NYLON HIGHWAY 8

...especially for the vertical caver

Nylon Highway 8

March 1978

NSS Vertical Section

INSIDE :

Details:

Deadline for NYLON HIGHWAY #9 is closing in as you read this. If you are planning to submit an article, let me know. #9 will be out before convention in June, so hurry and get your article in the mail! Articles need to be typed double spaced, if at all possible, and illustrations, graphs, etc., inked, ready for final copy. One need not be a Vertical Section member to contribute. Letters to the Editor are welcome.

NYLON HIGHWAY is published by the NSS Vertical Section, and available to non-members for $3 per year. Grottos may receive issues for the cost of postage; $1 deposit required. Recieipt of copies of articles appearing in the organization's publication concerning vertical techniques, equipment, etc., which may be considered for reprinting in the NH will be considered an exchange for one issue of the HIGHWAY. Overseas subscriptions are $4 ($6 airmail) a year. Frequency of publication is based on the availability of material.

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Cover:

Cover photo by Bob Alderson (14667) of Virginia. Hopefully, this is a familiar sight to vertical cavers! However, should you see things in this sort of contrast, perhaps you've been underground too long...

He Did It AGAIN . . .

AND SET ANOTHER WORLD RECORD!

YES, RIGHT THERE IN FRONT OF GOD AND EVERYBODY, BILL STONE CHARGED UP 100 FEET OF ROPE IN ONLY 28.1 SECONDS.

WAS IT THE MICHIGAN AIR? THE PMI ROPE? THE GIBBS ASCENDERS??

OR ALL THOSE MUSCLES RIPPLING UNDER THAT BEAUTIFUL BODY??

Reprinted February 1994

Letters!

[Write One!]

Editor:

The Vertical Section and its publication, the NYLON HIGHWAY, are in a unique position to postively influence the course of vertical caving throughout the world. It is my feeling however, that this challenge is not being met as fully as we are capable. Several thoughts come immediately to mind.

If one of the goals of the organization is the dissemination of vertical information and knowledge, my observations during recent widespread travels is that very few active cavers are aware of the existence of the Vertical Section.

Another point, perhaps related directly to the above, concerns the present membership requirements. It is my feeling that the current requirements actually mitigate against the fulfilling of the Vertical Section's goals of increasing and spreading knowledge of vertical equipment, techniques, and safety. Vertical caving is not restricted to cardcarriers of any organization. Nonmembers need good information just as much, perhaps more so, than members. An elitist policy of different (and unnecessary) membership classifications does not aid the cause. It actively hurts, as I know of people who have not joined because of these requirements.

To highlight the above points, NYLON HIGHWAY #7, page 22, has a list of members. In the bottom lefthand corner there is a category called "Membership Decline." It reads: "1973-75 = -31, including 17 charter; 1976-77 = -13, including 4 charter." The figures speak for themselves; something is wrong.

Because the Vertical Section and the NYLON HIGHWAY are important, and because the need is real, I offer the following specific proposals for discussion and implementation:

1. Membership restrections as they currently stand should be completely removed. Any person who wishes to join should be allowed. To take full advantage of this, the Vertical section should
2. implement an advertising campaign within the NSS and other caving organizations (i.e. foreign) to actively publicize the Vertical Section and to recruit new members.

Implementation of these ideas would give the Vertical Section a broader base among the active caving community and hence provide for wider dissemination of vertical equipment, techniques and safety information. This could be accomplished without violating any existing understandings in terms of caver proliferation and would place the Vertical Section in a more influential position (solely through continued high quality articles in the NYLON HIGHWAY) to affect the world of vertical caving. Related to this, two more items should be considered.

3. Use of the NYLON HIGHWAY not only as a medium for publication of top flight origional articles, but also continuing and expanding the policy of quality reprints from sources not commonly available to the average caver. Also, a policy should be pursued that actively encourages grottos to reprint articles of interest from the NYLON HIGHWAY in their own newsletters.

4. Increase the dues for membership and subscription by one or two dollars. Such an increase could lead to providing the following services in addition to publication of the NYLON HIGHWAY.

5. Money could be channeled into research and testing of vertical equipment, an area that needs immediate attention here in the USA; and

6. A policy could be established whereby a copy of each issue of the NYLON HIGHWAY would be sent to every active grotto within the NSS without charge. This would insure more effective information dissemination and publicity for the Vertical Section. In light of implementing a slight dues increase combined with an increase in membership, the actual cost should be negligible.

American cavers are responsible, to a large extent, for the high level of competence in the vertical caving workd today. The talent and abilities existing already within the NSS and particularly within the Vertical Section can be found almost nowhere else in the world. We need to continue the aggressive, creative approach to vertical caving that has placed American cavers in the forefront of this sport.

We cannot rest on our laurels, others are challenging. New ideas and approaches are needed. They do not come by closing the doors upon ourselves, but stepping out and meeting the challenge. The ideas outlined could have such an effect. I welcome any ideas, comments or criticisms. Who knows, if the membership requirements are changed, I may even join the Section.

/s/ Wil Howie
NSS 12149

Dear Editor:

Get out of your blissfulness, here is a letter!
Two things about NYLON HIGHWAY 7:

1. "The Birginia Region Artificial Aids Resolution (on page 1).
I think that point 2 in this should be reconsidered. ("After an artificial anchor has been used, the bolt hanger should be removed and the threads protected.") This practice eliminates corrosion of the hanger and allows more thorough inspection of the bolt, but it creates two problems that, in my opinion, outweigh these advantages.

One problem is dropped bolts and hangers. Many bolts are in places where dropped parts are lost parts. With hangers being put on hundreds of times more frequently than is now the case, not to mention an equal number of removals, lost parts may become a noticeable problem.

More seriously, bolts without hangers can be hard to see. Inevitably, significant numbers of cavers will miss hangerless bolts. Some of these cavers will place their own bolts, causing unnecessary proliferation of bolts. Others will use unsuitable natural anchors, loosing some safety. I think hangers should be left on.

Perhaps it is appropriate to investigate two technical possibilities. One is inventing a non-destructive bolt tester. Perhaps a miniature "metal detector" with suitable characteristics could give an indication of how much of a bolt is still solid metal. The same function might be achieved by briefly pulsing the bolt with sound and observing the echo, also with a small electronic device. (Are there any inventors out there?)

Less speculatively, it would be possible to adopt re-usable bolt holes, such as I saw in England last year. The English holes are about 15/16 inch in diameter by about 3 inches deep. Massive bolts that are expanded by tightening their heads with a wrench go in these holes. Such bolts last a long time, but, when they deteriorate, they can be loosened and removed, leaving the hole ready for a new bolt.

Obviously, in the long run, re-usable bolt-holes are probably the best idea, and perhaps we should forget non-replacable bolts entirely. It seems that it should be possible to use smaller bolts in, say, 1/2 inch holes. How about it, Virginia Region?

2. "Ergonomics and Efficient Climbing Systems" (on pages 15 to 21).
This paper is a useful first attempt in this field, but, like many first attempts, it contains some errors. Being too busy to write a second paper, I shall simply discuss these in order:

a) A small point, but last I heard (about two years ago), Bill Stone weighed 205 pounds. His record time in 1977 was 28.1 seconds (faster than the earlier time Dick used). Having assisted in Bill's 1977 race, I would judge that he actually went about 101 feet. (because the race rope is measured and marked under a tension well below one body-weight, the distance run in prusik races is usually a bit more than the stated distance.) Thus, Bill put about 1.34 horsepower into heating the spool and the pulley on the ceiling. Allowing for an additional energy loss for bouncing the rope, Bill's total power output in the 1977 record-setting race was probably somewhat over 1.4 horsepower.

b) Rearranging the equation on page 16 makes explicit an important fact:

$$t = (W/P)(1/550)d$$

A prusik racer's time depends on his weight-to-power ratio (W/P). Treating weight and power separately is useless, because the lowest value of (W/P) dows not necessarily occur for the person with the lowest W. It may occur for the person with the highest P. More likely, it will occur at an intermediate condition. Anatomically, the weight-to-power ratio indicates how much of a racer's body consists of bones, guts, fat, etc., and how much of it consists of the muscle that moves the body. Except for overweight people, the suggestion that speed falls as weight rises in incorrect.

