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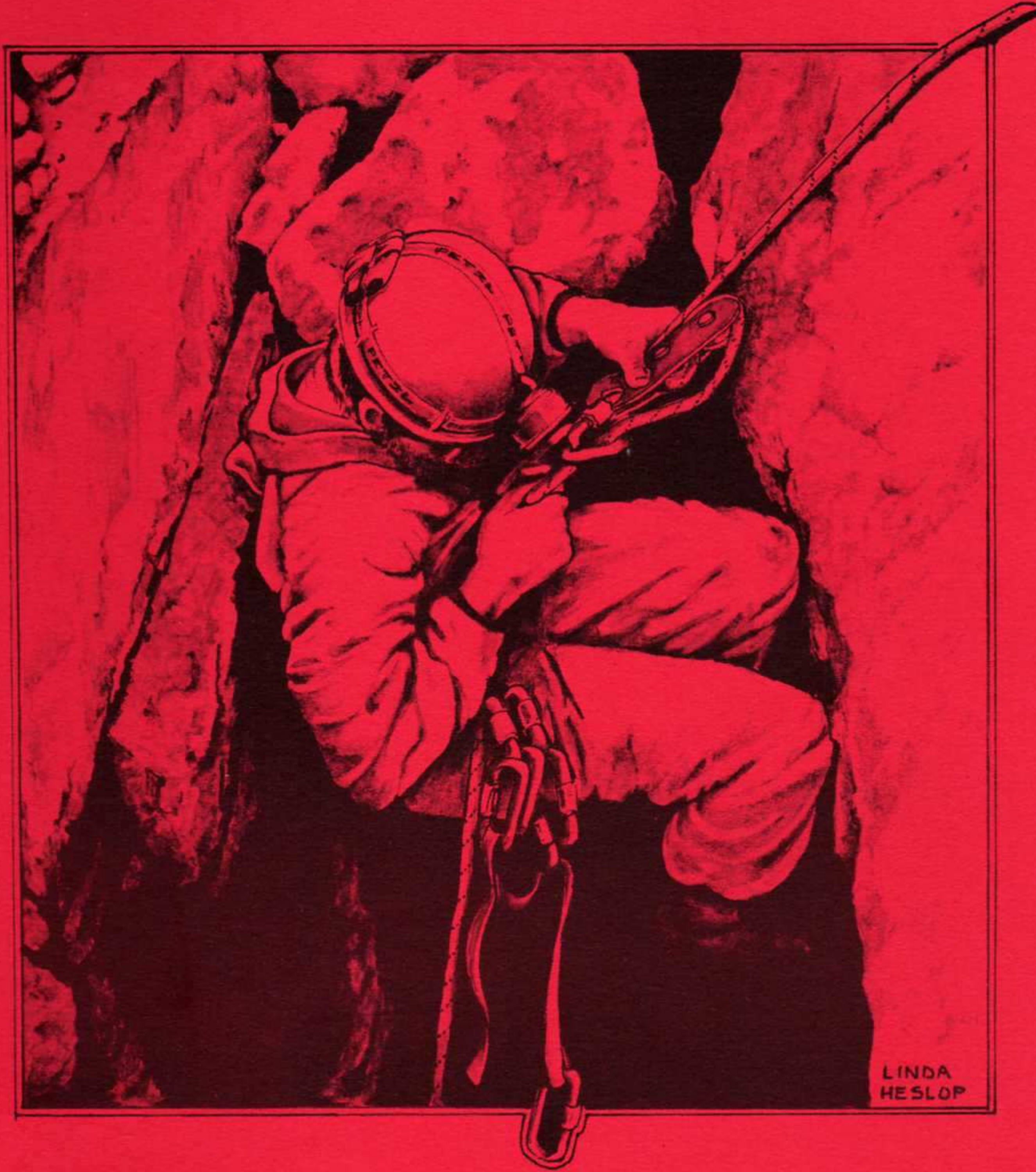

...ESPECIALLY FOR THE VERTICAL CAVER

NYLON HIGHWAY

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THE NYLON HIGHWAY

The Nylon Highway is published on a semi-annual basis pending sufficient material. It is the intent of this publication to provide a vehicle for papers on vertical work. All submitted articles containing unsafe practices will be returned to the author. With this issue, the Section has over 900 members, with a mail out of over 1000 copies each issue

Opinions expressed herein are credited to the author and do not necessarily agree with those of the Vertical Section, its members or its Executive Committee. Reprinted material must give gredit to author and source. Some material is designated copy written. Letters to the edior are welcome.

COVER: Mervin Mitchellin Close to the Edge of the Road Cave, Vancouver Island by Linda Heslop

JUNE 1991

NO. 34

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FEATURE ARTICLES

THE PRUSIK KNOT

A 60 YEAR HISTORY

A New Knot and its Application

In December 1931, the Austrian Alpenzeitung, the publication of the Austrian Alpine Club, published a treatise on rope techniques. The title was Ein neuer Knoten und seine Anwendung (A New Knot and its Application). The author was Dr. Karl Prusik, a climber, writer of technique and training manuals and professor of music [1].

At a time when climbers still dealt with the question of: Is it better to tie in below the backpack or above [2], a know with the properties of this "Wunderknoten" (miracle knot), as it was named by Maduschka [3], was a sensation. Today it has become routine. But the original work of Prusik is still worth reading. He describes in detail, the technical problem, the knot he had found (Figure 1) and numerous applications. The are, above all, the ascent on the rope, self-belay, belaying of a partner, pulley techniques and crevasse rescue.

The Question of Novelty

With his fundamental work, Prusik influenced alpine rope techniques probably more than anyone before or after him. His knot also played an important part in the history of SRT in modern caving [5,6]. But it wasn't new. This fact was discussed even in the thirties. However, it is too simple to define the Prusik knot as a Bale Sling (Figure 3) which would be as old as the hills [7]. Better sounding are the comments of Percy Blanford, according to whom the knot named after Prusik by mountaineers was already being used by sailors to support loads on horizontal spars [8]. Blanford mentions no references, but as a profound expert on nautical knots, he is absolutely reliable. The hoisting of spars, using the same knot, is shown by Ashley [9].

The Prusik knot at the end of a sling (Figure 4), known by Prusik, but not used for ascending because of its lower strength [4], was already shown as a "Magnus hitch" in a manual on seamanship and rigging by Steel [10].

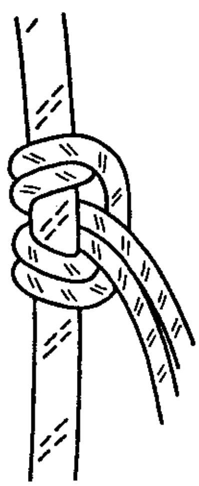

Figure 1. Prusik's Knot - four coils around the rope as a key to modern alpine techniques.

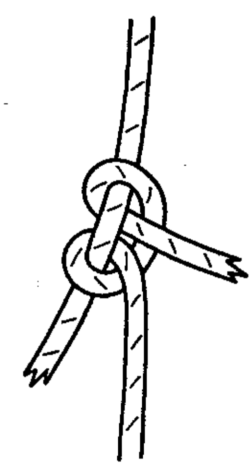

Figure 2. Repair of broken strings by a Cow Hitch in one of the ends.

The Origins of the Prusik Knot

The reason for his development is mention by Prusik, however, what special knowledge he used for his knot idea isn't described clearly enough in his article that his development can be re-enacted in one's mind. A companion of Dr. Prusik in the thirties related the following [4]: Prusik was a soldier in World War I. The winter evenings at the front were long and he played the guitar to pass the time. Eventually, the strings ran short. At this time, he remembered a knot for the repair of broken strings that he had seen once in a book. This knot consisted of two half hitches, tied in one end of the string, which contracted and held onto the other end by friction when loaded (Figure 2). On this basis, after the creation of the first mechanical ascender, Prusik developed his knot in search of simplification of his knot.

Likewise, prusiking was no invention of Prusik, though named after him, because the inventor of the mechanical ascender must have known about it. The inventor of prusiking is considered to be the Frenchman Brenot in 1929 [6]. But a drawing in Ashley's book showing a painter on a flag pole, shows the idea of prusiking may be older still in other fields [9].

Ascending on a rope by the friction of a knot was not new at the time, since it was documented by American tree surgeons [9] whose techniques can be traced back almost a century [11].

Dent's Double Clove Hitch

Prusik - and this opens an interesting point of view concerning his performance, though this is probably difficult to understand at the moment - was not even the one who introduced the friction knot into mountaineering. The proof can be found in the manual by C.T. Dent.

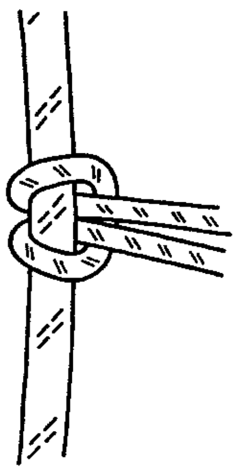

Figure 3 - Bale Sling Hitch

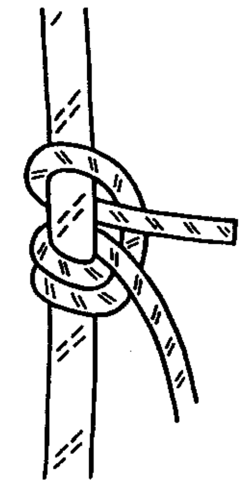

Figure 4 - Prusik Knot at the end of a sling.

The English original - the German edition is translated wrong and incomplete [12] - contains a statement in connection with the description of a simple mountaineering tent which could be set up by the rope tied on larger stones or on axes, driven obliquely into the ground: "If fastened to an axe, the rope should be attached by a double clove hitch, or it will slip up." [13]. Without a drawing, it is not clear if a numerical or a structural doubling of a Clove Hitch (Figure 5) was meant. But that the latter was the case, follows from another point in the same manual where Dent writes in another context: "The trick of making a clove hitch, and also the double clove hitch, should be learnt." [14].

To find out which knot this "double clove hitch" was is difficult, though it must have been so familiar that Dent saw not reason to go into details in either the first edition or later. [15]. It looks very much as if the Rolling Hitch (Figure 6), a knot which is frequently used as sea for a lengthwise pull [9] as described as a "clove hitch with a round turn" by Roding [16] and "a sort of double clove hitch" by Day [17] could have been meant. but, on the other hand, there is also a book from the time of dent which shows besides a "builders knot" - the Clove Hitch - a "double builders knot" (Figure 7), which is "considerably stronger" [18].

The remarks of Payne in the "Climbers' Pocket Book", the first British manual on crag rescue, after which the statements: "One rope may be made fast to the middle of another that is in tension by a rolling hitch" [19] and "Rolling Hitch is the same as a clove hitch with an extra turn in the middle" [20], confirm that the principle of the friction knot was really known among the old mountaineers. Moreover, they show a further stage, the attachment of a rope by friction on the rope. But which knot knot was definitely meant by Payne - the knot in Figure 4 or that in Figure 6 - isn't clear again, since his photo of a "clove hitch" shows a Bale Sling Hitch [21].

The early mention of friction knots in mountaineering, whichever it is, isn't only historically interesting. It shows it wasn't necessary to know a method for repairing

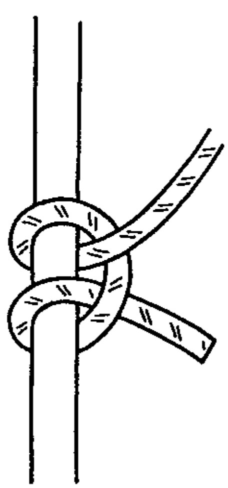

Figure 5 - Clove Hitch

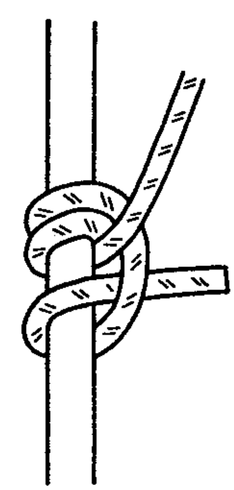

Figure 6 - function, a friction knot; structure, a double Clove Hitch

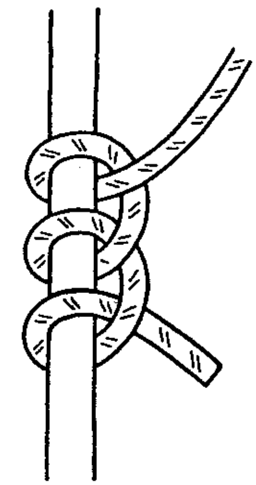

Figure 7 = Double Builder's Knot & double clove hitch

guitar strings to have the idea of ascending by knots. A whole generation of mountaineers had had the chance for that.

This article originally appeared in print in the Austrian climbing publication, Die Alpen (The Alps) in December 1991, on the 60th anniversary of the invention of the Prusik knot. The article was translated by Heinz Prohaska of Hoersching, Austria.

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[21] ibid., pg 73.

HORIZONTAL OR PARALLEL?

Dear Editor,

For the sake of accuracy and clarity, could everyone please stop referring to the proper and improper attachment of a rack to the harness as the "vertical" and "horizontal" positions. These words refer to one's position relative to gravity and the ground, and make absolutely no sense when describing the rack's position relative to the body.

What you actually mean is that the rack should be positioned "perpendicular" to the body, not "parallel" to it. Every time I try teaching beginners with the terms vertical and horizontal, I only get confused looks. Perpendicular and parallel makes more sense to everyone and are the terms I now use.

Even Bill Cuddington, in his article in Nylon Highway #33, feels compelled to explain the unclear term horizontal by saying that "the rack ends up with the bars parallel to me, which is the horizontal position".

Other than this one tiny complaint, you guys and gals are right in every thing else you say and I wouldn't dream of disagreeing with you on anything.

Happy caving,
Bob Zimmerman
NSS 27633

A Farewell to Chattanooga

by Maureen Handler

I recently left the Chattanooga area after living there for nearly four years. One of the last caving trips I made before leaving was a night trip to Ellison's with two very close friends. It was a chilly March night and it had been raining for a few days. That and a clear night with a full moon, promised an exciting trip. Here's what happened.

May 20, 1992

It's 6 p.m. and I'm waiting at the blue hole for Troy Keith and Dan Twilley to join me to go bounce Fantastic. I figure it could be a while before I get to do it again. The rain from the last two days has finally let up and the temperature is dropping. The waterfalls in the pits may be spectacular.

May 21

Last night was a dynamite experience. Dan and Toy showed up at 7:30. I was packed and pretty much ready to go. I had eaten a picnic lunch on the tailgate and walked around the fields to limber up. I felt in prime condition as I hiked up the mountain. I started up just after dark about 10 minutes ahead of the others. It was chilly out and I didn't break a sweat inside my suit until 3/4 of the way up carrying the rope for the warm-up pit. As I hiked along, I heard a noise in the woods. As I tried to focus my light on it I heard more noise in the trees above. Whatever it was, it was BIG! It was knocking down good size branches. Finally the noise stopped. I started walking again. After two steps it took off again right in front of me. I must have startled a large owl or hawk. What an adrenalin rush in the dark.

The water was raging as I climbed down the into the Historic Entrance. I was the most water proof, so I went in first to take the rope and packs. Walking through the stream passage, I felt really in tune with the cave. My feet were soaked in my leather boots and the water was cold. The waterfall at the warm-up pit sounded awesome as I approached. At first a distant roar, as I neared the pit I realized we were going to get soaked. Fantastic Pit would be like a hurricane. I descended first and quickly moved out of the spray. Troy came down and tied his rack on the rope. Dan had left his in the car, only discovering this at the entrance. I kept moving deeper into the cave. I crossed the mud bridge and quickly ascended the 18' nuisance drop[. I moved on to the ledge leading to the attic.

