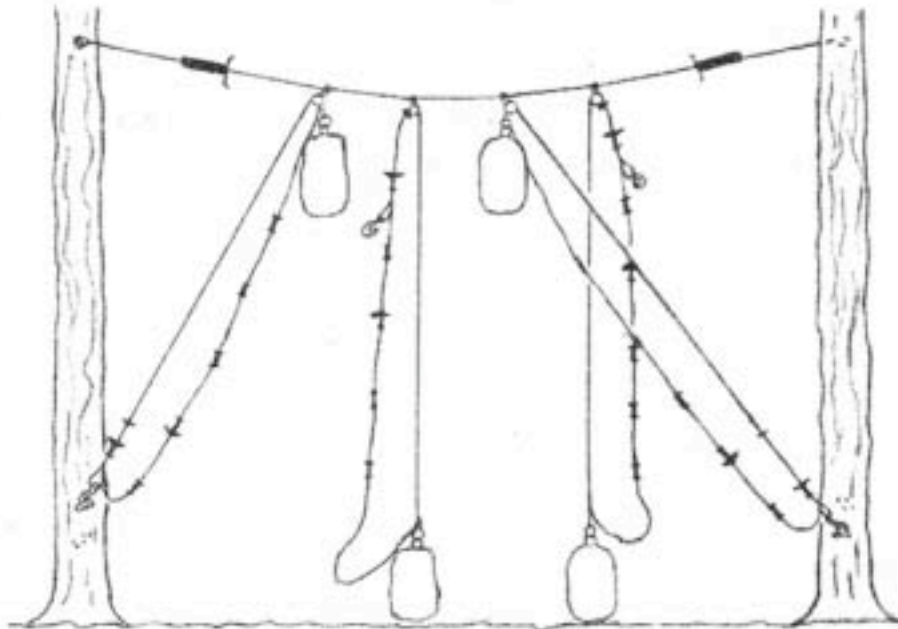


AERIAL FOOD STORAGE SYSTEM (BEAR CABLES)

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AERIAL FOOD STORAGE CABLE SYSTEM

The Carolina Mountain Club (CMC) had a number of bear sightings at shelters during 2007 and considerable problems with them getting hikers food in 2008. We have now installed aerial food storage cables (bear cables) at all ten of our shelters with a second cable in the tent pad area of the Roaring Fork shelter. The Great Smoky Mountains National Park September, 1999 publication "BACKCOUNTRY FOOD STORAGE CABLE SYSTEM" was used as the basis for our design. A list of materials and vendors is on page 5.

The CMC section of the Appalachian Trail has no restrictions on the number of hikers that can be at a shelter, so we have no control over the total amount of food sacks and backpacks that the hikers will want to lift up on the aerial food storage cable (bear cable). We have assumed that 16 hikers will each want to pull up a pack weighing about 31 pounds for a total on each of four pulleys of 125 pounds (250 pounds per pulley). See GENERAL DESIGN (pg 6) which is for trees 30 feet apart and with a slope of 2 feet between the bases.

The graph, EFFECT OF SAG ON CABLE STRESS (pg 7), shows how rapidly the stress rises as the amount of sag at the middle of a 30 foot cable decreases and also shows the breaking strengths of 3/16" and 1/4" SS cable. We chose a minimum sag of 2 feet and 1/4 inch diameter stainless steel (SS) for our cables because this puts onto the suspension cable a total stress no more than 50% of the breaking strength. This 2:1 safety factor will prevent cable breakage from infrequent overloads and any dynamically created forces when the load is being pulled up to the top.

We chose 3" diameter pulleys for the haul cables based on recommendations available in the literature. However, subsequent recommendations from a cable vendor were that 2" diameter pulleys are acceptable for use with 3/16" diameter SS haul cables. We purchased 3" pulleys that have bronze bushings and cotter pins holding the shaft so they can be taken apart and greased. Our shelter installations have the 3" pulleys but we will probably use smaller pulleys for cables at our camping areas because the loads will be less.

Some of the CMC shelters are a considerable hike from the nearest road access so we decided to carry in no more than the amount of material that was needed for that site. We did a preliminary survey to find two sturdy trees that were about 30 feet apart, accepting trees from 26 feet to 34 feet apart. We measured the span between opposite sides of the trees and the slope between the bases. For no slope, we arbitrarily chose a First Tree which will have the anchor eyebolt at 20 feet above the ground. The Second Tree eyebolt is the same when there is no slope, but if there is slope, the uphill tree is the Second Tree and the eyebolt will be at 20 feet minus the slope and on the opposite side from the First tree.

The eyebolts for the outside haul cables are on the same side as the suspension eyebolts and four feet above the ground. The inside haul cable eyebolts are on the other side of the tree and one foot below the outside eyebolts. This makes the outside haul cable too short to be connected to the inside haul cable eyebolt, thereby physically identifying the two cables.

The length of the suspension cable is the span between the trees plus two feet for connecting to the two eyebolts and some spare. The lengths of the four haul cables are determined from the two graphs, OUTSIDE HAUL CABLE LENGTH (pg 8) and INSIDE HAUL CABLE LENGTH (pg 9). These graphs include additional cable for the loop that holds the pack hooks and to compensate for minor differences in dimensions at the site. Use zero slope for the two cables that connect to the First tree. Slope only affects the cables that connect to the Second tree. We usually round up the length to be safe.

We have found that cutting the cables without fraying can best be done by first wiping on at the cut site a coating of "Goop" or "Liquid Nails *Clear*" and allowing it to dry thoroughly before cutting. Then, some additional glue can be put onto the cut ends to hold all the strands tight while putting on any of the tight fitting swaging buttons, handles, etc.

We prepared the suspension cable as shown on drawing SUSPENSION CABLE ASSEMBLY (pg 10) for our first installations but carried in all the parts for the haul cable handles and tried to assemble them on-site after determining there the number of handles we wanted to install. This proved difficult, if we had to cut any of the cables and could not wait for the glue to dry. Cable strands would get pulled up, forcing us to again cut the cable. We therefore went to calculating the number of handles for each haul cable so that we could completely pre-assemble each of them at the same time we pre-assembled the suspension cable.

We lay out a 1/4" = 1' scale drawing of the entire system to calculate the number of handles needed on each haul cable. HAUL CABLE HANDLES (pg 11) shows how just the Outside cable at the First Tree of a 30 foot span with a 2 foot slope is calculated. In PROCEDURE A, the Pack Hook Stop is drawn 4feet above the ground on the load side cable. This puts the pack hooks about 3 feet above the ground. The distance from the Pack Hook Stop to the intersection of the cable with the suspension cable (the circle) is measured and transferred to the tree side part of the cable, as shown. The Stop will be against the pulley when the Pack Hook Stop is 4 feet from the ground.

