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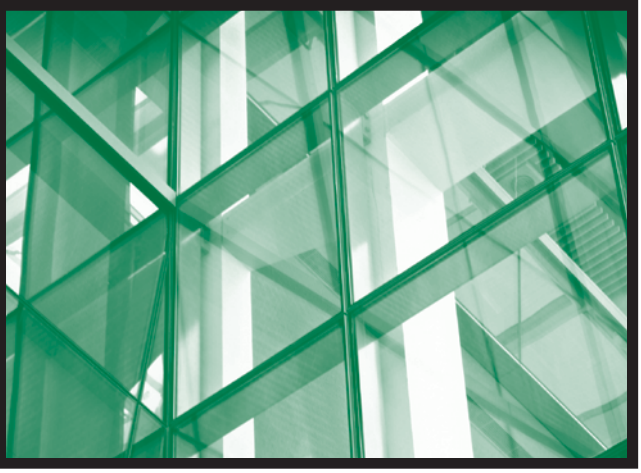
The Fletcher-Terry Company, LLC

The Cutting of Glass

Techni-Talk:
Basic Requirements for Hand Cutting



Basic Requirements For Hand Cutting

The technique for cutting glass with a hand cutter is very simple. The novice needs minimal practice to develop a feel for scoring and breaking out. However, it will help if he observes certain basic and easily understood requirements.

The primary objective in glass cutting should not be merely to sever the sheet but to score and break out so that the resulting cut edges have good quality surfaces, free of nicks and chips. A nicked or chipped edge is a weak edge and often contributes to glass failure.

The Fissure

A glass cutter does not and cannot cut glass in the sense of shearing, sawing or routing. A glass cutter is a force generator. By rolling on the glass surface, the cutting wheel develops a system of forces in the glass so that a minute fracture, called the fissure, is created in the sheet. A good quality cut edge can be attained at break-out only if a proper fissure was made by the wheel.

The fissure which will yield a good, clean, and strong edge is practically invisible when the glass surface is viewed. However, it can be seen by looking **into** the glass. The good fissure will reflect light and appear as a continuous narrow band of light.

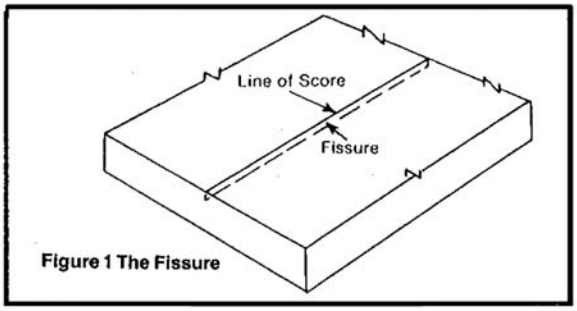


Figure 1 The Fissure

Figure 1 shows the fissure. It is very shallow but can easily be seen because its sides are mirror surfaces and readily reflect light. No glass chips or glass dust should be on the surface if a proper fissure is made. If the surface is not clean and if the score is a white gritty line, this indicates that a gouge or scratch has been made, not a true fissure.

A sheet can be broken out along a gouge or scratch: However, the edge will be chipped and weak. Such an edge should be ground or belted to remove the nicks and avoid almost certain glass failure.

The Table Surface

A very important consideration in cutting glass is the surface on which the sheet lies. It should be a hard, flat, and clean surface. It is recommended that an easily cleaned resilient material be used to cover the surface. A sheet of wrapping paper works well. If a permanent cover is desired, it should be felt not more than $^1/_{16}$" thick. A thicker resilient cover or a deflecting surface hampers good cutting. Cleanliness of the surface is vital. The height of the table affects the position of the person doing the cutting. He must be able to make the score comfortably without having to strain or change position.