The new rigging is fantastic. The overhang has been blasted away and a totally free, lipless drop is rigged off 2 ceiling bolts. My excitement was growing as I rigged onto the rope. I could hear the water thundering below me. I swung out over the edge and began the descent. I could hear the water rushing off the ledge 76 feet below me and crashing on the floor nearly 600 feet below. The thundering noise was deafening. As I passed the balcony, I could see the water shooting off the ledge. It seemed to be swaying back and forth as it began its descent. Another 200' and I was in a mist cloud. My carbide lamp gave me the feeling of driving in the fog with high beams. All I could see was the warm light of my carbide light glowing white all around me. The sounds were amazing. I could hear the water rushing off the ledge above me and a separate sound of it crashing in the bottom 300 feet below. Another 100 feet and I was in the waterfall. All I could hear was water rushing over me. The water kept putting out my flame so I switched over to electric for the rest of the drop. I hit bottom and bounced away from the spray. Standing on the bottom soaking wet and having a great time, I was joined by Troy 10 minutes later.

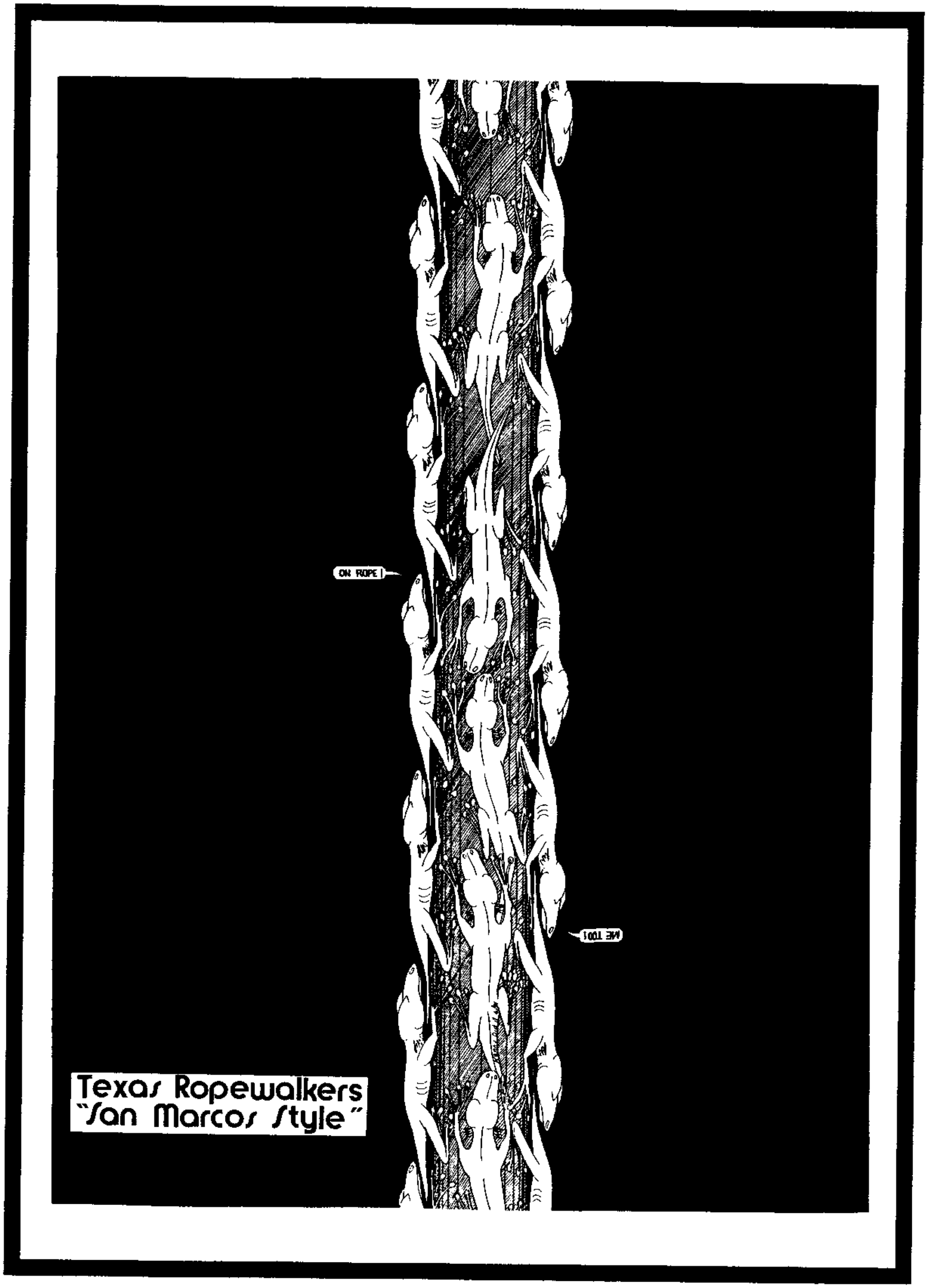
We geared up as quickly as we could. The water slamming into the floor after a 500 foot free fall, filled the pit with a white mist and created a cyclonic wind at the bottom. We were drenched and the noise was so loud we had to yell to one another to communicate. I clipped in and started climbing. Troy started up as soon as I was out of the way. I just started climbing keeping a good steady pace, thinking about breathing and raising my knees like on a stair stepper. I was feeling great and Troy was right behind me. With all the water, I was nice and cool and didn't start sweating until I was probably at the 450 foot mark. I climbed in the dark. The light from Troy's head lamp lit up a good portion of the pit creating huge shadows of myself and Troy's hands. Once my eyes adjusted, I could see the glow from Dan's lamp at the top. My new suit was comfortable all the time. A little warm at the top, but we climbed in about 20 minutes tandem. Everything worked so well, My gear, lights, suit, ME. What a great warm up for Mexico.

I headed for the nuisance drop as Dan started climbing. We stayed well staggered coming out. I carabiner wrapped the 18 foot drop (since Dan had my rack) and then cruised up the warm up pit. Troy was right behind me and Dan after him. I felt great! What a trip! I love wet caving. I need a photo rig to shoot this stuff. We pulled rope and headed off to the entrance.

It was below freezing on the surface and a full moon had risen above the eastern horizon. This called for an extremely loud yell on my part. The cold forced us to head down the mountain. Thirty degree temperatures and wet cavers don't mix well for long. We exited the drainage wash and bolted down the trail. The bright moon light provided enough light and we hiked down in the dark. Troy started talking about monsters and was getting worked up when a rabid-acting Dan came galloping and grunting up from behind, giving Troy a good start.

We reached the Blue Hole and our vehicles shortly after midnight. Warmth was of primary concern as we dug for dry clothes. I was home in bed by 2 am. It seemed an appropriate trip for what may be my last days as a TAG caver. Spending the evening with two of my best friends from Chattanooga. It felt good sharing the experience with them.

Author's note: I have since taken a job in Marietta, Georgia. So I will be able to remain in TAG. YES!!



Texas Rope Walker by Kenny McGee

VERTICAL TECHNIQUES

A EUROPEAN METHOD

by Peter Grant and Bill Bussey

Introduction

Though developed and used principally by cavers in Europe and Australia. European Vertical techniques are increasingly being used by cavers in the U.S.A. European techniques were developed to get into the very wet, sharp lipped, cold alpine caves of the French Pyrenees and European Alps. Even padded Nylon ropes quickly abrade when soaked by waterfalls and when run over sharp lips.

European Vertical methods are based on the premise that the rope never rubs on the wall. Wherever the rope touches the cave wall, it is again anchored or redirected to position it away from the wall. This prevents the rope from abrading due to contact with the wall. These 're-anchors', commonly known as rebelays, normally consist of placing a bolt and attaching the rope to it. The rope hangs free to the next rub point where it is anchored again. Also, ropes can be redirected using slings, normally attached to natural projections, to pull it away from the rub point.

The European Climbing system, also known as the Frog System, was developed to easily get around these rebelays and redirectionals on both ascent and descent. By utilizing easily detachable and attachable ascenders and descenders, which are within easy reach above the waist and two separate easily manipulated slings, known as cows tails, cavers with training get around these obstacles safely and easily. This article is only a brief introduction to the European method of Single Rope Techniques. It is no substitute for training from those use use the system and practice. For more information see the Caver Information Series (CIS) and the references at the end of the article.

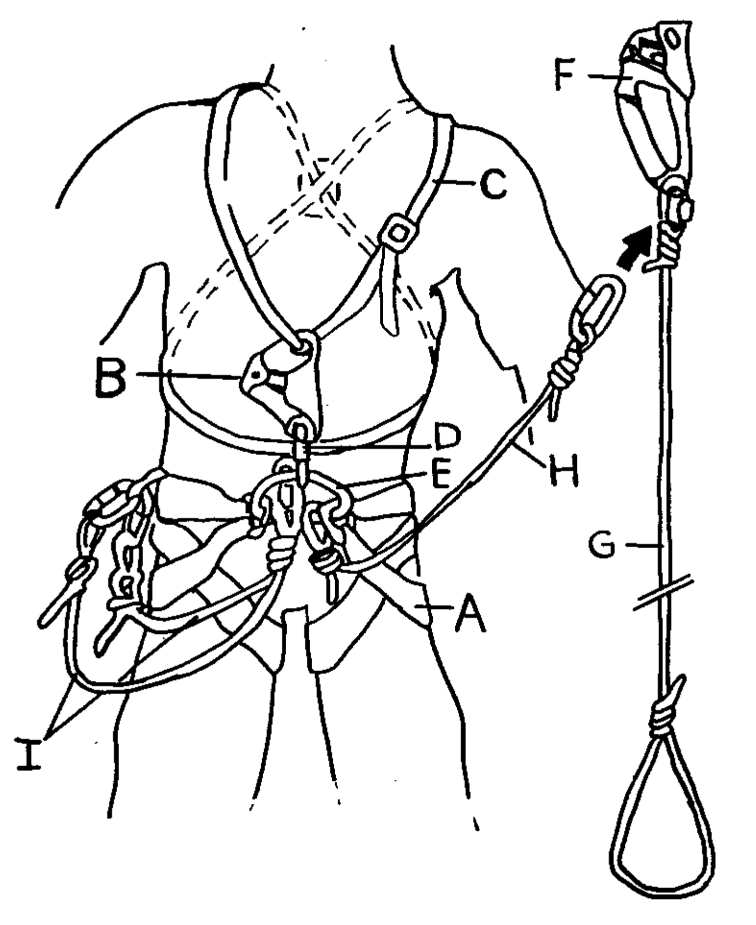
Materials

- Seat Harness
- 10mm Delta Maillon to hold seat together
- Chest Harness (made with 10 ft. of 1" tubular webbing with 1" buckle at end)
- Chest Ascender - Petzl Croll
- 7mm Oval Maillon to attach Croll to Seat Delta Maillon
- Optional 3mm Maillon or Quick Link to attach Croll to Chest Harness
- Foot Ascender - Petzl Handled Jammer or Jumar
- Foot Sling and Safety Cord (made with 7mm static rope)
- Optional - three 7mm Maillons for Foot Sling and Safety Cord
- 10mm or 11mm Rope to make cows tails
- 2 Non-Locking or Locking Carabiners for cows tail
- Descender - Petzl "Classic" Descender
- Extra Carabiner to add needed friction for Petzl Classic Descender

Seat and Chest Harness

See the Caver Information Series # XXX for making a seat harness. The seat harness should be as tight as is comfortably possible as it will loosen when moving around. However, it should not come loose when walk-

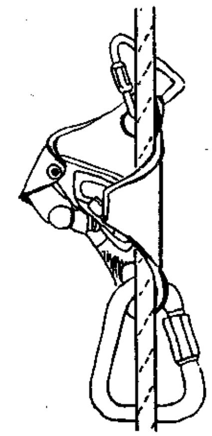
Figure 1



A. Seat Harness B. Chest Ascender - Petzl Croll C. Adjustable Chest Harness D. 7 mm Maillon connecting Chest Ascender to Seat Harness 10 mm Delta Maillon E. Seat Harness 10 mm Delta Maillon F. Foot Ascender - Petzl Handled Jammer G. Foot Loop H. Safety Loop I. Cows Tails ing around the cave. Most who use this system wear their seat harness throughout the cave. The seat harness should be comfortable for sitting in for long periods of time. See Figure 1. The chest harness is 10 feet of 1" tubular webbing with a buckle sewn on the end to make an adjustable loop. It is wound around upper body in figure eight fashion and threaded through the Croll and the connecting Maillon.

The purpose of the chest loop is to pull up the Croll chest ascender while preventing the caver from leaning backwards. Thus, the tighter this chest loop is, the more efficient it is on free hanging drops. However, on steep lopes or when wearing it in horizontal passages, tight might not always be comfortable, so the chest is normally loosened. Still, it should not be so loose as to snag on things when the Croll is not attached.

Figure 2 Petzl Croll Chest Ascender



The Croll was developed for use with this specific climbing system. See Figure 2. Notice that the shell is bent so the Maillon or quick link clipped to the bottom and top are offset so that the rope does not rub against them. Use a 7mm oval Maillon to attach the Croll through its bottom hole to the seat harness Maillon. This will allow the caver to remove or replace the Croll without undoing the seat harness. Shorter people may choose to attach the Croll directly to the seat maillon to prevent it from riding so high on the chest. However, this will reduce the safety and versatility of the system and is thus not recommended.

The chest harness is normally threaded through the top hole of the Croll. However, one may choose to use a small non-load bearing 3 - 6mm quick link here to allow easy removal of the Croll from the chest harness.

Notes on Maillons and Quick Links

Maillons are sometimes known as quick links or Rapides. Unlike carabiners, they can be loaded in any direction without significant loss of strength. Quick links should **only**, be used when **LOCKED** as they have no strength when unlocked. Quick links can be obtained from caving vendors or at some hardware stores.

When used properly, quick links are also small enough not to rub the rope as stated above. The important thing is that the links and the slings are positioned so that the Croll is held flat against the body and the links are not getting in the way of rope travel. This may involve loosening a link and rotating it.

The Foot Loop and Ascender

There is a wide choice of ascenders which can be used with the foot loop. A Petzl "Handled Jammer" is used most often because it was designed to allow easy operation by hands in bulky gloves. However, other handled ascenders may also be used according to preference. Also, use of a small non-handled ascenders on the foot loop may reduce the tendency to pull up with the arms.

The foot loop is made with 7mm, 8mm or 3/8 inch diameter static cord. First, using a figure 8 knot, tie a large single loop which will easily take one or both feet. For those who wish separate foot loops, optionally tie them as shown in Figure 3. As the climber must often remove feet from the foot loop to pass obstacles, chicken loops are not used.

The foot loop is attached to its ascender by a 7mm or 9mm quick link. The loop's length is adjusted so that the foot ascender and chest ascender almost, but not quite, touch when the legs are fully extended. See Figure 4.