This leaves us with two problems in using ergometer data. Firstly, how heavy were the subjects the power curves were derived for? Secondly, and more importantly, how do we know that the people with the greatest power outputs also had the best weight-to-power ratios? Given that it is generally impossible to maximize two things at once, we can be reasonably sure that the people used to estimate maximum power output were not the ones with the best weight-to-power ratios.

These are matters that future workers in this field should be careful to handle adequately. Obviously, getting hold of individual ergometer records and weights, calculating weight-to-power ratios, and proceeding from there is best.

For the moment, it can be noted that good racing cyclists are so partly because they have good weight-to-power ratios. Thus maximum-power ergometer results from cyclists should give reasonable acceptable minimum weight-to-power ratio results if divided into the average weight of the cyclists involved. The estimates obtained this way should be conservative (i.e. should give somewhat slow times).

How much did the cyclists in Whitt and Wilson (i.e. Figure 1, curve **A**) weigh? They didn't say; however, 175 pounds seems plausible. If we accept this, then the minimum time for the 100 foot race for a "175 pound climber" given on page 16 (21 seconds) is correct within the limitations of the assumptions and approximations described above. (Note that this time dows not allow for energy loss in rope bounce, and thus is somewhat too fast.)

The 400 foot race time on page 16 (170 seconds) is probably too low by about 10%. A number of statements in the heat disapation chapter in Whitt and Wilson indicate that the portion of curve A in Figure 1 that is right of about 2 or 3 minutes is for cyclists actually on moving bicycles, with ample ventilation. For ergometers (and for prusik races) power output is somewhat lower due to the build-up of heat in the body due to poor ventilation. Without going into the details (which are highly approximate anyway), it seems that this time should be increased to about 190 seconds. (Note that this too does not allow for rope bounce.)

c) The paragraphs headed "Friction and Acceleration" on page 17 are largely irrelevant. They do raise an important question: Is the action we are using power output figures for sufficiently similar to prusiking that the figures can validly be applied to prusiking? (Also: Can we work from total chemical energy release, modelling joint action, etc. in detail?) As for the 3300 foot-pounds calculated, if it equals anything related to prusiking, that is an accident. Firstly, the calculation should have been for 21 seconds, an equal time. Secondly, the fate of the power output is almost totally different in the two activities, and there are substantial differences in both the motions of the limbs and the forces acting on the torso. It is plausible that the energy lost within the body during a flat-out 21 second (not 100 foot) run would about equal the energy lost within the body during a flat-out 21 second prusik, but that would only be approximate, due to the different motions.

d) During one complete revolution of the pedals of a bicycle, each of the cyclist's legs bends and straightens once. Thus one revolution of the pedals in cycling in equivalent to two steps in prusiking. Thus 65-90rpm translates to 130-180 steps per minute, and the problem described under "Critical Dimensions" on page 17 does not exist. People who set records with Gibbs systems take large steps, and tend to be in the lower half of this range.

e) Table II strikes me as containing much fudge and little substance. Firstly, the sit-stand systems (Inchworm, 3-knot Texas) use motions rather different from those used on an ergometer, leaving doubts as to how to extrapolate ergometer results to these systems. Secondly, it is not clear how to calculate the effect of using knots instead of ascenders. Thirdly, additional work is required before good estimates of energy loss due to rope bounce, etc., will be available for use in calculating figures for any system.

A minor question that bothers me is the theoretical best times for the Mitchell system with extension handle (let's use relatively standard names for things, rather than various different names such as "Jumar-box") compared with those of the Gibbs system and the plain Mitchell system.

Note that if we apply the factor (24/21) to the revised-for-heating fastest time for the 400 foot race (190 seconds), we get a theoretical fastest time of about 3:40.

f) One last comment. The theoretical best time for the 400 foot race given above (3:40) is probably not very accurate. The effect of heat build-up could be wor worse than my crude approximation indicates. Also, one tends to take shorter steps in longer races, which would further degrade performance.

However, there does seem to be a real difference between real-to-theoretical ratios for 100 feet and 400 feet. I would attribute this to two things:

1) Pacing: Since 1971, 100 foot records have been set by sprinting, with no problems due to wrong pacing. The 400 foot race requires pacing. However, nobody runs the 400 again and again to learn his best pace. As a result, potential records are lost due to pace problems.

2) Psychological: A 100 foot record-setting race is over before the racer suffers much or has enough time to build up a desire to quit. A 400 foot race is not. The racer pushes himself to the breaking point on all four limbs at once in one of the most gruelling athletic events known, meanwhile having no visible competition, and going absolutely nowhere. Slacking off a bit is very easy, if only subconsciously.

Yours truly,
/s/ Kirk MacGregor

((Re your second "problem" with the resolution, the inability of cavers to locate the bolts. This is covered in point 3 of the resolution: "When an artificial anchor is installed, a tag or similar device ... should be attached to the anchor." Tagging the anchor not only aids in its location, but also serves to alert the caver to other pertinent data. Ed.))

Friction Capabilities of the Rack

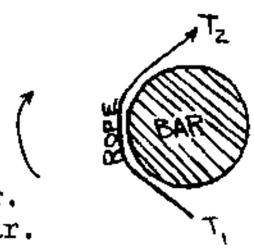
*Gary Moss

The intent of this article is to demonstrate the basic principles of the rappel rack, and then to give some basis of comparison between different types of racks. For those who do not wish to read through the whole paper, Figure 4 gives a good summary of the results.

For the first section, the rope is assumed to be very flexible so that it has no resistance to being bent. The next step is then to determine the friction caused by running a rope over a round bar. This proves to be quite simple, since most beginning statics books derive this basic relationship, which is:

$$T_2/T_1 = e^{au}$$

Direction of rope motion



where:

T_2 = Tension in rope <u>after</u> rope goes over the bar.
T_1 = Tension in rope <u>before</u> rope goes over the bar.
($T_2 - T_1$ = friction)
a = Angle change over bar in radians.
u = Coefficient of friction (sliding, not static coefficient).

Notice that nowhere in the equation is the radius of the bar required, only how far it goes around the bar in redians. So the same amount of friction would be generated by a 90° bend over a 3/4" bar as would be generated by a 90° bend over a 1" bar.

Next, the geometry of the rack must be taken into consideration. Since the spacing of the bars can vary a great deal on a rack, a few simplifying assumptions are made:

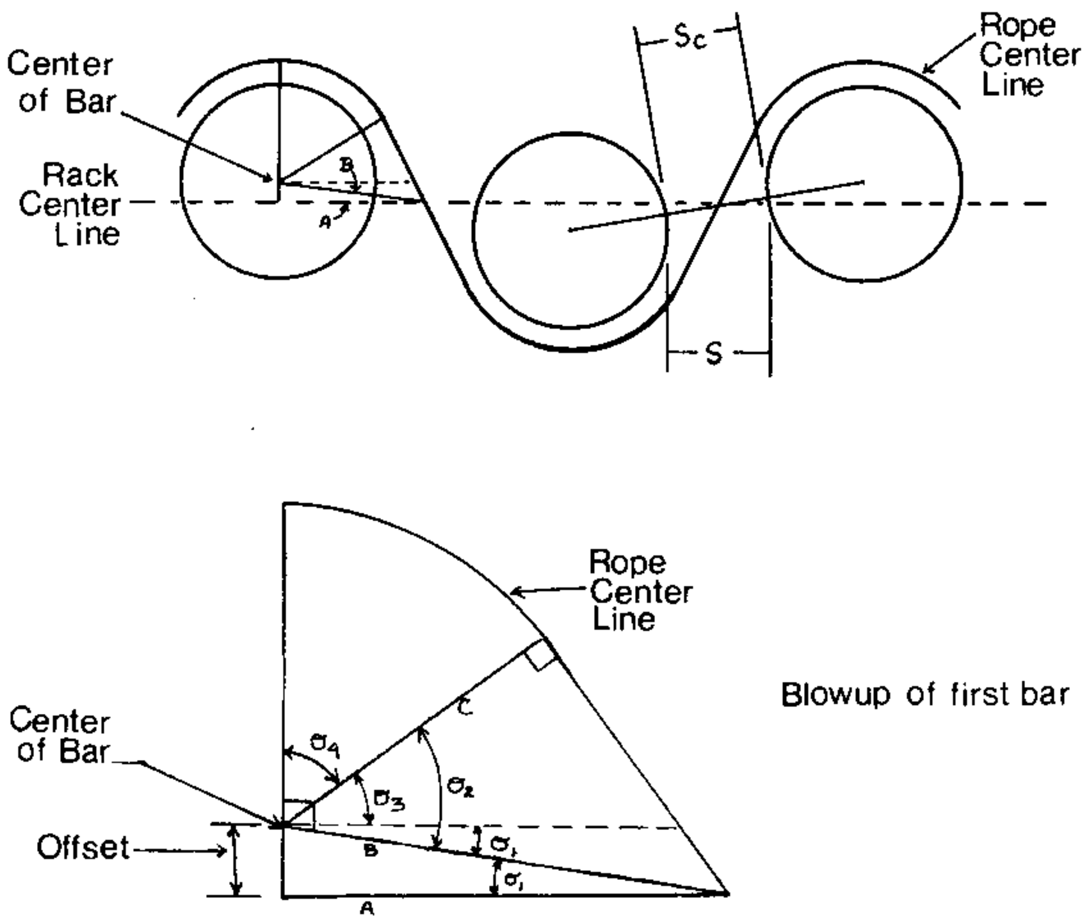
(1). The rope <u>leaving</u> the rack and the rack are in line with each other.
(2). The rope <u>entering</u> the rack and the rack are in line with each other. (Note: For comparison purposes, the angle that the rope enters the rack will make no difference, since it will only add an additional multification factor.)
(3). The bars are evenly spaced along the rack.
(4). The rope is flattened over the bar so that the distance from the center line of the rope to the bar is approximately equal to 3/16".
(5). The effect of wear grooves in the bars was neglected.
(6). U is constant.

