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Squeeze Brakes Up To 1982

By Kirk MacGregor

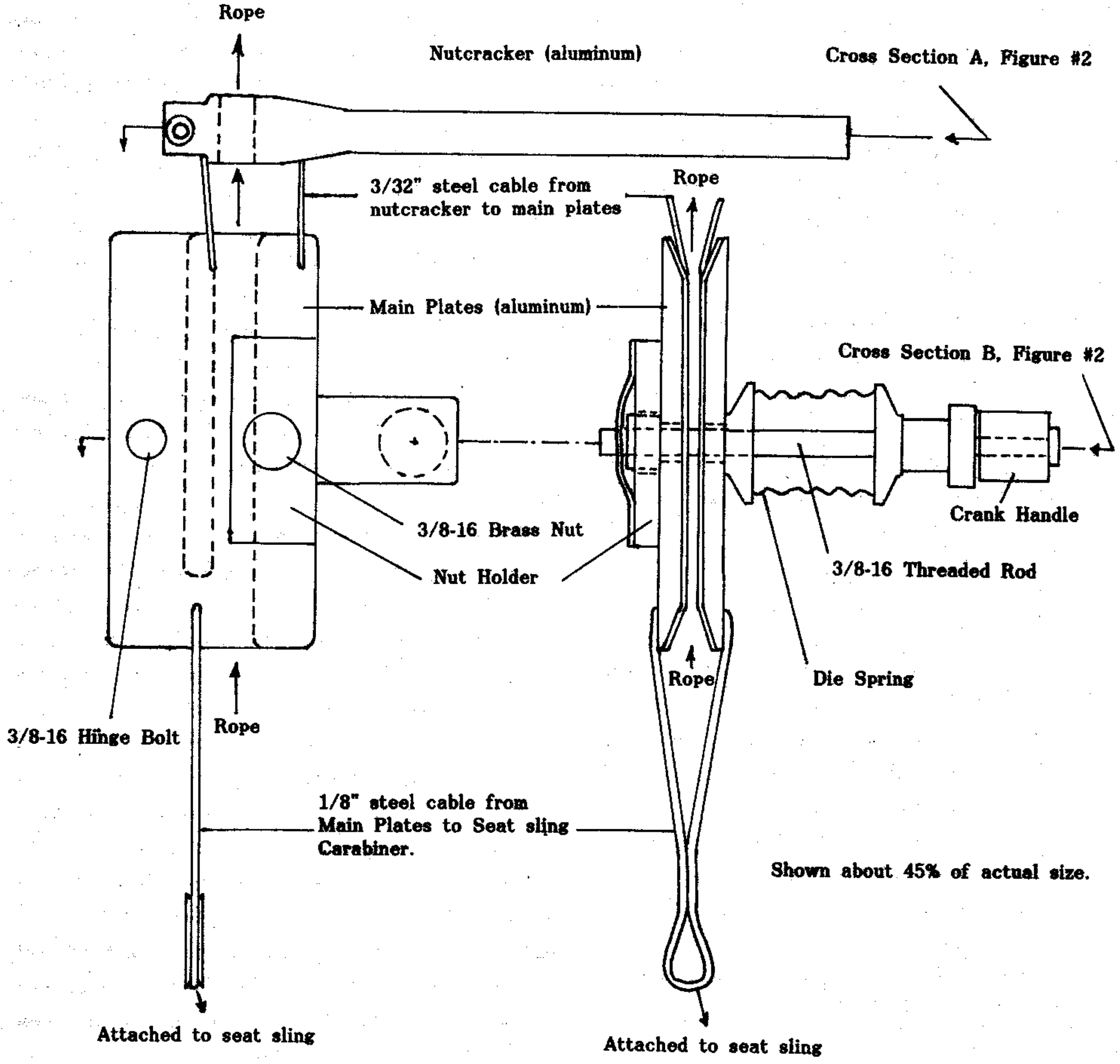


Figure #1: Side views of the Thor squeeze brake. On the left, the whole brake is viewed at right angles to the main plates. On the right, the brake is viewed parallel to the main plates <u>with the nutcracker omitted</u>. Most fastener detail has been omitted, including loops and ferrules on the steel cables, and the cords that prevent dropping the crank and die spring when the brake is open.

Most rappel brakes work by bending the rope, as in the rack. Squeeze brakes work by squeezing the rope as it passes essentially straight through the brake. As a result, squeeze brake operation is nearly independent of the tension in the rope, both during rappel and while the brake is being clipped onto the rope. This makes the squeeze brake ideal for use on long drops and for rappelling from above to rescue a caver incapacitated on the rope. It also allows squeeze brakes to be used for tandem rappelling and for descending steeply-sloping tyrolean traverses under control.

With further development, and if warning #1 below proves not to apply, squeeze brakes may become competitive with bending brakes (e.g. racks) for many types of rappelling. In the meanwhile, here is what has been done on squeeze brakes so far. (As far as I know, essentially nothing has been done from 1983 to the present.)

WARNING

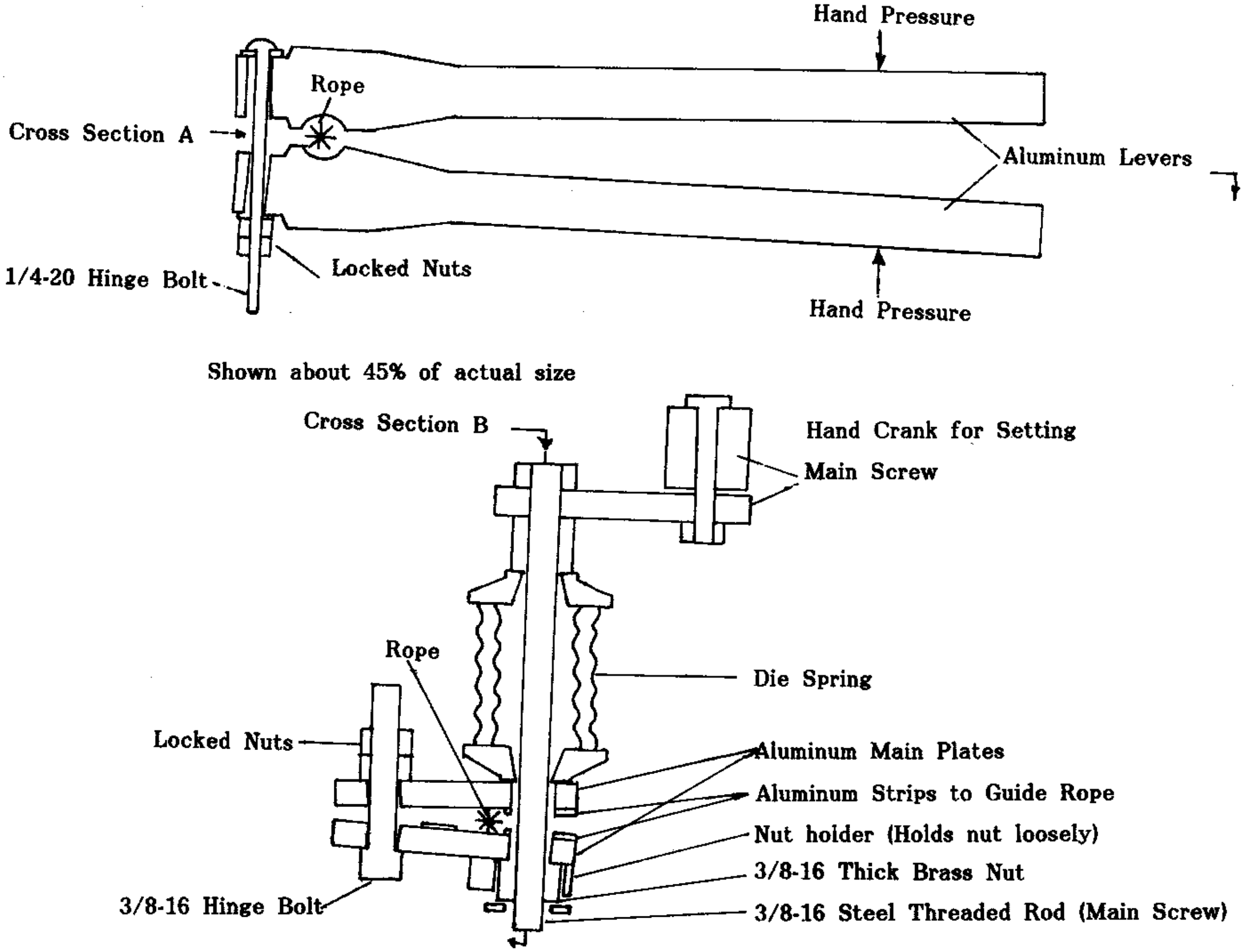
1. The rope used for the Thor Expedition broke at about 7000 pounds when tested right after weaving. Less than a year later, used samples of this rope broke at about 4000 pounds. It is not known why this happened, but one speculation is that the three squeeze-brake rappels made on this rope did the damage. Until this question is definitely resolved, anyone experimenting with squeeze brakes should start with tests for rope damage. Hopefully, I will have some test results on this later this year.
2. The Thor brake shown in figures #1 and #2 was just thrown together as a proof-of-concept testbed. No structural design was done on it, and some parts of it may not be strong enough to be safe. If you are building a squeeze brake, do your own structural design. Do <u>not</u> just copy figures #1 & #2. (This test brake was used at Thor only because its properly-designed successor was not finished in time. It is shown here partly because it is the one that was actually used, and partly because designs much better than either of my 1982 ones are now possible, so a 1982 design that you should not follow exactly is now preferable as an example.)

SQUEEZE BRAKE HISTORY

The idea of sliding down a rope by gripping it with one's hands must be ancient. So must the idea of putting something between one's hands and the rope for hand protection. This "something" would have been the first squeeze brake.

Getting to more definite history, I have read an article that mentions an invention by Leonardo da Vinci. This was a leather tube that could be gripped by hand for sliding down short lengths of rope. Unfortunately, I did not record this reference when I read it about 1983.

In the Malayan, emergency in the 1950's, Britain's Special Air Services Regiment used a more practical device of this type for rappelling to the ground from parachutes caught in the jungle canopy. It was a tube about 18 inches long that was strongly sewn to the outside of a reinforced section of the upper thigh of the parachutist's trousers. The top several inches of the tube were made of a leather that had high friction with the rope used. As he released himself from his harness, the parachutist gripped the leather part of the tube with one hand, held himself upright with the other on the rope, and slid down. Leg and arm wraps could be used for added friction, so this was



Shown about 45% of actual size

Figure #2: Horizontal cross sections through the Thor squeeze brake, looking down. On top, Cross Section A from Figure #1, the Nutcracker. On bottom, Cross Section B from Figure #1, the Main Plates. As in Figure #1, most details of how parts are fastened together are omitted. The position of the rope is indicated by ✳

not necessarily a pure squeeze brake. It had a safety feature. If the parachutist became unconscious, he fell over, putting sharp bends in the rope and tube where they met and left his thigh. This slowed or stopped his descent.

However, these early devices were for limited use on relatively short drops. They were not what cavers were looking for in the late 1960's, even if any cavers had heard of them then (I hadn't).

What I was looking for in 1967 was a long-drop device that could easily be clipped onto a rope under considerable tension, and could easily be controlled for descent on such a rope. What I thought of was two metal plates squeezed onto the rope by a hing on one side and a screw mechanism on the other. In February 1968, I constructed a model squeeze brake. I tested it on several ropes, using a spring scale to measure the squeezing forces required to support and lower weights up to 20 pounds. From this, and measurements of the flattening of ropes under pressure, I concluded that a full-sized squeeze brake was feasible.

With much help from Walter Chlebek, I built a squeeze brake out of aluminum alloy. (This later became the "main plates" shown in figures #1 &

#2. The nutcracker, die spring, and steel cables were added in 1982.) On October 26, 1968, I tested it with a rope belay. Its speed fluctuated randomly over a wide range as it moved down the rope, making accidents likely. I abandoned it.

Somewhat later, George Zachariasen of Wisconsin independently invented another squeeze brake. He showed his "Musicbox" to cavers at the 1972 NSS Convention. Both his brakes had the same speed fluctuation problem as mine. In a conversation with me during the 1983 NSS convention, George confirmed that the speed fluctuation was one of the major reasons he stopped work on these brakes.

