TABLE OF CONTENTS

1. General Description And Description Of Grades

General Description

A. Vulcanized Fibre

Vulcanized fibre is made by combining layers of chemically gelled paper. The chemical compound used in gelling the paper is subsequently removed by leaching, and the resulting product, after being dried and finished by calendering, is a dense material of partially regenerated cellulose in which the fibrous structure is retained in varying degrees, depending upon the grade of fibre. It is made in four primary forms--sheets, rolls, rods and tubes.

B. Sheets And Rolls

Sheets and rolls are the most commonly used primary forms. After calendering, thin fibre may be run into parent rolls or cut into sheets. Rolls are subsequently cut into coils and sheets into strips for punching, forming or swaging operations.

C. Round Tubes

Round tubes are made by winding the chemically gelled paper on mandrels of a size suitable for the desired inside diameter. After leaching out the chemical, the tubes are dried and calendered. They are finished by grinding and sanding to the desired outside diameter.

D. Round Rods

Round rods are ground from strips cut from sheets, so that the grain runs lengthwise of the rod. The plies are parallel chords of a circular cross-section.

Description Of Grades

A. Commercial Grade (Sheets, Rolls And Rods)

This grade is considered as the general purpose grade and is sometimes referred to as "Mechanical and Electrical Grade". It possesses good physical and electrical properties and can be fabricated satisfactorily by punching, turning and forming operations. It is made through the entire range of thicknesses from 0.010 to 2 inches. Rods are turned from Commercial Grade sheets.

B. Electrical Insulation Grade (Sheets And Rolls)

This grade is primarily intended for electrical applications and others involving difficult bending or forming operations. It is made in all standard thicknesses from 0.004 to 1/8 inch. Thin material of this grade is sometimes referred to as "Fish Paper. "

C. Abrasive Grade (Sheets And Rolls)

This grade is designed as the supporting base for abrasive grit for both disc and drum sanders. It has exceptional tear resistance, ply adhesion, resilience and toughness. The surface allows uniform adhesive distribution.

2. Vulcanized Fibre Grain

The concepts of “Grain” and “Grain Direction” are central to the successful fabrication of Vulcanized Fibre. Vulcanized Fibre is manufactured from multiple plies of paper. Each ply of paper is formed by depositing pulp on a moving wire belt. Pulp is composed of cellulose fibers, which are linear in nature. The pulp fibers tend to line up parallel to the movement of the belt, which is to say, parallel to the length of the paper roll.

When the plies of paper are made into Vulcanized Fibre, the resulting Fibre still maintains this fiber orientation, or “Grain”. Vulcanized Fibre has somewhat different properties whether you are using it with the Grain or against the Grain. The Grain Direction is also referred to as “Machine Direction”, sometimes abbreviated as “MD”. If the term “Machine Direction” is used, the other axis is referred to as “Cross Direction” (“CD”).

As stated above, the Machine Direction is parallel to the long direction of the Vulcanized Fibre roll. When the Fibre is in sheets, the Grain Direction is always listed as the second dimension of the sheet. For example, for a 52” x 42” sheet, the Machine Direction is the 42”.

Some of the properties which are affected by Grain Direction:

Stiffness

Vulcanized Fibre is stiffer (more resistant to bending) perpendicular to the Machine Direction.

Dimensional Stability

Vulcanized Fibre is more dimensionally stable in the Grain Direction

Forming

Vulcanized Fibre forms much better if bent parallel to the Grain Direction

Physical Strength

Flexural Strength, Tensile, Edgewise Impact, and many other properties are higher in the Grain Direction

3. Fabricating--General

Vulcanized fibre, a plastic material, can be easily fabricated with standard plastic-, wood- or metal-working machinery and tools. In addition to ordinary punching and machining, vulcanized fibre is sufficiently ductile to permit forming, bending, and swaging to special shapes. It is pliable and bends more readily parallel to the grain direction (lengthwise direction) of the sheet. Fibre items should be designed, wherever possible, with bends parallel to the grain.

In general, vulcanized fibre should be fabricated at the highest cutting speeds and feeds available even on machines of light construction. Cutting tools should be provided with greater clearance and with a range of zero to 15 degrees negative rake.