Mark the tree side cable at the back of the mouse barrier in the handle 20" from the haul cable eyebolt. Transfer the measurement "A" to the cable as it will be when the pack hooks are as shown in PROCEDURE B. Measure 5' up from the ground to what will be the first handle for pulling up the packs. The difference "B", is the length of cable that will have all of the handles, as shown. Measure this and calculate the number needed when they are ideally 24" to 30" apart. All of these measurements can be done on the scale drawing. The parts for the calculated number of handles can then be put onto each marked haul cable as in HAUL CABLE PRE-ASSEMBLY (pg 12).

Pre-assembly and on-site assembly of the suspension cable are combined as shown on SUSPENSION CABLE ASSEMBLY (pg 10) because the on-site amount is minor. These are the pizza pan squirrel and plastic tube raccoon barriers, as shown in the GSMNP publication, which are put on the suspension cable on-site.

We assembled the pizza pans as shown on PIZZA PAN ASSEMBLY (pg 13) to prevent them from oscillating in the wind. The lamp tube used is slightly larger in diameter than 3/8", therefore, the lock nuts for use with that tube must be used. The pans are 12" diameter aluminum with a rolled edge. Note that the rim faces inward. The plastic tubes are 2" X 20" PVC pipe which are loose on the cable and can roll when stepped upon.

Lay out the suspension cable on the ground at the site, put on the pizza pan assemblies and swage the buttons. Put on the tubes and clips, taping the clips so they will not slide. Fasten a 40 foot long haul rope a short way past the clips at the First Tree end. Connect all of the pulleys on the haul ropes to their correct rapid link on the suspension cable and tape together the two ends of each cable.

The person on the ladder uses a tool rope for bringing up tools, eyebolts, etc., that is about 23 feet long, has a hook on the bottom, and is marked at 20 feet and 18' feet from the hook. The person marks the side of First Tree at the 20 foot and 18 foot positions by lowering the tool rope until the hook touches the ground. A drill is brought up and the pilot hole drilled for the eyebolt at the 20' mark. The eyebolt with thimble attached is then turned into the tree with a pipe hammer made from 1/2" x 12" pipe, tee, close nipple, cap, and plug.

The haul rope is fed down through the eyebolt to the person on the ground who pulls until the cable can be fed through the eyebolt and the mark at 8 inches from the end is even with the tip of the thimble as in SUSPENSION CABLE ANCHORS (pg 14). Fasten clips to cable as shown and tighten thoroughly. Mark or fasten horizontally a piece of tape to the side of the tree facing the Second Tree at the 18 foot mark. Remove the haul rope and transfer it to the other end of the suspension cable.

Mark the eyebolt spot on the second tree at 20 feet less any known slope. Also, mark or put tape on the ladder side toward the First Tree two feet down from the eyebolt spot. Install the eyebolt and feed the haul rope as before. As soon as the cable end is through the eyebolt, fix a sight-line from the mark or tape on the ladder to the tape on the First Tree. Stop pulling the cable when the center part reaches the sight-line. Fasten the cable as shown in SUSPENSION CABLE ANCHORS.

As previously described, the outside haul cable eyebolts are directly under the suspension cable eyebolts and four feet above the ground and the inside eyebolts are on the opposite side of the tree and one foot down.

We made a "sliding stop" from upholstery foam (a sponge could also be used) that is clamped to the tree side of the haul cable so that it will slide but stay in position when the cable is pulled to where the Pack Hook Stop is at 4 feet from the ground. Mark the cable and swage the Stop at that position. See HAUL CABLE HANDLES.

Fasten a rope to the tree side cable section and remove the tape holding together the two sections. Connect the quick latch to the eyebolt, pull the cable up through the latch eye and through the upper duplex ferrule as shown in HAUL CABLE ASSEMBLY (pg 15). Remove most of the slack in the cable and mark the ferrule position as shown. Unfasten the quick latch and pull more of the cable through the ferrule in order to cut off the excess. Return the ferrule to the marks and swage three or four times.

Connect the quick latch to the eyebolt. pull the load side cable through the remaining duplex ferrule to remove most of the slack. Mark the cables, disconnect the quick latch and again pull through enough cable to cut off the excess. Return to the marks and swage a minimum of FOUR, preferably FIVE times. Two of these connections have failed when swaged only three times but failure could not be duplicated when a test section was loaded to 145 pounds. But play it safe! This is the connection that will come apart when the system is overloaded.

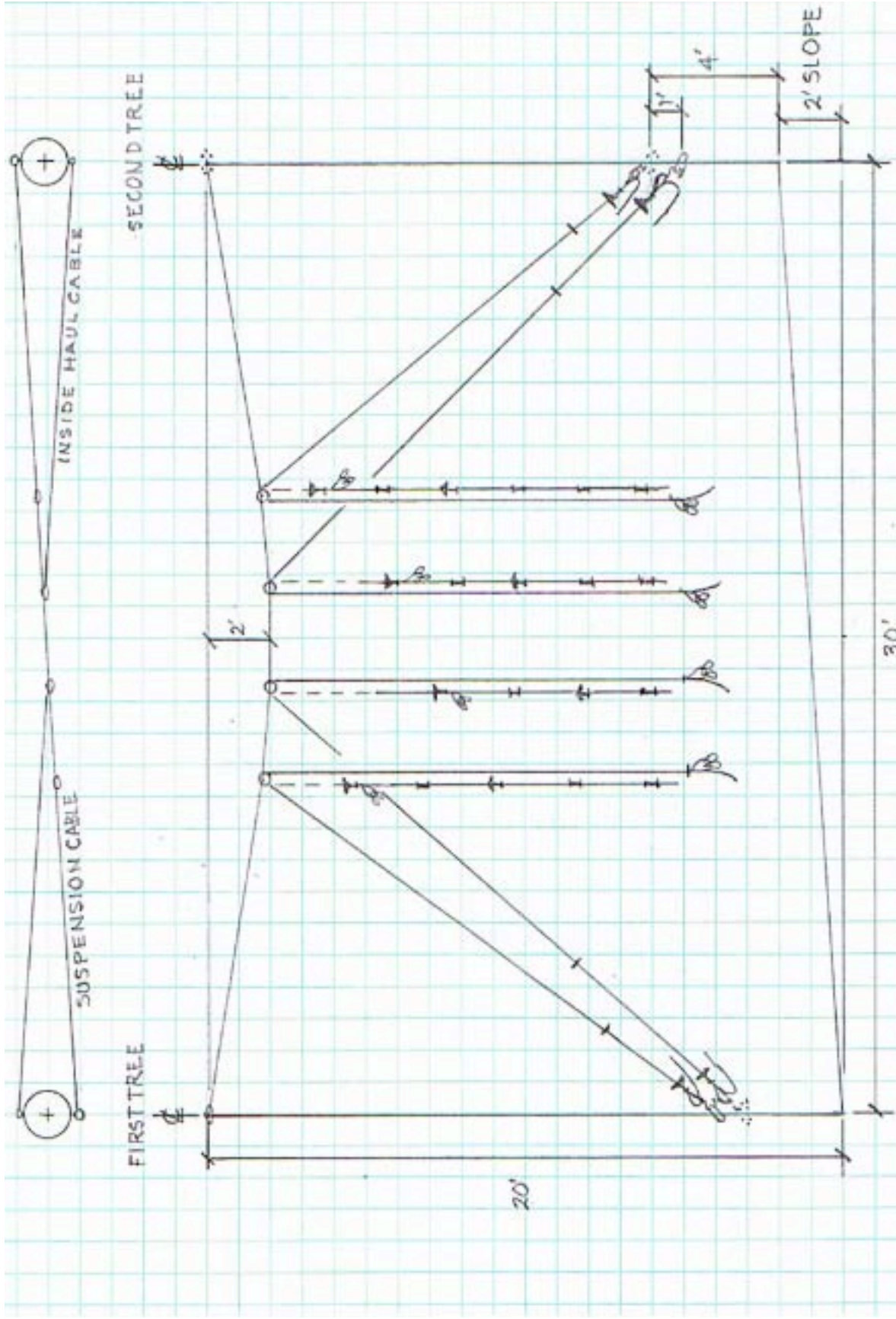
Assemble the MOUSE BARRIER (pg 16) to the tree side handle with the cone in the proper direction, 20 inches from the eyebolt, as shown in HAUL CABLE ASSEMBLY. Swage the upper button first for this handle then push up the rest of the handle before swaging the lower button.