Meanwhile, Kyle Isenhart and Delbert Province (then living in W. Va.) independently re-invented the squeeze brake again. They made three or four screw-operated versions of it during 1971 to 1973 and over the 1974-75 winter. All of these had speed fluctuation problems. In an attempt to avoid the speed control problems associated with squeezing the rope between flat surfaces, Kyle and Del also tried wavy surfaces. These improve control a bit, but not enough.

Sometime in the 1970's Jim Charlton of Virginia also invented a squeeze brake. It was of "Gibbs-like" construction. I presently have no information on how well it worked, but nothing seems to have come of it.

At least a couple of other people also built screw-operated squeeze brakes in the mid-1970's. Sara Corrie was trying one of these out on a 100 foot drop in November 1978, when she crashed to the ground and was seriously injured. Apparently, the rope became slipperier near the bottom, and Sara could not screw the brake up fast enough to avoid disaster. This ended the first era of squeeze brake development.

I returned to inventing squeeze brakes when I was invited on the Thor Expedition in 1982. It occurred to me that the fluctuating speed of these brakes could be due to variations in rope thickness, which could be handled by spring loading. Not having seen George Zacharianson's article then, I bought some big die springs, found my 1968 squeeze brake, and tried it out. A spring helped a bit, but not enough. However, during these tests, I realized why the speed fluctuated, and thought of adding the "nutcracker" to the brake. On June 12, 1982 I did five test runs down the middle 195 feet of the 205 foot free drop at Bon Echo, Ontario. The modified brake performed flawlessly, including doing violent starts and stops, and doing the whole 195 feet in 13 seconds. There was no visible rope damage. The long search for a workable squeeze brake design was over.

EXPERIENCE WITH THE "THOR" BRAKE

This first successful squeeze brake is diagrammed in figures #1 & #2. It grips the rope twice, with the "main plates" and with the "nutcracker". The main plates are held against the rope by a fixed "hinge bolt" on one side and an adjustable, spring-loaded "main screw" on the other side. The nutcracker's two parts are held against the rope by a hinge bolt near the rope, and hand pressure on the other ends of its levers. The rope is kept in position by strips of sheet aluminum attached to the insides of the main plates and by notches in the nutcracker. Steel cables join these two parts, and support the rappeller. The brake weighs about 3.5 pounds.

The rope is put into this brake with the main screw completely undone, and the main plates opened like a book. They open just far enough. The two arms of the nutcracker pivot apart, and the rope snaps into the notches. If necessary, the brake can be adjusted for different rope thicknesses by changing the positions of the locked nuts on the hing bolts, but I have not needed to do this.

In normal rappelling, most of the rappeller's weight is supported by the main plates, and just enough weight is on the nutcracker to provide fast adjustment for changes in rope characteristics. However, it is possible to rappel purely on the main plates, using one hand as a substitute for the nutcracker. And it is possible to rappel purely on the nutcracker, with the main plates loose. (This gives a beautifully simple brake, but don't let go!) As this brake was just thrown together out of cheap metal, this redundancy was comforting as I went over the lip at Thor.

When crossing a lip, the rappeller must coordinate the main screw and the nutcracker properly. This coordination develops easily, but it is best for someone new to this device to have a top belay for the first one or two lip crossings. Lips show up a design flaw in this brake. There should be rope quides that the rope cannot escape at the bottom of the main plates. Because these are lacking here, the rope tends to get out from between the main plates when it bends on entering the brake, as happens at lips.

The spring shown is not necessary. It is there because I had hoped it would solve the speed fluctuation problem. However, the spring is useful in another way. From the compression of the spring, the spring constant, and the distances between the centers of the hinge bolt, the rope, and the main screw, one can calculate the force squeezing the rope. This is essential design information itself, and can be combined with the weight of the rappeller to give the coefficient of friction between the main plates and the rope. The manufacturer of the springs used published spring constants for them, accurate to ± 10%. Allowing for other sources of error, this measurements of squeeze force and coefficient of squeeze force and coefficient of friction good to about <u>20</u> %.

Table #1 gives the results of a number of such measurements. The aluminum alloy used was the unknown structural alloy the brake was made of. It was cut from a large channel beam. The mild steel used was de-tinned tinplate. Sheets of this were firmly attached over the whole running surface of each main plate for these tests.

Three things are noteworthy in Table #1:

1. The coefficient of friction increases with speed. This must be so, or stable rappelling is not possible (if the coefficient decreased with speed, rappelling would have to be jerky). However, it is comon for the just-stopped coefficient of friction to be higher than the barely-moving coefficient. This does not seem to be the case here.
2. The coefficient of friction is lower for mild steel than for aluminum. This is expected, and still lower coefficients are likely for the hard steels that are probably the best running surfaces.
3. This squeeze brake tends to "creep". Under some conditions (newer ropes?) only a very high squeeze force will stop the brake. There is a wide range of forces between those that stop the brake and those that allow normal movement. In this range, the brake creeps down the rope very slowly, with the exact force having little effect. Creep seems to occur more when the brake is hot (see bottom line of table #1).

I rappelled a total of over 11,000 feet on this brake. Most of this was on clean kernmantle rope, but I also did 2 rappels down Outhouse Drop in My

Cave, WV. (an 85 footer notorious for its mud), and a couple of rappels on Goldline. During this rappelling, the tension in the rope below the brake varied from zero to about 350 pounds. Speeds ranged from very sow to above 15 feet per second. In all of this rappelling, I experienced no real problems in controlling the brake's speed. It was always possible to do anything from stopping abruptly to going fast.

The only significant problem that even appeared control-related was actually a mechanical problem. This occurred on my second Thor rappel, when I carried an 80 pound pack on a sling from the brake. This increased the load on the brake by nearly 50%, so I had to screw the brake up correspondingly hard. Under this force, the high -pressure grease on the nut and screw squeezed out, leaving bare metal running on bare metal. The screw required more force than normal to turn, and squeaked unpleasantly. This was worrisome, and I used the screw as little as possible for the rest of the drop. After being regreased, the screw operated normally on subsequent drops.

In experiments with adding and removing 330 pounds (2 people) on the rope below the brake, the brake's speed changed only slightly in response to these abrupt changes in rope tension. The change was less than what occurs naturally along the length of a rope. There was no consistent direction to the speed change. On some ropes the brake went a little faster with more tension in the rope, on others it went a little slower.

SQUEEZE BRAKE DESIGN REQUIREMENTS

In general, the most mininal squeeze brake possible needs:

1. **A way of squeezing the rope between two adequately-large, adequately-strong surfaces with adequate force.** New Para surfaces that are too small will cut the rope. At a minimum, the surfaces should be as large as ascender cams. However, ascenders weaken the rope, so larger surfaces are preferable. I suspect that the shortest length that should be considered is 1 or 2 inches, but have no test results.

The squeeze force required depends on the coefficient of friction and the load. For a coefficient of 0.03 (steel on new rope?) and a load of 300 pounds (heavy caver plus pack), a squeezing force of 5000 pounds is required. Are worse cases likely?

In designing the strength of the device, one should also consider the largest forces that can be produced by a very strong and desperate caver. A brake should be strong enough for these, or at worst, it should fail by bending, not breaking.

2. **A way for the rappeller to adjust the control force** <u>**rapidly**</u> **to compensate for the rapid variations in friction along many ropes.** Lack of rapid adjustment is why the early squeeze brakes failed. Screw mechanisms are too slow. No one realized this for 14 years because the control hand used with all bending brakes inherently gives fast control. Rappellers subconsciously learn to compensate for rope variation, and come to believe that ropes are more uniform than they actually are. this psychological problem is aggravated by the existence of a minority of ropes that are quite uniform. When testing a new rappel brake for control, it is a good idea to try violent starts and stops. If a brake can repeatedly drop you like a rock and then slam you to a halt in a couple of feet, it can handle friction variation along a rope.

TABLE #1

Plate Surface & Rope Type	Speed Of Rappel	Squeeze Force On Rope (lbs)	Coefficient Of Friction
Aluminum alloy with Old BluewaterII	Just stopped	559	0.16
	Slow	479	0.18
Aluminum alloy with Old Bluewater II	Just stopped	403	0.22
	Slow	322	0.27
Aluminum alloy with Old Bluewater II	Just Stopped	408	0.22
	Slow	317	0.28
	Medium	227	0.39
Mild Steel with Old Bluewater II	Just Stopped	634	0.14
	Creeping	544	0.16
	Medium	362	0.24
Aluminum alloy with Edelrid Everdry, a 11mm Dynamic rope	Just Stopped	523	0.17
	Slow	443	0.20
	Medium	322	0.27
Mild Steel with Fairly New PMI	Very Slow Creep	1132	0.078
	Slow Creep	951	0.093
	Medium	679	0.13
Mild Steel with Fairly New PMI	Very Slow Creep	1087	0.081
	Very Slow Creep	906	0.098
	Medium	589	0.15
Mild Steel with Old Bluewater II	Very Slow Creep	725	0.12
	Creeping	362	0.24
	Medium	317	0.28
	Fairly Fast	272	0.33
Aluminum Alloy with Fairly New PMI (Different rope from above brake hot, but not boiling hot, after fast 195' rappels.	Slow Creep	1355	0.065

(Note: The Figures on the last line are less accurate than the rest.)

The force exerted on the rope by one squeeze brake plate, and the coefficient of friction between on squeeze brake plate and the rope. These figures were measured using the brake of figures #1 and #2, but without the nutcracker. They have errors of about ± 20% due to the measurement techniques used, and fluctuate due to the fluctuation in characteristics along a rope.

NOTE: The coefficient of friction is half the rappeller's weight (177 lbs. including gear), divided by the squeeze force, as friction occurs twice: on both sides of the rope.

(Though it still may not handle another rope with lower friction overall.) If a brake is only capable of slower starts and stops, using it is asking for trouble. Friction changes along ropes can be large and fast.

3. A way of attaching the friction surfaces to the rappeller. This is obvious, and is mentioned primarily for completeness. However, those designing squeeze brakes should take a serious look at the steel cable technique used in the Thor brake. The cables allow hanging the rappeller's weight symmetrically on the two sides of the brake, and very close to the rope. This also allows the friction surfaces and the squeeze mechanism to be as simple as possible.

4. A way of keeping the rope properly positioned between the friction surfaces, especially if the rope bends while entering or leaving them. It is probably best if the friction surfaces have shallow grooves with about the same curvature as the surface of a rope in them. However, no tests have been done to show whether shallow grooves actually are better than a flat surface. It is important to not make any grooves too deep. The rope compresses as it is squeezed, the grooves get deeper with wear, and the brake may be used on thin or soft ropes. If the two sides of the brake meet, the rappeller is in trouble!

While shallow grooves will keep a straight rope in position, the rope may be bent on entering or leaving the brake. For example, when you are crossing a lip, the rope is bent 90 degrees or more, and may be heavily loaded by the weight of rope down the drop. With only shallow grooves, the rope will work its way out of position. Thus the rope must enter the brake between pegs or other structures that make pulling it sideways out of position impossible. While sideways forces on the rope at the top of the brake are rare, they can occur (e.g. on a sloping tyrolean), so the tops of the friction surfaces also need structures to ensure that the rope cannot move sideways.

While it is possible to rappel on a squeeze brake with only the above four features, practical devices also need the following:

5. A way of provideing an adjustable "base forces" that holds its setting without intervention by the rappeller and/or a way of stopping the brake automatically if the rappeller becomes unconscious. An ideal squeeze brake would include both features; however, such a brake could be quite complicated, and one or the other probably suffices. I am inclined to use the "base forces" only.

This is how the Thor brake works. The base force is provided by the main plates and the screws. The nutcracker provides a smaller force for fast control. This gives two advantages over a "minimal" squeeze brake: A). The fast-control hand has to produce much less force, and tires much more slowly. B). If the fast control is dropped, the rappel will stabilize at some speed well below free fall. This gives the clumsy or unlucky rappeller time to grab the levers again, and reduces injury to an unconscious rappeller.

