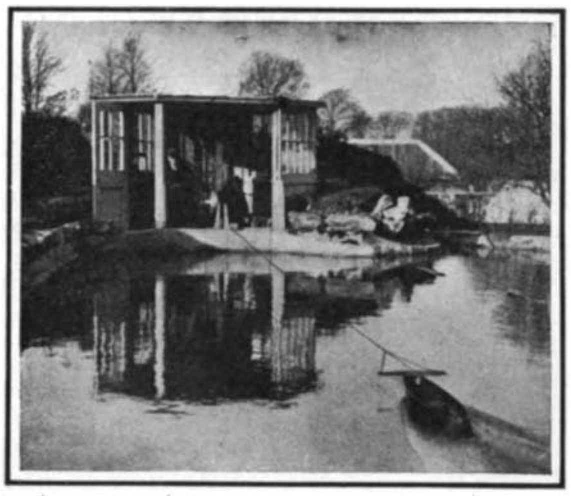
EXPERIMENTS WITH HYDROPLANES OR SKIMMERS.

BY THE ENGLISH CORRESPONDENT OF THE SCIENTIFIC AMERICAN.

The results of a careful series of experiments with models of this class have been published by Sir John I. Thornycroft, F.R.S., the well-known British naval architect. Special arrangements were adopted in the carrying out of these investigations. A small pond served as the towing tank, with requisite equipment in a small laboratory at one end for towing the models at varying speeds. Through the courtesy of the experimenter we are enabled to publish herewith a series of photographs showing the tests in progress. The results of the investigations were communicated by Sir John Thornycroft to the Motor Yacht Club.

Though the generic term "hydroplane" is adopted to individualize those vessels which greatly reduce their displacement when traveling at high speeds, Sir John Thornycroft points out that this use of the word is not correct, inasmuch as the surfaces on which they glide



"Gyrinus" model at moderate speed.

are not always planes. He prefers the designation "skimmers." The skimmer is no modern evolution of marine handicraft. As a matter of fact, it is very ancient, and is still in use among many of the islanders of the Pacific, among whom it performs useful service. These skimmers are extremely crude, representing as they do the hydroplane in its simplest form. They comprise a single slab of wood rounde' at the extreme ends. In the manipulation of these "surf-boards," as they are sometimes called, the natives are extremely adept. Standing upright or lying prone on the primitive support, they can dexterously "coast" down the waves at high speed.

But to make a boat glide steadily alon; the surface of the water is by no means so easy. S'eadiness can

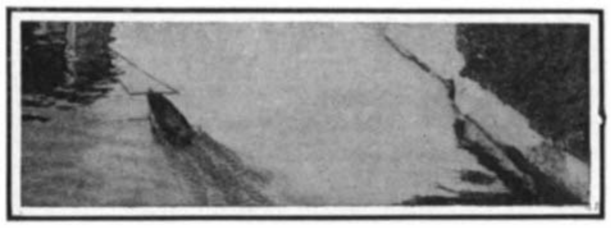
"Gyrinus" model towed backward to illustrate loss of pressure on cruiser stem and stern at high speed.

be attained probably by using a number of planes, but this is likely to increase the frictional resistance. When a number of planes are used to support a given load, each must be of less length than when only one is used. The friction per unit of surface being greater for small surfaces, it is improbable that a smaller total surface will be sufficient, and the necessary power required for a given speed must be more.

Mr. Froude, who carried out elaborate experiments in the same field, advanced the opinion that the best results could be obtained from a single plane, held at a particular angle to the water surface. He built a model on which three surfaces were attached to a frame, and towed in such a position that the wake of either of the three did not interfere with the water on which any one of them had afterward to run. He also proved by theory that the angle made by the plane with the line of motion should be such, that the resistance due to surface friction should be equal to the resistance due to gravity, or the horizontal component necessary to balance the weight of the vessel on the incline of the supporting surface.

This inclination he found to be about 1 in 14, so that the total resistance amounts to about one-seventh of the weight of the displacement of the vessel. This friction, however, depends on the value to be attached to the surface friction, which again varies with the character of the surface and the length of the rubbing surface. Mr. Froude ascertained in the course of his experiments with the Ramus model t'at the front plane lifted entirely above the water surface as the speed was increased, the center of gravity apparently overhanging all natural support. It is evident that this effect can be produced only by having the pressure on part of the surface less than the atmospheric pressure. Sir John Thornycroft carried out some experiments to illustrate this effect by means of a model, the bottom of which for the most part was a simple

Ramus model at rest.