Swage a handle at the five foot mark with the Stop against the pulley and the Pack Hook Stop at 4 feet from the ground as shown in "B" of HAUL CABLE HANDLES. Measure the actual length of cable, similar to "B", between the two handles and calculate the distance needed for handle separation. Put the second mouse barrier on the second handle from the quick latch and swage all handles. Repeat for each haul cable.

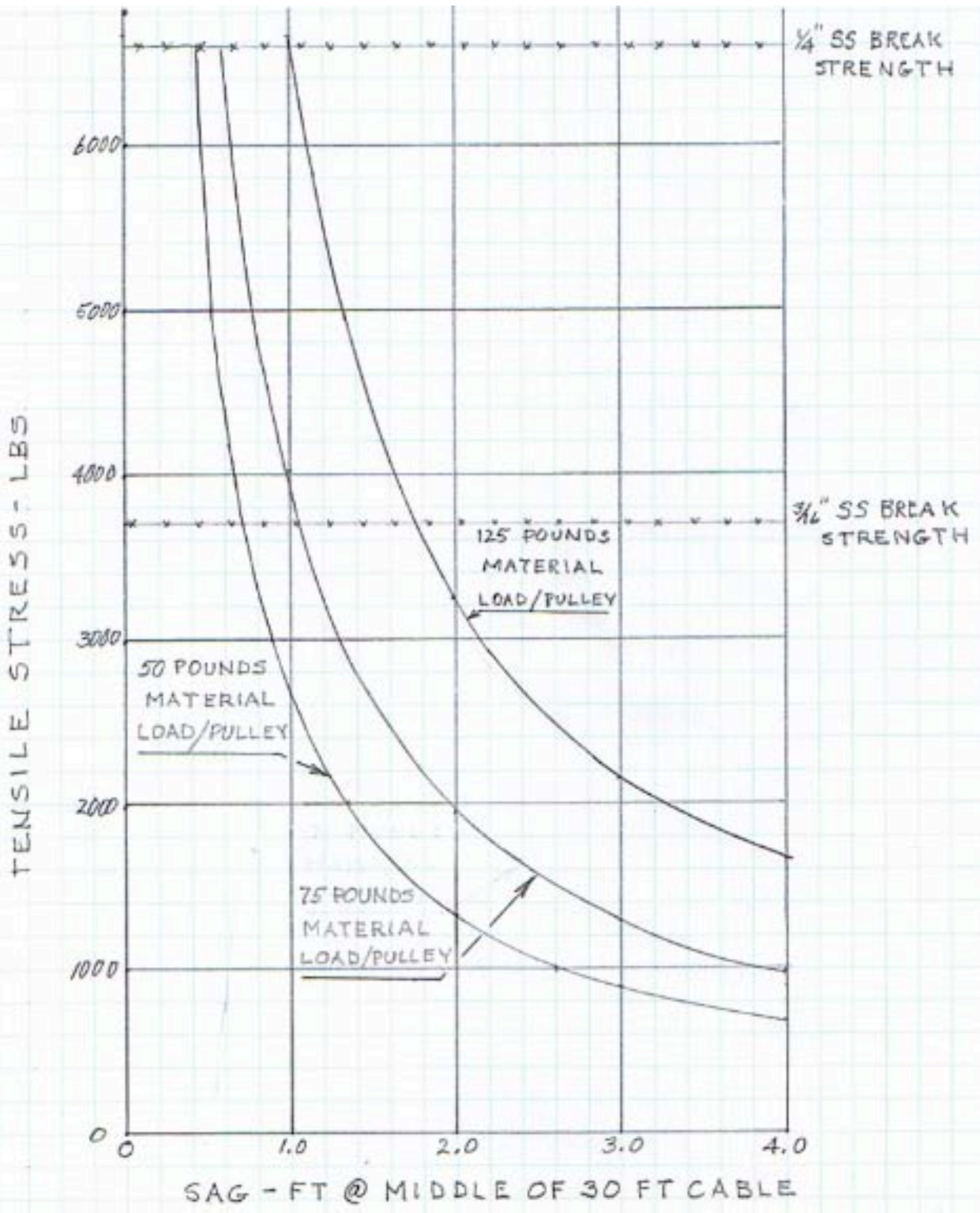
Put up a sign on the most visible tree to tell the hikers how to use the system. We are using the sign shown on page 17, FOOD STORAGE CABLE.