To determine the angle change over the bars, the relationships in Figure 1 were used. Since the T_2 force of the bottom bar becomes the T_1 force for the next to the bottom bar, and so on, the relationship for the system is as follows:

$$\frac{T_1 \text{ (top bar)}}{T_2 \text{ (bottom bar)}} = e^{a_1 u} + e^{a_2 u} + \ldots + e^{a_i u} = e^{u \sum_{i=1}^{n} a_i}$$

In other words, add up all the angle changes for all the bars and treat that total angle change as if it were around one bar. Figure 2 shows the θ_4 (angle change around a bar) for 3/4" and 1" bars. Figure 3 shows the total angle change for several types of racks.

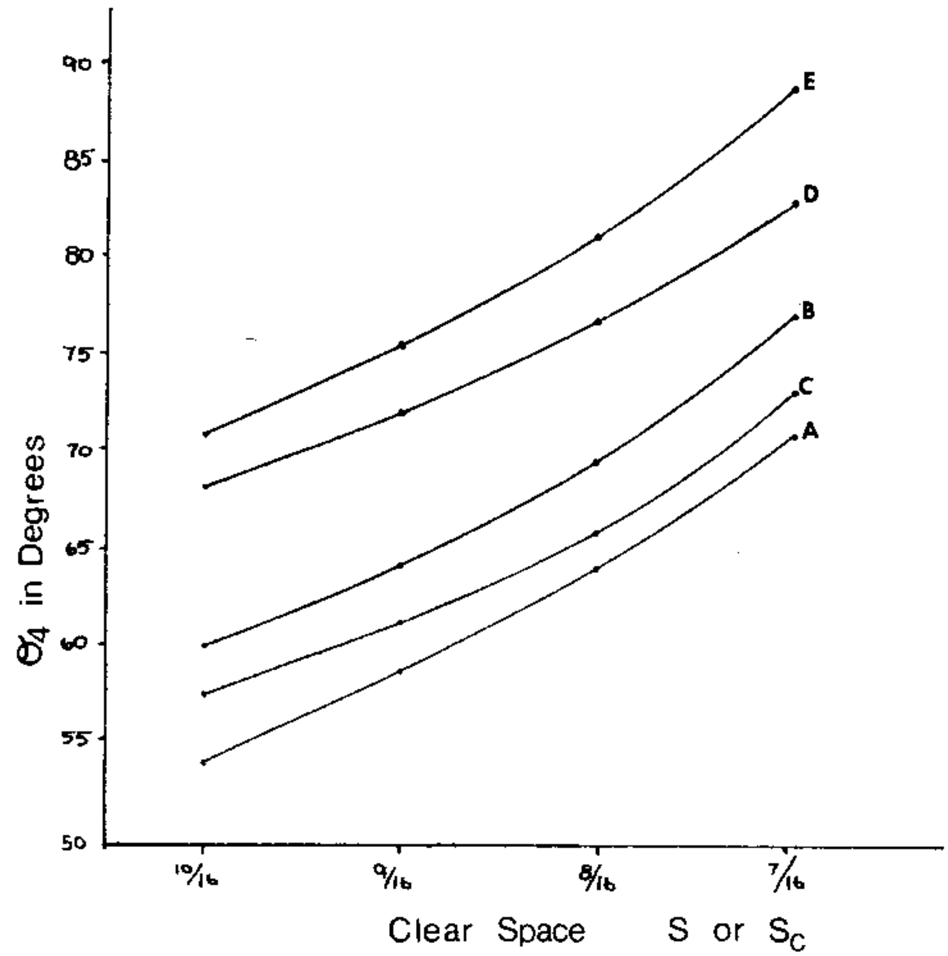
Figure 1



R = Radius of bar
S_c = Minimum clear distance between round bars. Measured on axis between center points of bars.
S = Minimum clear distance between square bars. Measured on axis parallel to rack.
C = R + effective radius of rope ≈ R + 3/16"
θ_1 = Arc Sin (offset/B) used for round bar.
θ_1 = Arc Tan (offset/A) used for square bar.
θ_4 (in degrees) = 90 − θ_3
Angle change caused by exterior bar = θ_4
Angle change caused by interior bar = $2\theta_4$