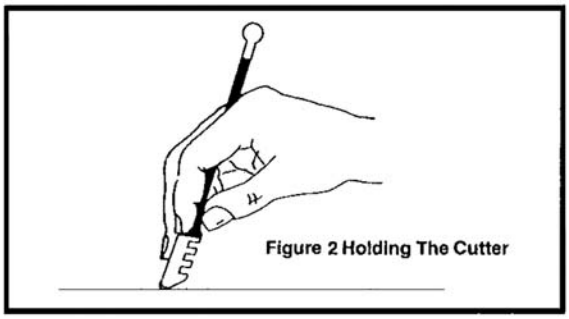


Figure 2 Holding The Cutter

The Glass Surface

The recommended way to hold the cutter is shown in Figure 2. When the cutter is held in this fashion it is usually pulled toward the operator. However, it is not critical how the cutter is held or whether it is pushed or pulled. The most convenient and comfortable grip and direction is always the best, providing the following requirements are observed: 1) The glass surface along the line of cut must be cleaned before the score is made; 2) the wheel must roll freely and be in direct contact with the glass to develop the proper fissure.

If the wheel must cut through any contamination, stain, or dirt particles, much of the energy required to make the fissure will be lost. An irregular fissure or a skipped fissure will then be made, resulting in chipped and weak edges at break-out.

Glass surfaces are usually coated with a special powder by the manufacturer. This powder protects the glass in shipment. It must be removed from the line of cut to prevent pick up by the cutting wheel. Cleaning the glass along the line of cut also removes this powder.

As stressed above, the wheel must roll freely at all times. Before attempting to score the glass be sure that the wheel slot is clean and that the wheel rolls freely without drag. It is vital that the wheel axle be lubricated.

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Cutting Force and Speed

The force applied on the cutter is dependent on the wheel angle, the condition of the wheel and on the type and thickness of the glass (more will be said about the wheel angle later). Regardless of the angle, the maximum force which can be applied is easily defined: It is the greatest force which can be used without crushing the glass surface. The limit is easily determined. When the score becomes a white gritty line or if chips and glass dust are created, then the maximum force has been exceeded. The resulting line of score is a gouge, not a fissure. A good rule is that the best score is clean of glass chips and barely visible when looking **at** the glass surface.

Some practice is required to get the feel of applying the maximum force without crushing. It is essential to maintain this force uniformly throughout the full length of score. If the force varies then the depth of the fissure will vary and affect the quality of break. This requires practice but the technique is easily learned. When scoring and applying this maximum non-crushing force, the score must be continuous until the wheel runs off the edge of the glass. Forget the edge of the glass: If you think about the edge of the glass as you approach it, you will unconsciously vary the force and speed of the scoring stroke.

The depth of fissure is directly affected by the speed of cut. The faster the wheel rolls, the deeper will be the fissure. But there is an inverse relation between force and speed. As the speed is **increased**,the force must be **decreased** to avoid crushing and gouging. Generally, the faster the score (below maximum non-crushing force), the better the cut. In hand cutting speed is not as critical as in machine cutting. What is important is that the speed be maintained uniformly throughout the cut until the wheel drops off the edge of the glass. If a good break-out is not achieved, then a new score must be made, with some increase in force. **Never** retrace the line of cut. A score can only be made once. Retracing only creates a gouge and damages the wheel.

Cutting Wheels

Cutting wheels are honed to various angles. See Figure 3. Angles shown as standards in the Fletcher-Terry catalog are104°, 114°, 120°,126°, and 134°. The catalog also shows normal applications for cutters with these angles.

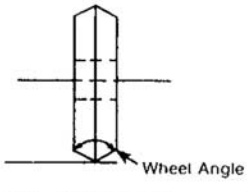

Figure 3 Wheel Angle

The selection cannot be specific. There are too many variables. The recommendations given in the catalog are reliable if the described techniques are applied. Standard cutters offered in most hardware stores have wheels honed to 120° or 124°. This is a good angle for glass ranging in thickness of .063″ to .093″.

While flaking can occur with any wheel, sharp angled wheels (under 120°) are more prone to cause this situation. Flaking can be delayed by wiping the score line before scoring with a cloth dampened with a score protection fluid such as kerosene or light oil. It is important to try to avoid the incidence of flaking because the character of the fissure is affected when flaking occurs. Flaking develops a tendency to chip when the breakout is made. While flaking does occur when sharper wheels are used, it is often necessary to use such wheels in cutting thin glass. In these cases, a score protective fluid must be used.