Due to the structure of vulcanized fibre, it is necessary to use additional care when drilling, milling, etc., parallel with the grain direction. In all machining operations, it is extremely important to keep tools sharp. Tungsten-carbide-tipped tools are recommended for production work.

For special requirements, it is recommended that the user consult with the fibre manufacturer.

4. Cutting

The following methods of cutting vulcanized fibre are in general use throughout the industry.

A. Shearing

Equipment

Hand or power shears.

Capacity

Hand shears will shear fibre up to 1/16 inch in thickness.

Power shears will shear fibre up to 3/8 inch in thickness, but above 3/16 inch the edges are likely to be rough. For close tolerance work, sawing is recommended.

Depending on thickness, some heating may be helpful.

B. Slitting

Equipment

Standard-type slitting machines.

Capacity

Fibre up to 3/32 inch thick can be cut into ribbon rolls, and fibre up to 3/16 inch thick can be cut into standard length strips. Any width may be slit and the width can be held to closer tolerances than by shearing.

Preparation of Material

Depending on thickness, some heating may be helpful.

C. Band Sawing

Equipment

Standard band saw.

Saws

File-hard, carbon-steel band-saw blades, or hardened steel blades with soft backs. Teeth range from 5 to 8 points per inch, 18 to 20 gauge, 1/4 to 1/2 inch wide for circles or shapes, 1 to 1 1/4 inches for straight cutting.

Capacity

All thicknesses.

Speed

Up to 8,000 surface feet per minute.

Feed

Feed work into blade as fast as it will cut without forcing the saw.

Remarks

Band sawing is recommended for curved or straight cuts where smooth edges and close tolerances are not required. Teeth should be given a medium set for straight cuts and a heavy set for circular cuts; the smaller the radius, the greater the set. Teeth must be kept sharp at all times. An automatic band-saw grinding or filing machine is recommended.

D. Circular Sawing

Equipment

Standard circular sawing machines.

Saws

Hollow-ground saws of high-speed or tungsten-carbide-tipped steel, without set, are recommended, 1/16 to 1/8 inch thickness and from 4 to 8 teeth per inch, depending upon thickness and form of material. Teeth should be ground square with axis for smoothest cutting and should have liberal clearance.

Capacity

Up to 1 inch in thickness where smooth edge and close tolerance are required.

Speed

Up to 13,000 surface feet per minute.

Feed

Feed work into blade as fast as it will cut without forcing the saw.

Remarks

For each thickness of vulcanized fibre there is an elevation of the saw above the table that will reduce chipping to a minimum. Set saw so that it just protrudes through the work; then adjust upwards until smoothest cut is obtained.

Small tubing and rod may be cut by feeding the material straight through the saw. Heavy-walled tubing over 3/4 inch diameter should be "rolled" through the saw to prevent excessive break-out.

Sawing is not confined to straight cutting but may also be employed for beveling, notching, grooving, etc. Saws must be kept sharp, and, if carbon-steel or high-speed-steel saws are used, frequent sharpening may be necessary. Automatic grinding or filing machines are recommended for sharpening these saws.

For production runs, tungsten-carbide-tipped saws are recommended.

5. Punching, Shaving And Broaching

Vulcanized fibre, a plastic material, can be readily blanked, pierced, embossed, shaved, broached, swaged and formed.

These operations are performed without cutting compounds but, in some cases, heat or a small amount of lubricant on the material is advantageous.

A. Punching

Equipment

Standard power-driven punch presses.

Dies

Progressive, compound, steel-rule and multiple-operating dies, including combination blanking and shaving. Dies are the same as those for metal, with the exception that little clearance is allowed between punch and die and punch and stripper plate. Allow 0.002 to 0.003 inch oversize for each 1/32 inch thickness for piercing punches.

Dies should not have any taper clearance due to the necessity of grinding frequently to keep cutting edges sharp. A properly hardened die should cut about 100,000 to 500,000 pieces before regrinding is necessary.

Steel-rule dies can be used for thicknesses up to 1/16 inch where close tolerances are not required.

Capacity

Thicknesses up to 1/4 inch are readily punched. Where a rough edge is not objectionable and under special conditions, thicknesses up to 3/8 or even 1/2 inch may also be punched.