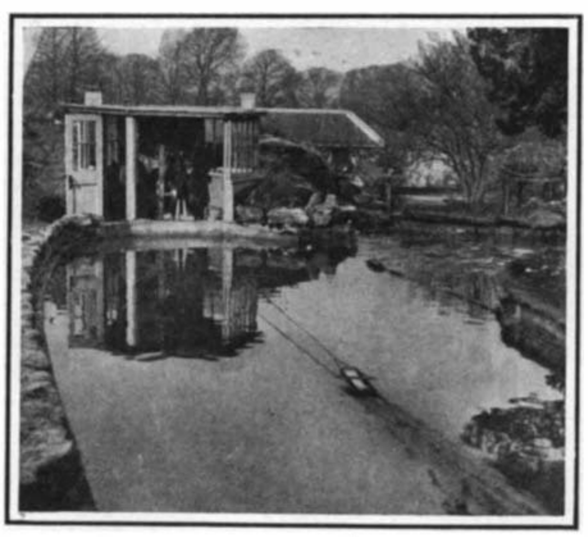


"Gyrinus" model moving at corresponding speed to about 19 knots.

plane, but the after surface of which could be turned at right angles. The result of this design was clearly shown by the model's jumping clear of the water surface.

When the bottom surface of the model was left flat throughout its length, it glided smoothly over the water, but when the tail part was bent down, it very promptly dived. From the result of these experiments it appears that the endwise vertical section of the bottom of a skimmer or hydroplane should be a straight line, although, as Sir John Thornycroft points out, a hollow curve would seem to promise a more even distribution of pressure on the bottom.

A number of factors must be considered in the evolution of a boat intended for skimming or sliding along



Ramus model jumping.

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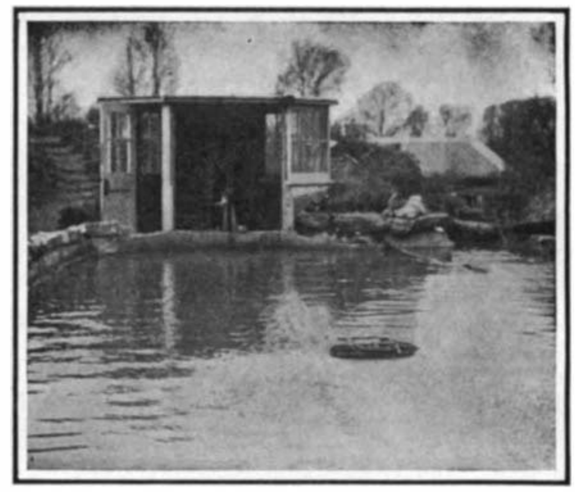
the surface of water with the least possible disturbance, and the problem is rendered more complex from the fact that these do not all lead to the same proportions in design. The lifting force depends on the amount of surface and speed, while the friction for a certain amount of surface will decrease with greater length; but the speed at which skimming will take place must increase with length. Below a certain velocity the performance of a skimmer model is very bad, owing to the formation of large waves, which allow the stern to fall and greatly increase the angle of the planes, thereby rendering it more difficult for the vessel to mount to the surface and to skim.

This difficulty he found to be capable of being lessened, either by extending the amount of the supporting surface or by reducing the weight of the vessel, the surface remaining the same. The reduction of weight, however, is a difficult matter, because of the degree of strength necessary to withstand the shocks to which this type of boat is subjected. The speed at which skimming commences, however, should be kept as low as possible. If the boat is short and wide it leads to excessive air resistance, which becomes quite important at speeds of about 30 miles per hour. Consequently, one must not resort to too great a width.