A safety cord, Figure 1, made from the same cord as the foot loop, is attached from the foot ascender to the seat harness. Use of the safety cord allow the caver to hang safely from the foot ascender should the chest ascender slip or fail. Attach it directly to the seat harness maillon using a figure 8 loop or a 7mm quick link. Attach it to the foot ascender using a 7mm quick link or locking carabiner. This safety cord should be long enough to allow maximum step with each climbing cycle but not so

Figure 3 - left, Normal Single Foot Loop. center, Double Foot Loop. C. Double Sling Foot Loop

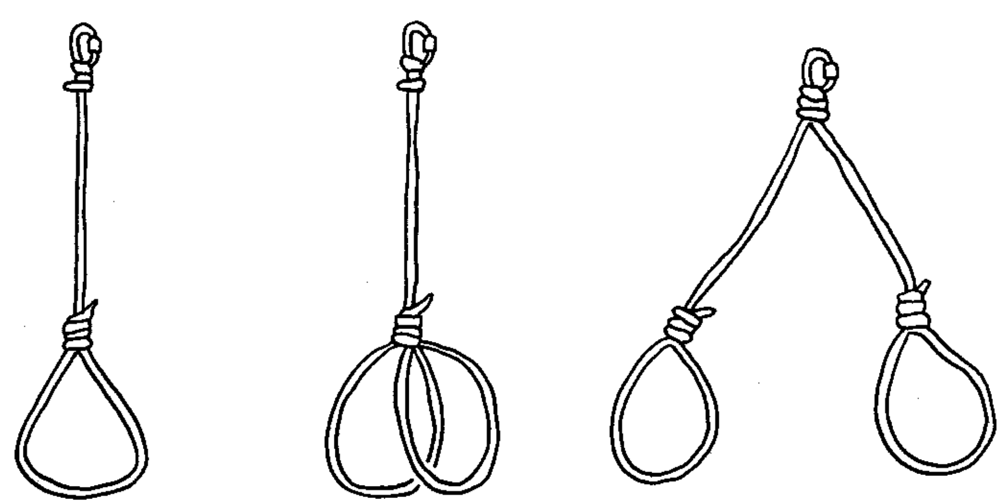
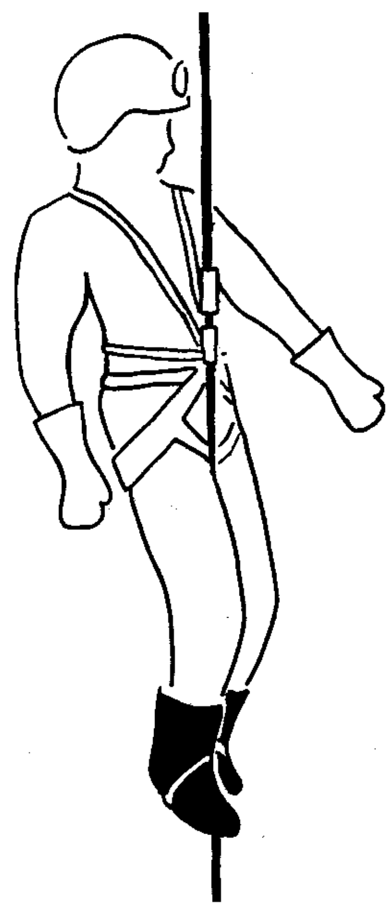


Figure 4. Chest Ascender and Foot Ascender should almost, but not quite, touch when standing in the rig.



long that the ascender is out of reach when hanging from it. While the foot loop and safety cord can be tied from a single length of cord, the use of two separate cords and attachments allows greater versatility.

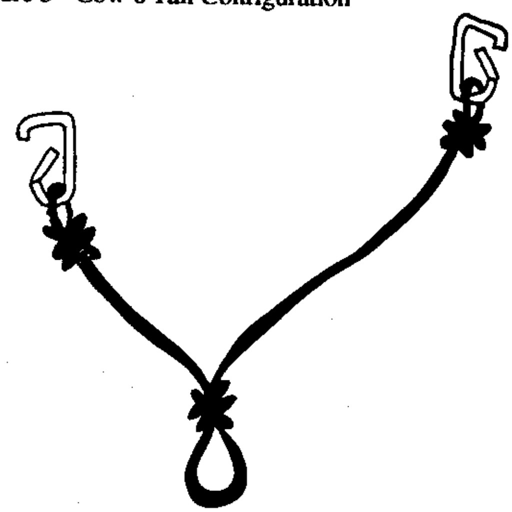
Cows Tails

One of the essential parts of this system are the cows tail slings. These are necessary for safety attachment on traverse lines, such as when moving out to the top of the drop or when passing intermediate anchors or rebelays on the drop. Cows tails are made with 10.5mm or 11mm climbing rope. They are comprised of two slings; one short, no more than 18" long including carabiner, and one long, about 27" including carabiner. The long sling should not be so long that the caver hanging from it cannot reach the carabiner. Because cows tails carabiners are rarely attached for very long, it is normal to use a non- locking "D" or "offset D" on the end of each sling. As one literally hangs one's life on cows tails, they should be inspected before every use.

Cows tails can be made from one piece of 11mm rope. See Figure 5. Tie a small figure 8 loop at one end. Attach a carabiner to this loop. In the middle of the rope, tie another figure 8 loop. This will attach directly to the seat harness 10mm Maillon. Adjust this knot so that the sling leg measures 10" or less from the bottom of this loop to the end of the carabiner. Tie another figure 8 loop in the other end. Attach a carabiner to this loop. Adjust length so that this sling leg measures about 27" from the bottom of the seat attachment loop to the end of the carabiner. Of course, this illustrates only one of many ways in constructing a cows tail.

Cavers should always use the shortest cows tail they can. If one can only attach the long cows tail, attach and use it. However, when one gets close enough to the anchor or traverse line to use the shorter cows tail, attach it and remove the longer cows tail.

Figure 5 - Cow's Tail Configuration



An optional item a caver may want to make is a pack hauling cord. Use 7mm diameter cord to attach the cave pack so that when climbing, it hangs just below the feet. Attach the cord to the 10mm seat harness maillon. The weight of the pack is transferred directly to the chest ascender for most of the climbing cycle with no weight on the climber. This allows both feet to lift the load the additional weight beneath helps keep the caver close to the rope.

There is generally no need to remove this rig when walking between drops. Just clip the foot loop to the chest harness and unclip it when it's time to climb.

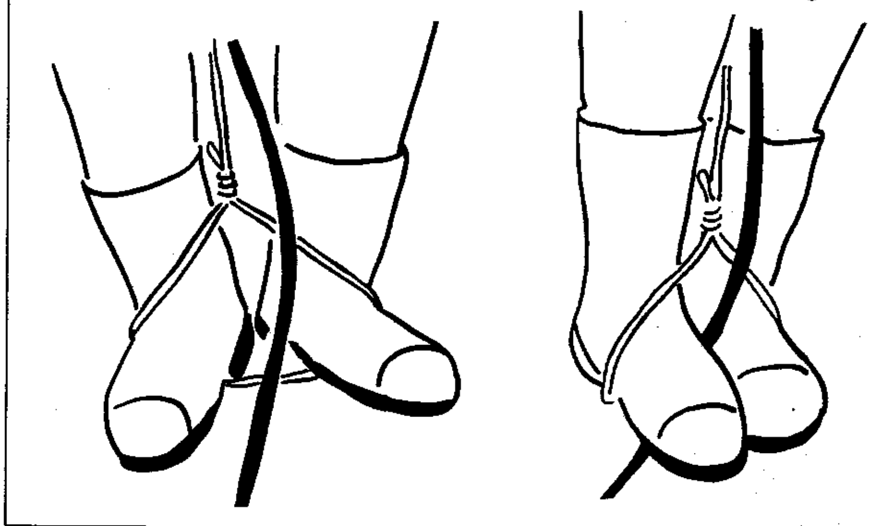
Ascending

To climb, connect the chest Croll to the rope. The rope is pulled down as the climber takes out the slack, sometimes by leaping up a little. When the climber has full weight on the rope, the foot ascender is clipped onto the rope above the chest Croll and the feet are put into the foot sling. To climb, grab the foot ascender with one or both hands and pull up to stand on the foot sling. As one rises, the chest Croll should automatically be pulled up by the chest harness. Then, sit down in the seat sling, raise the feet along with the foot ascender, then pull up again.

At the bottom of a free hanging climb, put both feet in the foot loop and pass the rope between the feet. See Figure 6. When standing up, trap the rope between the feet so that the rope does not ride up with the chest ascender. Also, one can pull the rope down through the chest ascender by hand if needed. In either event, this should only have to be done for about 10 feet or so. When climbing against a wall, use one foot in the foot loop and the other against the wall. Feel free to change feet often to avoid fatigue.

At the top of the climb, clip a cows tail to the anchor or traverse rope. Remove the climbing rope from the chest Croll. Once on good footing, remove the foot ascender and foot sling. Carry it and walk with the cows tail attached to the traverse rope, to a safe spot to unclip completely from the rope.

Figure 6 - Trap the climbing rope between the feet to allow for self starting



Getting Ready for Descending

While any type of descender, including the rack and figure 8, may be used with the system, the most common descender normally used by Europeans is the Petzl "Classic" or "Stop" Auto Locking Descender. The caver will note a diagram on the side of either Petzl Descenders which shows how the rope runs through it. Open the descender up and thread the rope as shown. Close the descender, connect it to the seat Maillon and clip the rope through an extra carabiner also attached to the seat Maillon. When using the Classic Bobbin, always run the rope through this extra carabiner to provide enough friction.

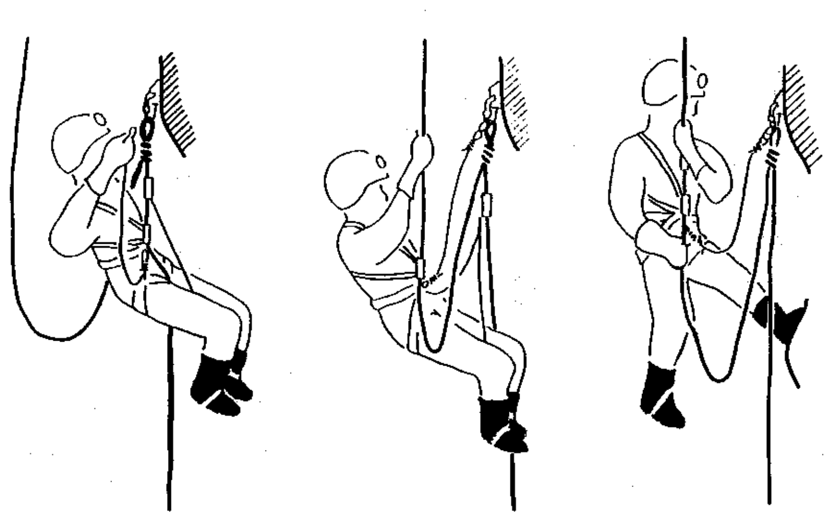
See Figure 8. The drop should be rigged with the main anchor out over the drop so as to deep the rope from rubbing rock at any point on the drop. Where the rope rubs the rock below, an anchor or a redirectional is usually set to position the rope out from the rock wall. In order to get out to the main anchor, a backup anchor is set, (sometimes utilizing a natural rock feature) and a horizontal traverse rope is run out to the drop. The caver uses the traverse to cross out to the main anchor. It also serves as a backup to the main anchor.

Ascending Around an Anchor

See Figure 7. Ascend until the foot ascender is just below the anchor point. this anchor point is commonly called a rebelay. Hook the long cows tail to the anchor during the cross. Remove the chest ascender from the lower rope and place it on the upper rope. Move the chest ascender up the upper rope until one's weight is completely on it. Remove the foot ascender from the lower rope and place it on the upper rope. Unclip the cows tail form the anchor and continue up the rope.

To pass a know, follow the above directions, except remove the foot ascender from the lower rope first and place it on the upper rope.

Figure 7 - To pass an anchor on ascent. A. Ascend up to knot and clip on long Cows tail. B..remove Chest Ascender from lower rope and attach to upper rope. C. move foot ascender to upper rope, remove cows tail and continue ascent.



Clip the long cows tail to the traverse rope for safety. Depending on the rigging, one may need to use an ascender for control to get out to the main anchor. Clip into the main anchor with the short cows tail.

Place the descender on the main rope, taking up as much slack as possible. Lock the descender off. Figure 9 shows how to tie off to lock a Petzl Classic. Remove the short cows tail from the main anchor, unlock the descender and begin the descent. Depending on the rigging and one's gear, this may be easier said than done. However, with practice and experience, this all will become easy and obvious.

Descending Around an Anchor

Descend until waist is level with the anchor. If necessary, lock off the descender. Clip the short cows tail onto the anchor. Continue descent until weight is on the cows tail. Remove the descender from the upper rope. Attach it on the lower rope immediately below the anchor and lock it off. In order to disconnect the cows tail, one's weight must be removed from it. Sometimes, there is a ledge or foothold one can stand on momentarily. If not, place a knee or foot onto the loop of rope coming from above and stand up in this. If all else fails, wrap the lower rope around one's foot a few times for a foothold or clip one's foot loop into the anchor. Then lower oneself onto the locked descender and check that all is well before unlocking the descender and continuing the descent.

Descending Around an Knot

Descend to the joining knot. Attach both ascenders on the rope above the descender, in essence changing from descend to ascend. Remove the descender from above the knot, attach it below the knot and lock it off. Down climb the few feet of slack rope to immediately above the knot, before changing back to rappel in the normal matter and continuing the descent.

References

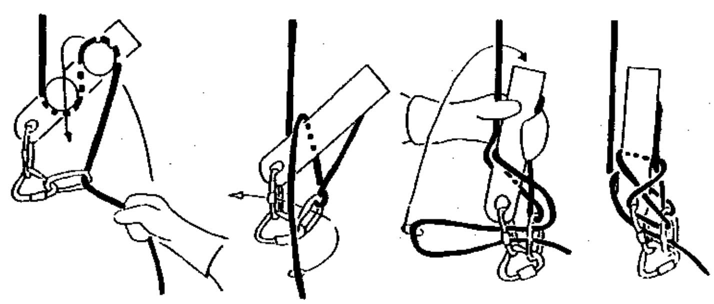
Vertical Caving, by Mike Meredith and Dan Martinez. Published by Lyon Equipment, U.K., 1986, 2nd edition

Caving Practice and Equipment, edited by David Judson. Published by David & Charles Inc., 1st edition

The Figures used were redrawn and modified from drawings in these books. Both books have important information which has not been included in this short Caver Information Series article. The reader is encouraged to check out these books for much more information on European Techniques. Both are available in the NSS Bookstore.

History of Vertical Caving a video by Peter Grant, available in the NSS AV Library.

Figure 8 Method of locking off the Petzl Classic Descender



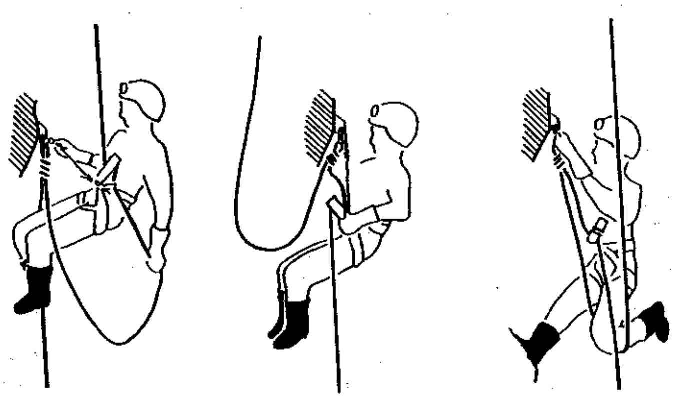


Figure 9. To pass an anchor on descent. A. Descend until level with anchor and attach short Cows Tail; B. Continue descent until weight is on cows tail, move descender to lower rope and lock off; C. Detach Cows tail by standing in rope loop, place weight on descender, unlock descender and continue descent.