A = R + S/2
B = R + S_c/2

θ_2 = Arc Cos (C/B)
$\theta_3 = \theta_2 - \theta_1$

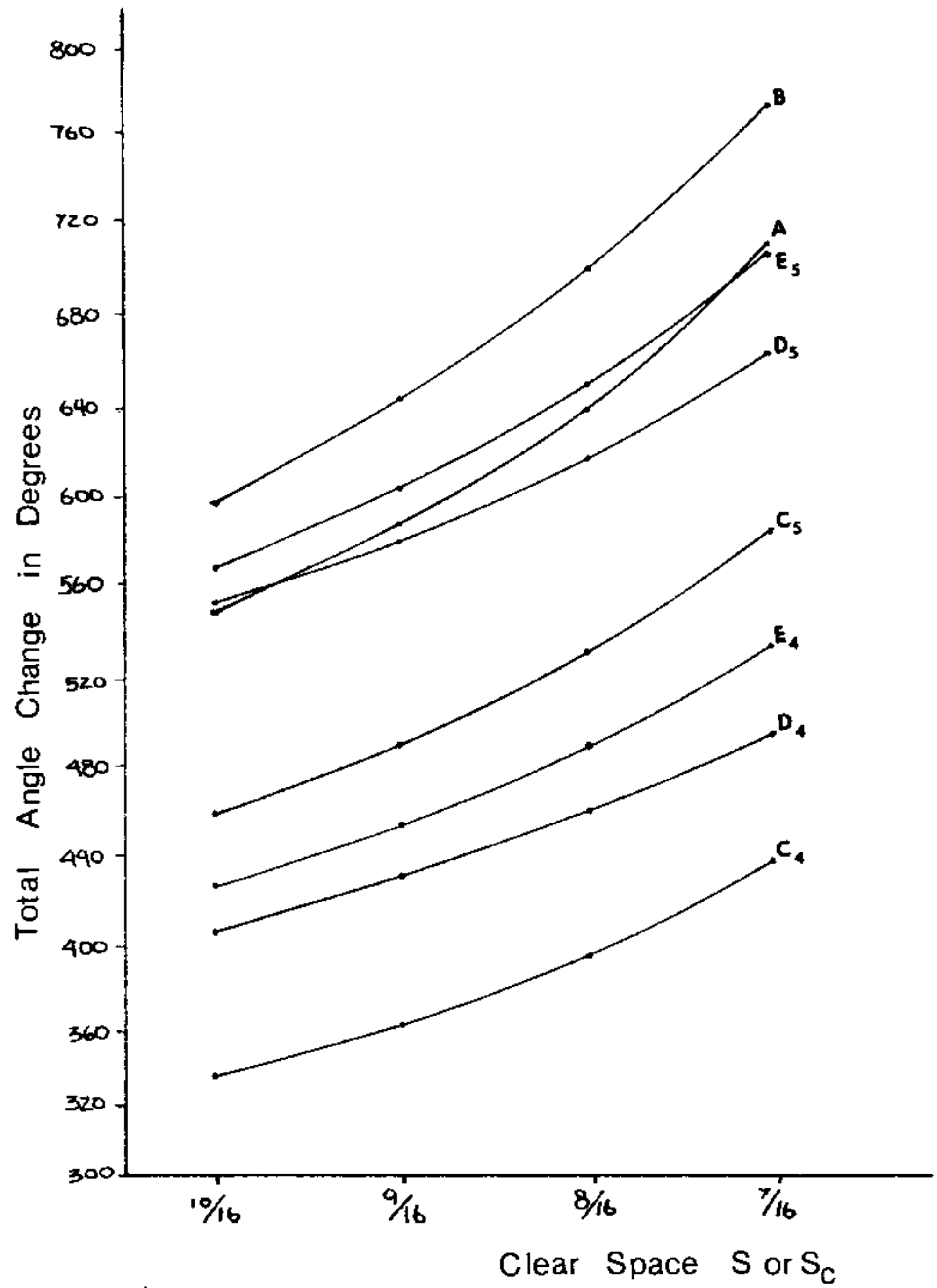


A = 3/4"	Bar	0" offset	
B = 3/4"	Bar	1/16" offset	
C = 1"	Bar	0" offset	square or round cut
D = 1"	Bar	3/16" offset	square cut
E = 1"	Bar	3/16" offset	round cut

Figure 2

Note for the case where there is no offset, the 1" bar has a larger θ_4 than the θ_4 for the 3/4" bar with no offset, which means it will generate more friction than the 3/4" bar. But if the 3/4" bar has a 1/16" offset, its θ_4 becomes larger than the θ_4 for the 1" bar with no offset. Figure shows clearly that even if the 1" bar generates more friction on a one-to-one basis with the 3/4" bar, the four 1" bars would not equal six 3/4" bars.

In an attempt to increase the amount of friction a rack using 1" bars can generate, a few modifications were plotted in Figures 2, 3, and 4. On the basis of a 3/8" hole, leaving 1/8" metal at the bottom of the bar, a 3/16" offset is tried. Note that a square cut and a round cut bar with offsets have different θ_4 for the same spacing and offset. This is because the square cut bar must be spaced further apart along the rack than the round bars to give the same minimum clear space between bars. (See Figure 1).



A = Six 3/4"	Bars	0"	offset	
B = Six 3/4"	Bars	1/16"	offset	
C_4= Four 1"	Bars	0"	offset	square or round cut
C_5= Five 1"	Bars	0"	offset	square or round cut
D_4= Four 1"	Bars	3/16"	offset	square cut
D_5= Five 1"	Bars	3/16"	offset	square cut
E_4= Four 1"	Bars	3/16"	offset	round cut
E_5= Five 1"	Bars	3/16"	offset	round cut

Figure 3

This may not seem to be a fair way to compare round bars to the square cut bars, but if round bars with offsets can be pushed closer together and still give the same minimum clear distance to prevent pinching of the rope, this is an attribute that should be considered.

To give a feel for the magnitude of the frictional forces generated by the different racks, Figure 4 was developed. In this graph, T_2 (tension in rope leaving the rack) is held constant at 200 pounds. The resultant T_1 force is then equivalent to the force required to maintain a constant rate of rappel. The U factor is the sliding coefficient of friction (sliding coefficient is generally 20% less than the static coefficiency of friction in other common engineering systems). For this graph, the minimum clearance was held constant at 1/2".

Other Considerations

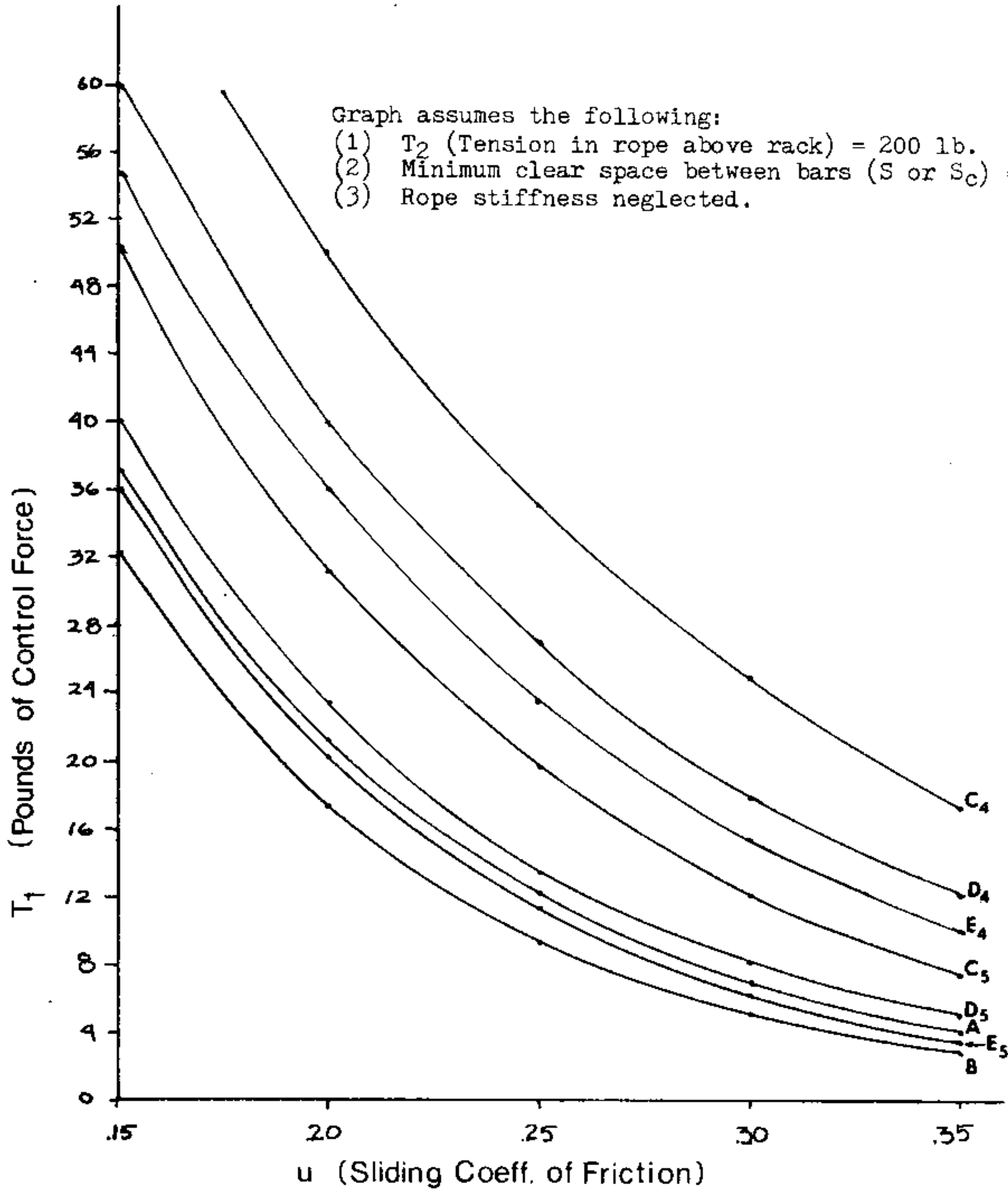
Up to this point, only the effect of friction caused by a normal force over the brake bar has been considered. At this time, perhaps a word or two on some other frictional type of forces is in order.

If the bars are pushed too close together, the rope is pinched between the bars, causing the rope to bind at those points. With the possible exception of the two top bars, which sometimes have spacers anyway, I don't believe this type of resistance will be very great. As the bars get close together, the angle of departure from the bar begins to approach a perpendicular angle to the rack axis. This means that the force caused by the rope to slide the bars together drops lower and lower. At the same time, the force that pushes the bar against the rack frame increases, which in turn increases the friction between the rack frame and the bar. The result is to decrease the net force that could force the bars into a pinching action.