In thicknesses above 1/8 inch, it may be found advisable to heat the stock to about 180 F before punching. This heating is necessary to prevent excessive checking. If the material is to be heated, allow 0.002 to 0.003 inch per lineal inch oversize in designing dies in order to compensate for the shrinkage.

Preparation of Stock

Strips or blanks for punching can be cut from standard sheets by shearing, slitting, or sawing. Thin material is also used in coil form. It is advisable to allow 1 to 1 1/2 times the thickness of stock for the width of webs and edges. Considerable saving in stock may be secured by cutting strips for two or more rows and staggering adjacent rows.

Speed

Any speed depending upon the size of the machine and the parts to be punched.

Feeds

Roll or manual feeds may be used with pin or automatic stops. Roll feeds are normally used when running coil stock. For second operations, dial feeds or other automatic feeding methods may be used.

Remarks

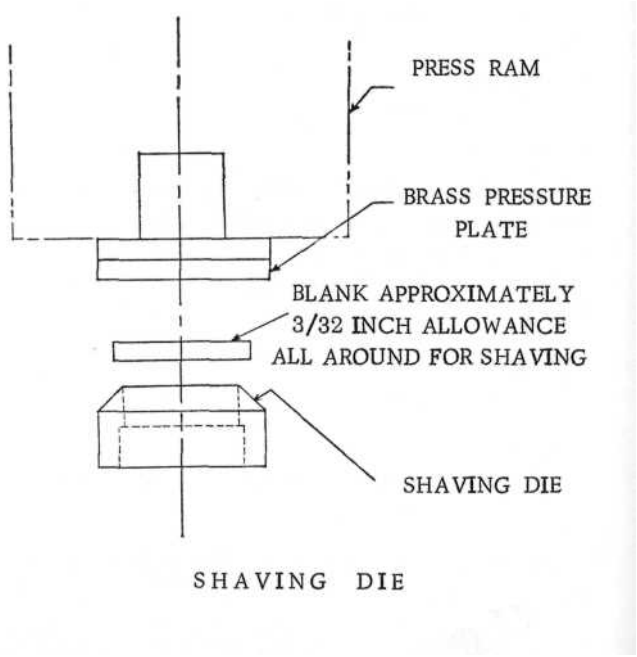
Due to the resiliency of vulcanized fibre and its tendency to shrink and expand under varying atmospheric conditions, extremely close tolerances are not practical.

B. Shaving

Smooth edges can be obtained by beveling the edge of the die to about 45 degrees for a distance of 1 1/2 or 2 times the thickness of the material. In doing this, the die is brought to a sharp edge with the parts entering the die in the same manner as for flat dies. Thin fibre can be shaved from strips, but thick fibre should be punched or sawed into blanks of suitable size prior to shaving.

Smoother edges on holes can be obtained in a similar manner by hollowing out the end of the piercing

punch to a depth of 1 1/2 to 2 times the thickness of the material, allowing a 45-degree bevel around the inside edge.



Equipment

Standard power-driven punch presses.

Dies

Shaving dies should be bell-mouthed out slightly with an oil stone in order to eliminate chatter and to give smooth edges. Either round or other desired shapes may be produced.

Blanks are pushed through the die by means of a flat brass or soft steel plate which is at least as large as the blank and does not enter the die.

Allow 0.002 to 0.003 inch per lineal inch for shrinkage in designing dies.

Capacity

Thicknesses up to 1 inch are normally handled and, in special cases, thicknesses up to 1 1/2 inches may be shaved.

Preparation of Stock

For thicknesses greater than 1/4 inch, it may be found advantageous to heat the stock to about 180 F. This is done to prevent checking and in order to obtain smoother edges. Heating should be done quickly to avoid excessive drying of the fibre. If the stock is to be heated, allow 0.002 to 0.003 inch per lineal inch in designing dies to compensate for the shrinkage.

Shaving requires slower press speeds than punching.

Feeds

The material to be shaved is fed by hand, by means of push feeds with magazine, or dial feeds.

Remarks

In cases where smooth edges are required, the shaving operation will often meet the requirements. This is especially true in the case of thick blanks which are too heavy to punch. Shaving will be found much less expensive than turning or grinding.