PRE-RIGGED SYSTEMS...AN OPINION

by David A. Stuart, Sr.
Baltimore County Fire Department
Advanced Tactical Rescue Team

Many organized rescue teams often have time-saving procedures that evolve as that team becomes more proficient with its equipment, systems and their intended use. One technique that often surfaces is the 'Pre-rigging' of certain systems that have the potential for frequent use. The idea behind this is to save time and confusion "in the heat of battle" of a technical rescue. But does this shortcut really serve its intended purpose? In this article we will examine the benefits and drawbacks of this common procedure and pose some alternatives.

Before proceeding, let me qualify my opinions by saying that they will not, of course, be the answer for all rescue teams. My team functions in the urban, suburban and industrial environment. We have the distinct advantage of having our equipment in a vehicle that can be positioned very near the rescue scene in most cases. We also have the great advantage of having the needed quantity of hardware and software to implement these suggestions. Hopefully, however, something positive can be gained by many of the readers.

For standardization, my team has decided to use a 4:1 piggyback (4:1 Pig Rig) mechanical advantage system (ref. <u>On Rope</u> pg 266) for hauling, hoisting and tensioning wherever possible and practical. This makes an ideal candidate for a pre-rigged system stored alone in a stuff-sack.

When trying to visualize this system, most will picture a schematic-like diagram similar to the one referenced in <u>On Rope</u>. When this pre-rigged system is dumped out of its bag, however, I feel safe in saying that it will look very little like anything you have pictured. Valuable time must now be spent untangling and untwisting this system before it can be used. You must also carefully inspect every component and the total system for proper assembly - all this taking more time. The problems that arise in this relatively simple system are compounded greatly as the system in question grows more complex.

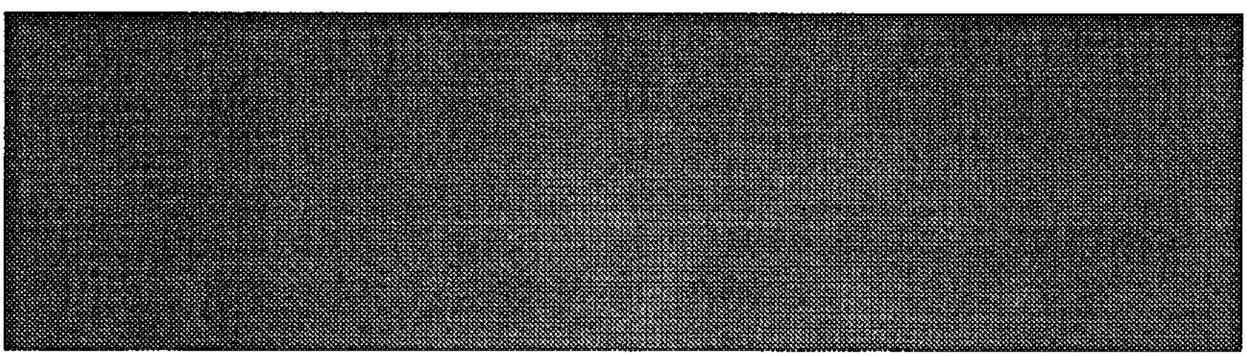
Alternatives? One is to simply keep all of the discrete components separate until assembly. That is, carabiners in one bag, Gibbs or Jumars in another and rope by itself, etc. While this eliminates the problems of pre-rigging it offers no advantages. However, if you do not have the luxury of sufficient equipment to dedicate to a system exclusively, this may be your only choice.

Now that we have explored the extremes of the spectrum, fully pre-rigged to fully disassembled, let us examine a better alternative.

I would offer as an alternative to pre-rigging...'Pre-Packing". Pre-packing is simply the gathering of all the component parts of a system and packing them together in a bag or case. There are advantages of this pre-packed system, such as having all of the needed parts on one location for rapid deployment, time savings over gathering and packing the discrete components and rope and software can be much more neatly stuffed into and deployed from the bag. In addition, each component can be inspected as it is integrated into the system.

Of course, there are some trade-offs for this method. First, as earlier mentioned, you mush have ample equipment to dedicate to one specific use. Second, one might respond that a pre-rigged system may help in the event of temporary loss of higher brain functions (i.e. you forgot how to do it !). My response to that is that if your rescue is sufficiently technical to require an assembled system, Your rescuers should be sufficiently technical to assemble and operate that system.

While pre-rigging your frequently used systems does offer some advantages, they are often outweighed by the deficiencies outlined above. A pre-packed system however can streamline rescue scene operations by allowing more efficient use of time and equipment. I welcome any comments or suggestions. David A. Stuart, Sr., Baltimore County Fire Department, Advanced Tactical Rescue Team, 700 East Joppa Road, Towson, Maryland 21204. David Stuart is a career firefighter with the Baltimore county Fire Department (MD) with eleven years experience in Fire/Rescue/EMS services. For five years he has been a member of the BCoFD Advanced Tactical Rescue Team (ATR) and is a qualified instructor.



A Look at Soviet Vertical Equipment

by Maureen Handler

For the last five years, the caving community in the United States has had significant contact with cavers from the former Soviet Union. Most of these cavers are from the Ukrainian Republic and the Republic of Russia. On the NSS/Vertical Section trip last year there was a special interest in vertical equipment. Due to a lack of manufactured ascender, descenders, rope, etc., their equipment development has been markedly different from ours. Most ascender and descenders are home made from aluminum, steel and titanium. Titanium carabiners, both commercial made and home made, are used. Also, due to the shortage of rope, steel cable techniques were also developed. The steel cable is approximately 1/4' or 7mm, so equipment was made that could handle this and larger ropes. Allen Padgett had the chance to climb some cable at a vertical session and noted "The stuff had absolutely no bounce". The soviet union has the largest reserves of titanium in the world. This metal is only slightly heavier than aluminum, but had some of the strength and wear resistant qualities of steel.

This article will show you some of the equipment that the vertical section has been given as well as pieces from individuals collections. I would like to thank Allen Padgett, Dwight Deal, and Brian Borton for letting borrow the equipment for nearly a year. I'll send you your stuff back soon guys. Due to the wide variation in the home made equipment, this will only be a cursory explanation of the pieces and their materials of construction. I have separated the pieces according to use and construction, such as Jumar-type, Gibbs-type, descenders, etc. There are a number of Gibbs type ascender for both cable and rope. These are further sub-divided into groups to better explain the various types. The Vertical Section owned equipment will be at the convention in Indiana for closer inspection.

Carabiners

All of the carabiners in this collection are made of titanium. Three different types were available to me. I'm sure other are available. See Figure 1.

Figure 1

Type 1 - The IRBIS carabiners are commercially manufactured. (See Figure 2.) The carabiners are date stamped; the three shown, from top to bottom, were

Figure 2

manufactured in May 1978, February 1980 and August 1990 respectively. There is a strength stamp, 3000. I have not been able to determine if this is kilogram mass or kilo-Newton force strength. The older models were also stamped "Made in USSR". The carabiners are purple anodized and come in four models. There are locking and non-locking models and both of these come with straight gates or offset opening gates. The locking mechanism is spring loaded, utilizing a 1/4 turn to lock or unlock. The granular look and texture suggest a powdered substrate metallurgy technique in manufacturing.

Type 2 - The second type, upper right corner of Figure 1, also appears to be commercially made. The granular texture again suggests powdered metallurgy. The shape is an offset "D" with a spring loaded gate. This is a non locking carabiner, however, the catch on the gate utilizes a ball and socket construction. The cross section shape of the carabiner shows a saving of material. The amount of material needed to make round stock is much greater than this skeletonized shape. The high stress points at either end of the long axis are reinforced with more material.

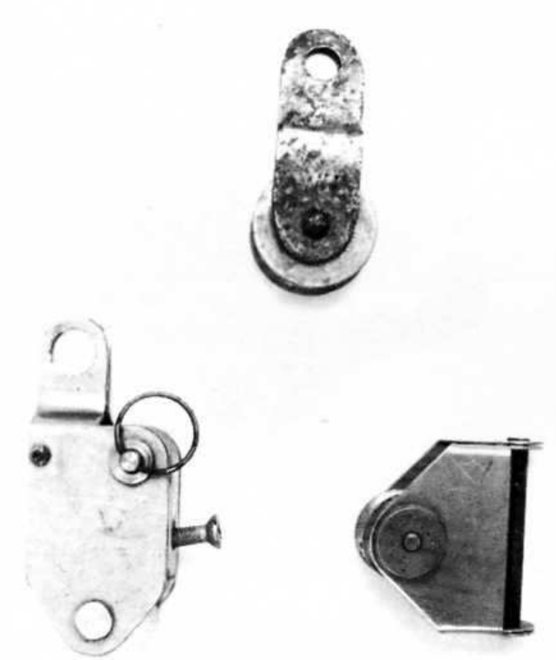
Type 3 - The third type, lower right corner of Figure 1, appears to be home made. The body of the carabiner looks like 1cm diameter titanium stock bar that was bent into an offset "D" shape. This is a locking carabiner with a spring loaded gate and threaded aluminum lock. Due to the properties of titanium (it can become brittle when bent), these carabiners are not recommended for use.

Chest Rollers

All of the chest boxes are of a single roller type. These appear to all be for use on steel cable, however, one pulley type seems large enough for use on rope. See Figure 3.

Type 1 - The first roller, top of Figure 3, is simply a

Figure 3



swing side pulley. It is made from a steel casing with a brass roller and looks like it can be used on both cable and rope. It simply clips onto a chest harness with a carabiner or quick link.

Type 2 - The second roller, lower left of Figure 3, is also a pulley type. One side swings open to insert the cable and then locks shut with a spring loaded pin. There is also a small spring loaded cam on the right side, which is adjustable by the use of a small brass screw threaded through the cam. The shell is made from titanium plate with aluminum roller and cam. This also clips onto a chest harness with a carabiner or quick link.

Type 3 - The third roller, lower right of Figure 3, is similar in function to a Simmons Roller. The roller is a brass with a pressure fit, threaded rod through the middle. The roller screws into the plate for closure similar to rollers on the Gossett Box. The titanium plate casing hinges open to insert the cable and the entire box simply threads onto 2" webbing.

Descenders

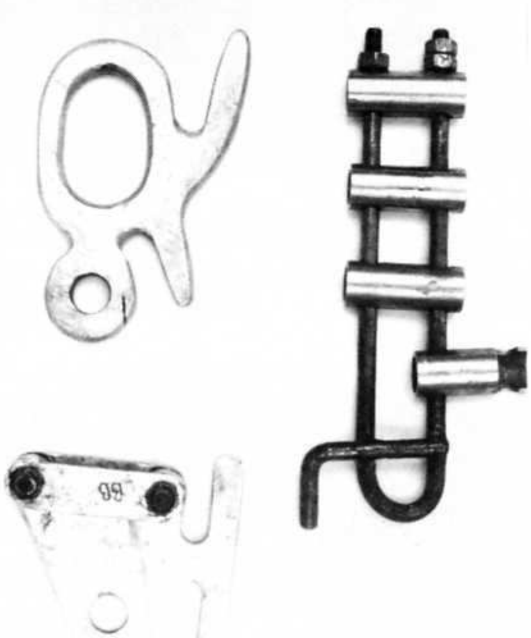
The descenders we have seen are fairly crude compared to commercially available equipment on the U.S. market. There are models that were constructed to function like our racks as well as Figure 8 type models.

Type 1 - The first descender, right side of Figure 4, is a home made rack. The frame is a bent steel bar, threaded on both ends with titanium brake bars. The set up is similar to the Petzl rack with the first and third bars fixed in place. The second and fourth bars open to thread in the cable. Additional friction is available from the small, bent, steel rod welded on the frame. The wear grooves on the bars show use on both cable and rope.

Type 2 - The second descender, top left of Figure 4, is a Figure 8 type with ears. This was saw cut and filed from a piece of 1 cm thick aluminum plate. Notice the wayward cut on the bottom of the Figure 8. This is used like a conventional Figure 8 with extra friction available from the ears. Wear groves indicate use on both cable and rope.

Type 3 - The third descender, bottom left of Figure 4, defied any type of categorizing. It seems similar in function to a belay plate with ears. The descender shell is cut from 1/4" aluminum plate. The bolts attaching the

Figure 4



upper and lower plate (the upper is much smaller) are sheathed with titanium spacers. A loop of the rope or cable is inserted through the gap and clipped into a carabiner running through the hole. This carabiner is then attached to the seat harness. Wear groves show the positioning of the rope and indicate cable has also been used. Additional friction is available by wrapping the rope or cable around the ears.

Ascenders

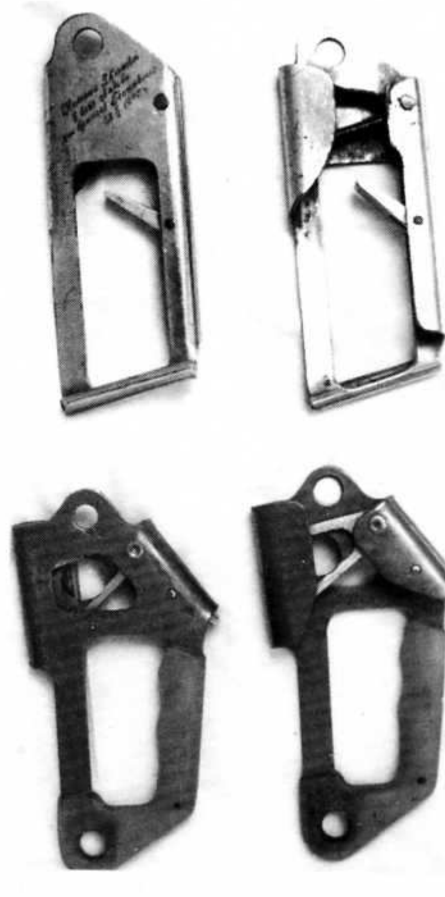
There are numerous types of ascender made in the Soviet Union. These are all home made and are all can type ascenders. They utilize whatever materials were available and incorporate various types of pin locks and spring loading mechanisms. Considering the manufacturing conditions, some of the workmanship is of very fine quality.

For ease with descriptions, I have split these ascenders into 3 major categories: Jumar type and Gibbs type. The Gibbs type is then separated into wire locks, spring loaded lock pins and other locking mechanisms.

Jumar Type

We have two pairs and two singles of Jumar type ascenders. See Figure 5 and Figure 6. Both pairs are home made and resemble commercially available ascenders.

Figure 5

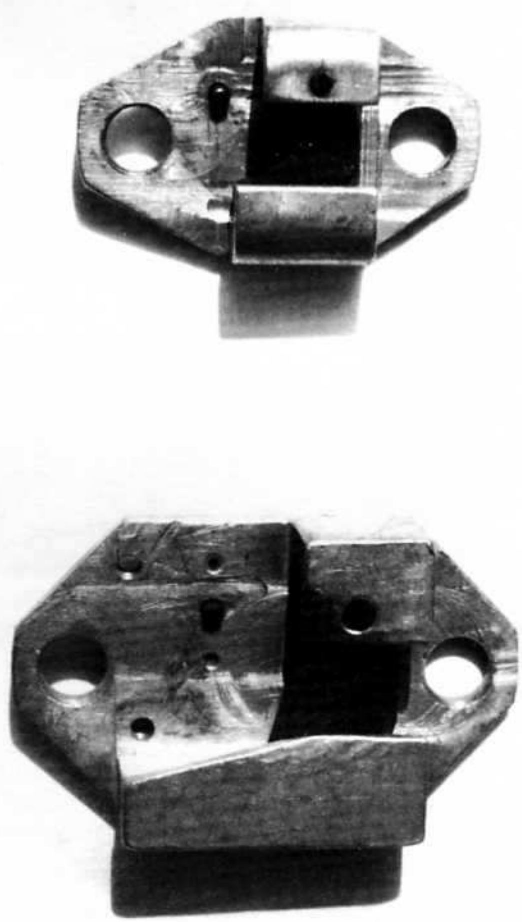


Type 1 - The first set, upper pair in Figure 5, closely resembles Jumars in design. The shell is made of steel plate with aluminum cams and thumb lock. These ascenders appear to have been designed for use on rope. The bottom of the shell has been reinforced by rolling up and welding the steel plate. The engraving on the right handed ascender was done by Alexander Klimchouk. He had given them to his wife as a wedding present.