Note, that it is possible to construct squeeze brakes so that the base force is active only when the fast-control is active only when the fast-control force is inactive, and vice-versa. The Thor brake would be like this if the spring were removed and the nutcracker were replaced by levers extending from the main plates. Such devices still limit maximum speed, but do not reduce hand force required on the fast-control levers. (The nutcracker was placed above the main plates on the Thor brake to eliminate a possible negative interaction between the two. As the nutcracker is squeezed, it presumably makes the rope a little thinner. If the nutcracker were below the main plates, this thinning of the rope would reduce the force produced by the main plates, counteracting the nutcracker to some extent. However, this is only an untested hypothesis, and the actual effect may be negligible.)

A system for stopping an unconscious rappeller is desirable. However, such accidents are very rare, and ones involving unexpected unconsciousness are rarer yet. (Unconsciousness that is felt coming on can be handled by feature #6 below.) Thus it is difficult to justify a complex and expensive system for this purpose.

Squeeze Brakes continues on page 22

"Let's Talk Prusiking"

By Bill Cuddington NSS 21770F

This is not really an article on whether to prusik or not, Instead, it is my opinion and that of many others that you should begin your vertical caving career by first learning to use prusik knots and stay in practice with them.

Now I don't mean anything else, but the actual prusik knots; 3 of them (figure #1).

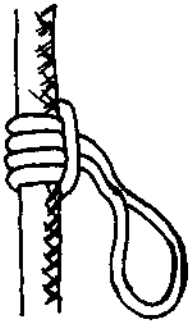


Figure #1 I reccommend Prusik knots first.

In our rope climbing class we teach the standard basic 3 knot system which is a swiss seat-chest connection to the top prusik knot and then the two foot loops. We find that most novices feel more comfortable in a "swiss seat rig" (figure #2).

I always demonstrate prusiking with actual prusiks before the students begin training. I also show and stress the importance of a quick attachment system (Ed. Jumar safety).

The students are trained on a pulley first. This way we can lower them quickly to the ground in case of a problem. We encourage the student to prusik at least 50 ft. The student is not allowed to prusik a in cave or on a cliff drop till after they do a "pulley climb." The student is taught the basic method of prusiking; i.e. not to fight the knots; but to loosen them and to move only one knot at a time, staying on two points at all times.

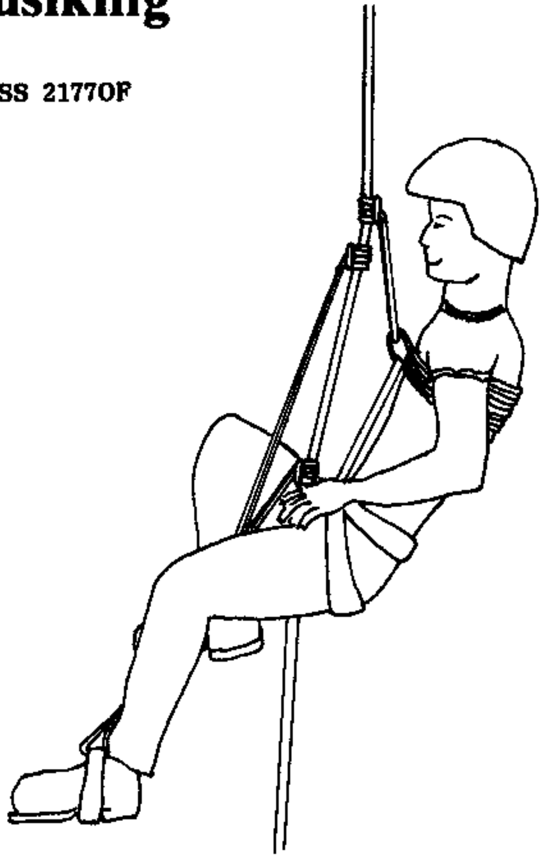
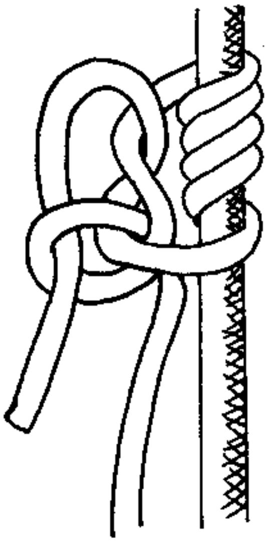


Figure #2 Start with a 3 knot system with a seat-chest connection to the top Prusik knot.

I have been asked, "Why not start the beginning student with helical knots?" See figure #3. (Ed. helical knots are often called ascender knots). I consider the helical an advanced knot. It is hard enough for beginning students to learn to tie a bowline around their waist, much less tie one

Figure #3 Helical knots are excellent knots for the experienced climber.



sideways as used when tieing a helical knot. Also, you can get in trouble with the helical. Example, learning the right number of turns for certain conditions and different sling diameters require different turns. If tied too tight, helicals wear out quickly.

I like to keep in practice with knots myself. So, I try to use them often in the field. Using knots does not seem to confuse me when I go back to my Gibbs rig. In fact, it makes the Gibbs rig seem easier than ever. However, if I stay on the Gibbs rig too long, I get very rusty with knots.

A lot of times in the field, I am able to use knots, as I do enjoy using them. Also, when I use knots, it's all knots on the rope. Of course, I always carry my Jumar safety.

I use the helical knot because of its advantages over the prusik knot which are important. They are: 1). It is faster, 2). You can increase your holding power by adding turns without having to take the slings off your body like you would with prusiks. 3). It is easier to switch ropes and do changeovers than with prusiks, and 4). It is easy to walk over and get on rope. You just put your foot and chest slings on when it's your turn to climb, just "tip-toe" over and get on the rope.

I like to climb using a chest harness and two foot slings. In the field, I do wear a seat harness, but it is not connected to my chest harness. If I have a problem or need to rest, I snap my Jumar safety on the rope above my chest knot. This gives me a fourth independent point of contact with the rope, since it's attached to my seat harness. My new chest harness is very comfortable, being modeled after the Martha Clark harness.

There is a myth that nylon will not work on nylon. This is not completely true. Sometimes nylon will not work on the same type of nylon. For example: PMI Sport on PMI Sport. I have been using nylon slings as climbing knots for many years. I am now using accessory cord for helical knots to climb PMI main line. Some of this cord is on the stiff side, so you may have to use 6 mm. as your sling size. A good rule is try to use as large a diameter as you can, especially for your chest knot. so I use 7 mm. when I can.

Most of the time you will be using 4 or 5 wraps for your helical knots, but when you fix your sling lengths, always allow enough for an extra wrap. Also, be aware that nylon shrinks after the first time it gets wet.

Usually 4 feet is enough sling material for my actual helical or prusik knot. Then I have 2 pieces of 1" webbing (5' and 4' 8"), which I double. (Ends are tied together with a water knot). I loop these through a 2" wide foot stirrup. Then this whole thing can be looped through the prusik or helical.

Why bother with nylon? Because it is stronger than Polypropylene. But for mud and water, I recommend tenstron 5/16" diameter. Sometimes I can climb using tenstron foot slings and a nylon chest sling. the condition of your chest sling is VERY Important! Keep an eye on it and always carry a spare chest sling.

Notice that my actual sling lengths are short. On the rope, I can just reach my foot knots without bending over and my chest knot "sits" at about the top of my head. With these short lengths I am more vertical on the rope and can get over lips easier. But, against a slanting wall, longer lengths are better.

Let's Talk Prusiking continues on page 25

Foot Mounted Croll

By Bill Bussey

While the various types of ropewalker climbing systems are probably the most efficient way to get up rope, they have several drawbacks. First and formost, is the trouble encountered in passing knots and bolts due to difficulties in working with the foot mounted Gibbs ascender used in most ropewalker systems. With gear and with weight on the rope, the contortions needed to put cam, shell and pin together (or take them apart), can be a major undertaking. It is the experience of trying to cross a knot while climbing tandem and failing to get the foot mounted ascender back together again after crossing the knot; which gave me the inspiration to try and find a better way.

After talking it over with friends, several suggested that the Petzel **Croll** ascender would be a good choice for replacing the foot Gibbs. It is an open sided, spring loaded cam device, intended for use as the body mounted ascender in the frog climbing system. Other than differences in the shell, the **Croll** deviates from the Petzel **Jammer** ascender in that the cam hinges from the left instead of the right when looking at its open side. Thus, the **Croll** could be thought of as being the left hand complement to the **Jammer**, as there are right and left hand **Jumars**.

The **Croll** is designed to lay flat against the chest. In this foot mounted ascender, it will normally lay flat against the boot. Also, the **Croll** opens and locks by pushing toward the toe when mounted on the right foot. This should be easier than trying to pull back toward the heel while awkwardly reaching through an already crowded crotch area.

Assembly

First thoughts indicated that due to the way the cam was made, a metal frame would be needed to attach the **Croll** to the foot stirrup. Since I have no access to a metal shop, why not try and keep it simple. Thus as a proof of concept, I sewed a quick foot stirrup using Mike Fischesser's Butt Strap Harness Foot ascender as a model (fig. #1). Then I simply threaded the 2 inch webbing through the small "up-rope" hole of the ascender, around the back, and back through the larger "down-rope" hole.

The ascender was mounted on the boot as shown in figure #2. It performed well on the initial climb of a 3 1/2 meter deck. There was some wear in the place noted in the drawing. This short climb proved it worked; now to sew it in place.

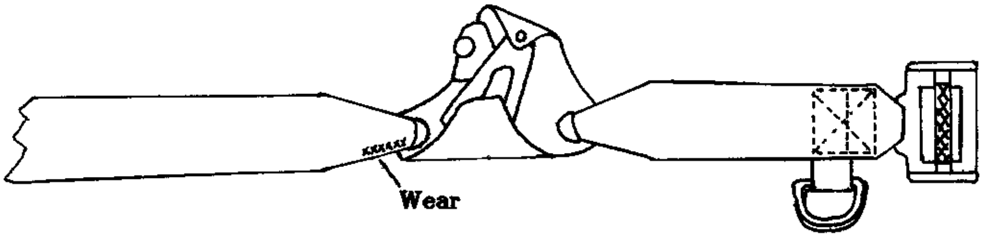


Figure #1 Proof of Concept

Foot Croll

First, I hand filed about one centimenter off the shell below the large hole (fig. #3). This was the only modification to the cam shell that I attempted. The purpose was two-fold. 1), to smooth and square this end so that the webbing would be subject to less wear, and 2), to prevent the shell from sticking below sole level so as to ease cam and webbing wear when walking on it.

Then, a 30 cm. length of webbing was threaded through the shell as described above. This was sewn, using a hand stitching awl, into a <u>tight</u> loop behind the rear of the shell. This loop must be tight so to prevent any unwanted up and down movement of the shell on the foot, when climbing.

This loop was sewn to the stirrup webbing which was used in the proof of the concept. Position was determined by checking placement on the foot. The bottom of the ascender should not come below the sole if possible. The loop should be sewn tightly as possible, here as well. Place a row of stitches as close to where the webbing is folded to go into the holes in the shell (fig. #4).

One other note in construction. I sewed a "grommet" of split one inch tubular webbing between the large hole end of the shell and the webbing, when the loop is attached to the stirrup. Since most weight on the ascender is focused here, this should help ease wear from rough edges and movement of the cam.

Practical Use

How does it work in actual use? At this writing, I have climbed approximately 450 meters on rope through a pulley in a tree. Except for one 70 meter climb, the only bottom tension was the weight of an average of three meters of rope below the ascender. That was plenty to allow the ascender to ride up the rope when the foot was lifted. As for comfort, it felt no worse, though no better, on the foot than a similar mounted Gibbs cam. On later climbs, I have noted a slight rubbing on the top of the ankle just above the boot. This is apparently from the top of the shell. .Though again, this is nothing compared to some blisters I have received in approximately the same area from a poorly adjusted Gibbs.