MATERIALS & EQUIPMENT

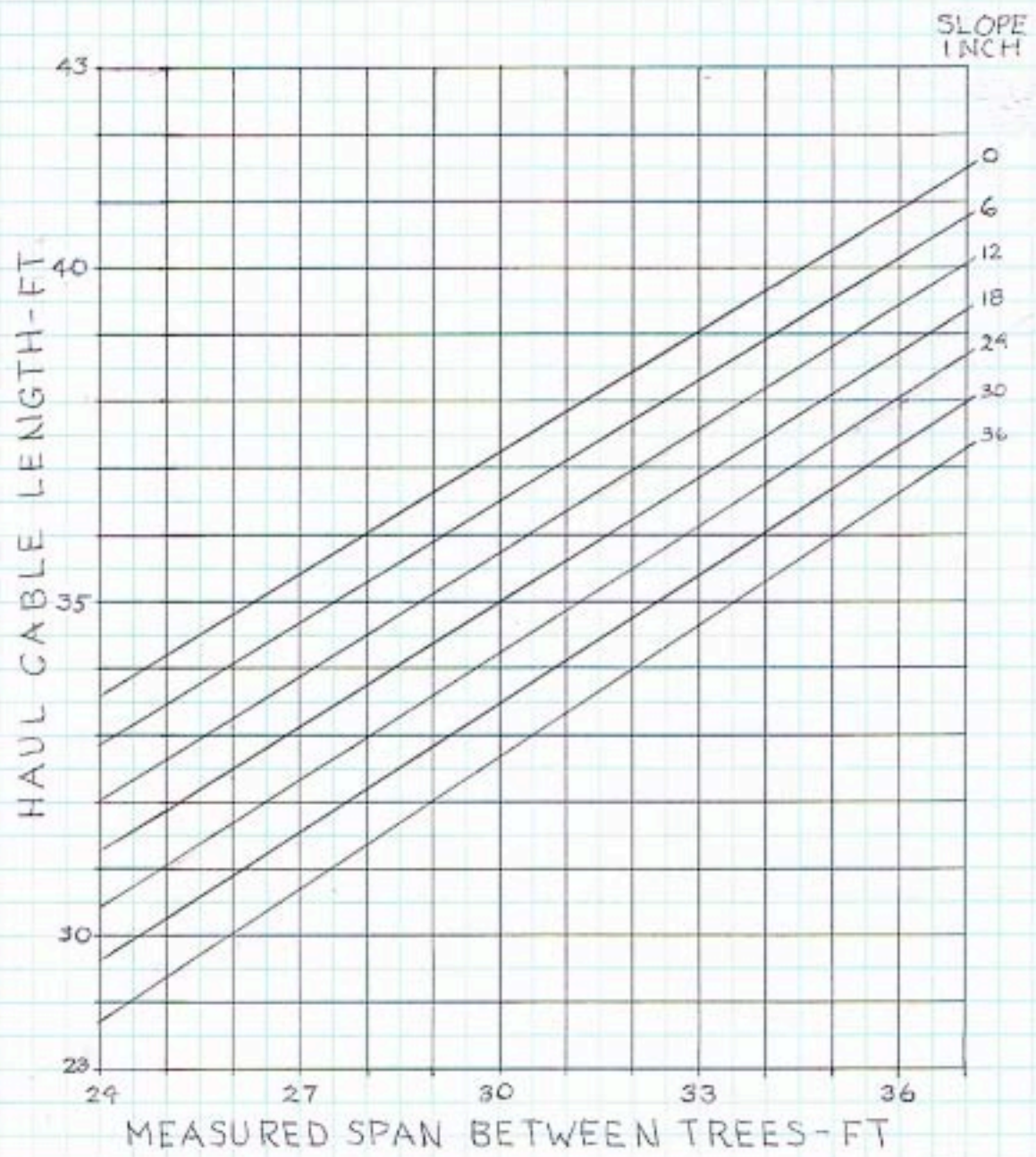
ITEM	VENDER
3" dia Gable (fixed eye) blocks	Deuer Manufacturing, Inc P.O. Box 4014 Dayton, OH 45401-4014
5/8" X 4 1/2" forged lag eye bolts	Bolts & Nuts, Inc 18 Sweeten Creek Road Asheville, NC 28813
3/8" X 3" galv lag eye bolts	
1/4" X 1 1/4" SS fender washers	
3/8" X 1 1/2" SS fender washers	
30" HIT swager w/cutter	American Presto Corporation 4001 Santa Ana Street Ontario, CA
6' Adjustable Lanyard	Forestry Suppliers, Inc P.O. Box 8397 Jackson, MS 39284-8397
10' Sectional Ladder, aluminum	
1/4" 7 X 19 SS cable	American Cable & Rigging Supply, Inc P.O. Box 546 Arden, NC 28704
1/4" SS wire rope clamps	
1/4" wire rope thimbles	
1/4" copper button stops	
3/16" copper button stops	
3/16" copper duplex ferrules	
3/8" SS universal snap hooks	
3/8" SS rapid links	
12" AL pizza pans	Swanner Restaurant Equipment Company, Inc 604 Seventh Avenue East Hendersonville, NC 28792
2" X 10' PVC pipe	Lowe's Home Centers, Inc
3/4" SS rigid eye quick snaps	
18" swaging tool	
1/8" X 24" threaded pipe	
3/16" Diamond Braid rope	
1/4" braided PVC tubing	
3/4" X 66' red tape	
1/2" X 12" galv pipe	
1/2" galv tee	
1/2" galv close nipple	
1/2" galv cap	
3/16" 7 X 19 SS cable	
1/8" X 24 lock nuts	
20" X 10' aluminum flashing	
1/8" X 1/8" pop rivet	
1/2 pt Rustoleum primer paint	



