water. A spring clothespin to which two slender pieces of wood are fastened is another approved form of forceps.

HANDY STICKS. What have been appropriately called "handy sticks" consist of two light wooden rods, having one end notched like an inverted V and the other cut to a chisel edge. They may be applied to many uses; making holes in the pebbles for planting, forcing down plants, cutting off runners, and straightening the leaves.

PLANT SCISSORS. The leaves and blades of aquatic plants should not be torn off, even cutting them with the finger nails so bruises them that further decay results. A scissors only should be used and to avoid putting the hand into the water, they should have long shanks. These may be made of a pair of round-end scissors from which the finger holes have been removed and replaced by long brass rods with finger holes bent at the ends. In using them two hands will be necessary. The clean cut affects the plant the least and insures a neat and tidy appearance.

Dipping or Lifting Tube. With this handy tool objectionable substances may be removed from the aquarium. The best form is a chemist's pipette or ½ inch glass tubing at least 6 inches longer than the depth of the water, having the lower end protected by a rubber gasket to prevent fracture or scratching of the aquarium glass. In use the upper end is closed with the fingers and the tube directed over the object, when the removal of the fingers causes an inrush of the water by atomospheric pressure, carrying with it the substances to be removed. Then the upper end is again closed with the fingers and the tube raised to the surface of the water, the lower end is closed by the fingers and the tube and its contents removed.

Siphon. A very useful accessory is a siphoning tube of ⅜ inch rubber house, that of red rubber being usually of the best quality, more durable and not so likely to kink or lose its cylindrical form. A piece of glass tubing of smaller diameter than the hose, inserted at the end, will prevent the sucking in of pebbles that may clog the tube; but the best device is a glass calcium tube larger in diameter than the hose and having a bulb to arrest any particles and check their entrance into the hose. To remove these particles the hose is pinched to stop the flow of water and the pebbles, snails, or whatever else may have been sucked in, will fall out of the bulb. Another device at the other end will serve to avoid getting water into the mouth in creating the necessary suction. This consists of a glass tube with a branching side to which a piece of small hose is attached, which when taken into the mouth and the lower end of the tube closed with the finger, in drawing up the water the finger will feel it before it ascends the small tube to the mouth. Unpleasant involuntary swallows are thereby avoided.

Thermometer. A thermometer is indispensable for the culture and maintenance of the goldfish. For the aquarium, floating thermometers are to be recommended, dairy thermometers answering the purpose, are the cheapest and most readily to be had. The bulb should reach to the centre of the water to indicate the mean temperature, as that of the surface is usually warmer. A little tin foil above the bulb will cause it to float upright.

Aspirators. A fountain syringe with which to aerate the water is not absolutely necessary, but if at hand will be frequently used, as it may obviate the frequent change of water in aquaria that are not properly conditioned or balanced, and may greatly relieve the fishes in hot weather. An ordinary rubber air bulb and a short piece of hose will suffice, but a garden sprinkler at the end will cause a finer division of the air particles

and a larger absorption by the water. A generally used device is the rubber florist's aspirator.

CONSTANT LEVEL SIPHON. Aquaria having a constant water supply or tanks in the open air sometimes require means of keeping the water at a fixed level. For this purpose the constant level siphon is best adapted, which consists of a metal or glass tube bent into the form of an irregular S with the inlet leg the longer; then bent at right angle and downward to carry it over the side, and the upper part bent upwards so that the outlet is at the desired water level. Once filled with water it will be in constant operation by capillary attraction. A funnel and tube may be arranged to carry off the overflow water, when necessary.

THE STRAINER. The ordinary household strainer will be found convenient to gather floating particles from the surface of the water. A tea sieve is of convenient size for the aquarium.

THE POLISHER. The best form of polisher to remove algæ from the glass sides of aquaria may be made of a felt jeweler's buff attached to a rod, the centre holding pin sunk into the felt to prevent scratching the glass. Brushes, wood blocks covered with several thicknesses of canton flannel or other materials have been tried but are not as good. Polishers are not intended for use when the algæ are thick, as then only the hand, a piece of soft cloth and a little table salt will properly clean the glass.

THE SCOOP OR DREDGE. A metal scoop on a rod is handy in many ways. With it the pebbles may be moved and shifted or put into the aquarium at the exactly desired locality. Any form having a straight front edge will serve this purpose.

THE MAGNIFYING GLASS. A good reading glass is a useful adjunct, as by its use objects in the aquarium will be enlarged and a clear observation of the contents obtained.

AQUARIUM STANDS. Stands may be constructed of a variety of materials. Tables of wood with shelves for smaller aquaria and brackets for flowering plants are quite general, and may be inexpensively constructed. An iron stand of ¾ inch gas pipe with iron fittings, either painted the color of the aquarium frame or with any desired color of bronze powder, makes a clean, neat and inexpensive support. Window brackets, secured at different heights to the trim of the window, have been shown in illustrations and are intended for one-piece glass or other small aquaria. If taste is displayed in their arrangement and of the contained plants, a very pretty effect may be produced. Shelving across the upper sash for placing a row of battery-jar aquaria would also be a pleasing arrangement.

A picturesque aquarium stand for the porch or garden may be made of a portion of the gnarled trunk of a tree, the main stem furnished with

a flat board the size of the aquarium and the branches sawed off at different levels to accommodate smaller aquaria and pots of growing plants. Other pots or trays could be arranged about the bottom and planted with creepers, which may be trained around the trunk and branches. The whole arrangement can be constructed on rollers, for use on the porch in summer and in the conservatory during the cold weather.