Where smoother edges are needed than can normally be obtained, two shaving operations may suffice. A shaving die about 3/32 inch larger all around than the finishing die is used for the first operation.

For large orders, pieces can often be pierced, punched, and shaved from strips at a single stroke of the press by using "double-decker" dies. In doing this, a blanking die is set over the shaving die and the pieces pushed through the shaving die by the succeeding blank.

C. Broaching

Equipment

Power-driven punch presses, hydraulic presses, vertical- or horizontal-type broaching machines.

Tools

Broaches for punch presses may consist of a piercing punch of the shape desired with a die to fit, having the end of the punch hollowed out to a depth of 1 1/4 to 1 1/2 times the thickness of the material. Cutting edges are tapered approximately 45 degrees. A regular-toothed broach with die to fit may also be used. The length of the toothed broach depends on the stroke of the press.

Broaches for vertical or horizontal machines are generally ordered from companies specializing in this type of equipment, and they will supply a style best suited to the required part.

Broaches must be kept sharp in order to maintain dimensions. It is well to order the broach large enough to make up to the maximum limits allowed. If the shape is such that the last 2 or 3 teeth can be faced with tungsten carbide, the longer life should more than pay the additional cost.

Capacity

Material up to 1 inch in thickness can be broached on punch presses, and any thickness can be handled on regular broaching machines.

Speed

On punch presses, speeds about 40 strokes per minute will give good results. On regular broaching machines, speeds suitable for brass are satisfactory.

Preparation of Stock

Holes in blanks should be roughed out as large as possible to reduce the amount of finish cutting. For a square hole, the blank should be drilled to a diameter at least as large as the side of the square.

Heating the stock to approximately 180 F before broaching will give smoother edges. Lubricating the blanks will prolong the life of the broach and improve the finish.

Remarks

Close limits should be avoided. Changes in dimensions may be caused by dulling of the broach and varying atmospheric conditions. Another factor is the spring-back after the broach is withdrawn due to the resiliency of the material. Due allowances for all these conditions must be made in specifying broach dimensions.

6. Forming

Vulcanized fibre is sufficiently ductile to permit forming, bending and swaging to special shapes under proper conditions. When bent parallel to the grain, the fibre is more pliable and bends most readily. However, if sufficient radius is allowed in the bend, the vulcanized fibre may be bent against the grain.

Fibre can be formed after creasing, scoring or stippling. Thin fibre may be formed easily in a punch press.

Thick fibre up to approximately 3/16 inch and items with sharp bends may be shaped in hot forming operations as described in the following paragraphs.

Because of its ductility, vulcanized fibre may be swaged into special shapes, such as flanged bushings. Swaging is performed in a die in a punch press using fibre intermediate in thickness between the overall and shoulder thicknesses

A. Hot-Forming Operations

The expression "hot-forming" means a die-forming operation in which the fibre has previously been conditioned by dry heat, steam, or hot water before closing the die.

Equipment

The standard equipment usually employed in the forming of vulcanized fibre consists of (1) suitable means for applying pressure, (2) a die to produce the desired shape, (3) a means for heating, such as a heated water-immersion tank, a steam chamber, an oven or hot plate, or a humidifying device.

Presses

The pressure-applying devices found to be suitable in the various forming operations are the coining press and presses of the punch, air or hydraulic types.

Forms

Forming dies may be made of metal, wood, phenolic laminate or other material found to be suitable in operation. They may be of various types such as plain, compound, tandem or multiple. In forming operations requiring heat, forms are sometimes heated by self-contained electrical heaters, platens heated with electricity, steam or infra-red rays. Metal dies will, in general, give shorter cycle time because of better heat conductivity.

Preparation of Stock

For simple items, heated thin fibre can be formed in a die. In general, however, prepare the stock by dipping in hot water at approximately 150 F or by exposing to steam, or a combination of both, for periods of time depending upon the thickness of the fibre to be formed. In certain other cases, the fibre is conditioned by exposure to moist air at room temperature.

The duration of the cycle should be such that sufficient moisture is removed from the material to enable it to retain its shape after removal from the form. In general, the forming cycles extend over a range of from as little as a fraction of a second to as much as 30 minutes.