GENERAL DESIGN

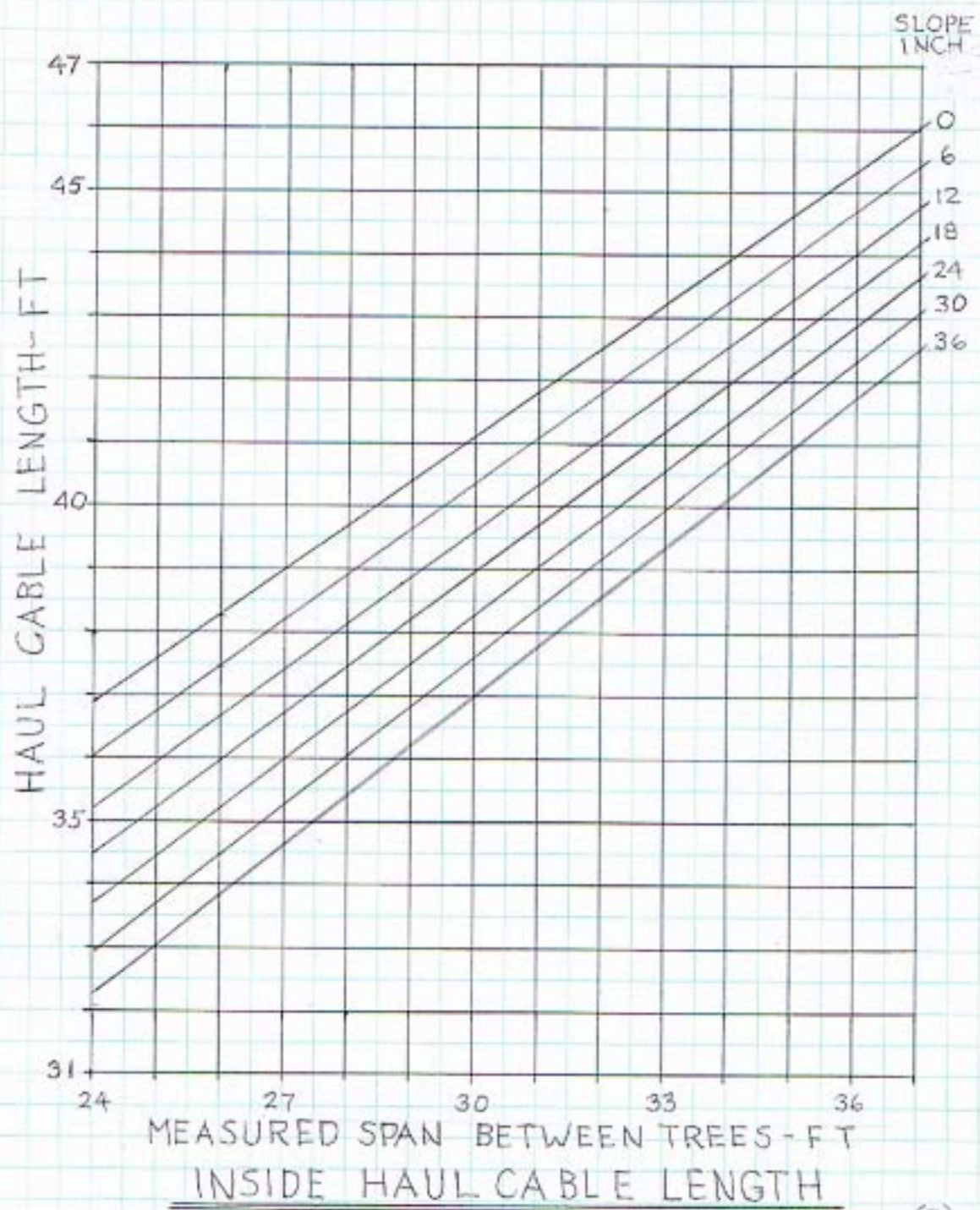


EFFECT OF SAG ON CABLE STRESS

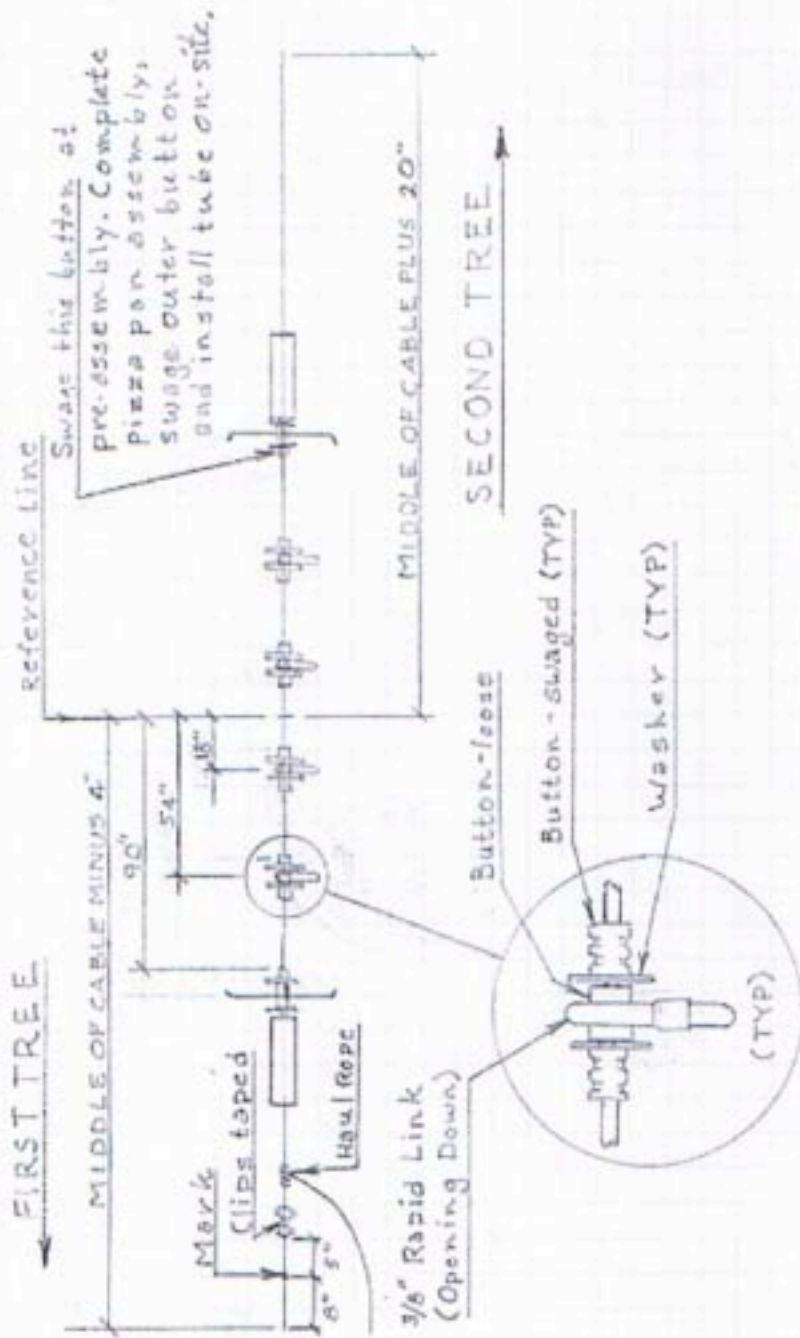


OUTSIDE HAUL CABLE LENGTH

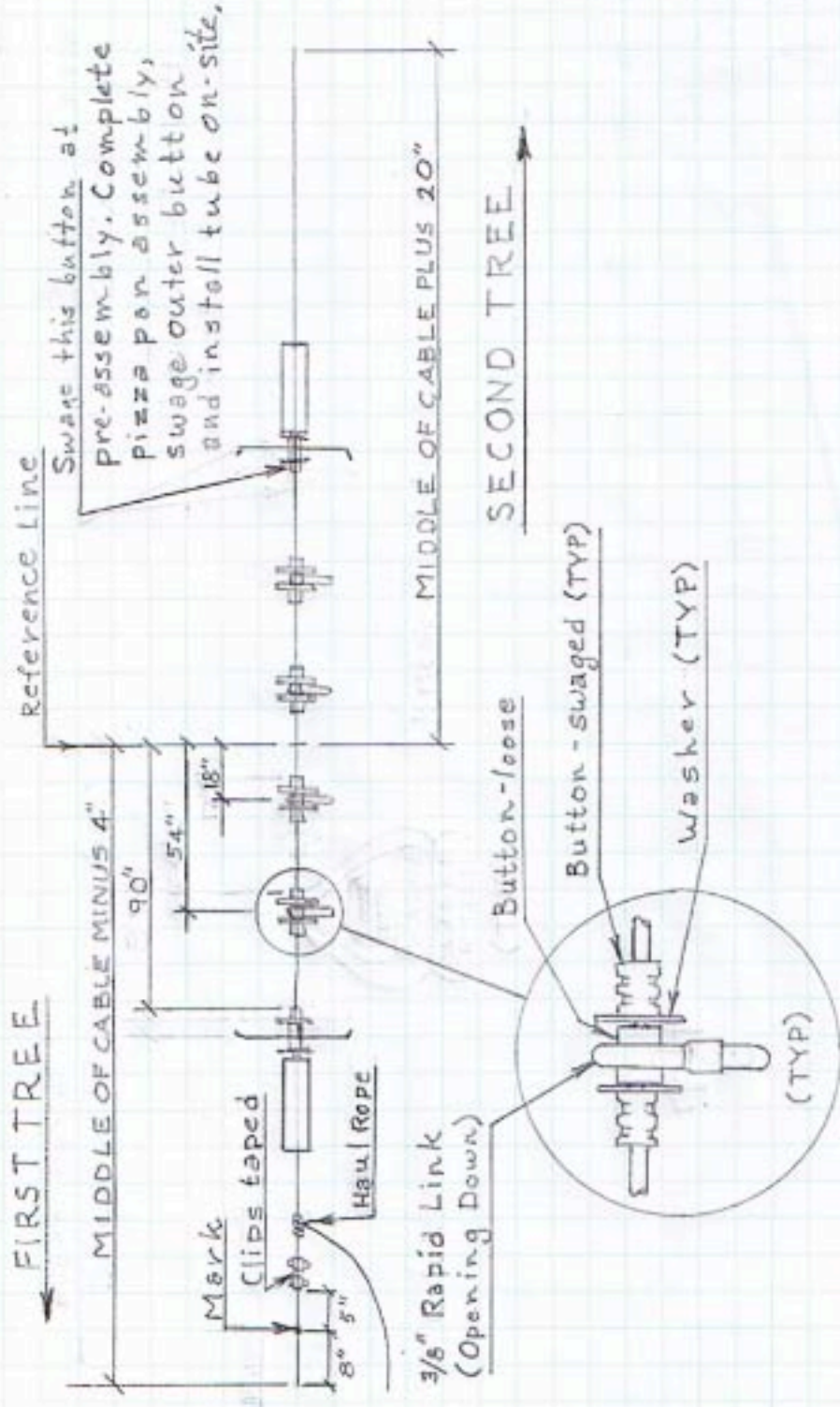