To determine the best wheel angle to use for a specific glass, the procedure is:

1. Start with any cutter, say a standard 120° wheel.
2. Score the glass, using the maximum non-crushing force.
   a. When thin glass is used, if the wheel punctures the glass, then use a sharper angled wheel. The maximum non-crushing force will be less.
   b. If an apparently good score is made but a good break-out does not result, use a higher angled wheel. The maximum non-crushing force will be greater, but a deeper fissure will be made.

Verticality of the cutting wheel must be maintained in scoring. When the cutting wheel is tilted, the angle presented to the glass changes and affects the quality of score. With a tilted wheel, external angle A (Figure 4) is

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that which would be presented to the glass by a higher angle wheel. External angle B is that which would be presented by a sharper wheel. The applied force is insufficient for one side (A) and excessive for the other side (B). This results in gouging and a very poor and weak edge.

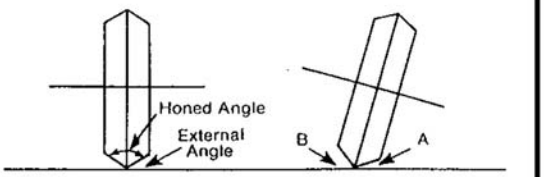

Figure 4 Wheel Tilt

Summary for Scoring

In summary, the requirements for good scoring are:

1. A good cutter.
2. A firm flat support for the glass.
3. Clean glass.
4. Clean cutter.
5. A score protective fluid on the glass.
6. Not tilting the wheel.
7. Uniform application of force and speed: The maximum non-crushing force.
8. Running the cutter off the edge at the end of cut.
9. A score clean of glass chips and barely visible when looking **at** the surface of the glass.

The Break-Out

Having made an excellent score, you can still fail in the objective of achieving a good strong edge. This can occur at break-out because the amount of bending required to break out a score is very, very small.

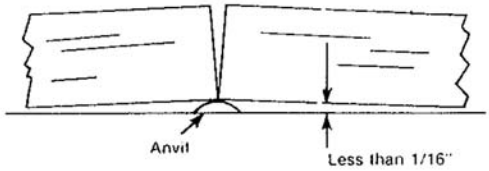

Figure 5 Break-out at Minimum Angle

The break must always be initiated at the edge where the cutting score **ended**. The amount of bending can be controlled by using an anvil less than $^{1}/_{16}$" high; $^{1}/_{32}$" would be even better. If the cut is run by hand or with cut running pliers, hold the amount of bending to the barest minimum. If the break-out is made too fast by bending excessively, chipping cannot be avoided. See Figure 6.

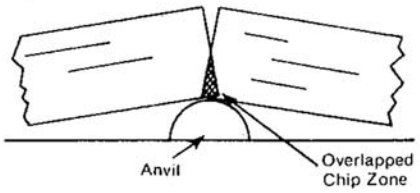

Figure 6 Break-out at Excessive Angle

The minimum break-out angle must be maintained whether the break method used in cut-running or snapping.

Conclusion

The objective in glass cutting is not only to sever the sheet but also to attain a cut edge which is free of nicks or chips. A chipped edge is often the cause of glass failure.