Remarks

Relatively simple forming operations can be performed on fibre which has been surface moistened, such as by brief exposure to steam or water vapor. More severe operations can be performed on fibre which has been prepared by dipping in hot water.

Because of the many interrelated factors, it is not possible to give specific rates of conditioning and forming for each of the various thicknesses of fibre. It is recommended that users adjust experimentally such variables as temperature and duration of both conditioning and forming cycles for best performance, or consult with the fibre manufacturer for specific information.

B. Bending Operations

The expression "bending operations" means those operations in which vulcanized fibre in sheet form is bent by Cornice brakes.

Equipment

A standard Cornice or other similar bending brake of suitable length.

Preparation of Stock

Condition stock by exposing in steam or hot water for varying periods of time, depending upon the thickness of the stock.

Whether the brake is operated manually or by mechanical means, the rate of bending should be slow enough to permit the fibre to flow.

Remarks

The distance between the fixed and movable clamps on the brake should be sufficient to avoid excessive pinching or stretching at the bend.

It is recommended that vulcanized fibre be formed parallel to the grain. However, if sufficient radius is allowed, the vulcanized fibre can be formed against the grain.

7. Drill-Press Operations

Drilling operations on vulcanized fibre are normally performed dry, without cutting compounds.

Standard steel drills may be used for plain work or for limited production, but specially designed drills, as described in the following paragraphs, are recommended for difficult operations or for extensive production work. Drills of both types are readily available.

A. Drilling

Equipment

Standard drilling machines, vertical or horizontal, single, gang or multiple.

Drills

For best results, use standard plastic drills for fibre. Such drills, when properly ground, should have a zero or slightly negative rake, liberal clearance, and wide, smoothly polished flutes to allow chips to be discharged freely. The drills are made of high-speed, high-speed nitrided or tungsten-carbide-tipped steel. It is necessary to sharpen the high-speed-steel drills frequently. Because a drill tends to cut an undersized hole in fibre, it is advisable to use a drill one size larger than the hole required.

Up to approximately 400 surface feet per minute, depending upon the size of the drill. Speeds up to 10,000 rpm are not excessive for a No. 60 drill.

Feed

Generally, as fast as the drill will cut. The drill should be withdrawn frequently to clear chips, usually whenever the depth equals three or four times the drill diameter.

Remarks

Dubbing the lip of the drill and giving it liberal clearance will cause it to cut free and will prevent grabbing. Drill should be fed at its highest speed without burning and should not be forced into the work. To avoid chipping and grabbing when drilling thin material and tubing, the included angle of the point may be modified to as low as 60 degrees.

Use well-designed drill jigs, employing pins to serve as stops for locating the work and clamps to hold the work between the top and bottom plates. For best results, all holes being drilled should be supported from the back.

Drilling parallel with the laminations should be avoided whenever possible. If drilling must be done in

this manner, the work should be held in clamps or in a suitable jig and due care should be exercised.

B. Counterboring And Countersinking

Equipment

Standard counterboring, countersinking and drilling machines.

Counterbores and Countersinks

High-speed-steel or carbide-tipped conventional counterbores and countersinks. Generally, two-lipped tools having rake of zero to minus 10 degrees and liberal clearance are used.

Speed

Up to approximately 400 surface feet per minute.

Feed

Generally as fast as the tool will cut.

Remarks

If chattering occurs, try slower speed. If a drill is used as a counterbore or countersink, dubbing of the inner surface of the cutting edge will decrease chatter.

C. Fly-Cutting

Fly-cutting is generally employed to cut discs or large holes where drilling is not practicable.

Equipment

Standard drilling machines.

Fly- cutters

Generally a single-point tool of a type which is designed for the required diameter or a type which is adjustable to various diameters.

Speed

Highest attainable without excessive heating of the tool.

Feed

Machine feed is easier to control than hand feed and prevents grabbing and tool breakage at breakthrough.

Remarks

Fly-cutting tools are generally designed so that the center post which holds the cutter bar can be used as a pilot in a previously drilled hole to steady the bar during the cutting operation. Cutting tools must have clearance both on the bottom and outside edges and should be ground to a zero or slightly negative rake.