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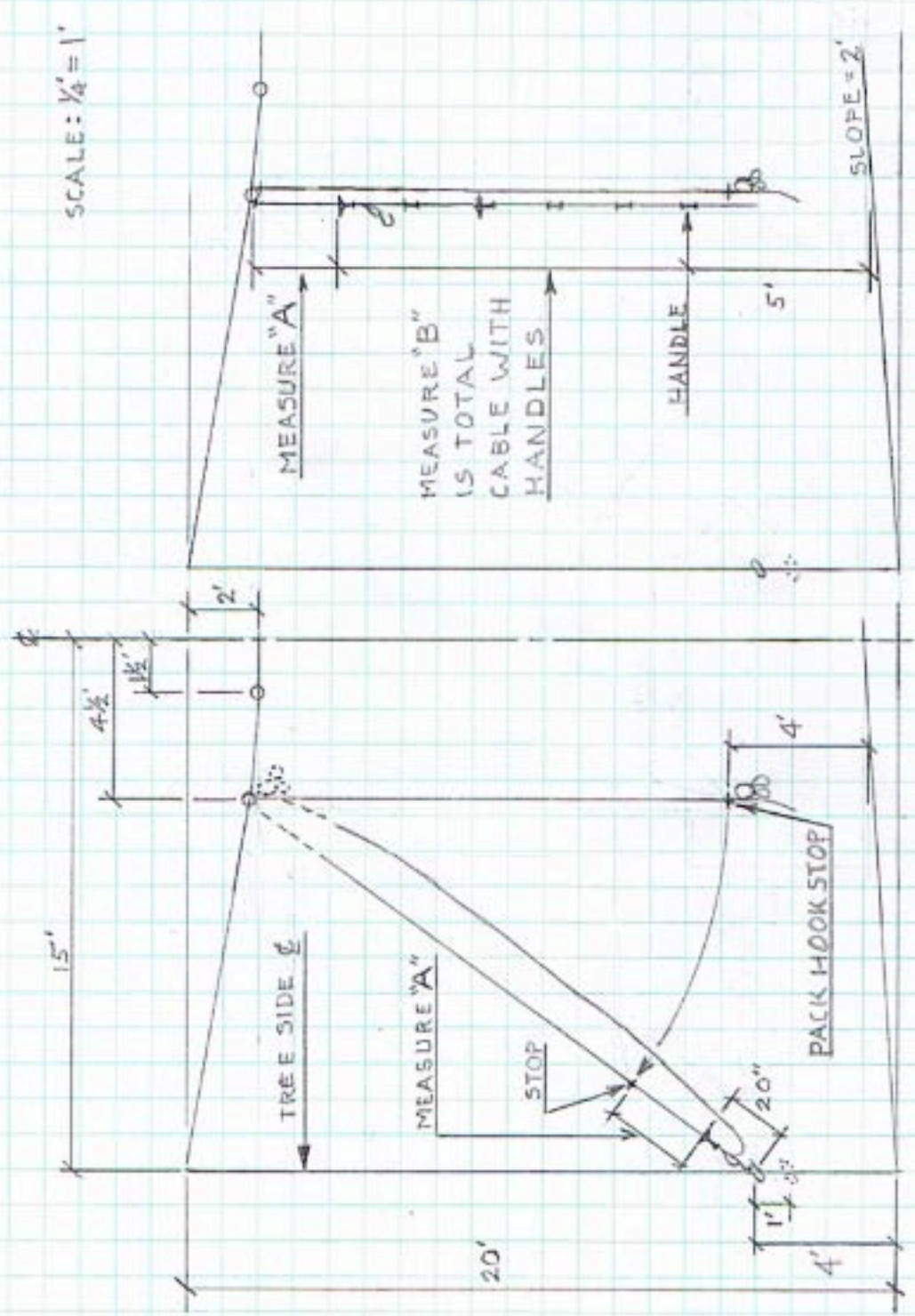
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SUSPENSION CABLE ASSEMBLY