A very important frictional force is caused by the rope's resistance to being bent. If the rope is very flexible and has zero resistance to being bent, this force would be zero. In rope like new Blue Water III or II, which is very flexible, I believe the resistance caused by the many bends would still be small. To get a rough idea of how large this resistance is, clip a rack on a piece of rope and pull it through the rack. Of course with an old, stiff piece of rope, this resistance can be very large. I believe this bending resistance would be related to the sharpness of the bend (not how far it is bent, but what the radius of curvature is) and number of bends it has to make in a rack, i.e., the sharper the bend and the more bends there are, the more resistance would be produced. From this point of view, six 3/4" bars should generate more resistance than four 1" bars. But still, as flexible as some of the braided ropes are, I believe that bending resistance should be neglected in determining the capabilities of racks. If a stiff rope is encountered, bars can always be taken out or spaced to accommodate the additional resistance.

Generalizations

It is not the objective of this article to conclude which type of rack is best, but only to give some basic idea of how they will compare in ability to generate friction. However, one thing can be easily observed: If five square-cut bars with a large offset are used to make a rack, this rack should have similar capabilities as a standard six 3/4" bar rack. This new five-bar rack might possibly be less susceptible to rope stiffness which would give smoother control on old rope that has sections of variable stiffness.



A = Six 3/4"	Bars	0"	offset	
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C_4= Four 1"	Bars	0"	offset	square or round cut
C_5= Five 1"	Bars	0"	offset	square or round cut
D_4= Four 1"	Bars	3/16"	offset	square cut
D_5= Five 1"	Bars	3/16"	offset	square cut
E_4= Four 1"	Bars	3/16"	offset	round cut
E_5= Five 1"	Bars	3/16"	offset	round cut

Figure 4

Ideas for Optimizing the 4 Gibbs System

*Gary Storrick

Due to the increasing demand in Pittsburgh for a description of my 4-cam Gibbs harness, I have decided to publish the following description for all interested cavers. The basic design of the harness has been in existence for many years; however, in the years I've been using Gibbs, I have run across many ideas which improve the design. Unfortunately, I do not know who originated most of these ideas.

The concept of an optimum harness is difficult to define. A harness may be designed for ultimate efficiency, for comfort, for light weight, etc. The harness I use is designed for a mixture of these, along with versatility, expecially in such maneuvers as rappel to ascent, ascent to rappel, changing ropes and general use. It is assumed the reader is familiar with the basic 4-cam Gibbs system and hence only special points will be mentioned.

Figure 1A illustrates the elements of the seat harness. The seat harness is made of a single piece of parachute webbing, insuring high strength. The harness should fit tightly; i.e., such that distance A is approximately one's belt size. The distance from the V-rings to the crosspiece (B) should be short. This insures that the rack (or other descender) will be held low relative to the body, a feature desirable so that the shoulder Gibbs may be attached to the rope above the rack when changing from rappel to ascent. The V-rings serve two important functions. First, it makes attaching the seat carabiner much easier and neater than if the carabiner had to be clipped directly to the webbing leg loops. Secondly, and more important, it causes the seat carabiner to sit sideways (i.e., gate towards the caver's side rather than up or down). This allows the rack to ride in a proper orentation, i.e., with the open side towards the caver's feet rather than his side. Notice that at C, the crosspiece passes over the strap to the V-ring. This forces the two straps together rather than peeling them apart. Note the redundancy in the design -- at least two "things" must break before the rappeller can fall out of the rig. Assembly D-E is for attachment of the shoulder Gibbs strap. Point D should be close to C' (the diagram is drawn to illustrate a left shoulder gibbs, hence D is on the caver's right side.) The adjustment is made at most once per climb, at the start, and accidental slippage is undesirable. With a properly positioned shoulder Gibbs, the rope passes within one inch of the caver's chest, and he remains nearly vertical. The adjustment is made to account for changes in clothing, caver's weight, etc. Trying to permanently fix the location of the shoulder Gibbs inevitably results in three or four sewing sessions before an <u>almost</u> good location is found.

Figure 1B shows the shoulder Gibbs strap. At F, the webbing is folded back on itself, making accidental detachment from buckle E highly unlikely. Note the gap at G for attachment of the shoulder Gibbs. At H is a quick adjusting buckle, used to adjust the front strap length for various conditions of general climbing, resting, overhangs, etc. A second strap used in the front passes through buckle H and is connected to the seat sling at I. A combination quick adjusting V-ring is <u>not</u> used for a very simple reason: it is much easier to tighten the front strap by pulling sown at the shoulder rather than up at the stomach, especially with some weight on the strap. Note that the triangle ring will not sit flat against the caver's stomach. If this is bothersome, a small quick link can be used to connect it to the seat carabiner. A separate seat carabiner for the shoulder Gibbs and the rack is recommended for ease in Gibbs to rappel changeovers. (Try it!)

Figure 1C shows how the shoulder cam is mounted. J is a parachute connecting link (separable), K is two pieces of turned nylon (although wood will work if heavily varnished -- the loading is small), and L is the shoulder Gibbs cam. This arrangement allows the shoulder cam to ride squarely and rotate freely and is both strong and neat.