8. Screw Machines

Hand-screw and automatic-screw machines are highly productive and operate on vulcanized fibre the same as for brass, except at much higher speeds and feeds, performing such operations as drilling, threading, tapping, knurling and contour forming. For detailed information, refer to the specific sections and illustrations covering drilling, threading and tapping.

Most screw-machine work is performed dry, without cutting compounds.

Deep-hole drilling should be performed by withdrawing the drill from the hole several times. A good practice is not to drill in depth more than three or four times the diameter of the drill without withdrawing it from the hole so that the chips can be cleaned away.

Internal and external threading can be performed with standard threading tools properly ground. Chasers should have a 33-degree chamfer on the lead and a negative top rake up to 10 degrees. For more detailed information see Part 9 on threading and tapping.

Forming and undercutting can be performed successfully and are best accomplished by taking deep cuts. Circular and square tools can be used for forming but should not be greater in width than 75 percent of the diameter of the stock.

Equipment

Standard hand- or automatic-screw machines.

Tools

High-speed steel, tungsten-carbide-tipped, and diamond tools are used with excellent results. Tools are ground similar to those used for brass, should have a negative top rake, and should be kept sharp for best results.

Speed and Feed

Highest speeds are recommended. For the higher speeds, use tungsten-carbide-tipped or diamond tools.

Any desired feed may be used, depending upon the finish required.

The method of machining vulcanized fibre is essentially the same as that used for brass. Typical spindle speeds are as follows:

Diamond, Inches	Speed, RPM
Hand-screw Machines	
1” and over	800 to 1000
Under 1”	1500 to 2000
Automatic-screw Machines	
Over .625”	2500
.563” to .187”, inclusive	3600
Under .187”	7000

9. Lathe Operations

On vulcanized fibre, lathe operations can be performed on all standard types of engine and turret lathes. Such operations include turning, boring, recessing, threading, knurling and facing.

Lathe work is generally performed dry, without cutting compounds.

In general, lathe operations on vulcanized fibre are carried on much the same as those on brass, except that the surface cutting speed should be higher.

Equipment

Standard machine lathes are sometimes modified for high spindle speeds.

Tools

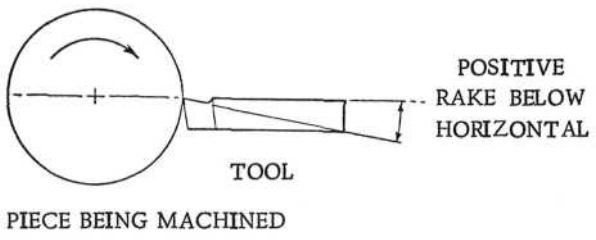
High-speed-steel, tungsten-carbide-tipped or diamond tools are recommended for turning, boring, sizing and cutting. The tools should be ground from zero to 15 degrees negative rake. (See the illustration at the right.) A clearance of 15 to 30 degrees is recommended. Tools should be kept sharp for best results.

Speed

Cutting speeds range from 500 to 4,000 surface feet per minute. For highest speeds, tungsten-carbide-tipped or diamond tools are recommended.

Feed

0.001 to 0.030 inch per revolution depending upon the finish required.



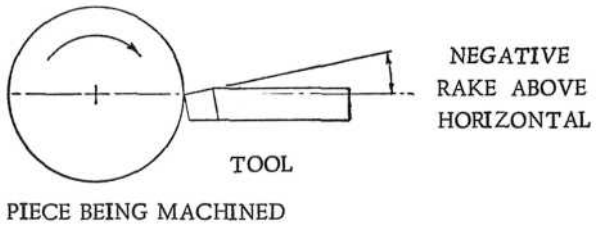


ILLUSTRATION OF RAKE ANGLE

10. Threading, Tapping And Knurling

Vulcanized fibre can be readily threaded, tapped or knurled with ordinary tools and equipment.

A. Threading

Equipment

Standard lathes and hand- or automatic-screw machines may be used. Threads can also be cut to advantage on small bench lathes equipped with a threading attachment.

Tools

Standard chasing tools, preferably with a zero rake, may be used on a lathe, taking a succession of cuts 0.002 to 0.005 inch deep.