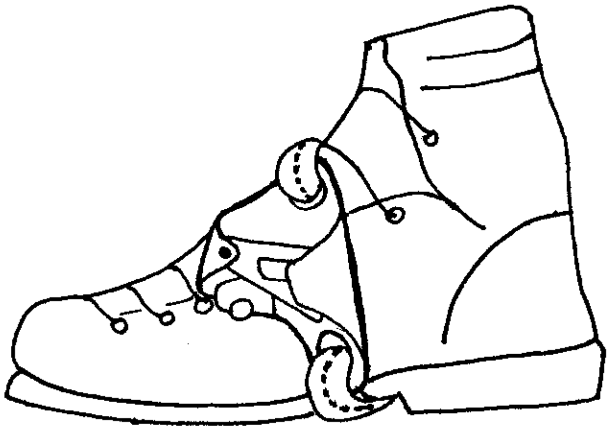


Figure #2

The foot does seem to turn or yaw sideways when weight is on the stirrup. This is, possibly only slightly worse than on a Gibbs rig. Modifications can probably be made to make it a bit more comfortable.

There was some wear on the webbing loop immediately below the large hole on the Croll. This was apparently caused by the rope rubbing the webbing intruding inot the path of the.rope in this area. A possible fix might be sewing the Croll to a more vertical position on the foot, or perhaps using thinner webbing. As it is, the ascender tips a bit ·forward until weight is placed on it on rope. Then the slight slack in the webbing lets the cam ride parallel to the rope.

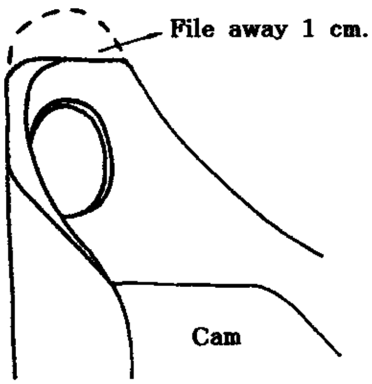


Figure #3

Crossing Knots

However, the Croll does make crossing knots which are loaded from below much easier. This is the whole idea and reason for this ascender. It was indeed a fairly simple matter to remove the ascender from the rope and place it back on above or below the knot. There were no problems in either direction. A friend, caver John Harris weighted the rope from below by sitting in a sling below the knot. This provided what should be an accurate test on crossing loaded knots.

Racing

In a test simulating racing conditions, with tension below and a hard, fast climb the ascender seemed a bit slower than a Gibbs. This is probably due to the added friction from the action of the spring constantly acting on the rope and the yawing of the ascender and foot which I mentioned earlier. There were however, no slippage or missteps. I will definitely try racing with this ascender at the Tularosa Convention.

Conclusion

Thus, I feel the testing so far has proven that this is a workable foot ascender. Modifications can no doubt be made to make it more comfortable, and perhaps more efficient. I plan to use this ascender on future climbs on mountain cliffs, in caves and in racing at conventions.

How about you? What improvements can be made? How can this ascender be made more comfortable and eficient, and perhaps longer wearing? Please build one and report the results of improvements in this publication.

Parts for this ascender can be bought from most caving retailers, including those that advertise in this publication.

Parts Lists

1 Petzl Croll Ascender
1 2" Adjustable Seat Belt Buckle
2 1" D-Rings
Approximately 1 meter 2" Seatbelt Webbing
Approximately .5 meters 1" Tubular Webbing

Tools Used
Sewing Awl (or Sewing Machine)
Small file

Special thanks to John Harris, Jim Richards and Keith Goggin. □

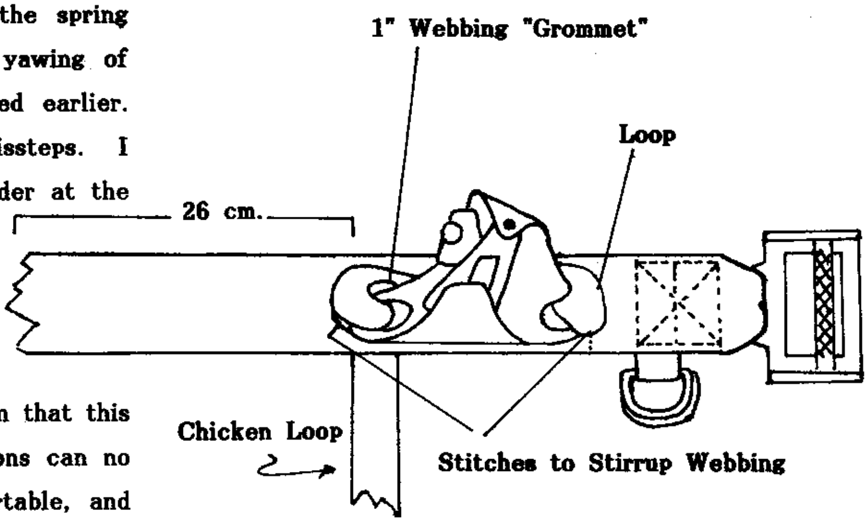


Figure #4 Placement on boot is the same as Fig #2

I'd Rather Dye

Jim Hall

Several years ago while reading a box of Rit dye I noticed that it no longer carries a warning against using the dye on nylon. The instructions now say for washable fabrics of cotton, nylon, rayon, acetate, linen, silk, wool and some polyester blends. So I purchased a package of Royal Blue and a package of Scarlet Red, and took my fairly new 300 foot PMI, washed it and let it dry. Measured off 100 feet on each eand and wrapped electrical tape around the rope at the hundred foot marks. Then I fed a hundred feet of each end into two plastic McDonald's pickle buckets (5 gallon size). I mixed the dye with 160 degree hot tap water and poured it into the buckets until the rope was totally submerged...one red bucket one blue. If you don't take a stick and move the rope in the buckets you will have some light spots where the rope lays over itself. Let the dye and rope set until the dye water cools and then rinse once or twice with cold water. Then I had my all American Red, White and Blue 300 foot PMI rope.

It was actually 100 feet of blue on one end, a 100 feet of red on the other end and 120 feet of white in the middle.

ADVANTAGES

1. You know exactly how much rope to put in a pit.
2. You know how far you have climbed or rappelled.
3. No one mistakes your rope for theirs.

DISADVANTAGES

1. On a cave trip or a rescue it is very hard to convince anyone else that the rope is blue on the top, white in the middle and red on the bottom.

RECOMMENDATION

Dye the center 100 feet (or 50 feet on a 150 foot rope) so that the two ends stay the same color.

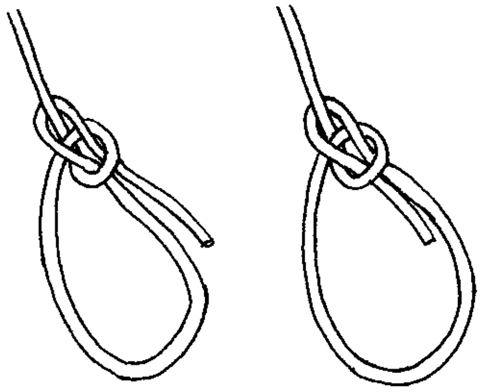
*****GO AHEAD AND DYE***** ☐

Which is Stronger?

By Bruce W. Smith

For years many of us have heard rumors that if you tie a bowline as it appears on the right it is 50% stronger than the bowline on the left. Sooner or later these myths need to be put to rest. Recently during research on the North American SRT book "On Rope", PMI opened up their lab so some simple testing could be performed. After several tests the results were conclusive...there was no difference in the strength of the the two knots. Both knots tested to be equally strong.

Further research revealed the real caution behind tieing a bowline as it appears on the right. With the tail part of the knot exposed to the side, it becomes vulnerable to possible bumps and has a tendency to invert. An inverted knot turns into a simple slip knot and very useless for its intended purpose. ☐



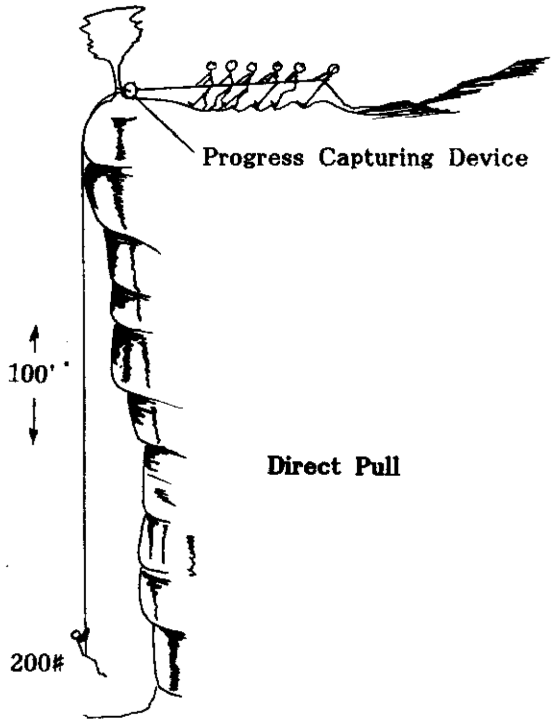
Moving People and Things Up

By Jim Hall

The quickest and simplest way to remove a person from a pit is to secure him to the end of a rope and pull him out. However don't try this by yourself, a rough guide for the direct pull of a person out of a pit is:

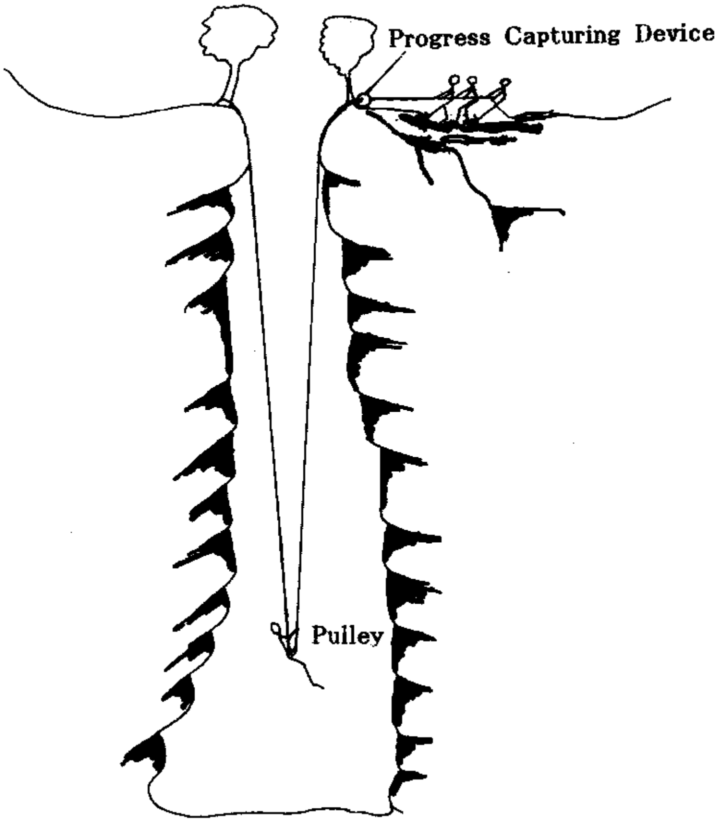
$$\text{Persons needed} = \frac{\text{Depth of pit + weight of person}}{50}$$

For example, a hundred foot pit and a 200 lb. person would require about six people to pull the victim out. For this method only the main rope and one safety Jumar (or cam or prusik) is needed (Fig. #1).



Direct Pull

Another way is the single pulley method. Its main disadvantage is that the rope must be twice as long as the pit is deep. Secure one end of the rope, lower the center of the rope, attach the person to the rope by means of a seat sling and a rescue pulley. This method gives almost a 2 to 1 mechanical advantage. (Each pulley has about 10% efficiency loss) See Fig. #2.