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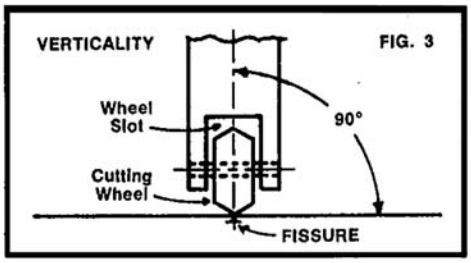
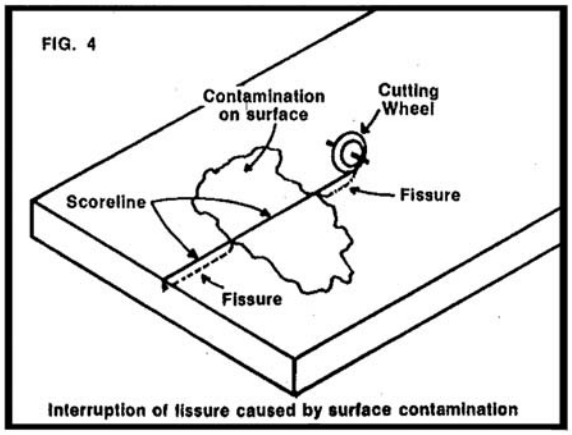
The cutting wheel must roll freely over the surface of the glass. Anything which impedes free rolling will cause the wheel to skid, — and a skidding wheel develops an interrupted fissure. Also, the service life of a wheel is drastically reduced if it skids. To ensure free rolling:

(1) The axle must be lubricated.
(2) The axle must be hard and show no wear marks.
(3) The wheel slot of the cutter must be clean.
(4) The cutter must not lean sideways. (See Fig. 3).

Item (4) is very important. If the cutter leans sideways then the sides of the wheel will bear against the sides of the cutter slot and result in partial skidding.

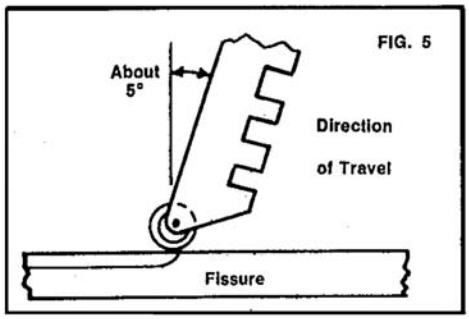


The surface of the glass must be clean. Energy is required to cut through film, scum, or dirt lying on the surface. The apex of the glass cutting wheel must be in intimate contact with the glass and all the energy expended in scoring must be used to develop a continuous fissure. When part (or all) of the energy is used to cut through surface contamination the resulting fissure will either vary in depth or be interrupted. (See Fig. 4). An interrupted fissure will yield a poor or an irregular break when parting of the sheet is attempted.



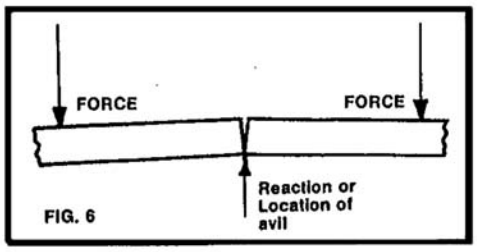
A damaged cutting wheel will cause an interrupted fissure. Cutting wheels are made of very hard steel or carbide, and can be chipped if not carefully handled. Another cause for a skipped fissure is a cutting wheel with a 'flat spot' caused by skidding.

Alignment of the cutting wheel with the scoreline is essential. For good control, the top of the cutter must lean into the direction of cut. (See Fig. 5). The minimum angle of tilt should be about 5°. (Fletcher self-aligning wheel holders used in machine cutting should also be tilted 5° into the direction of cut.)



Much has been said about lubrication of the cut. Kerosene is often used. We recommend a mixture of 50% kerosene and 50% very light oil. Subsequent articles will discuss this important subject. Lubrication of the score will delay flaking and improve the break-out.

Break-out, or the parting of the sheet after scoring is a matter of bending the sheet about a line below the scoreline. (See Fig. 6). A bend of only 2° to 3° is sufficient. This bending develops tension transverse to the scoreline which deepens the fissure into a full fracture. When 'running a cut' the break must be initiated by bending the glass at the end of the scoreline where the cut was terminated.



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NOTE: It is essential that the cutter be *run off the edge* of the sheet at the end of score. This then becomes the beginning point for the break-out.

Once the break-out fracture is initiated it will self propagate along the entire scoreline if the bending force and angle are maintained.