For hand- or automatic - screw machines, it is preferable to use self-opening dies. A self-opening die with a center trip will give better results. For tubes, use high-speed chasers of a circular or milled type. For rods, use a tangent-type chaser.

High-speed or tungsten-carbide-tipped tools are recommended.

Speed

See Part 8.

Remarks

It is necessary to keep the tools sharp. A 60 to 70 percent thread with Class 2 fit is the maximum accuracy obtainable in vulcanized fibre. Class 1 or Class 2 fits are advisable due to the tendency of vulcanized fibre to change dimensions slightly under varying atmospheric conditions.

Where possible, it is advisable to avoid short threaded lengths and also threads which are close to shoulders. It is helpful to cut a recess next to the rounded shoulder for clearance.

B. Tapping

Equipment

The types of equipment used are hand tap wrenches, drill presses equipped with tapping heads, reversible hand- or automatic-screw machines, and automatic tapping machines.

Tools

High-speed-steel or tungsten-carbide taps will give best results. Tapered ends, as in No. 1 taps, will enter more easily. Taps 0.002 to 0.005 inch oversize will give best results in vulcanized fibre. For larger holes, collapsible taps will give satisfactory results, and zero rake is recommended.

Speed

See Part 8.

Remarks

It is necessary to keep all tools sharp. A small amount of lubricant will be of benefit. Drill the hole a size larger than shown in tables showing standard tap drill sizes. This is done to give a 65 to 75 percent thread and to cut down the tap breakage. A slight chamfer around the edge of the hole before tapping will facilitate tapping and prevent uplift. When tapping parallel to laminations, clamp the material tightly to prevent splitting. It is necessary to allow enough extra depth in blind holes in order to clear the end of the tap.

C. Knurling

Equipment

Standard lathes, turret lathes, hand- and automatic-screw machines or standard knurling machines can be used.

Tools

Standard knurling tools can be used.

Speed

Speeds slower than for turning are recommended for knurling.

Remarks

Lubricants will help. Care should be taken when knurling rods.

11. Milling

Vulcanized fibre can be milled in standard milling machines with standard milling cutters. In general, higher cutting speeds and deeper cuts are recommended than with hard metals, provided tungsten-carbide-tipped cutters are used. Under such conditions, single-point cutters may be run up to 15,000 rpm with good results.

For all normal operations, milling can be done dry, without cutting compounds.

Equipment

Standard milling machines or high-speed routers.

Tools

Standard milling cutters or single - point tools may be used. For a smooth finish, cutters should be ground with a rake from zero to 15 degrees negative. Tungsten-carbide-tipped tools are recommended, but high-speed-steel tools may be used for limited production. Tools should be kept sharp for best results.

Speed

Up to 1000 surface feet per minute for standard milling cutters and up to 7500 feet per minute for tungsten-carbide-tipped single-point cutters.

Feed

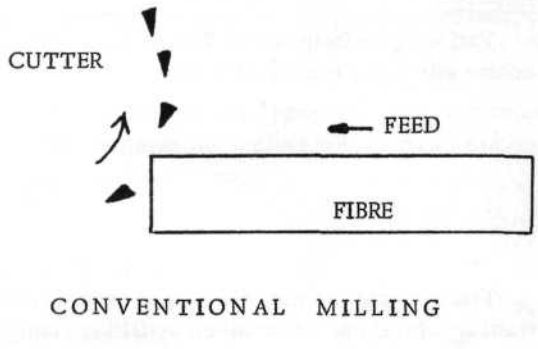
Generally up to 20 inches per minute. Coarse feeds prevent wearing and dulling of tools.

Remarks

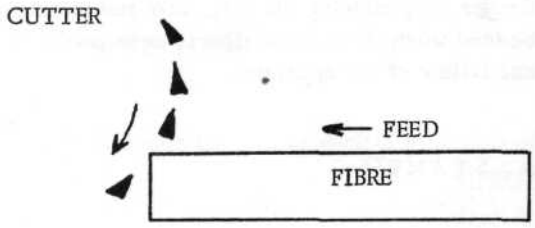
Backing plates of hard wood or other suitable materials are recommended when cutting across the laminations.