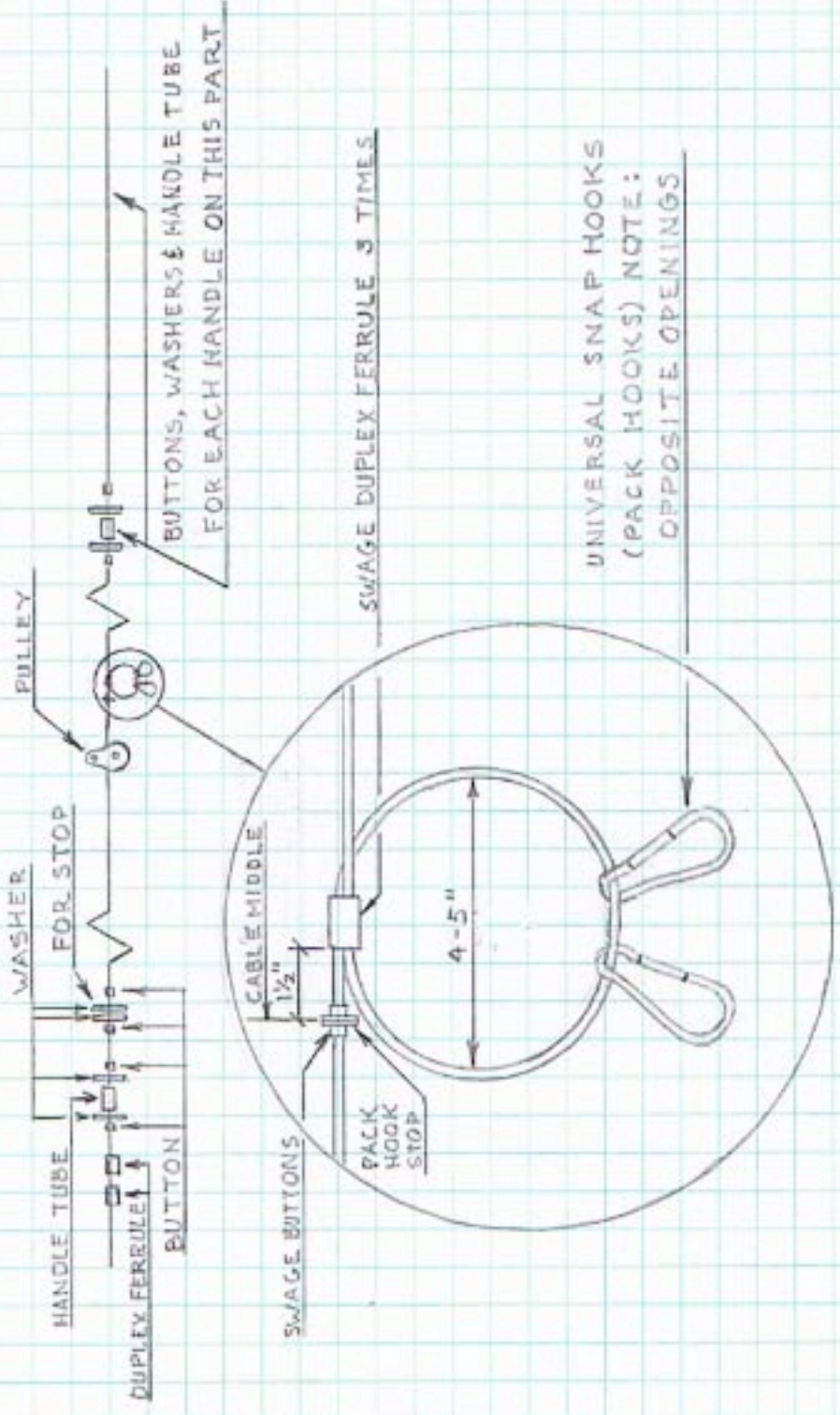
SUSPENSION CABLE ASSEMBLY



PROCEDURE A

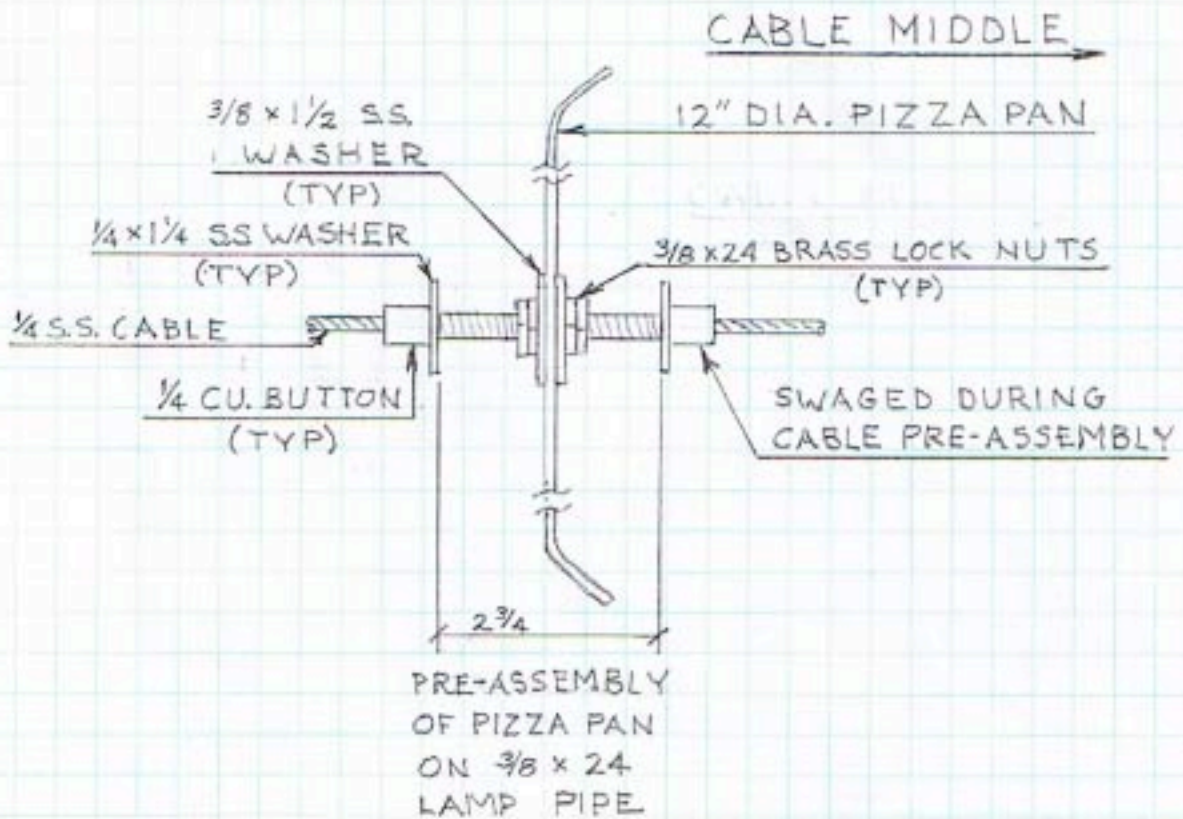
PROCEDURE B

HAUL CABLE HANDLES (11)