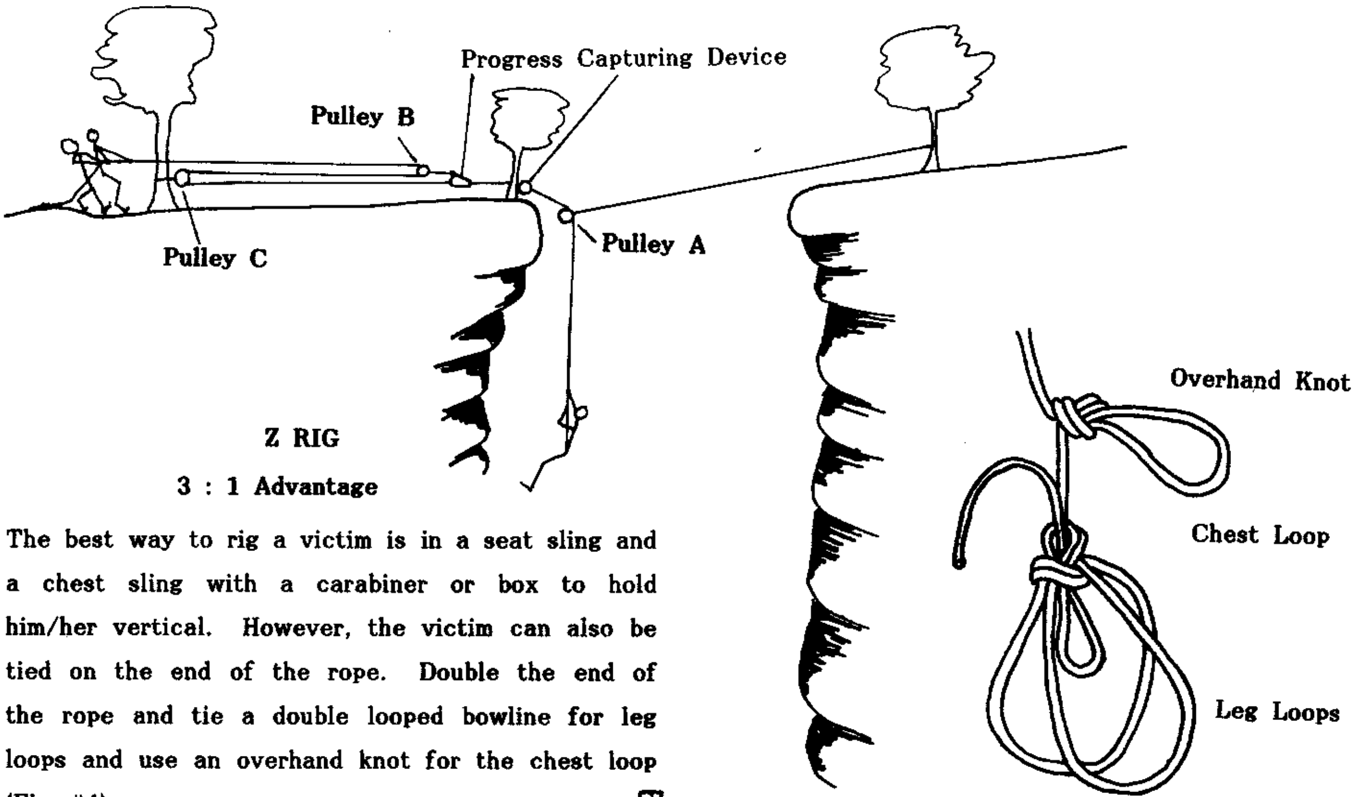
2 : 1 Advantage

A third way is the Z or S pulley system, it requires a rope slightly longer than the pit, 2 pulleys and 2 Jumars (Fig. #3). In the Z pulley system, care must be taken not to let pulleys B and C touch as this removes the mechanical advantage. This system gives almost a 3 to 1 mechanical advantage.

In all three systems a Jumar safety must be used at the lip to hold the rope while the pullers get a new grip on the rope. If a cam or prusik is used instead of a Jumar another person is required to control the safety.

A pulley rigged at the lip removes the friction of the rope on the lip and greatly reduces the lifting power required. Carabiners can be used in place of the pulleys, but they are far less efficient.

Moving People



Z RIG

3 : 1 Advantage

Bowline tied in the end of a doubled rope.

The best way to rig a victim is in a seat sling and a chest sling with a carabiner or box to hold him/her vertical. However, the victim can also be tied on the end of the rope. Double the end of the rope and tie a double looped bowline for leg loops and use an overhand knot for the chest loop (Fig. #4). □

WHAT'S NEW...WHAT'S HAPPENING

EDITOR

BLUEWATER

Kyle Isenhart reports that Bluewater has many new and useful products that are either being developed or are in the patent stages. Among these Kyle specifically mentioned the **Slot Harness**. This harness features extreme comfort and an adjustable fit that will fit anyone. It seems to be relatively compact.

The **All Terrain Edge Protector** is a new patented long form of multiple edge rollers. It was described as a large bicyle chain, 4" wide and 2 1/8" thick and comes and two lengths...24" and 32". The cost appears as if it will be about $115. It rolls up tight and compact.

Bluewater has just made available **Superline Plus Scotchlite** It is a rope that has a 1/8" wide reflective tracer in its sheath and is available now in their 1/2" and 7mm ropes. On a dark night or in a cave it will reflect with the glow of a flashlight 1000' away.

PMI

Pigeon Mountain Industries reports that they now stock a new very well engineered head lamp... **Petzel Laser Accetylene/Electric Lighting Unit.** It is basically two lights in one. 1). An electric lamp with an adjustable beam and 2). a carbide light with a parabolic reflector. The lamp is on a pivot mount with a spring which allows for the user to manually point the lamp where he/she wishes as well as providing for impact absorption. The carbide lamp part features a piezoelectric ignition system with a large waist mounted plastic carbide generator. The entire unit is small and compact and seems to provide the best of both worlds.

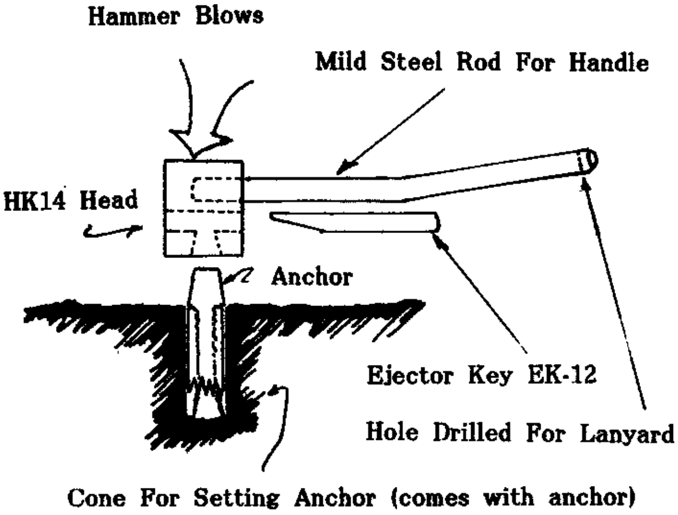
Caving Equipment

By Steve Knutson

A BETTER BOLT KIT

The Phillips Red Head Company makes self drilling anchors that are ideal for caving. To make a driver, one must order the head for the impact gun and have a handle (a length of metal rod) welded into the upper hole. The anchors can usually be bought at hardware stores. The HL14 head is for 1/4" anchors (takes 1/4" bolts). A handle can also be purchased (H-128), but I recommend welding in a handle. One also needs an "anchor ejector key" (EK-12). The head and key are about $20 wholesale.

With a side handle (as shown) instead of the handle in line with the anchor like I've seen others used, the anchor can't bind up while drilling and can be held further from you and still be hit with the hammer. Also, this driver is lighter that the straight type. Use hardened bolts to hold hangers to the anchor. The parts apppear as in the drawing.



The anchor is placed in the tapered sleeve in the head, set against the surface and the hole drilled by pounding on the head while rotating the head. The powder must be blown out of the hole in the end at intervals to keep the hole from packing up and preventing the cone from entering. Once the hole is drilled (head flush with the surface) the cone is placed in the end and the anchor and cone put back in the hole. A few blows of the hammer will set the anchor and a blow to the side breaks off the tappered part of the anchor exposing the threaded hole that well accept a 1/4" bolt to hold a hanger to which a carabiner can be fitted. The tapered sleeve is removed from the head with the ejector key (EK-12).

WET SUITS

To make a wetsuit easier to move about in, thin the material inside the elbows and behind the elbows and behind the knees. The arms and legs are difficult to bend in a wetsuit because of material bunching up inside the joints (behind knees, inside elbows). Just take a pair of scissors and start snipping off bits until 1/4" is down to 1/8". To find the appropriate area, just put that suit on, and mark the area that bunches when you bend your arms and legs.

If you want to decorate a suit, or add color to a black one, you can paint it if it is Nylon II (nylon outer covering). Use Latex paint. Don't put on a very heavy coat (diluting the paint works well) or you'll leave some on the walls of the first crawlway you go through.

HEADLAMPS

The Roose-lite can now be obtained from Miles & Patti Hecker in Casper, Wyoming. This is a water proof adjustable focus headlamp of high-impact plastic that uses the same 6 volt bulbs as the Justrite metal headlamp but seems to have a better reflector. It puts out a beam nearly as good as a Wheat Lamp without the huge and outrageously heavy battery pack, and is adjustable for tilt. I believe it is priced around $20. A Superior item.

PIEZOELECTRIC LIGHTERS

This item has definitely proven itself under wet conditons. Whether it is Ok in gloppy mud remains to be seen, but whether or not, its utility in water is sufficient. Attached to a carbide lamp, it will light it, even in a shower, just tilt the lamp down and "Pop!", on it goes. I've used them for 3 years now and the one from Edmund Scientific wears quite well. One went down a 100' pit. The lamp was a bit bent, and the piezoelectric housing was cracked so that the plunger was loose. When the plunger and spring were replaced, it sparked the first time.

I've seen where they have been mounted to the reflector; I've mounted them on the side of the lamps, both Justrite and Premier. I think this offers more stability. It might be best to mount one on your helmet, if connectors can be found that won't allow arcing, and put only electrodes on the lamp, so that one piezoelectirc will serve all lamps you might want to use.

Edmund Scientific seems to have discontinued their piezoelectic but I believe it is sold by Ian Ellis, and the barbeque-RV propane stove lighter by Coglan still seems to be available.

ROPE

In caving, the rope in standard use is always nylon, with a tensile or breaking strength of some 6000+ pounds. Why is this? The reason is that that was the standard size for mountaineering and rock climbing, where one took leader falls and could easily generate forces of 1-2000 lbs. Indeed, there have been falls that pushed nylon rope to its elastic limit -- that is, actually generated a force very close to the breaking strength.

In caving, however, one rarely does leader climbs and does not need anything close to 6000 lbs. to have an acceptable safety margin. In rappelling and prusiking, one must use very poor technique indeed to generate forces to more than 500 lbs. Thus a 4000 lb. test rope, which should break at no less than 2000 lbs. with a knot in it, would provide at least a 4:1 safety margin -- more than adequate.
Thus, there is no real reason to use a rope as big as 7/16" (11mm) in pit work in caving. Of course, one must be more careful with rope abrasion and not be sloppy, as when one reads of ropes that were allowed to abrade until the sheath was entirely gone. With a 7/16" rope the core still has plenty of strength and this is no big deal, but with smaller ropes, you have less material to work with. Also, and obviously, any ascending method that is bouncy is very bad (if you start bouncing it is not difficult to damp it with the climbing motions), and rappelling in great lunges and swoops is out.

So, I intend to convert to 10mm or 3/8" ropes. Ropes of this size are available from both Bluewater and PMI. I used the 10mm Bluewater in deep pits (up to 100 meters) in Mexico last year and will try the PMI this year. The Bluewater worked great and the bright orange color is a real asset. Save weight, money, and bulk and use 10mm ropes.

POLYPROPYLENE LONG UNDERWEAR

This is an obvious improvement over many thermal underwear types -- the fiber is apparently hydrophobic and wicks water away from itself. Thus, it dries quickly after being soaked and doesn't retain sweat.

Caving Equipment continues on page 29

1985 Vertical Section Minutes

The 1985 meeting of the NSS Vertical Section was held Monday, June 24, in Frankfort, KY at Kentucky State University. Approximately 45 Section members were present. Executive Committee Members present were Bill Cuddington, David McClurg, Jim Hall, Bill Bussey and Kirk MacGregor, who chaired the meeting.

After a luncheon, Kirk MacGregor, called the meeting to order at about 1:00 pm.

The meeting started with Bill Bussey reading the Secretary's and Treasurer's report. These are printed on page 4 of **Nylon Highway #21**. Kirk MacGregor noted the closing balance made us look "...richer than we, in fact, are", due to the introduction of multi-year memberships. This money is committed to printing **Nylon Highway** in later years. There was discussion about placing these funds in a savings account or money market fund. Bill Bussey said he was looking into this.