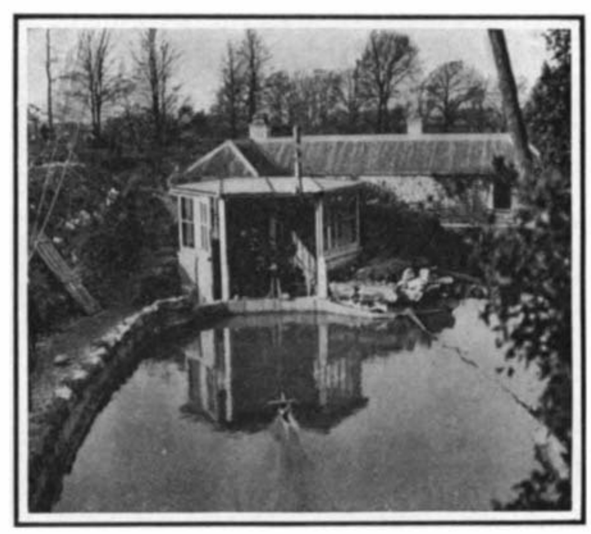
When a skimmer is moving below the skimming phase, the wave formation resembles that of an ordinary vessel, but the waves are larger in proportion to the size of the vessel and diverge at a wide angle. The contrast is strikingly shown when the same model is made to travel fast, since then the volume of the waves is much less and the angle divergence is small. An important poin' in order to achiev- the best result is the position of the center of gravity. In the course of his experiments Sir John Thornycroft found with his models that improvement appeared to take place as this was moved aft, until skipping or flapping commenced. Though this dancing motion may become



A very beamy Thornycroft model at high speed showing very small surface disturbance.

dangerous, still the best results seem to coincide with its commencement.

Some months ago the Thornycroft Company built a motorboat, the "Gyrinus," which has proved very successful in races, and which differs radically in design from the majority of craft of her class. The vessel has an over-all length of 22½ feet, with a breadth of 5 feet 4 inches and a draft amidships of 8 inches. At the bow the water lines are comparatively full, while the stern is quite flat, finishing in a sharp angle, so that all drag from the water, as mentioned above, is eliminated. This boat has proved most successful in speed contests, and last season carried off the international race for 8-meter vessels. The lines of this craft have provoked considerable discussion, and it has been sug-



Ramus model; steady motion at high speed.

gested that they lifted and reduced its displacement to some extent like a skimmer. Photographic records carefully made while she is under full speed refute this contention, since the bow is nearly at the same level at rest or speed, while when moving fast the stern is much lower. The forepart of the boat appears to plow a channel into which the stern falls, and with increase of speed the resistance rises very rapidly, although the form of stem would seem well adapted to avoid this result. Because the lines of this motor boat rise very gently and terminate in a sharp angle, there is no surface which can suck up the water, and by so doing reduce the pressure below that of the atmosphere.

The increase of resistance in a skimmer differs markedly from that in an ordinary boat. It rises very rapidly at first with increase of speed, but once the phase of skimming is established, it may fall temporarily and afterward rise only very slowly, so that the power required increases but little faster than the elocity. This was conclusively shown by experiments ıade with a model of the above motor boat and a amus skimmer model of the same weight. The lotted records showed that the resistance curves rossed at approximately 17 knots. For lower speeds ıe boat form is much superior, but above the point here the resistances between the two models are equal, ıe skimming model possesses decidedly greater ad-antages.

Thornycroft also carried out a series of experiments ith the model of the "Gyrinus" motor boat towed ackward, in order to illustrate the clinging of the ater around the rounded form of stern, which the ow then represented; and although this gave no rouble at ordinary speed, the effect at extreme speeds ras found to be surprising. The real stern lifted, rhile the bow was depressed until the model made a ırge angle with the line of motion, as was found to e the case by Mr. Froude with his Ramus model.

Sir John Thornycroft also studied the passage of ir underneath skimmers. It is generally supposed hat air does pass beneath them when traveling at igh speed, but he contends that this is only likely to ccur when the water surface is broken, as it is well nown that a jet of water impinging on a surface ven at an acute angle does not all pass under in the irection of the jet. A small part near the surface ıas its motion reversed, and renders the passage of ny air between the jet and the surface impossible. f, however, the surface of the moving water is broken or churned into foam, then that mixture of air and water will pass along the surface. What will be the effect of this seems uncertain, but the late Lord Kelvin was thoroughly of the opinion that the friction of this mixture would be greater than that of solid water. The form used by M. Fauber is adapted to eject any air from under his vessel, and Sir John Thornycroft thinks it possible that he obtains from this advantages which balance what would appear to be a loss due to the many short skimming surfaces.