Figure 1A

SEAT HARNESS

BACK VIEW

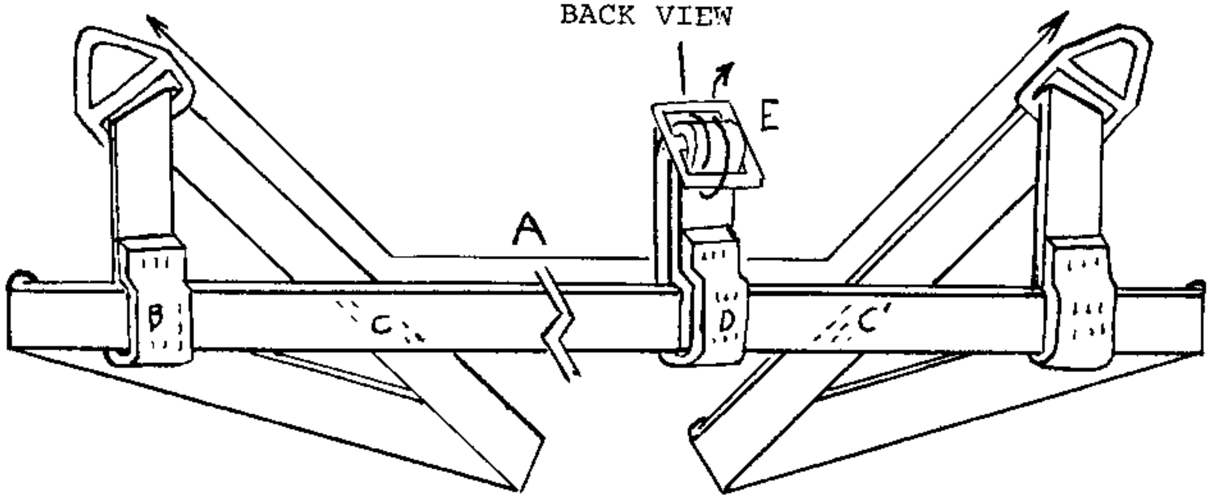


Figure 1B
SHOULDER STRAP

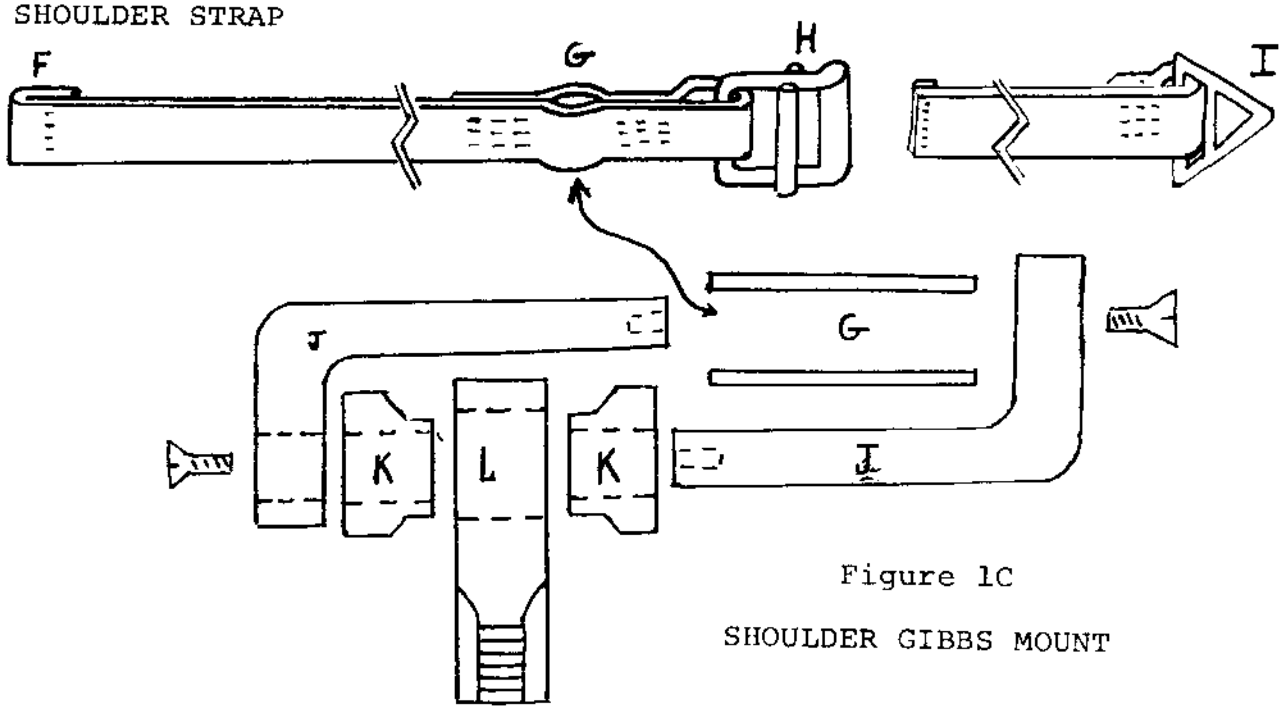


Figure 1C

SHOULDER GIBBS MOUNT

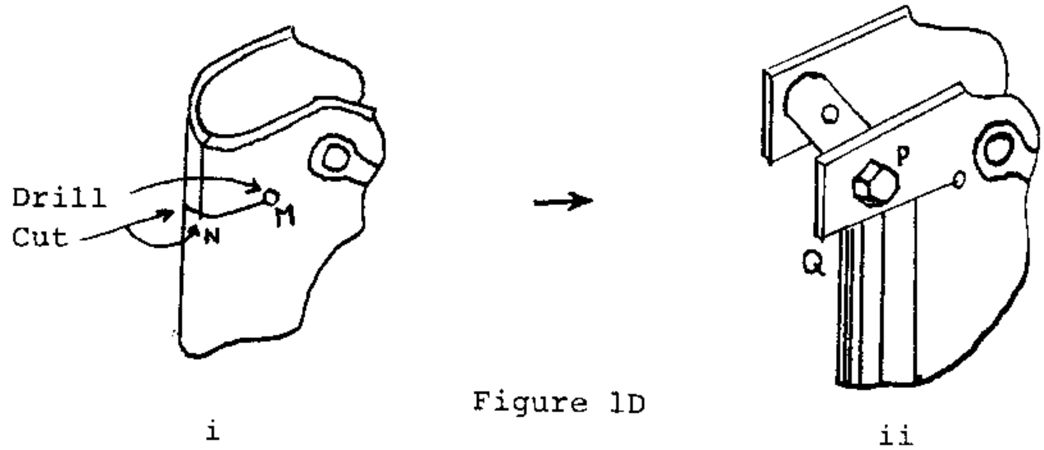


Figure 1D

ROLLER GIBBS

One last modification is worthwhile for the shoulder cam. By drilling (1/8") and cutting (with a razorsaw) the Gibbs as shown in figure 1D(i) at points M and N respectively, the top of the cam may be straightened and a roller installed as in 1D (ii). P is a 1/4" stainless steel bolt; O is a piece of stainless steel tubing. The corners at Q can be rounded. A roller should be installed at both the top and the bottom of the cam. Theoretically, the roller should reduce friction, but the significance of the amount is questioned by some. However, it does greatly reduce wear on the Gibbs shell. Whether there is enough merit in this idea to modify all four Gibbs is a personal choice. I prefer to change only the shoulder cam since the roller does reduce rope clearance in the Gibbs by a small amount.

For comfort, construct a pad to go beneath the shoulder strap. I use 1/2" dense foam rubber. The pad should have a provision to hold a piece of 1/4" shock cord in line over the pad (see knee Gibbs description below). One can include snaps in the guiding system so that the shock cord can be slipped off the pad if desired; otherwise, when one slips the shoulder strap off the shoulder at the lip of the pit, the shock cord will come off too, and as a result, the action of the floating knee Gibbs is sacrificed.

Lastly, sew a loop of 1" webbing around the harness at C', including two 1" O-rings. These are used with the fixed knee Gibbs rig described later. Also, one may wish to tie a piece of 1/4" nylon rope onto the harness at this point for use in holding a safety Jumar, carabiners, etc.

Oops!

The following Vertical Section members were inadvertently left off the membership list in the last issue. Sorry!

Larry Novikoff	(10565)	Richard Schreiber	(6782)
Karen Padgett	(13184)	Bill Sconce	(6819)
Mary Saunders	(11425)	Bruce Smith	(12458)

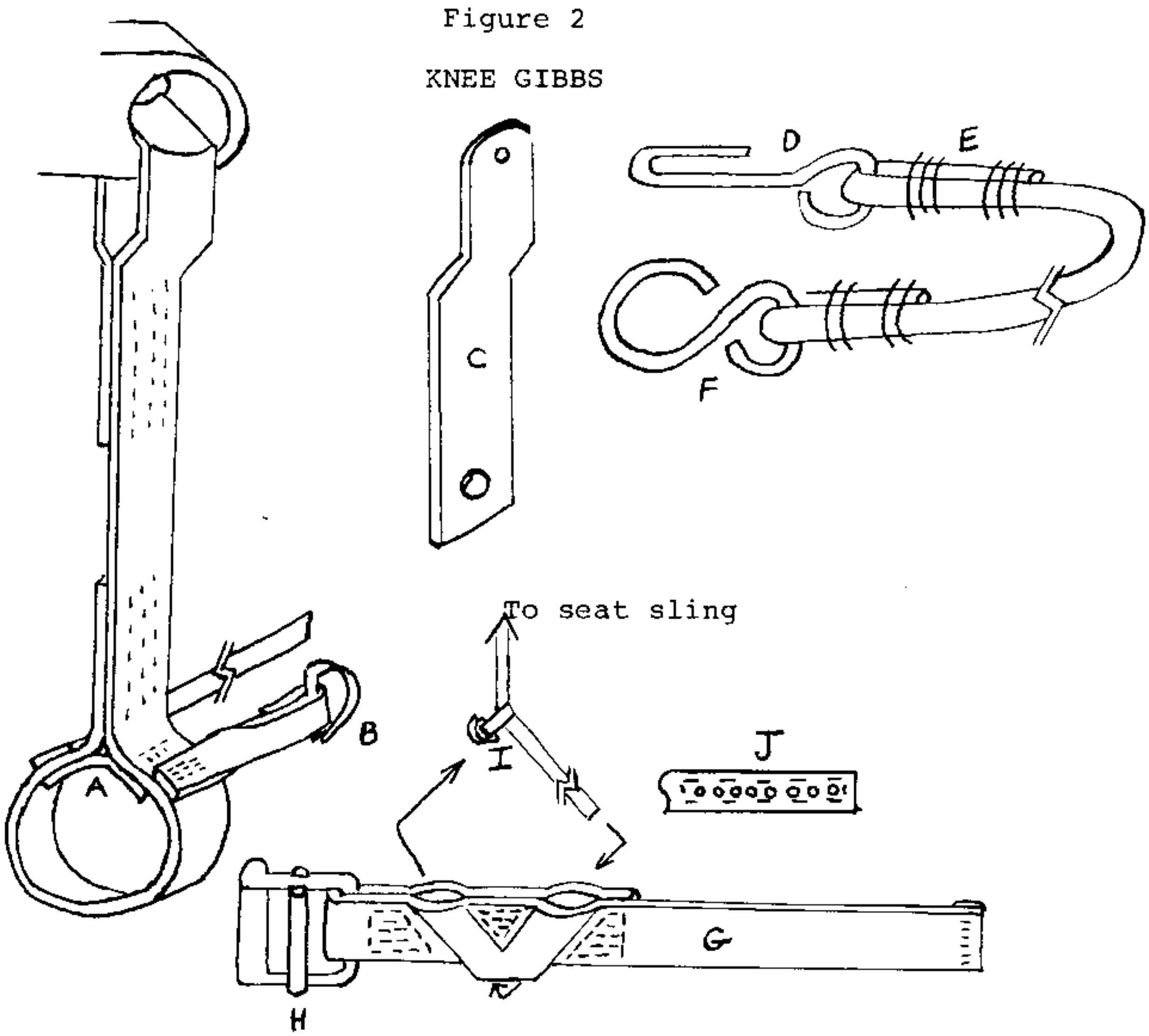
Also, James E. Smith's NSS number should have read: 5037.