Bruce Smith asked why there were only 345 issues mailed, as listed on the Secretary's report. Kirk MacGregor replyed saying the report reflects only what would have been mailed on the report date.

Kirk MacGregor noted that there was a significant increase in members over the year. Membership rose from 231 to 308.

Kirk MacGregor mentioned a typographical error in the 1984 meeting minutes. On page 19 of **Nylon Highway #19**, Vertical Committee needs to be changed to Vertical Section.

There was much discussion on the Editor changing the wording or intent of meeting minutes as printed in **Nylon Highway**. Kirk MacGregor moved that:

> The Editor must publish the annual meeting minutes exactly as received from the Secretary/Treasurer except for obvious errors in grammer, spelling and usage.

In the discussion, Allen Padgett stated that the situation was that "Chairman" was changed to "Chairperson". Kirk MacGregor noted that the only minutes we have are those printed in **Nylon Highway**, thus they should be as accurate as possible.

Bruce Smith said the Editor should have a right to edit. Since this publications goes out internationally, we have a duty not to look like "American Chauvinist Pigs." Smith finally contended that in this case "Chairman" was incorrect usage and made the appropriate adjustment.

The vote carried with only 2 opposed.

Next, Kirk MacGregor handed out copies of an Executive Committee Job Description which he completed as directed in the 1984 meeting. These clarify the specific duties of Executive Committee Members. He proceeded to cover the high points of the Chairperson's job.

Greg Valent noted that the Secretary/Treasurer's job is seemingly overloaded. Discussion then followed about this job. The consensus was that the Secretary/Treasurer's job will remain as it is as long as someone will do it. Kirk MacGregor then proceeded to go over the high points of the Secretary/Treasurer's job. Bruce Smith then complemented the Sec./Treas. on the job he had done over the past year.

In order to save time, Bruce Smith asked that the Executive Committee look these descriptions over, and make a finalized report for the section meeting next year. This was adopted by acclamation.

The matter of purchasing a "Headline Maker" in order to make better headline copy for the **Nylon Highway** was then discussed. Kirk Macgregor moved:

> The Vertical Section spend up to approximately $300 to purchase a headline maker for the Editor's use. The Executive Committee and the Editor will make a reasonable effort to find one which would give us the best possible value.

The motion was passed unanimously.

Allen Padgett then gave a report on the progress of **On Rope**. The vertical techniques book he and Bruce Smith are writing for the NSS, and which is being sponsored by the Vertical Section. He noted that it should be in print by next year if all goes as scheduled. Kirk MacGregor then made an informal motion on whether the Section wanted to continue work on the book. The motion passed, with a chuckle, with all present in favor and Allen Padgett and Bruce Smith opposed.

Discussion was held on whether the section should have a patch, hat, or other symbolic device. Kirk MacGregor moved:

> The Executive Committee will look into getting a Logo for use as a symbolic device.

The motion was passed unanimously.

Bruce Smith made his usual plea for articles. He noted several areas where work was needed. Articles on bolting, big wall and dome SRT, and the Dougle Bungie climbing system are all in need of being written about and would be especially welcome.

Bill Cuddington urged people to sign up to help with the Vertical Contests starting the next day.

The meeting concluded with elections. Those elected were:

Dave McClurg	1986 Convention Coord.
Bruce Smith	Editor **Nylon Highway**
Bill Bussey	Secretary/Treasurer
Bill Cuddington	Exec. Committee Member
Richard Schreiber	Exec. Committee Member
Kirk MacGregor	Exec. Committee Member
D. C. Province	Exec. Committee Member

The duties of the Convention Coordinator were then quickly discussed.

The meeting was adjourned at approximately 2:15 pm.

After the meeting the Executive Committee met and selected Richard Schreiber as Chairman. ☐

Respectfully submitted,

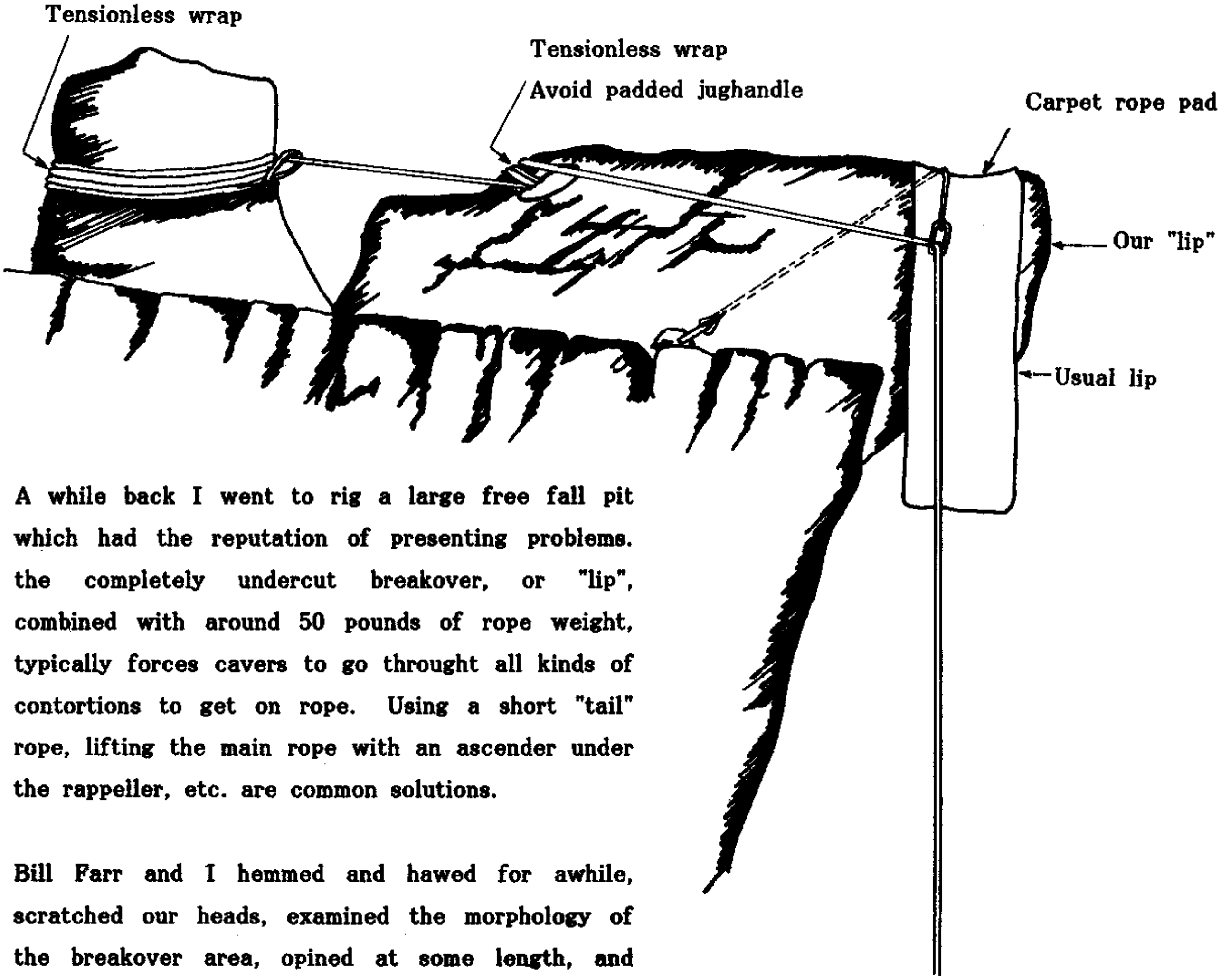
Bill Bussey

RECORD TYROLEAN DONE IN CANADA

The Editor has just heard of a record long 1471' Tyrolean that was successfully done in the Canadian Rockies in March by a Canadian Rescue group during a training class. PMI was the rope while the top to bottom drop in the gorge was estimated at 1000'. The 1471' was reported as the actual free space traversed. I will attempt to get the whole story for a future issue for the Great Vertical Events column.

An Anecdote on Avoiding Pit Break Overs

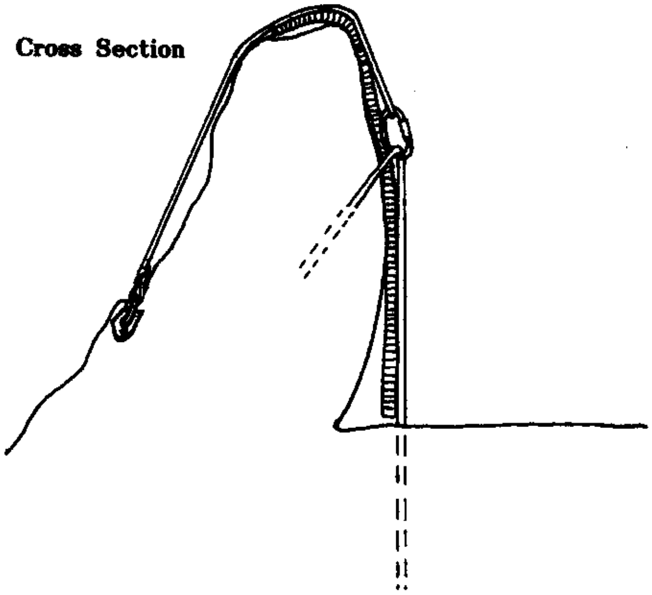
BY JOHN GANTER



A while back I went to rig a large free fall pit which had the reputation of presenting problems. the completely undercut breakover, or "lip", combined with around 50 pounds of rope weight, typically forces cavers to go throught all kinds of contortions to get on rope. Using a short "tail" rope, lifting the main rope with an ascender under the rappeller, etc. are common solutions.

Bill Farr and I hemmed and hawed for awhile, scratched our heads, examined the morphology of the breakover area, opined at some length, and decided that the simplest thing to do was to move the lip. What?!

The illustration tells the story. Sure, every drop has a lip where the rope goes free, but we moved ours up about 3 feet on the side of a conveniently situated rock mass. As a result, people could just safety themselves, step up, rack in, and step off. As it turned out, we did rig an auxiliary tail to help tandem climbers get off rope, but we could have done without it. Everyone was surprised and pleased that the "battle of the lip" had been avoided. Spending a little time and thought, and being carefully unorthodox, can pay off. ☐



Squeeze Brakes continued from page 8

Another problem is that it seems to be easy to design automatic-stop systems that use bad human engineering. The obvious example is a device where you squeeze handles to go faster and let go to stop. People do not let go easily in falling situations, and such devices would probably cause more damage than they prevent.

Automatic-stop systems also do nothing to reduce hand effort on fast-control levers. However, if you can invent a simple, human-engineered one, it would be a nice extra.

6. A latch to hold the fast control in the stopped position, preferably one that engages automatically at maximum stopping. Stopping on the rope by latching the fast-control is much faster and easier than cranking up the base force. The lack of such a latch on the nutcracker of the Thor brake was a problem on several occasions. An easy-to-operate latch on the fast control is almost essential in a practical squeeze brake.

If the latch is constructed so it engages automatically at a large stopping force (beyond normal control forces), it becomes the onset of unconsciousness, hearing a falling rock, or confronting an urgent problem just gives one quick, hard squeeze of the fast-control levers, and is stopped on the rope.

7. High abrasion-resistant and/or easily-replaced friction surfaces. Squeeze brakes are fairly elaborate and expensive, and having to throw them out because the friction surfaces are worn is undesireable. Worse yet, many squeeze brakes fail fairly abruptly from wear. For example, when the main plates on the Thor brake are worn to the point where the rope-guide strips inside meet, they cannot be screwed up any further, and the force on the rope diminishes with further abrasion. This could create a dangerous situation on a long rappel on dirty rope. Thus the friction surfaces should abrade very slowly, even on gritty ropes, or they should be small, separate parts that are easily replaced.

There seems to be a trade-off between abrasion-resistance and the weight of a brake. Presently, it is not clear how to handle this. Naively, high abrasion-resistance looks good. However, abrasion-resistant metals tend to have low friction on nylon. This requires a heavier brake that can squeeze the rope harder. It may be that easily-replaced, softer, high-friction friction surfaces are the best idea. If squeeze brakes damage rope at the pressures required with hard, low friction surfaces, but not at the lower pressures required with soft, high-friction surfaces, this would definitely be so, but this is presently unknown. Also, are there safe-for-nylon materials that are both abrasion-resistant and high in friction?