Type 2 - The second set, lower pair in Figure 5, closely resemble Bonaiti ascenders and even has glow in the dark handles. The shell is cut from titanium and the cams are milled from a steel block. This pair also has a thumb catch to prevent accidental opening of the cam.

Type 3 - These ascender resemble Jumars only in function. They have an attached cam and are side loading. (See Figure 6). The shells are milled from aluminum block and the cams are cut from 3/8" steel plate. There is a small spring loaded pin mounted on the shell below the cam which acts as a thumb catch to prevent accidental opening.

Figure 6



Gibbs Type

There were many variations on the Gibbs type ascender. Some were designed for rope, others for cable. The locking mechanisms are as varied as the individual pieces. See Figures 7, 8, 9 10 and 11. The basic division between the types of ascender is the locking mechanism.

Wire Lock - These ascender are all variations of the same idea, a cam and shell device with a pin to hold the cam in place. See Figure 7. All variations use a wire threaded through the pin to lock the pin in place. The materials of construction vary. Some use steel and others titanium for the shell. The cams are also made of steel, titanium or aluminum. Many of the shells have two sets of holes with allows varied cam placement for use on either rope or cable. On the inside of one of the shells, is a titanium wear plate to minimize wear to the shell.

Figure 7

Spring Loaded Pin - All of these Gibbs type ascenders, See Figure 8 and 9, have a spring loaded pin which locks the cam in place. The designs are all variations of the same ascender. The shells are made of steel and titanium with hinges for opening the device. The cams are steel and titanium with the spring loaded pin mounted through it. The machining work on some of the hinges is very well done. These are designed for either rope or cable and are not adjustable for use on both. The device in the lover left corner of Figures 8 and 9 has a reversible cam for use in either direction and a titanium wear plate on the shell.

Figure 8

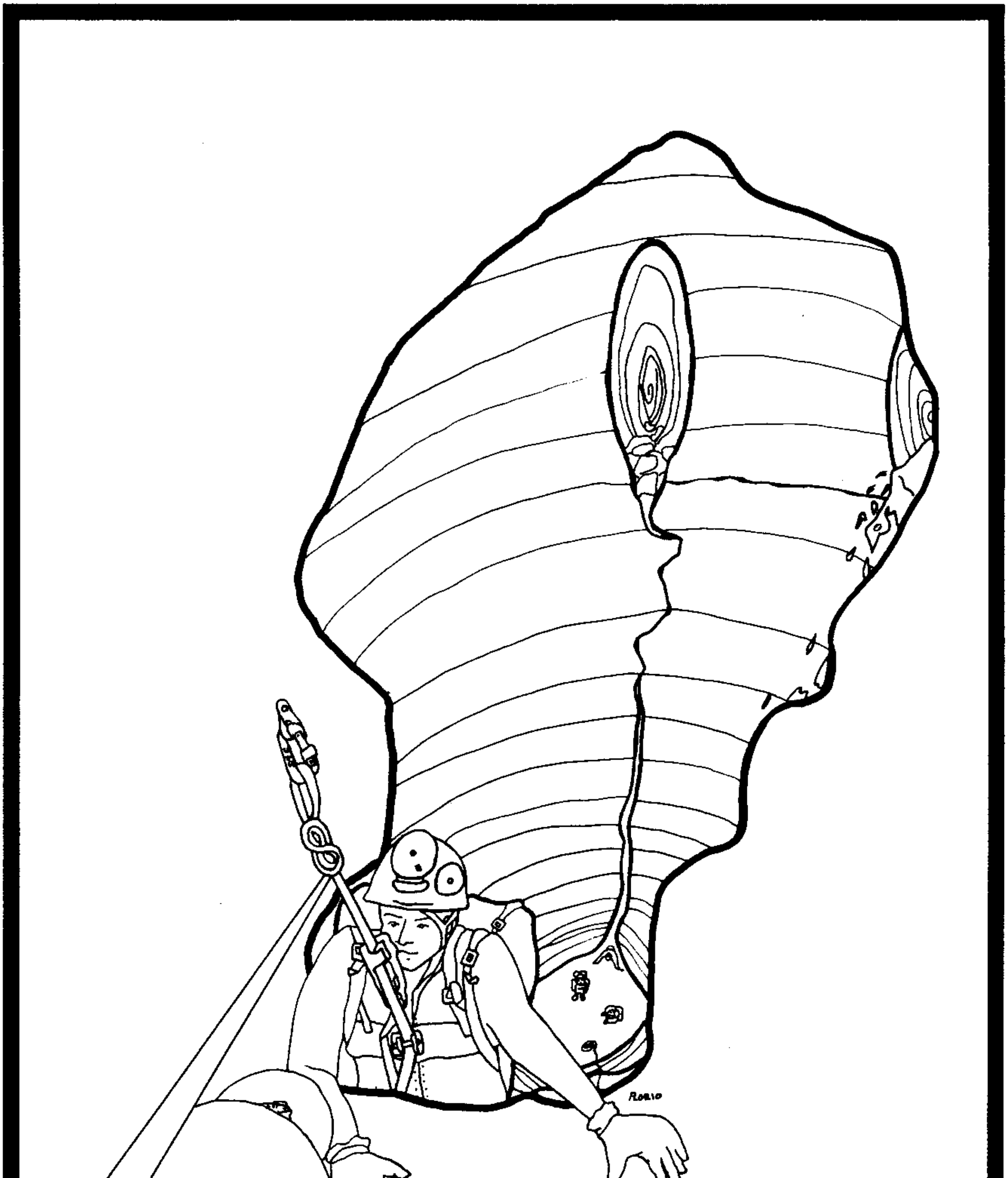
Figure 9

Miscellaneous Closures - The final group (Figures 10 and 11) are all Gibbs type ascenders with various modifications, mostly in the pin or closure mechanisms. The pair in the upper right hand corner of Figures 10 and 11 look remarkably like Heiblers with a safety closure. The cams and shell are milled from aluminum block and the cover plate is steel. A small spring loaded pin locks the cover plate in place. The pair of ascenders at the bottom of Figures 10 and 11 have a hinged plate for closing the device. A small bar turns the locking clasp to open or lock the hinged plate. The ascender in the middle right of Figures 10 and 11 uses a hinged pin which acts similar in function to the wire locks mentioned above. The ascender in the middle left of Figures 10 and 11 has a cam that slides up and down a track to open and close the device. The last is a very unique, upper left Figures 10 and 11. A push on a small spring loaded pin releases a small bar on the side of the shell allowing this side to swing away opening the cam. The materials of construction again range from aluminum to steel and titanium. The quality of the workmanship various with the individual pieces but overall is fairly good.

Figure 10

Figure 11

Now with the opening of our two countries to each other and the rest of Europe, I feel we will see less and less of the home made equipment. Access to commercially made equipment will improve when market economies and convertible currency is available in the Republics. These pieces I have shown here, will become a part of caving history.



Coming Up Anyone? McFails Cave, Schoharie County, New York

by Joanna Florio Jeffreys

THE FRITZKE SPRING BOX

by Mark Fritzke

I am introducing a state of the art chest box for rope ascending systems. I designed the Fritzke Spring Box to be the most versatile and comfortable low- profile chest box ever made. Strong yet lightweight, it has the features and quality you can expect to last a lifetime of caving.

FEATURES

DUAL ROLLERS

Versatile. Use the second roller for a Mitchell system or a bungie pulley for a rope walker rig.

FIXED SHAFT

The rollers and gates are mounted on a fixed shaft. A rope under tension can be easily inserted or removed. When clipping into a rope, the fixed shaft permits you to lean back as soon as you flip the rope onto the roller and then close the gate. This feature allows you to operate the Fritzke Spring Box with one hand. This is a definite advantage in awkward situations like re-belays, passing knots, tight crevices, or swims. It simplifies rope handling on multiple drops. You will appreciate the increased efficiency any time you are cold and wet, or just plain tired.

SIMPLE, FAST, SECURE LATCH

Each gate is separately secured by a foolproof flat-spring. Operation is so simple you can even do it with wetsuit gloves on. Open a gate with your thumb and forefinger; just press the brass button on the spring and rotate the gate. Closing a gate is even simpler; rotate the gate until you hear the spring "click", a one finger operation! The audible click assures you are safely clipped in, even if your light has gone out. Efficient rope transfers can be made without removing the Jumar sling from the chest box.

COMFORTABLY WIDE CHEST PLATE

The 8 inch wide chest plate is broad enough for easy breathing, yet compact for stuffing into a cave pack.

SLIM, ROUNDED PROFILE

Pass through tight crevices and over sharp lips with ease. The ramping profile greatly aides passing ledges.

LIGHTWEIGHT AND STRONG

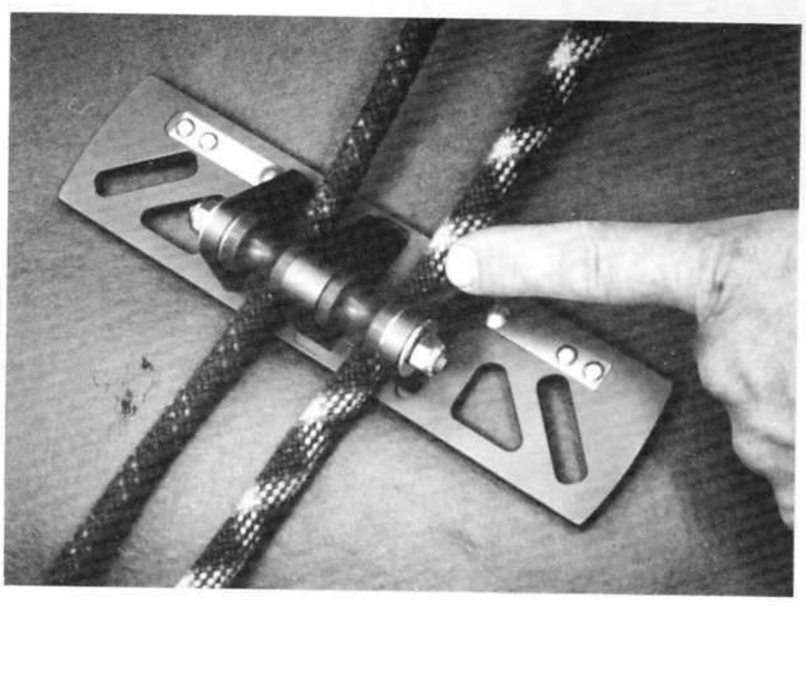
The Fritzke Spring Box weighs less than any other double roller chest box. In laboratory testing, it took over 600 lbs to bend the chestplate.

MATERIALS

The Fritzke Spring Box is fabricated from the finest materials available. Aircraft quality aluminum plate is precisely machined and anodized for a corrosion and wear resistant surface. The washers and rivets are brass and monel. Corrosion resistant stainless steel was selected for the shaft, springs, nuts, and screws. The self-lubricating Delrin rollers are easily replaceable.

DESIGN

The wide but short roller channel means the rope won't rub the gate or center post when ascending diagonal ropes. The spring is recessed and mounted flush to the chestplate surface to prevent accidental release of the gate. The gate channel can be easily cleared if clogged with mud. Diagonal rope tension over the sloping gate edge pushes the gate closed rather than open. One handed gate operation is essential when your other hand is clinging to a handhold, ascender, rope, or your honey! The Nyloc nuts permit replacing a worn-out roller. Diagonal webbing slots can be utilized for a variety of innovative harness designs. The low profile means you can easily pass through tight squeezes and crawls between drops without removing the chest box. Although the second roller can be used for bungies, some may prefer to attach a pulley through the triangular lightening hole. Each chest box is engraved



with a serial number. The red anodizing not only protects the aluminum, but makes the chest box easy to see in a muddy pile of cave gear. Not all cavers clean their gear after a trip. This box can stay muddy in a cave pack since it has no rusting parts. I designed the Fritzke Spring Box for wet, cold, tight, nasty, multi-drop alpine caves, but it works just fine for running up your local practice cliff without spilling your beer!

ACKNOWLEDGMENTS

Thanks to all of the cavers who discussed various design problems with me over the years. Special thanks go to Steve Knutson, Steve Gonzalez, Bob Richardson, Linda Villatore, Jerry Fritzke, and all of the cavers who have urged me to come out with a commercial product.

PERSONAL HISTORY

NSS #16064, Mark Fritzke has been caving for 18 years. He has been developing and testing the Fritzke Spring Box for the last 10 years. Currently, he is the World Record holder in the Men's Mechanical 30 meter rope climb, 30-39 Age Class. He is the only caver who has explored and surveyed in the four deepest caves in the U.S. He is primarily known for digging, climbing, and pushing the limits of the Bigfoot Cave system in the Marble Mountains of northern California. He was employed by the U.S.F.S. in 1991 to inventory the abundant karst features found in Tongass National Forest. This summer he plans to return to Alaska.

MORE COMMENTS ON THE SHUNT

Dear Editor

This letter is in reference to the use of a spelean shunt as mentioned in Nylon Highway #33.

I would have to question the validity of Allen Padgett's comparison to an eye protection device where the user is required not to blink to activate the device. He is correct in stating that the automatic nervous system response is to blink and thus defeat the device. Rappelling is a different matter all together. Rappelling is a learned skill, not an automatic response to an outside stimulus. The rappeller can be trained to respond correctly. This is much like military service where the soldier is trained to return fire when fired upon. The first response is to duck and run. But with training, he is able to return fire, thus neutralizing the threat.

The Spelean shunt would be useful in situations where the rappeller loses consciousness, thread the rack wrong or as in the case mentioned in Ray's Review, February NSS NEWS, when a caver 'froze up' on rappel resulting in an out of control descent. I have used the Spelean shunt on several long drops with no problems. I did have a fall once, with a shunt on the rope, near the lip of a pit and it worked just fine. I did not grab the rope or shunt. I had practiced with it before using it and had full confidence in the device. (I did scare the people waiting at the lip!)

The only draw back to the shunt is when it lock off accidentally leaving you stuck on the rope. It is a hassle to free yourself but less of a hassle than a body recovery.

Michael Compton
NSS 33221

SOLO PRACTICE MADE EASY

by DAVID D. CLARK

The simplest solution to a problem is often the best one. I needed a way to practice SRT climbing at home, alone and whenever the mood struck me. The rack and pulley system utilized at the NSS Convention climbing contests requires a partner to control friction. The system works great, but partners are not always available. The solution is to keep the system and do away with the partner.

A rope walker with a chest roller can leave your hands free to self belay while climbing. But what happens if you let go? A munter hitch tied into the rope and attached to your seat harness, between the rope bag and rack, will serve as a belay while climbing. The belay hand can even let go of the rope; the hitch will capture progress. To operate the system, rope is fed through the munter hitch with a free hand to match the rate of climb. See Figure 1 for the climbing system set up.

