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AQUARIUM CONSTRUCTION IN THE HOME WORKSHOP

The popularity of tropical fish and goldfish has become so widespread that aquaria--in a wide variety of sizes, shapes, and prices--have now become a part of the regular stock of most pet shops. Though ordinarily a factory-made aquarium can be purchased for about the same price as the materials required for its construction in the home workshop, some people prefer to build their own, deriving added pleasure and satisfaction from the construction of a suitable home for their fish.

The construction of an aquarium is not too difficult for anyone who has a workshop equipped with the usual tools--and average ability to use those tools. With careful planning, attention to detail, and patience, it is possible to make a satisfactory aquarium in the home workshops.

It must be understood that the type of aquarium herein described is suitable for fresh water only. Salt water aquariums must be all-glass or have frames of stainless steel or monel metal so that no corrosion may occur, and the work must be done by experts with special equipment. Aquariums of this type may be purchased in most up-to-date aquarium supply stores.

PRELIMINARY

Almost invariably the home-built aquarium is rectangular in shape. Its length is not particularly important, but this should not be out of proportion to the other dimensions. Of primary importance is the width of the aquarium in relation to the depth of water. As the great part of the oxygen essential to the fish will be absorbed by the water from the air in contact with the water surface, the "width" of the water should be equal to or greater than its depth. Incidentally, more pleasing effects in under-water gardening are possible in an aquarium of these proportions.

A small aquarium cannot sustain much life. A 5-gallon aquarium, if it is well-balanced, may be expected to maintain two goldfish (each 2 inches long, exclusive of tails). A tank 24 inches long, 12 inches wide, and 15 inches high, with a capacity of 18 gallons, should maintain eight

2-inch fish of different varieties. When larger aquaria are used, the number of fishes and plants may be increased proportionately; if the fish are larger, their number should be reduced proportionately. If the aquarium is to have neither plant life nor artificial means of aeration, the builder would do well to allow 25 square inches of surface, or 1 gallon of water, for each inch of goldfish in the tank. The minimum requirements of tropical fish vary: 3 square inches of air surface per full-grown Guppy, 8 square inches per full-grown Swordtail or Platy, 20 square inches per medium-sized Barb, and 54 square inches for a large Barb or 5-inch Cichlid.

After the desired size of the aquarium has been established, its finished weight must be considered, as this will largely determine the strength required of the materials used in the construction of the aquarium. The principal item of weight is that of the water, and this weight may be determined on this basis:

One gallon of water weighs 8.337 pounds and contains 231 cubic inches.

For example, if the desired aquarium is to be 30 inches long and 12 inches wide (inside dimensions) and to provide a 10-inch depth of water, the volume of water will be 3,600 cubic inches or 15.5844 (3,600 divided by 231) gallons of water, which will weigh 129.927 pounds (15.5844 multiplied by 8.337)--or practically 130 pounds. Including the sand, plants, and ornaments, the aquarium will probably weigh about 150 pounds. It is apparent, therefore, that the frame and glass must support 180 pounds, and that the builder must select his materials accordingly.

The frame is the "backbone" of the aquarium. The frame must be perfectly squared and rigid, as it supports the sides and bottom, as well as the weight of the water. If the frame does not provide this support, the glass (somewhat flexible) will spring away from the cement (not flexible) and the aquarium will not hold water. Wood should never be used in frame construction: wood does not provide sufficient rigidity and, if brought in contact with the cement, will tend to draw the oil from the cement, making it slightly porous so that moisture will permeate the wood and cause it to wrap. Galvanized sheet-metal of 14 gauge, bent to form 1-inch angle iron, may be used for the frame of an 18-gallon aquarium. Regular angle iron is generally used for the frame of aquaria holding more than 20 gallons of water.

Builders of the larger aquaria have usually found slate best for the bottom. An 18-gallon tank (24 by 12 by 15 inches) may have a bottom of 3/8-inch slate. If slate is not readily obtainable--from a hardware

store, a building-supply company, or perhaps as surplus from a roofing job--plate glass or double-strength window glass will be satisfactory for small aquaria.