8. A way of adjusting the range of rope thickness over which the brake functions. While there may be squeeze brakes that function well over a wide range of rope diameters without any special adjustments, this is not true of the Thor brake. It is adjustd for rope diameters much different from 7/16" (or for very soft ropes) by changing the positions of the locked nuts on the hinge bolts with wrenches.

It would be better if this adjustment could be made easily and without any tools.

As far as I can tell, making a squeeze brake operate well over a wide range of rope diameters becomes more difficult if the brake goes on and off the rope quickly and easily. Thus, a convenient range adjustment is probably more necessary on brakes that are more practical than the Thor one, which is too slow on and off the rope to be useful on short drops.

MORE SQUEEZE BRAKE DESIGN CONSIDERATIONS

Additional information that may be useful to squeeze brake designers follows:

On squeeze brakes that include a screw, it is probably better to use a doorknob type of handle on the screw, rather than the crank handle used on the Thor brake. when the screw is done up, large torques are required to turn it. I found that I could use the Thor brake crank handle in the intended manner only while initially taking up slack. When the rope was fully squeezed, I had to hold the arm of the handle like a doorknob, and turn the assembly like a doorknob. However, the lightest possible handle consists of just an arm radiating from the screw, without a knob on the end as in the Thor brake. This approach is also worth considering.

The coefficient of friction between metal and nylon fiber measured in a squeeze brake is probably somewhat higher than the coefficient measured between flat surfaces. This would be expected because the rope is compressed and flattened as it enters the brake. This dissipates additional energy, and this loss appears as additional friction in the measurement. This effect would be expected to increase as the length of the flared section where the rope enters the friction surfaces decreases, as the length of the friction surfaces decreases (shorter surfaces give higher rope pressure and greater deformation), and as the force applied to the rope increases, causing greater deformation. It may be that substantial increases in friction can be obtained by using short friction surfaces that compress the rope abruptly. Unfortunately, such friction surfaces are also more likely to damage the rope. No experimental data on either of these effects is presently available. The Thor brake compresses the rope gradually in the main plates, which apply pressure over a substantial length of rope. The nutcracker both compresses more rapidly, and applies pressure over a short length of rope.

The friction between a surface and a rope can be increased by texturing the surfaces (e.g. Jumar teeth). Using textured friction surfaces made out of very hard materials may give a better trade-off between abrasion-resistance and friction than can be achieved with smooth surfaces.

The main plates of the Thor brake originally had 4 hinge bolts. I reduced this to one to allow the plates to pivot relative to one another. This should make the pressure on the rope more uniform along the plates, and may make the brake less sensitive to lumpiness along the rope. On the other hand, hinge bolt breakage can be serious. So there is something to be said for two hinge bolts, if they can be positioned so they don't degrade friction surface behavior, and don't cause other significant problems.

If you use springs in a squeeze brake, minimize both the chance of them breaking, and the consequences if they do, Use quality springs, and use them well within their maximum compression or extension specifications. If possible, design the brake so the rapid control can immediately take over for a broken spring, and the base control can then be adjusted to give workable performance with the broken spring. (This is the case with the Thor brake. The nutcracker can support the whole weight, and the screw can be screwed up as far as needed to restore main plate pressure.) If this cannot be done, use several springs in parallel, so breakage of one causes little trouble.

One would expect long friction surfaces, (several inches or more) to average out inch-by-inch variability in the rope better than short ones (one or two inches). This would be particularly significant on laid ropes like Goldline. However, there are essentially no test results on whether long surfaces are worth their extra weight.

There is a rather definite upper limit to the amount of weight a squeeze brake can support without going out of control. This limit is roughly equal to the maximum force the rappeller can maintian on the controls multiplied by a constant that depends on the construction of the brake and its friction with the rope. Little can be done to increase this. There is no mechanism analogous to adding or moving bars on a rack, and the limited amount of friction that can be produced by leg wraps or the like only adds to the squeeze brake friction. (In a bending brake, the friction of a leg wrap is multiplied in the brake, allowing major increases in supportable weight. This not so in a squeeze brake.) On a slippery rope, the maximum supportable weight for a squeeze brake may be less than twice the rappeller's weight. this can be a problem where a rescuer rappels down to an incapacitated victim, hangs the victim under his or her squeeze brake, and continues rappelling. Both may go out of control when the victim's weight is transferred. There are two general solutions to this problem. One is building squeeze brakes with provision for augmenting the base force. One idea is a screw mechanism at the top of the brake that can force a sharp bend into the rope there. Another idea is a base force mechanism with two different mechanical advantages. The second solution is simpler. Just use two squeeze brakes. Set one a bit fast, and use the other to provide control for both. Both brakes can be on the rescuer, or one can be on each person. There is also a technique for doing such rescues using one ordinary squeeze brake, but it is beyond the scope of this article.

It is worthwhile to look at the forces involved in the operation of devices like the nutcracker on the Thor brake. According to the person I talked to in physical education at one of the local universities, a university male athlete can squeeze a pair of handles such as those on the nutcracker with a maximum force of 80 to 90 pounds, using one hand. A particularly strong athlete trying very hard could briefly achieve perhaps twice this force. Using both hands would almost double the force again. Thus the levers of a nutcracker should be capable of withstanding about 350 pounds. However, most nutcrackers would never experience a force this large, and a very low safety factor should be acceptable. If the levers of the Thor nutcracker are grasped reasonably close to their ends, the force on the rope is about 11 times the gripping force, and the tension in the hinge bolt is about 10 times the gripping force. In the worst case, this gives 3850 pounds on the rope and 3500 pounds in the hinge bolt. 3500 pounds tension in an ordinary 1/4-20 bolt is highly unsafe. As the 3850 pounds on the rope is applied over an area of less than .5 square inches, this gives a pressure on the rope of at least 7700 psi. Using just the Thor nutcracker as a brake, a 180 pound athlete exerting 350 pounds on the levers could just support himself on a rope with a coefficient of friction of 0.023. However, all these figures are unlikely extremes.

More realistically, the coefficient of friction between the Thor nutcracker and old rope seems to be somewhat over 0.20, though I have no actual measurements. Assuming a coefficient of 0.20, a person weighting 180 pounds can be supported by the Thor nutcracker alone if its levers are held shut with 41 pounds of force. However, the nutcracker is normally used with the main plates supporting most of the load. If the main plates are carrying 75% of the load, it only takes 10 pounds of force on the nutcracker levers to control the 180 pound rappeller. By varying this control force from 0 pounds to 30 pounds, the rappeller can rapidly achieve anything from fast descent to abrupt stopping.

If I were designing the Thor nutcracker again, I would give it a mechanical advantage of about 15 to 1 instead of 11 to 1. The modest increase in control (or reduction of control force) would be nice, and the modest increase in control movement would not create a problem. However, if the mechanical advantage were increased to 20 to 1 or higher, the increased movement of the levers would probably cause trouble.

The Thor brake was only used in a cave twice. Thus I have essentially no experience on how well screw mechanisms survive mud and grit. It may be that the life of screws in caves is short enough that they should be eliminated from practical squeeze brakes. On the other hand, coarse screws made of hard metal may give adequate service.

PROBLEMS AND POSSIBILITIES

The major problem for squeeze brakes at present is the unresolved question of whether they damage rope. There is no real reason to believe they do. On the other hand, there is no proof that they don't. Perhaps some squeeze brakes damage rope and others don't.

If it is eventually proved that at least some squeeze brakes do not damage rope, considerable improvement over the Thor brake is desirable. In particular, one would want a smaller, lighter brake that goes on and off the rope faster. It should be possible to make a brake with only one set of relatively-small friction surfaces that just "clips" on and off.

If it could be produced for a price comparable to that of the rack, such a squeeze brake could see substantial use. On the other hand, perhaps the Thor brake will be the last of the squeezers.

...We will see.

ACKNOWLEDGEMENTS

I would like to thank Walter Chlebek and Michael Magill for their assistance, in 1968 and 1982, respectively. ☐

Let's Talk Prusiking continued from page 10

A common mistake, some beginning prusikers make, is to have their lengths too long and they have to raise their legs too high. This throws their body back too far and they don't get much of a step.

In summary, a vertical caver might enjoy developing an efficient 3 knot rig and of course, be skilled with Gibbs rig, too. Remember, there will be many times when the Gibbs rig will be the better choice. But there will also be times when you will be able to use your knot rig which will allow you to "slow down and smell the roses."

P.S. If Dave Hughes had written this, it would have been called, "Why Not Knots Part II?" ☐

Tie - Offs

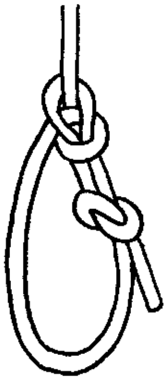
By Bruce Smith

Knots by themselves are strong, but with nylon as the primary medium, the need and use of various tie-offs are essential.

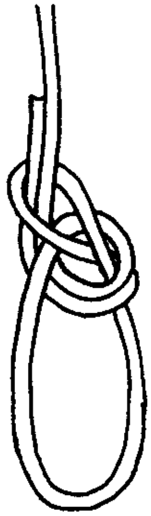
Half hitches are nice, but the push of the vertical world seems to be heading towards over-hand tie-offs. Half hitches are bulky and tend to be over done, while an over hand knot can be tied once, insure security and not involve the bulk of multiple half-hitches.

Tim Setnicka in his book **Wilderness Search and Rescue** published in 1980 writes about another tie-off that he learned during ranger clases at Yosemite National Park. The "Yosemite Tie-off" is tight, clean and left the loop of the bowline uncluttered, so it could be easily used. I have personally experimented with this particular tie-off and find it very reliable. The Yosemite tie-off works well with many of the bowline versions. In addition, the Yosemite tie-off provides for an 8% stronger knot because it opens the knot up a little and curves the bends of the knot more gently. ☐

Half hitch tie-off



Overhand tie-off



Yosemite tie-off

ADMINISTRATIVE

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For Spouse memberships add $1.00. Please insure that these payments are in U.S. dollars. Frequency of the publication is based on the availability of material. All material that is submitted must be readable. The Editor is able to arrange, upon request relatively quality drawings explaining your topic. As many of the articles published in the **Nylon Highway** are experimental, the NSS, Vertical Section, the Editor as well as any and all authors whos names appear in the **Nylon Highway** absolve themselves of all responsibility. It should be understood by the reader that the responsibility lies with those who choose to experiment further with the information contained here. The **Nylon Highway** attempts to screen and publish reliable high quality material that in the Auther's and Editor's best judgement appears to be sound in principle and is backed up with supportive testing or facts. The science of SRT is ever changing because cavers and climbers are constantly finding better safer and more effecient ways of acheiving our goals. Always experiment using good judgement and adequate caution. **...THE EDITOR**

NYLON HIGHWAY #22 MAY 1986

COVER: "Eye of the Vertical Caver"

Cover Photograph by Michael Williams of Noel Benedict beginning the 30' rappel just before "Tilted Well" in **Run To The Mill Cave.**

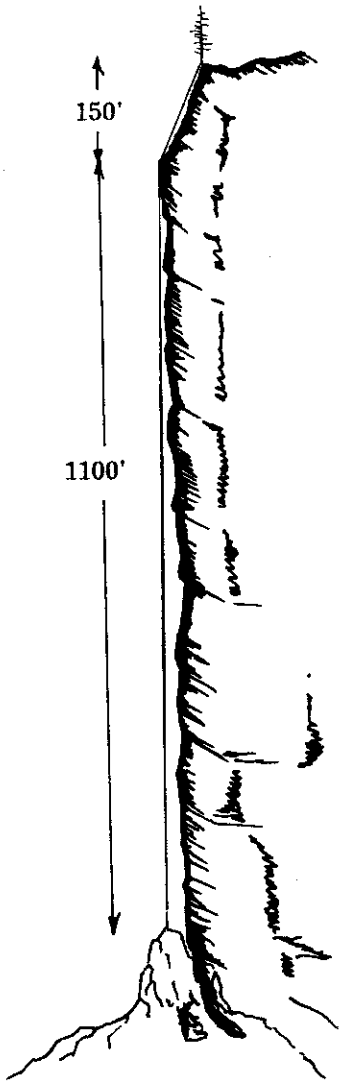
The Watchtower Rappel, Sequoia National Park

By Richard Schreiber

The 1966 NSS Convention, held at Sequoia National Park, California, saw the gathering of numerous vertical cavers from across the U. S. Early discussions of long drops lead to the formulation of plans to attempt a long rappel/climb. Coming to mind early in the planning stages was the idea of rappelling Moro Rock, not far from the Convention activities area within Sequoia Park. After discussing our plans with the Park Service on Tuesday, it was concluded that though Moro Rock was easily accessible, it was not a good choice because of the chances of falling rock and debris due to the very heavy public activity along the trail to the end of the Rock, all above potential rigging points.