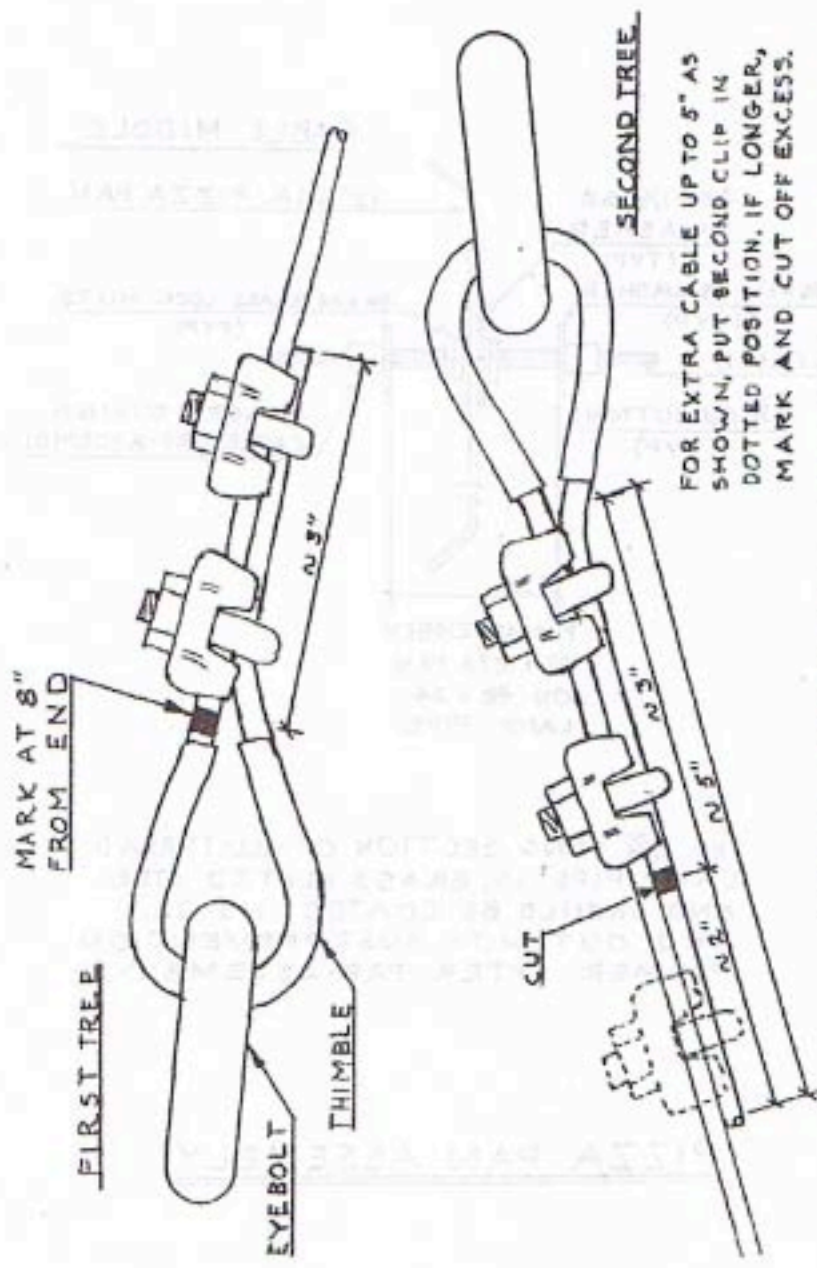
UNIVERSAL SNAP HOOKS
 (PACK HOOKS) NOTE:
 OPPOSITE OPENINGS

HAUL CABLE PRE-ASSEMBLY



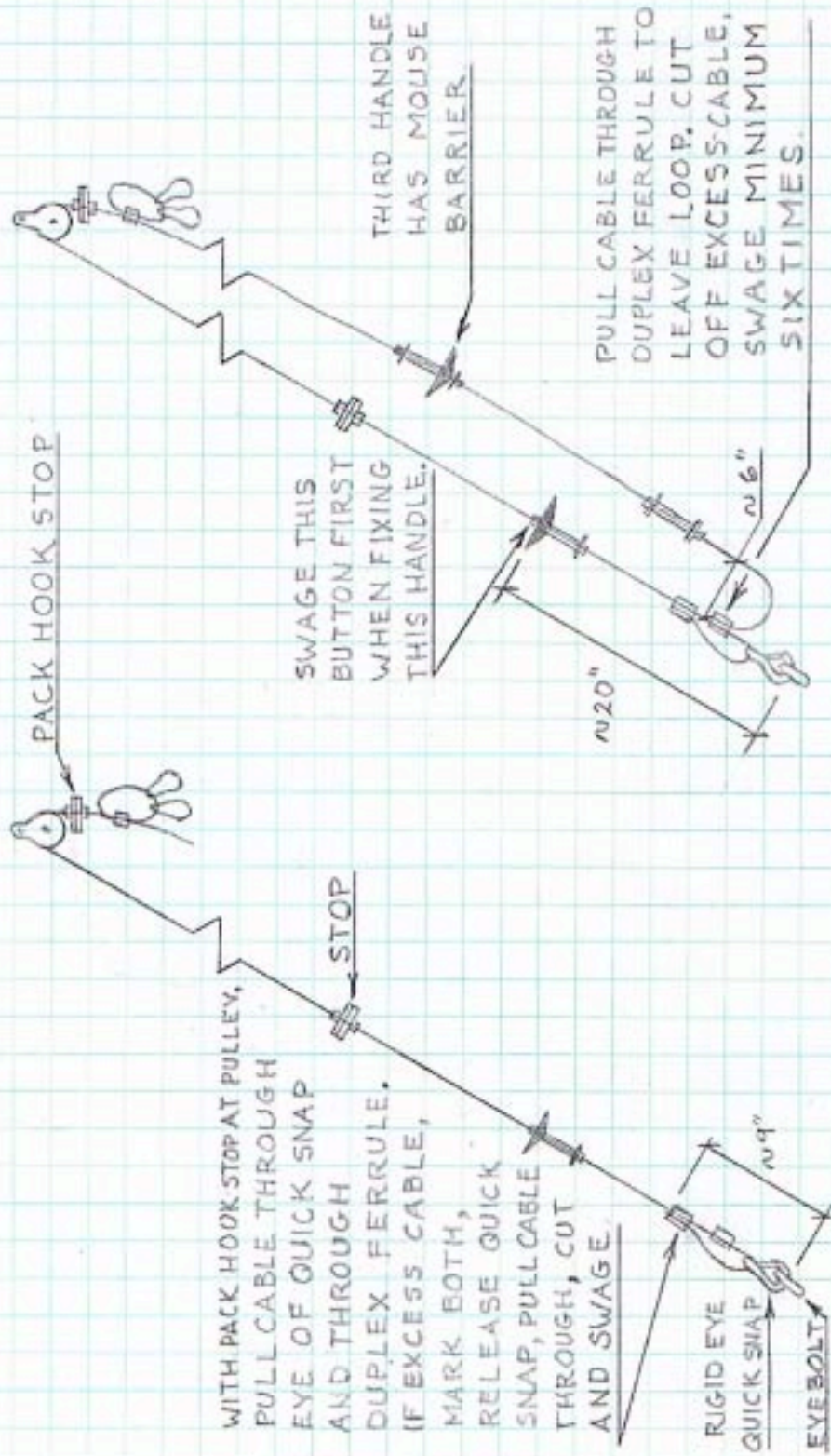
THE $2\frac{3}{4}$ " LONG SECTION OF ALL-THREAD LAMP PIPE IS BRASS PLATED STEEL AND SHOULD BE COATED INSIDE AND OUT WITH RUST PREVENTION PRIMER AFTER PRE-ASSEMBLY.

PIZZA PAN ASSEMBLY



FOR EXTRA CABLE UP TO 5" AS SHOWN, PUT SECOND CLIP IN DOTTED POSITION, IF LONGER, MARK AND CUT OFF EXCESS.

SUSPENSION CABLE ANCHORS



HAUL CABLE ASSEMBLY