When cutting parallel with the plies, climb milling is recommended.

For deep cuts, side-milling cutters prevent binding.



CONVENTIONAL MILLING



CLIMB MILLING

12. Planing And Shaping

Vulcanized fibre can be planed and shaped on standard metal-working planers and shapers. Generally, these operations are performed dry, without cutting compound.

Equipment

Standard planers and shapers.

Tools

High-speed steel for short runs and tungsten-carbide-tipped tools for long runs. Tools should be ground with a zero to a 15 degree negative rake. Side and face clearances vary from 10 to 30 degrees. Tools should be kept sharp at all times for best results

Speed and Feed

Surface speeds vary from 40 to 90 surface feet per minute with 0 002 to 0.015 inch per cut depending upon the finish required.

Remarks

When cutting across the laminations, the end of the cut should be backed up to prevent chipping and splitting.

13. Sanding

Vulcanized fibre can be readily sanded.

Equipment

Standard belt, drum, or disk sanding machines.

Abrasives

Various grits from 40 to 240, according to finish desired. When the fibre is to be glued to another surface, coarse grit paper is generally used.

14. Marking

Trade-marks, names, dates, and decorative effects can be permanently imparted to vulcanized fibre. Contrasting effects can be obtained by filling stamped depressions with color.

Vulcanized fibre can be readily marked by hand, using soapstone, chalk, wax crayon, or ordinary pencils; or by machine stamping, printing or silk screening. Mechanized operations such as stamping or printing are particularly adapted to parts produced in large volume when the marking device can be made to function with the die for producing the part. Inks and marking pencils containing electrical conducting components must not be used when the marked fibre is to be used in an electrical application since the marks may cause short circuits and failure of the apparatus.

A. Stamping

Equipment

Standard marking machines with or without color feed; a suitable stamp mounted in a punch press; or a suitable stamp in the form of a roller.

Stamps

Hardened steel or rubber.

B. Printing

Preparation of Stock

The surface should be free from any oily film and, if necessary, cleaned with a suitable solvent. Where "letterpress" printing by use of set type and printing plates is to be performed, the fibre must have a smooth calendered finish. Where lithographing is to be performed, the surface may have either a dull or a highly calendered finish. Fibre sheets intended for either of these operations should be carefully stored in order to hold them flat.

Remarks

It has been found to be advantageous to use quick-drying inks and, in some cases, to apply a protective coating of lacquer.

Equipment

Standard printing presses, lithographing machines or silk-screening equipment.

For some special applications, the consumer may wish to use a rubber hand stamp for which a standard inking pad will be found to be satisfactory.

15. Finishing

Fabricated parts of vulcanized fibre generally require one or more finishing operations to remove the burrs and to produce the desired appearance of the surfaces. Burrs around holes can be removed by use of countersinking drills while those around the outside edges can be removed either by use of a vertical-spindle drill press on the shaft of which is mounted abrasive wheels, or by use of one of the many standard types of sanders.

Dirt, burrs, and fuzz can sometimes be removed from pieces by tumbling in standard revolving barrels. A cloth saturated with oil can be placed in the revolving barrel with the pieces when an oil finish is desired.

Where desired, fibre may be coated with wax, lacquer, or enamel to improve its appearance and to reduce the rate of moisture absorption. Finished parts may also be buffed with standard rag buffing wheels to a brilliant finish. The use of rouge will help restore a high polish to machined surfaces.

16. Packaging And Storage Conditions

For general uses, vulcanized fibre should be stored where it will maintain its normal moisture content of approximately 5 to 8 percent.

If subjected to extremely damp conditions, it will pick up moisture and tend to warp out of shape and to increase its dimensions slightly.

If subjected to extremely dry conditions, such as the low humidity which develops in heated rooms during the winter season, it will tend to dry out. This tends to cause warpage and slight shrinkage in all dimensions as well as some increase in stiffness and hardness.

Avoid storing fibre under extremely damp or extremely dry conditions. Approximately 50 percent relative humidity is recommended.

To minimize dimensional changes, polyethylene bags or waterproof paper are recommended.

17. Acknowledgements

Parts of this publication were adapted from information provided by the National Electrical Manufacturers Association. This information is used with their permission.