<u>OBSERVATIONS</u>

The Munter hitch does not wear out the rope. I have used the same rope for years. It will twist the rope, so start with the opposite end each time to reverse the twist.

With a little practice, I was able to climb with a double bungie system at a rate of 60' per minute, (in short spurts), with this configuration. That should accommodate almost anyone.

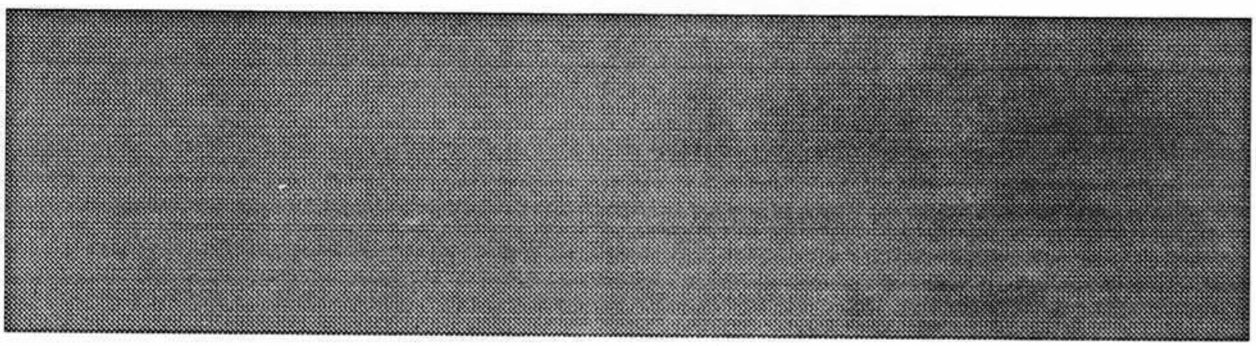
The Munter hitch, rack and pulley system will work best if the rack is mounted up high, near the pulley. I use steel bars on the rack, set on three full bars. The pulley is secured 14 feet overhead. I am 6'5" tall and weigh 230 pounds. My wife weighs one hundred pounds less than I do and uses the same friction setting.

If you climb from floor to pulley, without feeding rope, you will have climbed almost twice the true vertical distance. Remember, the rope is traveling through a loop. As you ascend, the standing line is travailing downward as the belay section travels upward with the climber.

Any climbing system can be used. Systems which do not leave your hands free, such as Mitchell or Frog, require that you stop every 20' or so climbed to lower yourself.

If you tie the Munter hitch wrong, you will bust your ass.

1991 David D. Clark, NSS 25941



A SAFETY ENHANCEMENT OF THE CURLED EYE OF THE BRAKE BAR RAPPEL RACK

By Bernard M. "Butch" Feldhaus

Authors Note: The following is an extraction from an Engineering Design Project Report presented to the University of Tennessee at Chattanooga (UTC) School of Engineering as part of the Freshmen Engineering Design Project course requirements on 26 November 1991. The intended audience of the report was the Rescue Community; however, the caving community at large can benefit from the information presented in this report. This is by no means the complete report. For more information, please contact the author.

ABSTRACT

The failure (deforming and uncurling) of the older model curled eye brake bar rappel rack during a rescue lowering is a concern of rescue personnel. Testing has shown that this type eye configuration will fail (deform and uncurl) at a force as low as 800 lbs. This allows for a maximum rescue load of 160 lbs. This is not acceptable since the standard minimum requirement for a rescue lowering system is 2000 lbs. This is based on a 400 lb. rescue load. A simple modification of the curled eye enhances the ability of the rack eye to withstand rescue loads. Welding the curl of the rack eye will increase the force at which the eye will begin to deform and uncurl to 2900 lbs. This represents a rescue load of 580 lbs., which is well above the standard minimum requirement.

PURPOSE

The purpose of this design activity was to enhance the safety of the curled eye of the brake bar rappel rack (Ref. Figure 1), hereinafter referred to as "rack." This enhancement will enable the curled eye of the rack to see greater loads without failure. Failure of the curled eye of the rack usually results in the serious injury or death of the user.

HISTORICAL PERSPECTIVE

The Brake Bar Rappel Rack (Ref. Figure 1) was invented by John Cole in 1965 to facilitate the exploration of deep vertical caves[1]. As designed, the rack was intended for use by one person and their equipment. The rack was attached to a stationary rope which passed through the rack. Depending on the number and spacing of the brake bars, the rack was used to control the rate of descent of the person "on rappel."

The early models of the rack consisted of lengths of cold rolled steel forged in backyard barbecue grills. The final step of the fabrication process consisted of one of the uprights (legs) being rolled around a couple of times to form a loop for the carabiner[2] (Ref. Figure 2a). Newer models are fabricated in manufacturing facilities. The eye of the rack is formed by bending the longer leg of the rack back around on itself and welding it (Ref. Figure 2b).

Within a few years, the rescue community determined the rack to be an excellent tool for use as a lowering device during high angle rescue. The primary difference between lowering and rappelling is that in most cases during a lowering, the friction device (rack) remains stationary while the rope moves through it. When used to rappel, the rope remains stationary while the friction device (rack) moves along it[3]. Additionally, during a rescue application, the rack will see greater loads (e.g. a patient, equipment and attendant(s)).

PROBLEM STATEMENT

When the newer models of the rack (with eyes that are welded) are utilized in rescue lowering systems, manufacturers data show that these models will withstand the rescue loads[4]. When the older models of the rack (with the curled eyes) are used in the rescue lowering systems, large loads can cause the eye to uncurl. Therefore, the curled eye rack should not be used for loads larger that one person[5].

The rescue community has warned its members against the use of the curled eye rack in this application; however, due to the abundance of curled eye racks in service (they were the first manufactured and are considerably less expensive than the newer welded eye racks), the inadvertent use of a curled eye rack in a large load rescue lowering system is very possible. This is especially true with the large number of persons who are called in on an every-now-and-then basis to assist with large rescue operations. They are generally cavers or caver types who have put their name on a resource list for the local cave/cliff rescue team. These people are generally not as well informed as day-to-day members of the rescue squads.

A simple and inexpensive method is needed to enhance the safety of the curled eye rack so that its inadvertent (or designed) use in a rescue system will not cause the lowering system or a portion of a lowering system to fail.

DESCRIPTION OF SOLUTION

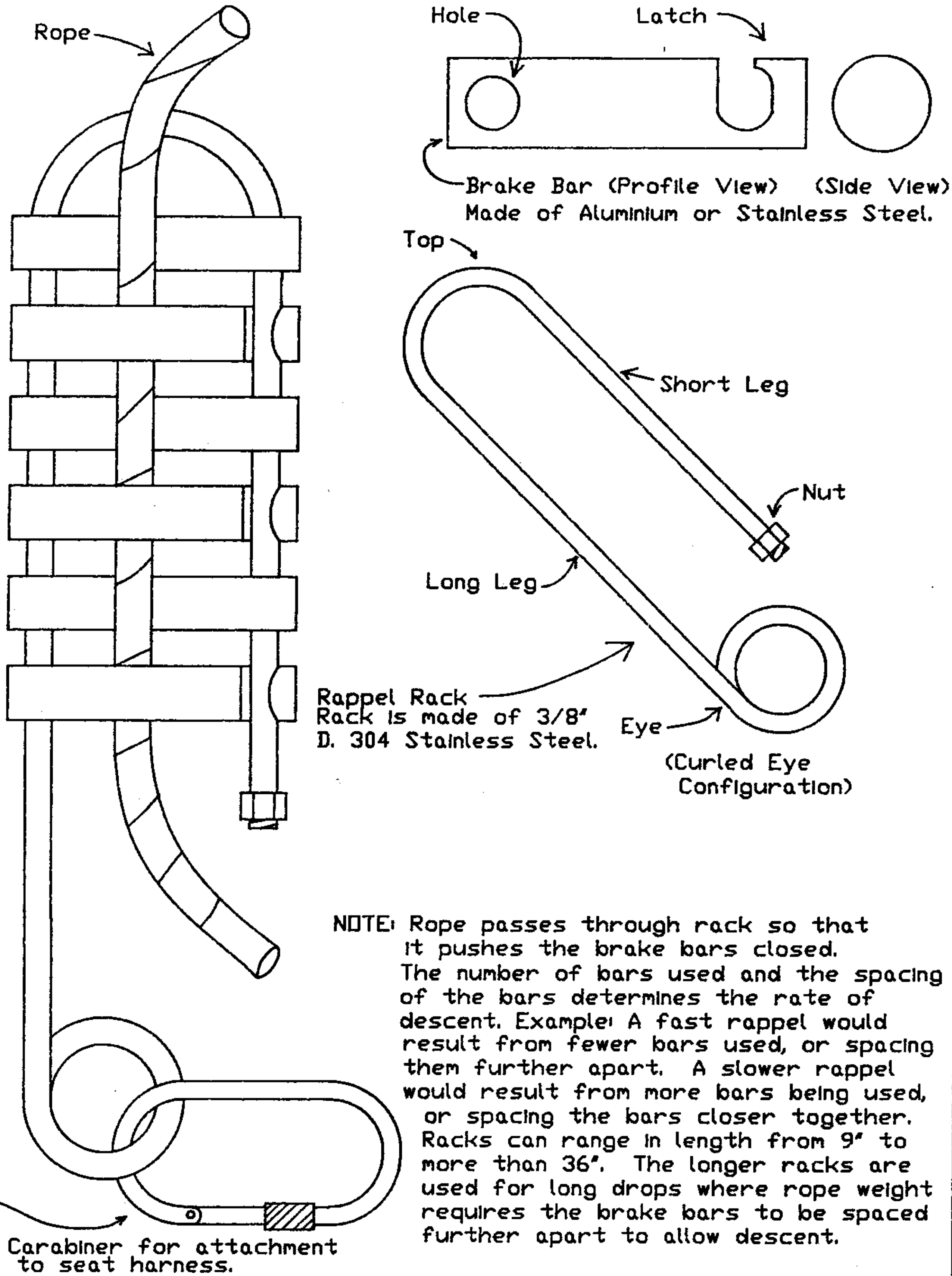
DESIGN:

Two solution designs are proposed to enhance the safety of the curled eye rack.

METHOD 1:

Weld the curls of the eye in a manner that will prevent uncurling (Ref. Figure 3). This is the preferred method because:

- o It is simple.
- o It involves no modification to the original and tested design of the rack (e.g. none of the original strength is lost)
- o It is inexpensive and therefore it is more likely that it will be implemented by rescue personnel.



NOTE: Rope passes through rack so that it pushes the brake bars closed. The number of bars used and the spacing of the bars determines the rate of descent. Example: A fast rappel would result from fewer bars used, or spacing them further apart. A slower rappel would result from more bars being used, or spacing the bars closer together. Racks can range in length from 9" to more than 36". The longer racks are used for long drops where rope weight requires the brake bars to be spaced further apart to allow descent.

FIGURE 1 - Brake Bar Rappel Rack.

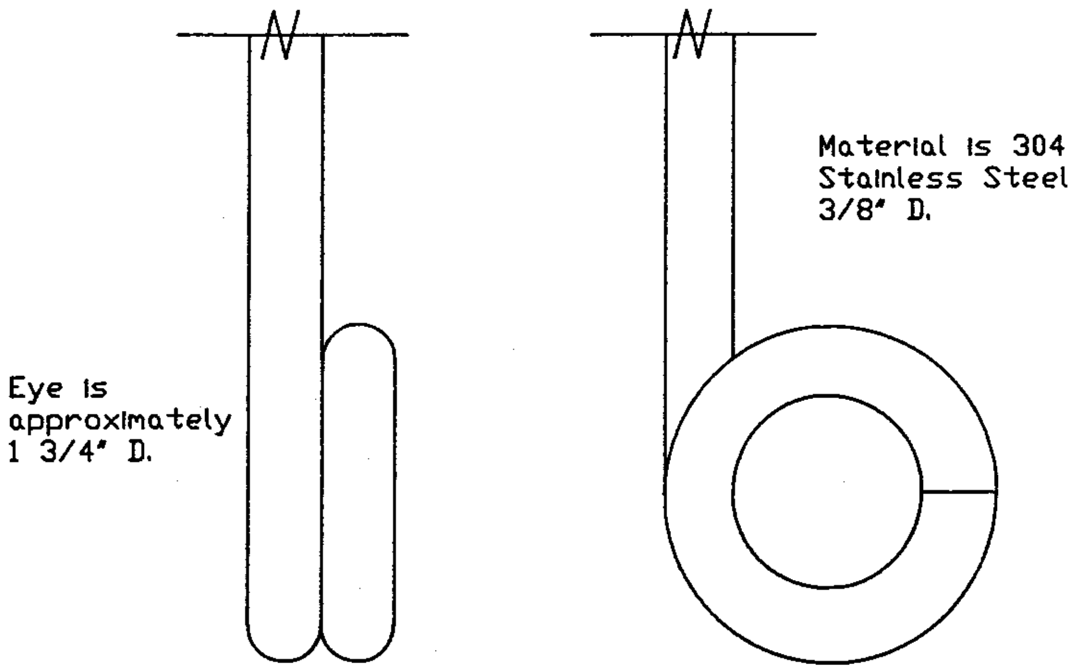


FIGURE 2 - a. Curled Eye Configuration of the Brake Bar Rappel Rack.

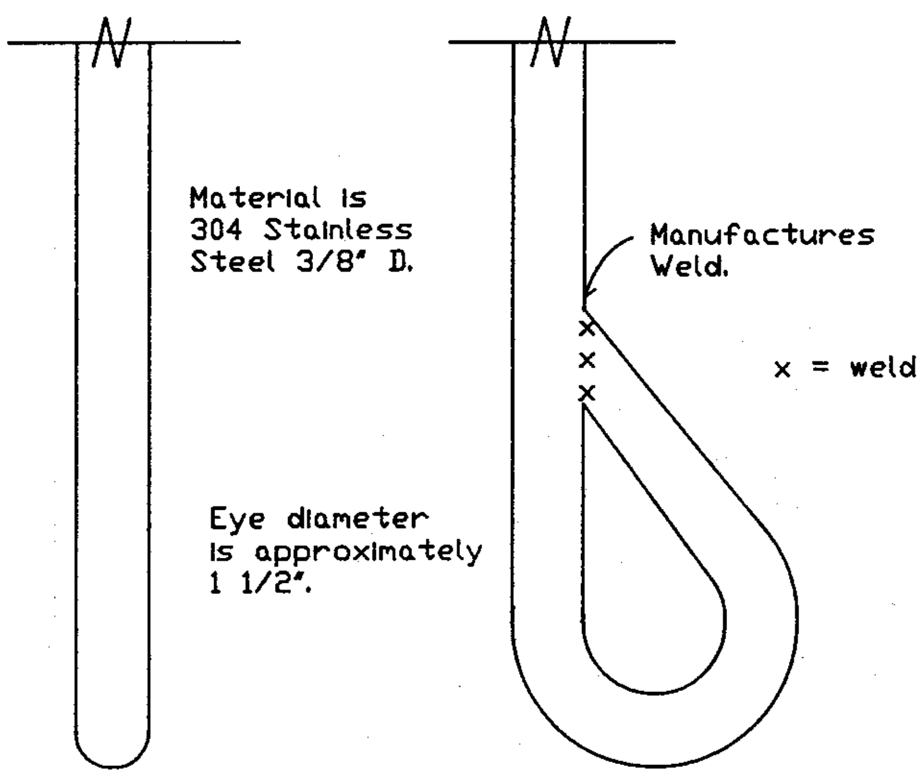


FIGURE 2 - b. Welded Eye of the Brake Bar Rappel Rack.