Figure 2 shows my knee Gibbs rig. Note the short piece of webbing at A which prevents separation of the webbing at the stitching by preventing a peeling action. Be sure to include chicken loops to hold the foot in the loop, which may be cinchedby two D-rings at B. In most pits I use a floating knee Gibbs. A piece of strap aluminum is bent and drilled as shown in C. The large hole is for the Gibbs pin (I use spring wire Gibbs, since QR pins tend to clog on me). The small hole is for a modified S-hook D, which is lashed to 2-1/2 feet of 1/4 inch shock cord at E, which in turn is attached to another S-hook at F. In practice, the shock cord passes over the left shoulder (Gibbs shoulder) and down the back and attaches to buckle E, Figure 1A. The knee Gibbs is worn on the knee opposite the shoulder Gibbs.

For some pits (against the wall), a floating Gibbs tends to hang up, hence the Gibbs should be fixed to the knee. G is a piece of 2" webbing with a quick release buckle H sewn onto the end, and is strapped just above the knee. Note the stitching pattern. The two channels will accommodate a piece of 9/16" webbing threaded down one channel, through the Gibbs cam, up the other channel and around the leg where it attaches to two D-rings at I. A 3" piece of aluminum J is sewn inside the webbing and acts as a needle for ease in threading. The advantage of this arrangement is that it is easily connected or disconnected from the knee Gibbs.

Figure 2

KNEE GIBBS



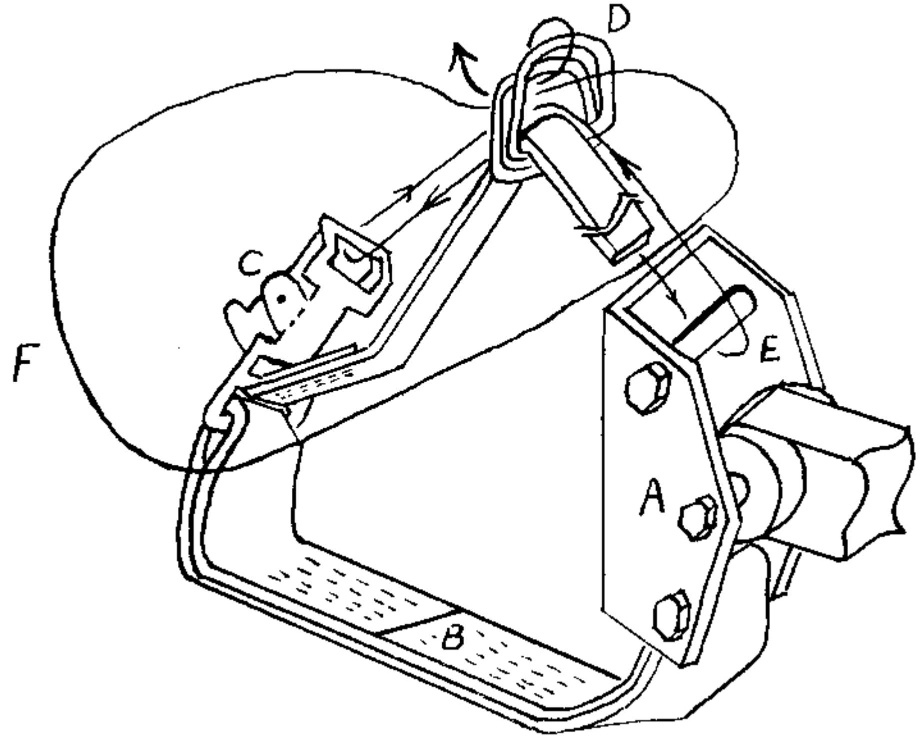


Figure 3

FOOT GIBBS

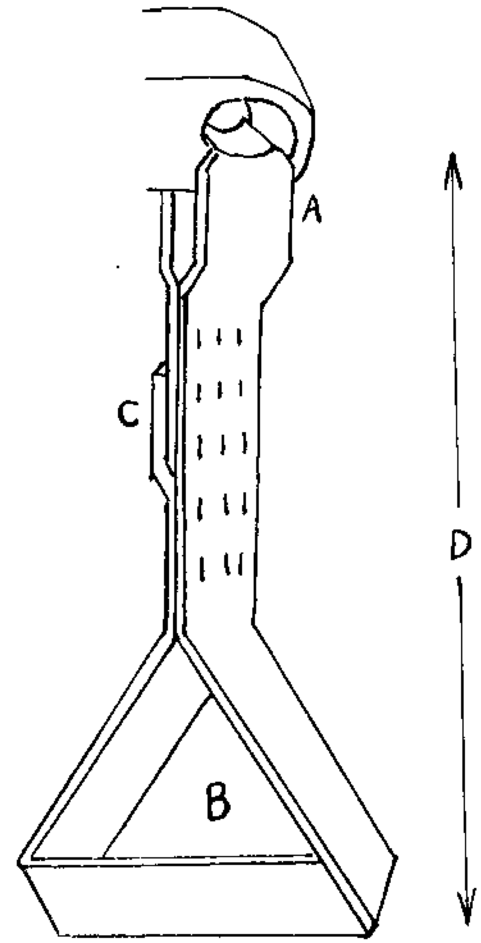


Figure 4

HAND GIBBS

Figure 3 shows my present foot Gibbs. At A is a device made from a piece of sheet steel, three bolts and two pieces of turned nylon. It enables the foot Gibbs to rotate freely. B is 2" webbing under the foot. At C is a webbing buckle which must not slip. From here, a 1" piece of webbing goes over the foot, through two O-rings at D, around the bolt at E, back through the rings, and is pulled tight at C. The end is taken back through the O-rings, behind the heel (F), and cinched at the rings. As one last modification, the two large end teeth of the Gibbs are filed down to provide more rope clearance ("channelled Gibbs")[1]. Using this rig, it is possible to start a climb with no rope weight below, without requiring the use of a "self belay"; i.e., holding the rope under the opposite foot.

Last is Figure 4, the hand Gibbs. I use 1" x 1/8" stiff solid webbing sewn as shown. The webbing passes through the cam at A and forms a wrist loop at B. Note the half twist at B which enables the webbing to lay flat around the wrist. Also note the overlap at C. The webbing is stiff enough so that if sewn this way, the Gibbs may be pushed up by the webbing. Length D should be long enough that if the wrist loop B is clipped to the seat carabiner, the Gibbs can be attached above the rack. This makes rope switching easier. Also, the loop at B is large enough for a foot, if need be.

Finally, there is a modification which can be made on all four cams. Take each cam and countersink the hole where the pin goes through. This makes it much easier for clumsy cold fingers to attach the Gibbs to the rope, since in effect one is trying to insert a 5/16" pin in a 1/2" hole.

The harness just described has proven to be a very good one, especially in the aspect of versatility and efficiency. Almost any kind of motion will cause the caver to move up the rope. The rig is bulky (I use 6500 pound parachute webbing for the main harness), but optimization in size rules out mechanical ascenders altogether. However, I have one small complaint. As with all designs I've seen, the foot Gibbs foot tends to turn outwards, putting a strain on the leg muscles. I have seen some designs which have actually caused pulled muscles and placed a caver on crutches. It appears to me that to prevent this torque on the foot, some means of distributing the load between the inside and outside of the foot must be found. Ankle braces are bulky, and may transfer the twisting to the knee. Mounting the Gibbs on the top of the foot may help, if a good way could be found.[2] In any case, I am willing to offer $10.00 to the person who can give me the best foot Gibbs design (one I've not tried!) which allows the easy starting at the bottom that mine does, has no foot torque, does not have any excess slack and has no other problems.

[1] A more detailed description of Channelization may be found elsewhere in this issue.
[2] For one solution to this problem, see NYLON HIGHWAY #2, "The Davison System". Ed.