Drop selection

The Park Service did suggest an alternate site about a mile up the valley from Lodge Pole, a high more vertical cliff at a point known as The Watchtower. Here we were told of a 1200'-1400' drop free from the presence of public interference and still reasonably accessible. We were granted permission to rappel/climb at The Watchtower and thus began our climbing project in earnest. On Tuesday afternoon, a scouting party left the lodge at Lodge Pole and hiked up the valley to the base of the Watchtower. With binoculars, the drop was studied. Present were Bill Cuddington(AL), Richard Schreiber(GA), Sara Corrie(WV), Ron Bridgemon(AZ), Barry Spreen(MO), and others. It appeared to be essentially vertical, mostly sheer with ledges. The degree of free fall was not disconcernable from the bottom. Also, the width of the ledges was not detectable. On Wednesday morning early we set out along a 3 mile trail to the top of The Watchtower. Our plans included a group of 5 climbers and a support crew of 3. The climbers included those mentioned earlier. The support crew included Bill Biggers(VA), and two others including a photographer. We carried with us as our rigging rope a 250' length of braided rope and a 1180' length of 1/2" Sampson 2 in 1, the main rappel line. It was carried as a large chain on several shoulders to the top of The Watchtower.



Watchtower

Watchtower

Rigging

When we reached the top of The Watchtower, we concluded that the chances that the rope would reach the bottom were slim if we rigged at its highest point. A rigging point in a notch down from the top, perhaps 100' was chosen. The 250' rope was tied off to a very large pine tree as a rigging rappel line down to the initial breakover to the main long drop which was approximately 150' down. The main rope, the 1/2" Sampson 2 in 1, was fed from the top down to the breakover and then lowered on below. Almost all of the 1180' of rope was used minus that which was necessary to tie to the 250' from above.

Descent

Bill Cuddington descended first using a John Cole early prototype rappel rack with solid aluminum brake bars. His descent was lengthy and slow because the lowered 2 in 1 rope had snagged on numerous projections, ledges, etc. on the way down. He carried a Jumar safety if the need arose. It took over an hour for him to reach the bottom where he found that he was very near the end of this rope and not yet at the true bottom of the Watchtower. He had landed on a pinnacle above a steep talus slope as much as 100 feet above its base. Fortunately, he was able to leave the rope and climb down the large boulder slope.

Second down was Richard using a large spool rappelling device (fig. #1). The descent was steady, but slow, as feeding was necessary at the top. With the rope dressed clean down the drop from Bill's efforts, the rappel went smoothly without event. A Jumar safety was carried.

Third down was Ron using a Roloff rack (fig. #2) with hollow steel brake bars. Ron's descent went well.

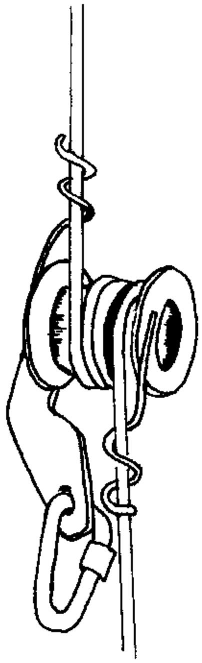


Figure #1 **The Rappel Spool**

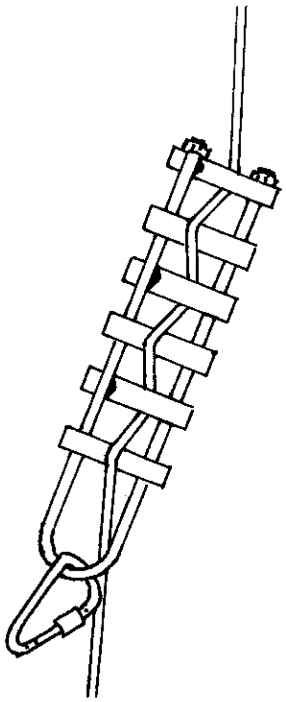


Figure #2 **The Roloff Rack**

Next followed Sara on a rappel spool. She had to feed a fair amount of the way. High, late afternoon winds swept her about along the cliff face as she descended.

The last and final climber to descend was Barry who descended on a rappel spool. Being heavier than Sara he experienced less wind effects.

Ascent and Derigging

It was decided that time did not permit all climbers to ascend the drop and that daylight would be gone in 2 to 3 hours. Bill elected to ascend, untie the main rope and hike out with the 250' back to the cars. He climbed, using a 2 knot-chest harness-balance knot-Swiss seat system with floater knot on the balance leg (fig. #3). He ascended in approximately 1 3/4 hours. Upon arriving at the top, he untied and dropped the 1180' 2 in 1 which fortunately for us blew out from the face and down into the talus pile at the base. While Bill derigged the 250' and returned to the car, Ron, Barry, Sara, and Richard coiled up the main rope, a slow process due to its being tangled and interwoven among and around the talus boulders. We stashed gear in safe places at the base of the talus pile and beat a hasty retreat down the valley with the rope to the lodge as the last rays of daylight faded. We returned the next morning to retrieve the remaining gear.

After Thoughts

The climbing at the Watchtower was accomplished without incident and went smoothly...all things taken into account. No radios were available so lifting the rope provided our only clue to an empty rope ready for the next rappeller.

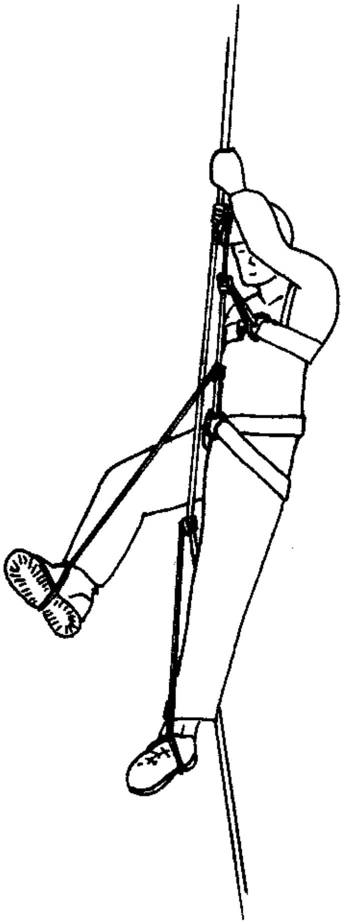


Figure #3 **Cuddington Climbing System**

We estimate that the 150' plus a 1100' rope length gave us a descent at 1250', mostly against the face. Some free fall was experienced when high wind blew us from the wall. Ledges were narrow and provided no step-off resting place to speak of. Rope contact with the face did not result in extensive abrasion as was initially feared.

The Watchtower was a nice vertical event for the 1966 NSS Convention, a time when the rappel spool was in its waning days and the rappel rack was just coming into its own. □

Caving Equipment continued from page 18

THE FUTURE

I hope to see a move to lighter and more compact vertical gear. For instance, the **rappel rack** is a fine item but is a bit overly built, being heavier and larger than it needs to be. A miniatureized version would be nice.

The **chest blocks** commercially available all have deficiencies. The Gossett is too heavy and the rollers can be difficult to screw in or unscrew at times (like when in a swim). The Bluewater is a real clanky affair, but I prefer it to the Gossett. Wider backing plates on either would hold the block closer to the chest and allow it less twist. John Blum has made a prototype that pivots open when a vertical pin is pulled (Ed. Called the Q-Box). This looks better than the Gossett or Bluewater. Radio Shack now offers a **2-way radio** in a head set with voice-actuated mike. I expect to see these mounted in helmets for communication down pits and around waterfalls in the near future.

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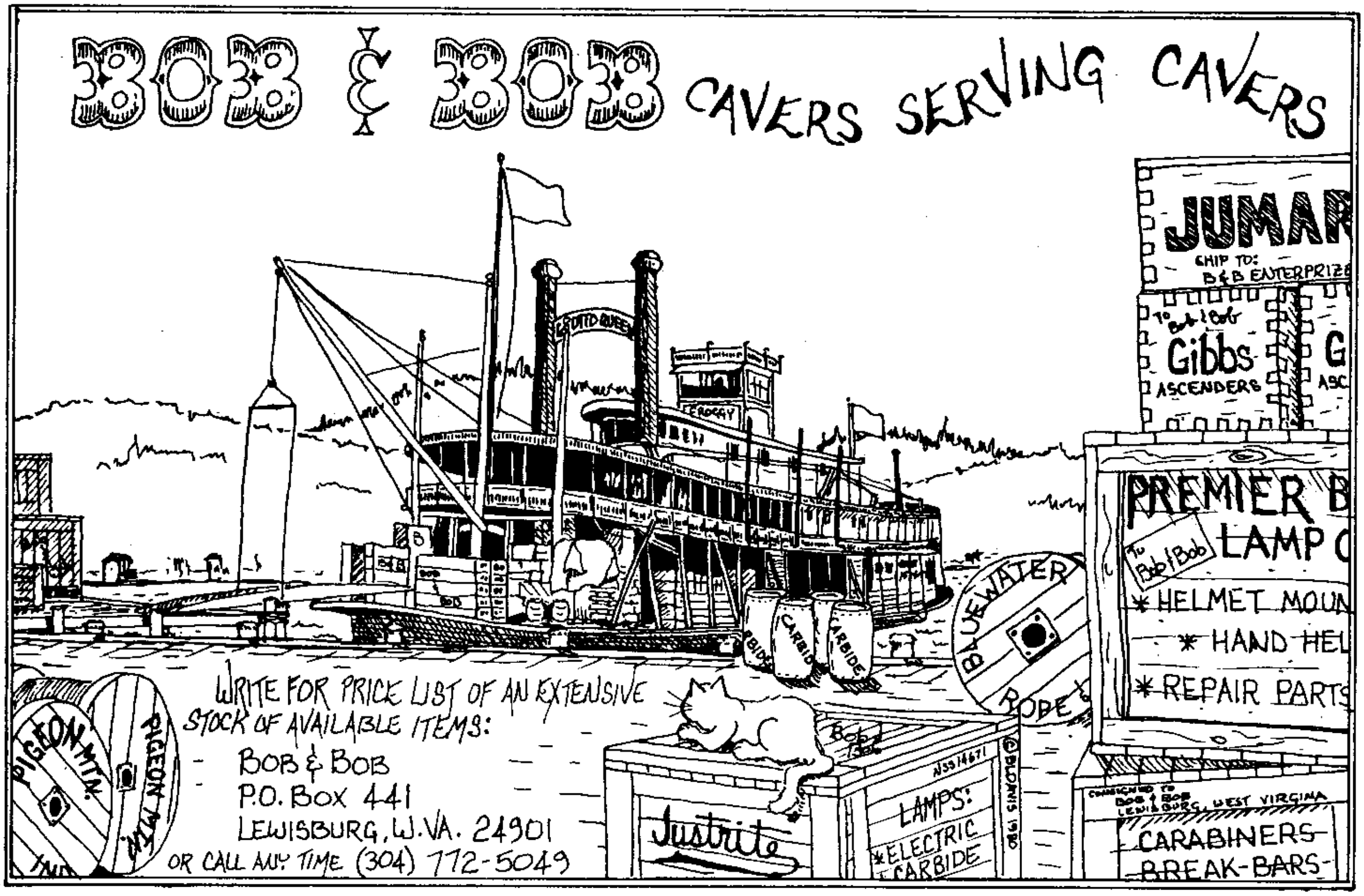

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