Clear glass should be used for the sides and ends. Regular double-strength window glass is strong enough for an aquarium of 1- to 5-gallon capacity, but plate glass will be required for a larger aquarium. Car windows, obtained from junkyards and secondhand-car dealers, have been used with success. If possible, however, new glass should be used, as old glass is usually scratched and this detracts from the appearance of the finished aquarium.

PROCEDURE

1. Drawings. -- When he has finally determined the size and approximate weight of the aquarium that he wishes to construct, it is essential that the prospective builder prepare a complete set of detailed drawings, preferably full size, which will show the actual dimensions of all materials to be used. From these drawings the aquarium builder can make up his "bill of material."

2. Glass. -- The glass should be cut to sizes which allow from 1/8 to $\frac{1}{4}$ inch for the cement. Two panes for opposite sides may be cut about 1/16 inch shorter than the spaces into which they are to be put. The other two panes must be shorter than their respective spaces by an amount equal to the combined thicknesses of the first two panes plus two layers of cement (which may be estimated as about 1/8 inch each). If the builder does not plan to have a strong metal frame, or trim, around the top, the upper edges of the panes for the sides must be ground smooth, as they would otherwise be unsightly and dangerous.

If the bottom of the aquarium is to be glass instead of slate, this glass should be heavier than the sides. The piece of glass used for the bottom should be cut so that it will extend well out to the side frame, allowance being made for the thickness of the four side pieces and the cement.

3. Templates. -- Patterns, commonly known as "templates", should be made and carefully fitted before the metal for the frame is cut. Heavy cardboard can be used for this purpose, but thin strips of wood of the same width as the metal are much better. The finished templates can be placed directly upon the metal for the frame, and lines scribed around these templates will provide accurate guides. The builder can then cut the iron with a hacksaw and dress the metal down to the scribed lines with a file.

4. Frame Assembly. -- Three methods of frame assembly are recommended: each has its advantages and disadvantages, and the builder of the aquarium may decide which method will be best for his use. In the first method, the corners of the frame are bolted together; in the second, the corners are welded; in the third, they are soldered.

Bolted corners. -- This method requires the use of fishplates to strengthen and support the corners. (Fishplates are pairs of plates, which may be of brass, bolted rigidly to each of two abutting parts of the frame.) The fishplates must be prepared and fitted to the templates in order to spot the bolt holes accurately in both the plates and the frame. Because the inside of the frame must present a continuous and even surface to the cement and glass, the holes in the frame must be countersunk on the inside to receive the heads of the flathead bolts. This is the method usually adopted, and it has proved very satisfactory. Its advantage lies in the fact that the frame can be fabricated entirely in the average home workshop.

Welded corners. -- Because properly welded corners form the strongest part of the frame, fishplates are not used in this method. Except for the fishplates, the corners are prepared just as they are for the bolted frames. An expert should do the actual welding; otherwise, the frame may be warped, and a warped frame will not permit proper fitting of the sides and bottom and will invariably result in a leaky aquarium or broken glass. Aside from the possibility of warping, the principal disadvantage of this method of assembly lies in the fact that the frame must be "taken out" for welding. This feature is usually inconvenient and adds materially to the cost of construction.

Soldered corners. -- Because a galvanized-iron frame is not sufficiently rigid when the corners are fastened by rivets, these corners should be soldered. A soldering-iron, rather than a torch, should be used. Care must be exercised to prevent the frame from warping. The corners should be provided with gusset or connection plates for additional rigidity. This method is usually used only for smaller aquaria.

5. Aquarium Cement. -- Various brands of aquarium cement are available from aquarium supply stores, and new types are appearing on the market from time to time. While the Service does not recommend any particular brand in preference to others, it does suggest that the aquarium builder can save much time and effort by purchasing a good grade of aquarium cement, rather than attempting to mix his own. However, for those who are interested, the following formulas have been used with success in the past:

Formula #1.