In the opinion of Sir John Thornycroft, hydroplanes are closely related to aeroplanes. Although smooth water would seem to form a definite plane on which to travel, a boat of this kind when moving at high speed is not content to be limited to motion in two dimensions, but tends to oscillate vertically and to jump from the water surface, and under some conditions to dive.

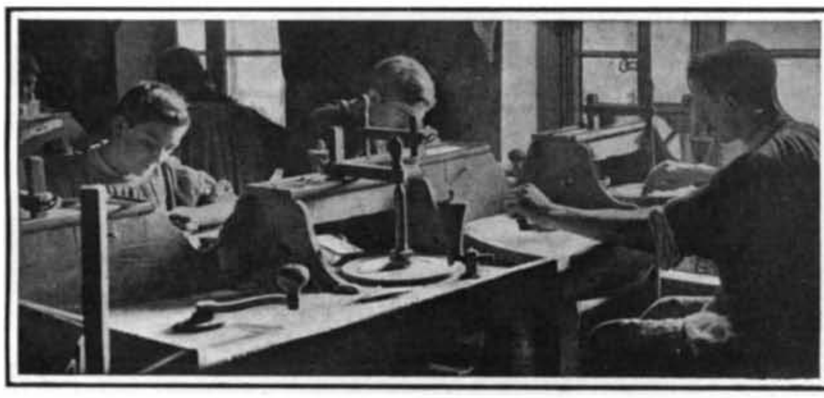


Fig. 3.—Cutting "scientific" rubies.

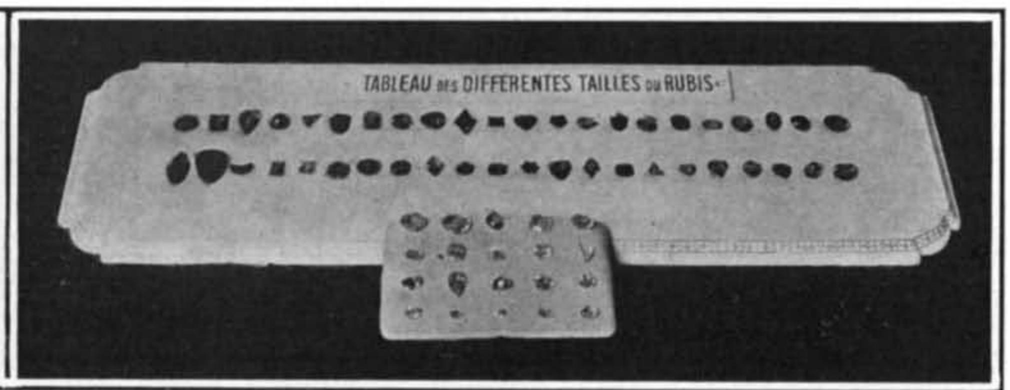


Fig. 5.—Rubies of various shapes.

ARTIFICIAL RUBIES.

BY VICTOR BARTON.

Diamonds are composed of pure carbon, but most other precious stones consist of alumina, colored by various oxides. Hydrated silicates of alumina are known as clays and are found in vast quantities everywhere, but all varieties of crystallized alumina, or corundum, are comparatively rare. Some corundums are colorless, while others derive various tints from the presence of metallic oxides. Red, blue, green, and yellow corundums are used as gems and are known, respectively, as rubies, sapphires, oriental emeralds, and oriental topazes. Rubies and sapphires are by far the rarest and most valuable of these gems.

Many attempts have been made to produce rubies and sapphires synthetically by fusing alumina with coloring oxides and crystallizing the mass by cooling. The first partial success in the synthesis of colored corundum was obtained in 1837 by Gaudin.

In 1852 Ebelmen, director of the national porcelain works at Sèvres, produced rubies of microscopic size by heating a mixture of alumina, borax, and oxide of chromium in a porcelain kiln. St. Claire Deville and Caron succeeded in producing rubies, in the form of very thin crystalline laminæ, by means of the reaction between vaporized anhydrous boric acid and aluminium fluoride. In the course of their experiments they occasionally obtained crystals of sapphire, the formation of which they could not explain, but which were doubtless due to the presence of particles of oxide of iron.