With thick glass the initiation of the break-out fracture can be effected by first tapping the underside of the glass with a *round* headed object. It is best to use a copper or very hard polyurethane headed tapper to prevent chipping. The blows must be directed exactly beneath the scoreline and only one inch or so from the edge where the score was terminated. This develops a deep fracture which can be propagated by stressing the sheet over an anvil. (See Fig. 7).

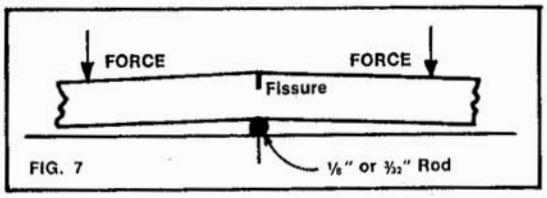


FIG. 7

To achieve a square edge it is important that the anvil or line of bend *under* the sheet be located exactly below the scoreline. (See Fig. 8). If located to one side, the fracture will be directed to the point of anvil contact (or point of pressure). This will yield a "flared" or "toe-nailed" edge.

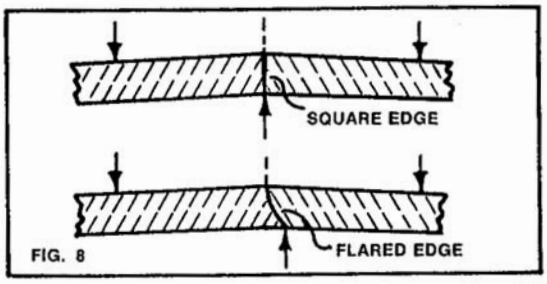


FIG. 8

When breaking out there are essentially 3 areas of application of force. Fig. 8 shows 2 forces applied downward on the top surface and a reaction bearing upward against the bottom surface. This bottom reaction is the area of maximum compression and the break will travel downward toward it.

FIG. 9
Cut-Running Pliers

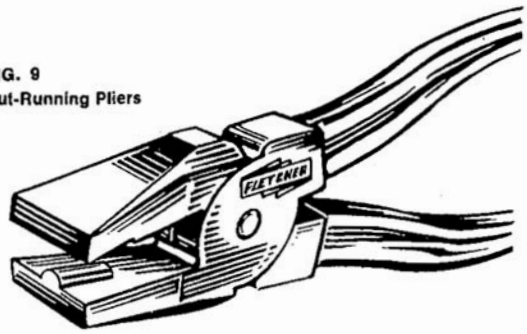
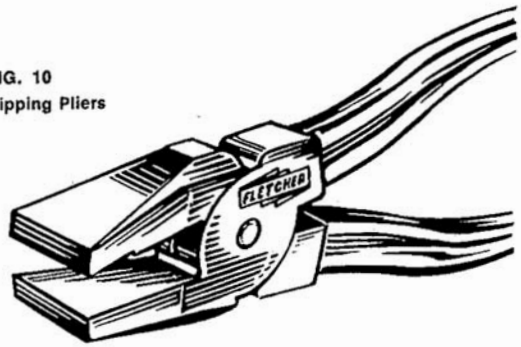


FIG. 10
Nipping Pliers



The break-out of a scored sheet of glass can be done with glass breaking pliers. There are three types usually used. **The cut-running pliers** (see Fig. 9) have jaws which are especially designed to initiate the break-out fracture at the edge of the sheet where the score was terminated.

The nipping pliers (see Fig. 10) have flat surfaced jaws for breaking out narrow strips scored near the edge of the sheet. **The grozing pliers** (not shown) are used for nibbling and shaping at the edges and corners.

NOTE: More about pliers in subsequent articles.

What we have discussed in this article are the basic elementary conditions for successfully cutting sheet glass. These conditions are most important and apply whether the glass is cut with a hand cutter or by machine. As indicated, subsequent "TECHNI-TALKS" will discuss in detail other important factors.

The importance of safety must be stressed. Glass is brittle and if not handled carefully it can be hazardous. Wear gloves when cleaning or wiping it, and especially when breaking out a score. Do not rush the job. Be Careful.

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