Bolted whiting	10 parts
Dry white lead	1 part
Dry zinc white	1 part
Litharge	1 part
Lithographer's varnish (medium)	as necessary.

Formula #2.

Bolted whiting	14 parts
Dry white lead	1 part
Dry zinc white	1 part
Dry red lead	1 part
Lithographer's varnish	as necessary.

Formula #3.

Whiting	10 parts
Graphite	1 part
Rosin	1 part
Dry zinc white	1 part
Red lead	1 part
Litharge	1 part
Lithographer's varnish	as necessary.

In these three formulas, if lithographer's varnish is not available, a mixture of 1 part of raw to 3 parts of boiled linseed oil may be substituted.

The dry ingredients should be carefully blended, preferably in a flour sifter, before the varnish or oil is added. If color is desired in the cement, lampblack or dry, colored calcimine may be added to the dry materials during the blending. It is important that all grit and lumps be sifted out and removed before the varnish is added.

When the dry ingredients have been blended, a small amount should be placed on a slab of glass or a nonabsorbent plate, and a little of the varnish or oil added. These materials should be mixed thoroughly with a spatula or wide putty knife, then kneaded--the worker's hands covered with powder--until the mass is smooth and of heavy consistency like glazier's putty or bread dough.

Commercial window putty is too soft and contains materials which are harmful to fish. It should never be used in cementing an aquarium.

6. Assembly of Sides and Slate Bottom. -- The first operation is to drill quarter-inch holes (at regular intervals of about 3 inches) in the bottom frame, and to countersink these holes on the inside of the frame to receive the heads of flathead, quarter-inch bolts. When the bottom of the frame is placed squarely upon the slate, the slate can be scribed through the holes in the frame, and the quarter-inch holes drilled through the slate will then register with the holes in the bottom frame. The holes drilled through the slate bottom should be counterbored from the underside in order that the nuts on the flat-head "hold-down" bolts (which should be cut short enough so that they will not extend beyond the bottom) will pass up inside, and the bottom of the aquarium will present a smooth surface.

The holes in the bottom of the frame should be placed squarely over the holes in the slate, and lines should be scribed lightly on the slate close to the bottom web--both inside and outside. Removing the frame, the builder should coat with ordinary varnish the lower surface of the bottom web of the frame and the area within the scribed lines on the slate. When the varnish on both surfaces has become quite "tacky", the bottom of the frame should be coated with about 1/8 inch of aquarium cement.

After replacing the frame squarely upon the cement-covered slate, the builder may proceed to coat the inside edges of the bolt holes with cement. The bolts are then put in position and drawn up very snug and even. Excess cement, forced out around the edges of the frame, can be wiped off and returned to the batch.

The next operation is to apply a thin coat of varnish to the inside surfaces of the frame. While waiting for the varnish to become tacky, the builder should make certain that the edges of the glass are quite clean. When the varnish in the frame has become tacky, it should receive a generous coating of cement. Without delay, the glass--first the front and back, then the ends--should be set in place and forced into the cement. Several slender strips of wood, a little longer than the distance between opposite panes, may be used to hold the panes under gentle pressure against the cement.

As soon as the glass is in place, the joints must be "pointed" with cement from the inside. The aquarium should then be filled with warm water (about 100° to 115° F.), and the cement should be pressed as firmly as possible into the joints. When the water has cooled, the builder should empty the aquarium, trim off any rough or uneven edges of cement, dry the cement, and apply one or two coats of asphaltum varnish.

7. Assembly of Sides and Glass Bottom. -- If the bottom of the aquarium is to be of glass, this should be placed on the inside of the cement-coated bottom webbing of the frame, as outlined here for the placement of the side panes. The side panes of glass should then be placed in the frame, between the edge of the webbing and the bottom piece of glass.