In 1865 Debray and Hautefeuille attacked the problem, but it was reserved for Frémy and his assistants, Feil and Verneuil, to solve it in a series of remarkable researches distributed over the period 1877-1890.

In the method first employed by Frémy and Feil, an aluminate of lead was formed, and this salt was then decomposed by the action of silica, the result being to set free the alumina and to cause it to crystallize. The crystals of corundum thus produced were colorless, but rubies were obtained by adding 2 or 3 per cent of potassium bichromate, while the

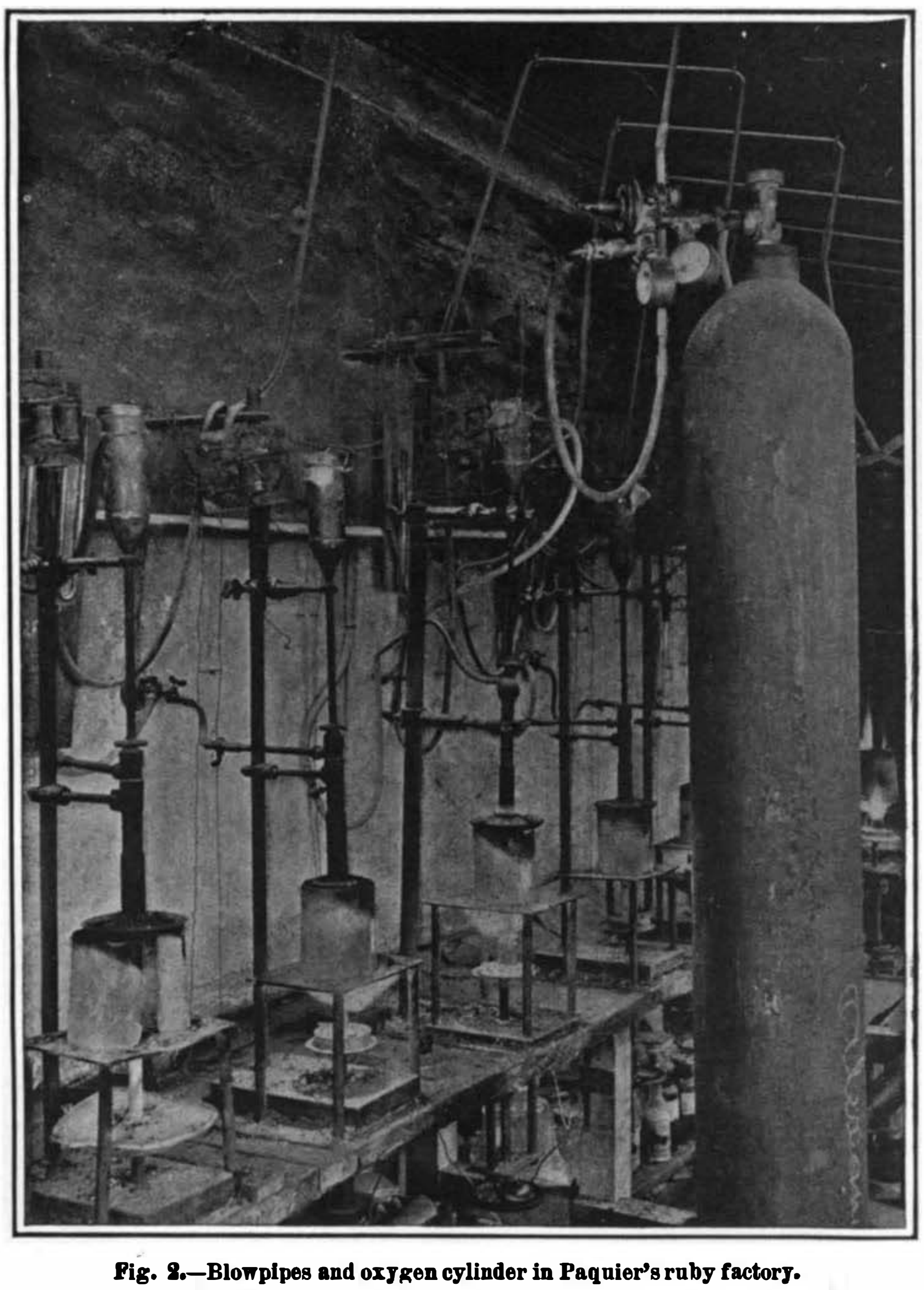


Fig. 2.—Blowpipes and oxygen cylinder in Paquier's ruby factory.