FIGURE 2 - Brake Bar Rappel Rack Eye Configurations.

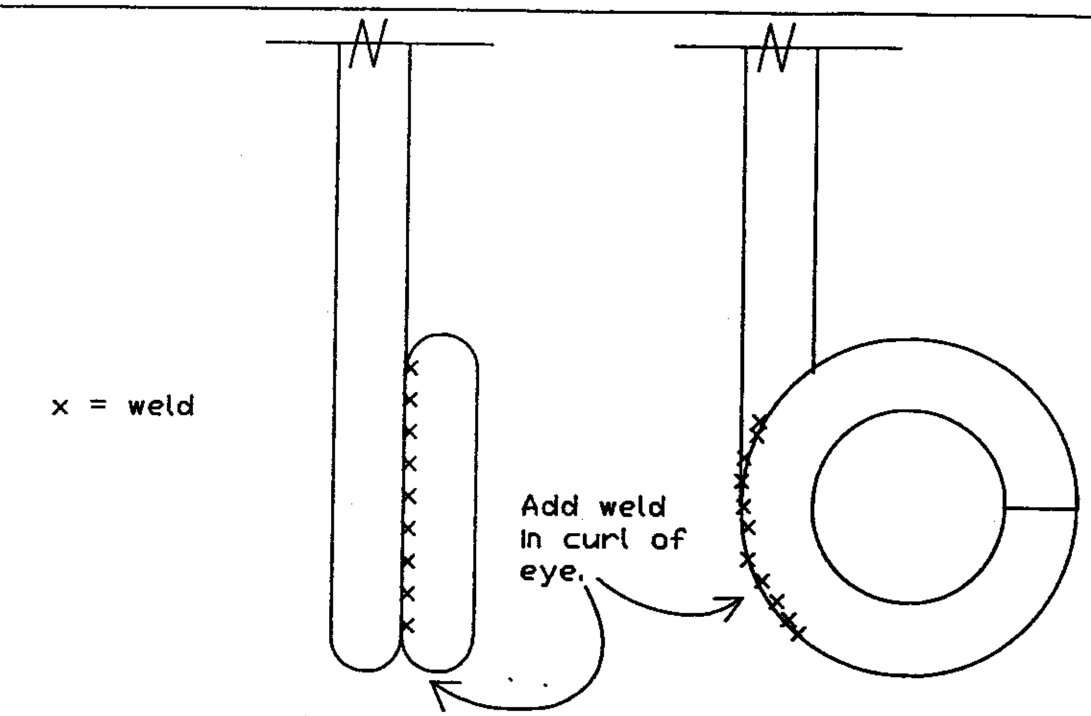


FIGURE 3 - Method 1 Modification of the Curled Eye of the Brake Bar Rappel Rack.

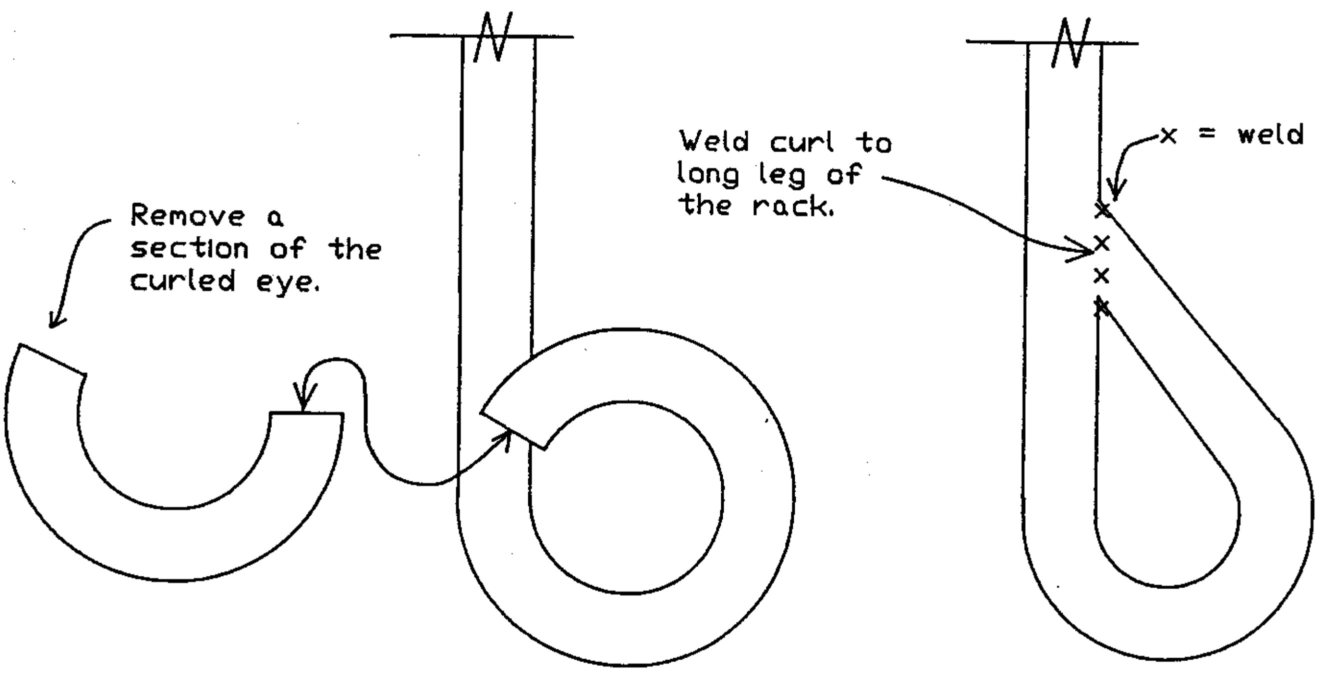


FIGURE 4 - Method 2 Modification of the Curled Eye of the Brake Bar Rappel Rack.

METHOD 2:

Cut the curl of the eye and weld it to the long leg of the rack in a manner similar to the newer model racks (Ref. Figure 4). This is not the preferred method because:

- o It is not simple.
- o It involves modification of the original and tested design of the rappel rack (e.g. a portion of the original strength of the rack is lost).
- o Failure of the weld would be catastrophic.
- o The producer has to be concerned with pre-heat, post-heat, contamination, and susceptibility to inter-granular corrosion from chromium carbides formed in the weld zone. The corrosion and any chance of manufacturing defects detract from the reliability of this method[6]. In addition to this, non-destructive examinations and testing would be required, as well as welding specifications and welder qualifications. This would be a costly process. It is highly unlikely that rescue personnel would utilize this method.

To determine if the enhancement to the curled eye of the rack will be suitable for use during rescue operations, an analysis of the load during a rescue lowering operation and testing of the proposed solutions will be necessary.

ENGINEERING ANALYSIS

During testing of rescue equipment a rescue load is usually considered to be 400 lb. This load represents two 176 lb. persons plus equipment[7]. A good rule of thumb in selection of equipment for use in a rescue system is a 1:5 ratio of the breaking strength of the hardware, and a 1:15 ratio of the breaking strength of the software[8].

Under normal circumstances with a rescue load, the curled eye of the rappel rack will be required to withstand a 2000 lb. load. {This is based on 400 lb. x 5 = 2000lb.}

TESTING

Five test pieces were fabricated with non-welded curled eye configurations on one end and the Method 2 eye configuration on the other (Ref. Figure 5). Four of these test pieces were pulled to failure on a dynamometer while one remained a control sample. Similarly five test pieces were fabricated with the Method 1 eye configuration on one end and a method two eye configuration on the other (Ref. Figure 6). Again four of these test pieces were pulled to failure by a dynamometer with one test piece remaining as a control sample.

It should be noted that the reason the Method 2 configuration was utilized on all the test pieces was to enable the test pieces to be installed in the dynamometer. It could also be shown by manufacturers data that configurations such as this would withstand a 10,000 lb. force before failure, and that the failure in these cases was not necessarily the weld or eye failing, but the rod elongating.

RESULTS

The results of the pull testing of the test pieces can be seen in Table I.

DISCUSSION OF RESULTS:

The results of this design project indicate that the Method 1 modification will enhance the safety of the curled eye of the brake bar rappel rack. The enhancement is enough of an improvement that the rack could be used in conjunction with a rescue lowering system with a load not to exceed 580 lbs. This is based on the 5:1 ratio of breaking strength required to rescue load.

It should be noted that the results indicate the curled eye of the rack, unmodified, could be used for a rescue lowering of a load not to exceed 320 lbs. This is based on the unmodified eye beginning to uncurl at 1600 lbs. of force.

This will not be recommended, however, because the deformation of the eye occurred at a force as low as 800 lbs., indicating a rescue load of no greater than 160 lbs. could be applied. It is widely held that when equipment cannot operate as intended in an application, the equipment is not appropriate for the application and should not be used. The deformation of the rack eye is an indication that the equipment (rack) is not operating as intended.

The maximum load of 580 lbs. is based on the lowest force required to cause the Method 1 modifications to fail. This force was selected as opposed to the mean due to the large standard deviation (523+_25 lbs.) associated with the deformation and failure of this method.

The Method 2 modification showed no deformation or failure during any of the testing. It is identical to the method by which the newer model racks are fabricated. This indicates that they will fail at much the same force (10,100 lbs.) and could be used for rescue loads up to 2000 lbs. This method is not preferred to the purchase of a newer model rack, since it would cost in excess of $60.00, and a newer model rack can be purchased for under $30.00.

It is interesting to note that during the testing of the Method 1 modification, it can be seen that the deformation and failure of the rack occurred at the same force. The deformation and failure occurred when the weld tore. As the weld tore, the rack initially deformed and began to uncurl. When the weld tore, the force on the rack would be reduced until the dynamometer took the

TABLE I - Results of Pull Testing

	Curled eye Configuration Without Enhancements	Curled eye Configuration Enhanced by Method 1	Curled eye Configuration Enhanced by Method 2
Deformation			
Lowest force	800±25 lb.	2900±25 lb.	DNO
Greatest force	1500±25 lb.	4000±25 lb.	DNO
Mean	1125±25 lb.	3300±25 lb.	NA
Std. Deviation	299±25 lb.	523±25 lb.	NA
Failure (uncurling)			
Lowest force	1600±25 lb.	2900±25 lb.	DNO
Greatest Force	1850±25 lb.	4000±25 lb.	DNO
Mean	1725±25 lb.	3300±25 lb.	NA
Std. Deviation	104±25 lb.	523±25 lb.	NA

DNO = Did Not Occur NA = Not Applicable

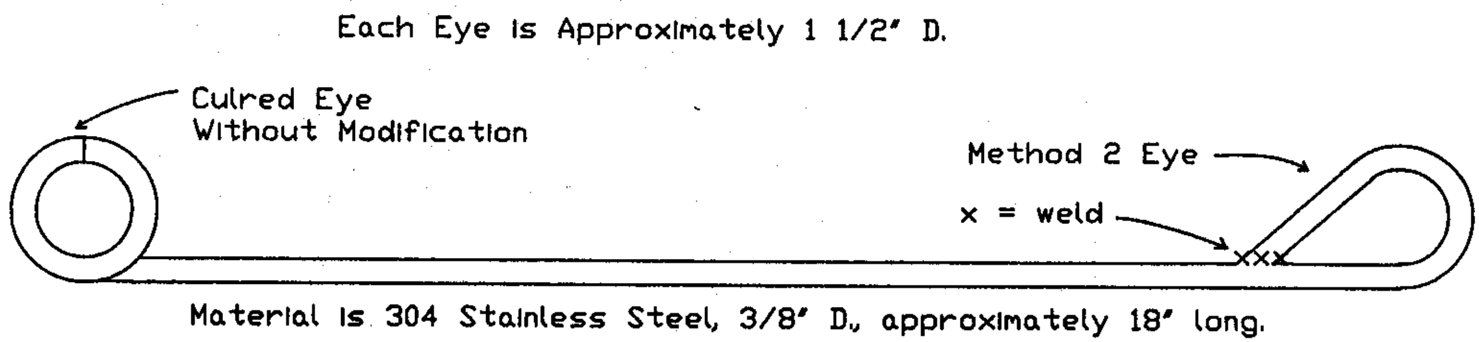


FIGURE 5 - Curled Eye Configuration Test Piece Without Weld.

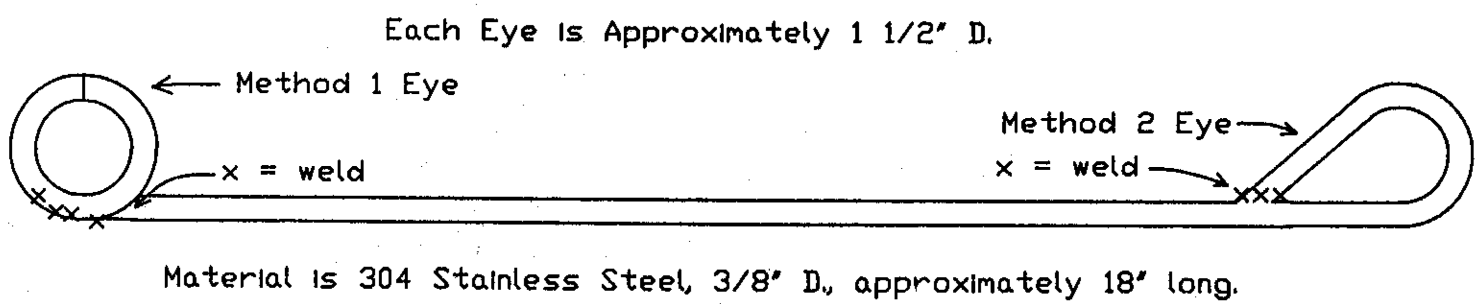


FIGURE 6 - Curled Eye Configuration Test Piece With Weld.

"slack" out of the system due to the lengthening of the test piece (caused by the uncurling). The weld would not tear again until the indicated force of deformation (and failure) was reached again.

CONCLUSIONS:

Welding the curled eye of the brake bar rappel rack enhances the safety of the rack. Specifically:

- o The Method 1 modification (Ref. Figure 3) will allow the rack to be utilized in conjunction with rescue loads up to 580 lbs.
- o The Method 2 modification (Ref. Figure 4) will allow the rack to be utilized in conjunction with rescue loads up to 2000 lbs.

RECOMMENDATIONS:

The following recommendations are based on the results of this design project:

- o Those persons utilizing a brake bar rappel rack with a curled eye configuration in conjunction with rescue loads not exceeding 400 lbs. should modify the curled eye of the rack as per Method 1. This is the simplest and least expensive way to assure the curled eye of the rack will not fail (uncurl) during a rescue lowering.
- o For those applications where the curled eye configuration of the brake bar rappel rack may be utilized in conjunction with a rescue load that may be greater than 400 lbs., it is recommended that the Method 2 modification be made to the rack.
- o In lieu of the second recommendation, a newer model rack with a manufacturers welded eye should be utilized. An investigation of the cost of modification vs. replacement should be made to determine the least expensive method.

DATA

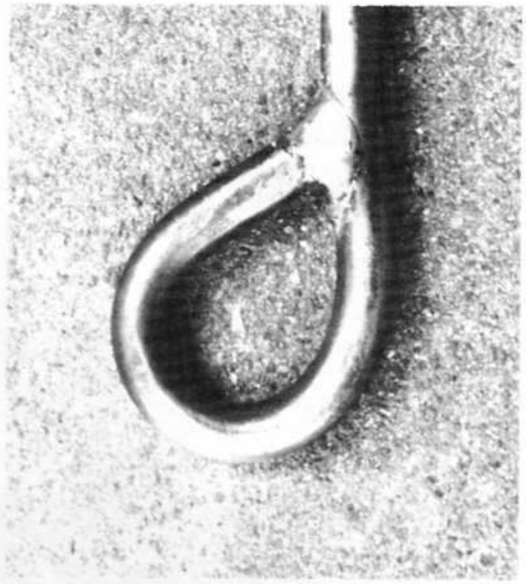
The results of the individual pull test of the test pieces can be found in Tables II and III below.

TABLE II - Raw Data From Pull Tests of the Test Pieced Without Welded Curled Eye

Test Piece	Non-Welded Curled Eye		Method 2 Eye	
Number	Deform	Uncurl	Deform	Uncurl
1	NA	NA	NA	NA
2	1000±25 lb.	1600±25 lb.	DNO	DNO
3	1200±25 lb.	1700±25 lb.	DNO	DNO
4	800±25 lb.	1750±25 lb.	DNO	DNO
5	1500±25 lb.	1850±25 lb.	DNO	DNO

TABLE III - Raw Data From Pull Tests of the Test Pieces With Welded Curled Eye

Test Piece	Method 1 Eye		Method 2 Eye	
Number	Deform	Uncurl	Deform	Uncurl
6	NA	NA	NA	NA
7	2900±25 lb.	2900±25 lb.	DNO	DNO
8	2900±25 lb.	2900±25 lb.	DNO	DNO
9	3400±25 lb.	3400±25 lb.	DNO	DNO
10	4000±25 lb.	4000±25 lb.	DNO	DNO



ALTERNATE DESIGN CONSIDERATIONS:

The following three alternate designs were considered during the process of this project. They were not recommended based on the indicated reasons.

METHOD 3:

Paint the curled eye of the rack with a bright color to serve as a visual reminder not to use the rack for a rescue load lowering system. This method was not recommended because:

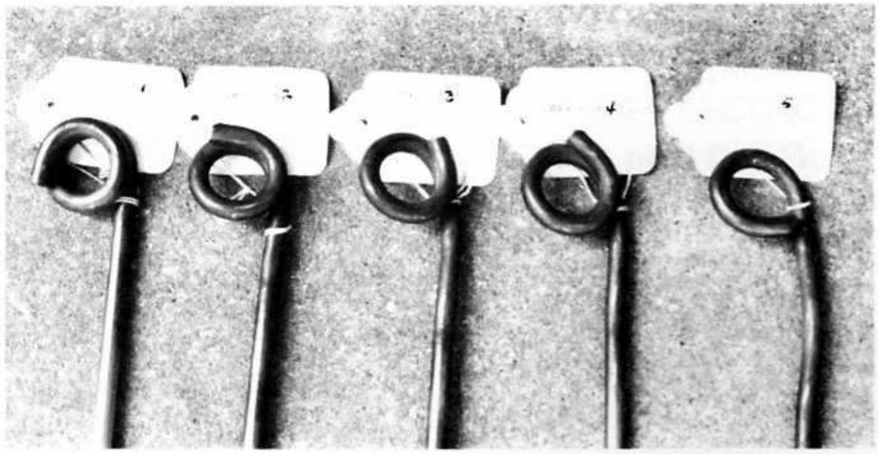
- o The rack is used in conjunction with nylon ropes and slings. The inadvertent use of petroleum based paints and solvents could prove detrimental if the paint or solvent came in contact with the nylon. Nylon deteriorates when exposed to these products. Painting specifications would be required.
- o Most persons are hesitant to paint their personal gear, additionally, getting everyone to agree on a color would be impossible. Multiple colors would be confusing since many persons color code their equipment and it would be difficult to distinguish between a color code and a warning.
- o During normal use of the rack in rough and muddy underground terrain, the paint would not last long on the rack.

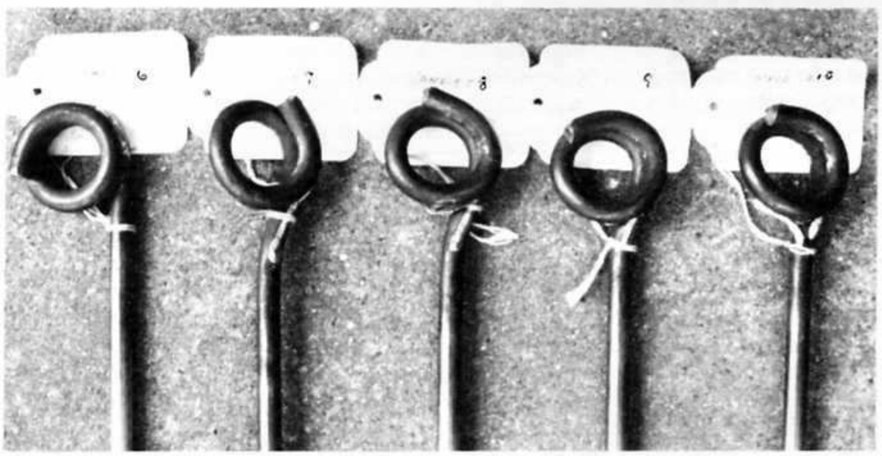
METHOD 4

By destructive examination of several racks, determine the maximum load the curled eye of the rack can safely be utilized in conjunction with, then test each rescuers rack to this load. If the rack passes the test, stamp it with a "MAX LOAD XXXX" and leave the rack in service, otherwise retire the rack.

This method was not recommended because:

- o This could involve the destructive examination of the rack. During testing the rack could be stressed to failure, or very close.





After the testing the rack would have to be retired if it failed. This could become very expensive.

o MAX LOAD means different things to different people. Does this take into consideration the 1:5 ratio or not? Some persons consider the MAX LOAD to be the working load. Others consider it to be the load at which the device fails. The stamping of equipment with load ratings is risky.

METHOD 5:

After testing as in Method 4, present the data to rescue personnel. Show them that the curled eye of the rack fails at low loads. Require these persons to purchase the newer welded eye racks. This method was not recommended because:

o It is expensive.

o Most cave, pit and cliff rescues can be easily handled by the teams currently in place; however, on some occasions large scale operations are required. At these times a general call goes out to all cavers, etc. At this time persons who are not affiliated with a rescue service will be utilized. These persons may still be using the old style racks. Since the likelihood that they will be called in on a rescue is small, they will be very reluctant to replace their "old reliable" rack with a new one for the very infrequent times they are required.

SPECIAL THANKS

The author would like to thank Buddy Lane and Lane Steel Fabricators of Chattanooga, Tennessee, for manufacturing the test pieces and providing technical advise and guidance. Thanks also goes to Steve Hudson and Pigeon Mountain Industries of LaFayette, Georgia for technical advise and guidance and the use of their facility to test the test pieces. Additionally thanks to the cave rescue teams of Chattanooga-Hamilton County (TN) Rescue Service and Walker County (GA) Rescue for their input and assistance. Troy Slatton and Sheri Politte also contributed to the preformance and documentation of this design project. Thanks also to my wife, Mary Beth who tirelessly edited and spell checked this report.

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TREASURER'S REPORT
NSS VERTICAL SECTION

FOR PERIOD BEGINNING JUNE 26, 1990 AND ENDING MAY 31, 1991
MAY 31, 1991

INCOME:

Memberships	$ 2654.00		
Subscriptions	179.00		
Back Issue Sales	874.50		
Symbolic Item Sales	1351.65		
Vertical Techniques Workshop (89)	579.96		
Soviet Exchange Program Contributions 1990-91	810.00		
Bank Interest	385.63		
Interest on CD's	35.34		
Total Income			6,870.08

EXPENSES:

Editor:				
Printing Nylon Highway #31		1720.07		
Mailing Nylon Highway #31 Internat	62.29			
Domestic	97.21			
Resends	10.65			
Total Mailing NH #31		170.15		
Printing Nylon Highway #32		1626.86		
Mailing Nylon Highway #32 Internat	158.53			
Domestic	297.66			
Resends	0.00			
Total Mailing NH #32		456.19		
Dues Due Notice Postage		33.10		
Other Postage		30.42		
Graphic Arts Salon Fee		3.00		
Bulk Permit		60.00		
Mailing Envelopes		358.63		
Supplies		22.64		
Total Editor Expenses			4,481.06	
Secretary-Treasurer:				
Postage		$ 501.04		
Supplies Dues Renewal Notice	$48.48			
Envelopes	27.82			
Copies	13.95			
Mail Labels	16.26			
Fax and Copies for USSR	49.37			
Other	30.50			
Total Supplies		186.38		
Vertical Techniques 90 Workshop Expenses		391.33		
Reprint NH #'s 9,12,17, & 18		303.98		
Soviet Exchange Pins and Patches Cost		806.60		
Symbolic Items Cost		858.75		
Cave Register Project Donation		25.00		
Awards		47.20		
State Tax from 90 Convention Sales		26.54		
Returned Checks & Service Charge		45.00		
Other		24.90		
Total Secretary-Treasurer Expenses			$3,216.72	
TOTAL EXPENSES				7,697.78
NET LOSS				(827.70)

BALANCE AS OF JUNE 25, 1990		4929.45
NET LOSS	(827.70)	
BALANCE AS OF MAY 31, 1991		$4,101.75

NSS Vertical Section
Symbolic Items

Items featuring the Vertical Section logo are available from the Secretary-Treasurer. Logo colors are: Gold Background, Dark or Royal Blue Figure and Inner Background, Red Letters and Hardware, and Orange Formations.

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T-Shirt 100% Cotton White in M,L, and XL Limited Edition Vertical Section 20th Anniversary Commemorative T-shirt. Design by Linda Heslop. Sold only during 1992.	**8.00**	**1.50**
Sweatshirt 50/50 Red or Gold in M,L, & XL	**14.00**	**2.50**
Hooded Sweatshirt 50/50 Red or Gold in M,L, & XL	**17.00**	**3.00**
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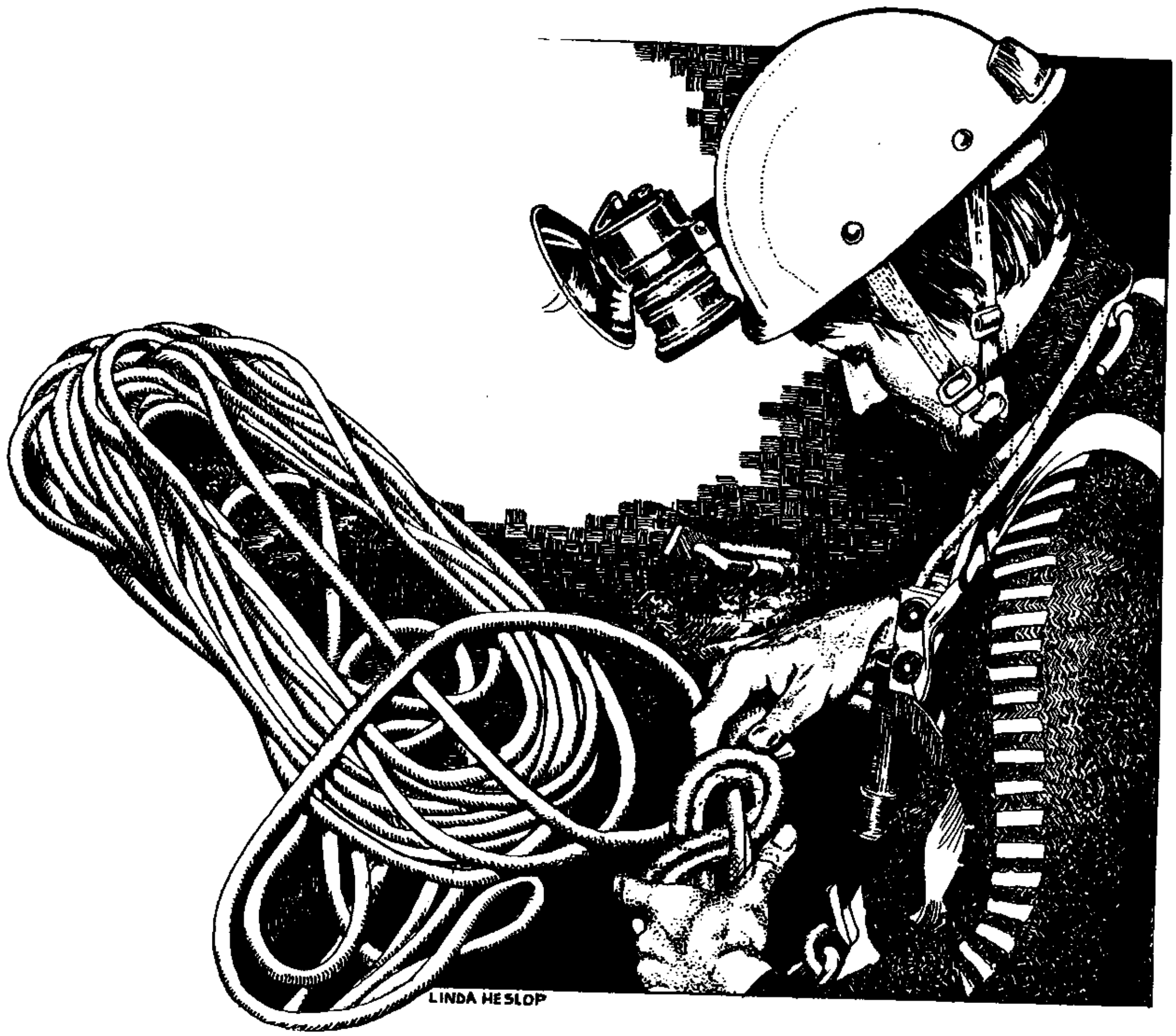

RIGGING, Jewel Cave, from Photo by Scott Fee
by Linda Heslop

Editor's Space

by Maureen Handler

Well, another issue is ready for the press. It is 4 am and I'm ready to call it a night. This issue was a difficult one to produce. There have been many changes for me since the last issue of the Nylon Highway. I lost my job back in March and have spent the last couple of months travelling and looking for a new job. I start that new job tomorrow morning at 8 am in Marietta, Georgia. I will publish a new address, as soon as I have one, in an upcoming issue of the NSS News.

Some more important News. The Ukrainian Speleological Association was established during the Constituent Assembly held in Kiev, January 11, 1992. Once the Soviet Union broke up into independent state, a formation of national speleological organizations in the former Soviet Republics became inevitable. Cavers and speleologists in different states have to deal with their own governments in many fields such as the management and conservation of cave resources, development of international speleological relations and so on.

The Ukrainian Speleological Association was granted status as a national organization by the government and exclusive authority to represent the Ukrainian speleological community on the international scene. It is dedicated to cave exploration, study and conservation, as well as to recreational and sport caving. There is the possibility of forming a speleological federation within the newly established Commonwealth of Independent States.

At mignight, July 4, 1992, by Kiev time (5 pm in New York), there will be an Intercontinental Toast of Caving Friends. This event continues a tradition established by American and Ukrainian cavers in 1991, when dozens of cavers in various localities in the USA and Ukraine raised their glasses to toast simultaneously. This toast confirms a friendship and unity in caving that extends under oceans and continents and knows no boundaries. Join the toast to "One World Underground". This year we also have cavers in Mexico, Czechoslovakia and China joining in.

Now, on to a little more business. Dues are due with this issue. Look on your mailing lable to see if your dues are due. If so, use the handy little form enclosed to renew. With my new upgraded computer, the quality of the highway can only get better. Don't miss out on any issues. And of course, my in box is now empty again. Keep those great articles coming for good future issues. Since now it is closer to 4:30 and I have to get up in an hour to go to work, it's time to say good night!