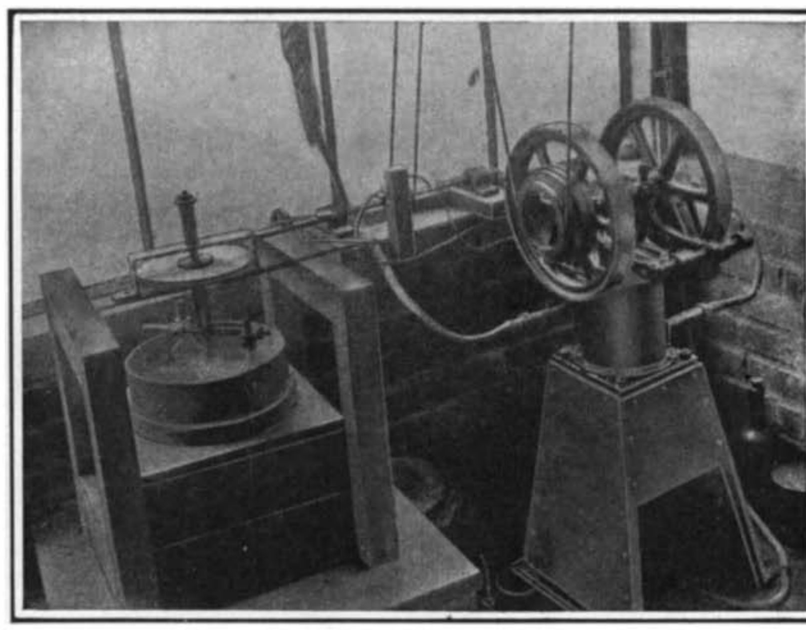


Fig. 1.—Sifting the mixture of alumina and oxide of chromium.

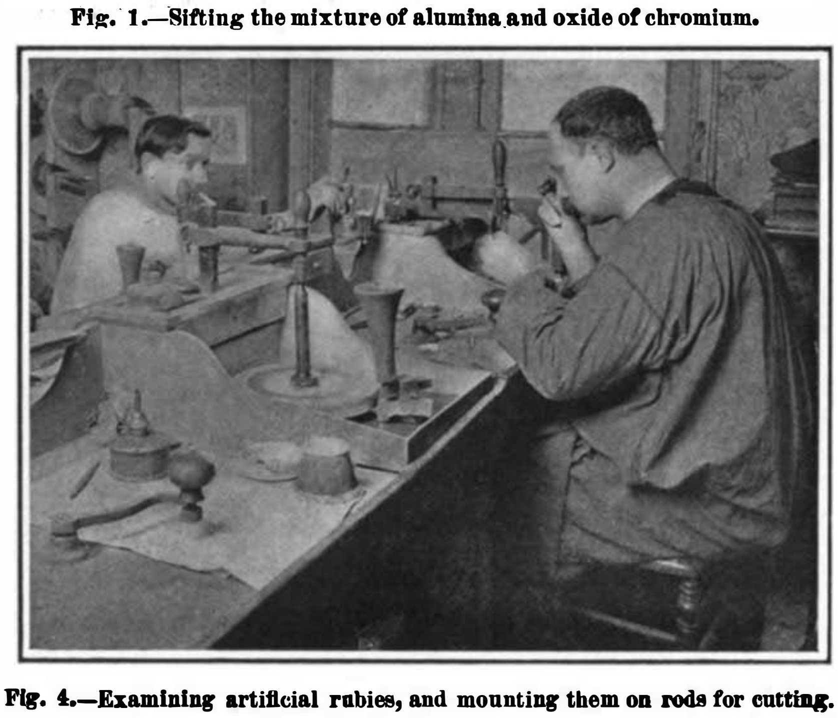


Fig. 4.—Examining artificial rubies, and mounting them on rods for cutting.

ARTIFICIAL RUBIES.