We Did? But We Don't! hmmm....

The editor visited an outfitting store in the Washington, D.C., area recently, and was surprised to find Bluewater racks being advertised as the only rappelling device endorsed by the NSS Vertical Section. A discussion with a salesman resulted in the removal of the tag from the rack. Somehow, some people have gotten their facts wrong! The Vertical Section has never endorsed or sanctioned equipment, and passed a resolution in 1977 to reaffirm this position (in response to another false endorsement claim. See NSS NEWS, May, 1977, pg. 109.)* Section members should be aware of this policy and take corrective action whenever further abuses of the Section's name are encountered.

*The text of the resolution may be found in the minutes of the meeting, elsewhere in this issue.

The Gossett System

* Jim Gossett

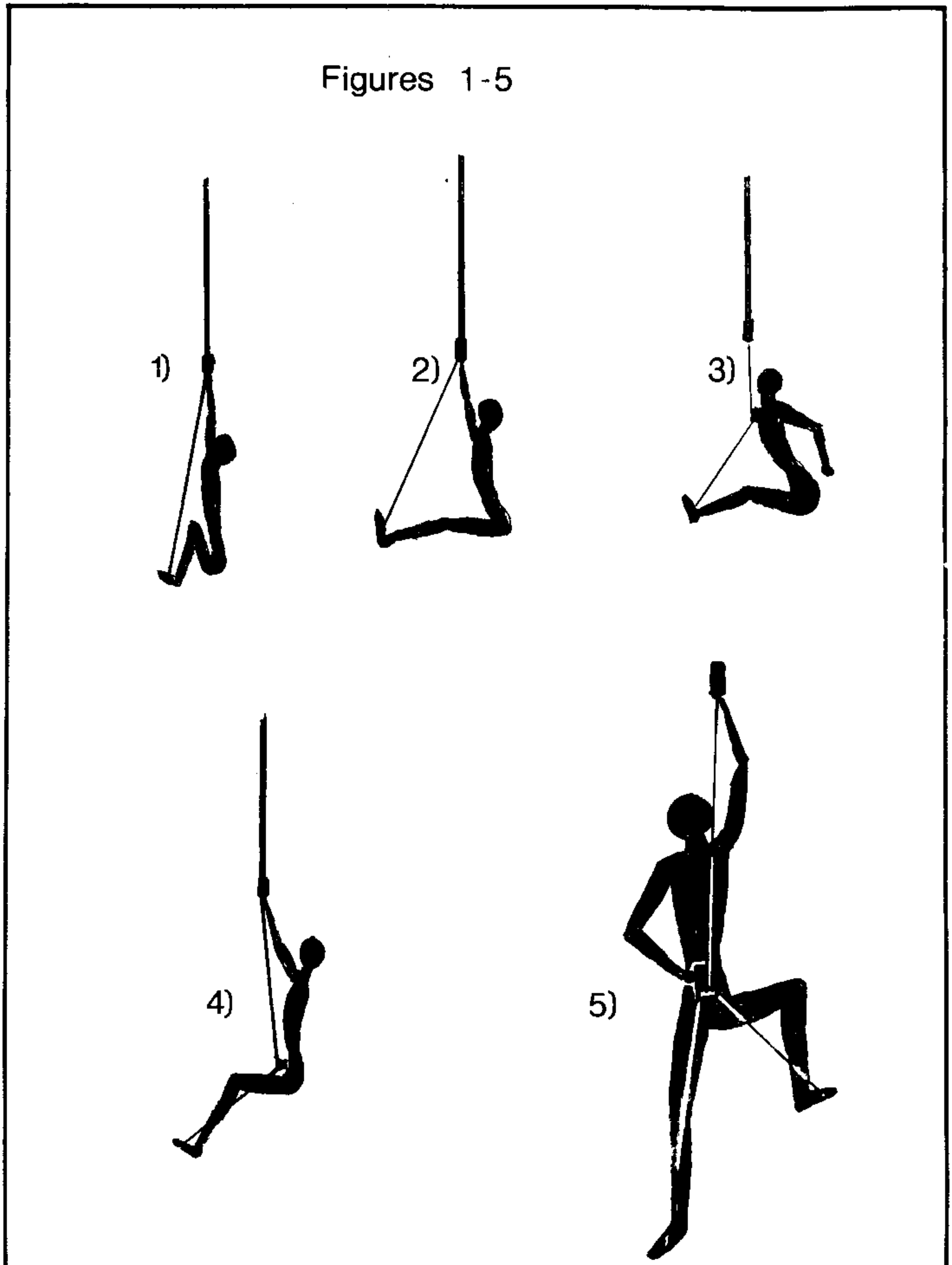
This article concerns climbing with Jumars. My experience suggests that it can be done with greater comfort, maneuverability, economy of effort, and safety. To keep the verbiage within bounds, I will indulge in some simplifications which will distort the picture a little, but which will give the same essential result as a more precise analysis.

Figure one is a toothpick-man diagram of a one-armed, one-legged climber preparing to take one step up the rope. His hand is on the Jumar (or other Prusik device) which is connected by a sling to his foot. Ideally, this step up should cost him no more effort than that required to straighten out his leg against a force equal to his weight. If you have tried Jumaring with no body harness to hold you to the rope, you know that just straightening out a leg gets you nowhere. It only results in the configuration shown in figure two, with no change of elevation of the center mass. The realization of the attempted step upward requires herculean efforts involving hip, back, arm and shoulder muscles. Exhausting! Yes, and dangerous because many climbers lack the arm development and endurance to last out a fifty foot climb by this method.

The introduction of a chest harness a and ascender box to bind body to climbing rope relieves the arms of a tremendous (for them) load. With this gear, when our toothpick-man straightens out his leg, he gets the result shown in figure three. His arms are resting, but his center of mass got nowhere. To realize the gain, he has to keep his back stiff and work his hip muscles. Since the shoulder and arm are not involved, this represents a large saving of energy compared to the previous case. Although entirely practical, the chest box system is still somewhat unnecessarily inefficient and uncomfortable to a degree that few climbers can force themselves to practice it regularily on a static line outside a cave.

Figure four diagrams our toothpick-man with the ascender box fixed at the hip level. With this configuration (Gossett System) his center of mass is going to rise when his leg is straigentened and little effort is required of other muscles. Some people may argue from a vector point of view, saying that the angle of leg action makes a difference with only the vertical component of the leg force being effective against the pull of gravity. In this case the work is being done by the foot pushing on the sling with force and motion parallel, so the angle makes no difference. You can ascend with your legs pushing out horizontally, or you can even flop upside down and ascend by pushing upward with no loss of efficiency. (That's theoretical. If you try it you won't like it.)

Since most Jumar climbers are solidly habituated to the ascender box at the chest level, they will be understandably reluctant to make the necessary changes in equipment, re-educate their muscles to a new pattern of action, and get emotionally adjusted to a support system of nearly neutral stability. However, I am hoping that some of the new cavers with less systemic momentum and emotional inertia will be inclined to experiment with the ascender box placed nearer their center of mass. For those who want to try, figure five illustrates how to adjust the slings for the Gossett System. Note that both Jumars are above the box and both slings, but not the climbing rope, go through the box. The sling for the lower Jumar is just long enough to permit the high arm to be extended full length overhead when the foot is raised to the highest step you care to take while climbing.


Figures 1-5
1)
2)
3)
4)
5)

My big gun in this development has been energy efficiency. However, some other advantages of the Gossett System may be of equal or greater importance to you. One advantage of the popular Mitchell System is the feeling of stability that results from the point of suspemsion (ascender box) being above the center of mass. That is, the support given by the box tends to hold the body securely upright, and people like it that way. Now the bad news. This very built-in advantage is what makes you feel a prisioner of the rope and prevents ease of maneuvering. The Gossett System, with point of support near the center of mass,results in neutral stability, and monkeys like the freedom of motion it affords. You can flip over horizontally to reach out sideways with arms or legs. You can even flop upside down, then recover with ease. When climbing over an obstruction, you can get more of your body over before the box impinges. Did you ever have to pass a knot in the climbing rope? With the Gossett System, the climbing rope does not go through the box, so just unsnap one Jumar at a time and clip it above the knot and you are climbing again.[1] In a similar manner you can switch ropes in the middle of a climb. For some ridiculous fun try climbing two parallel ropes with one Jumar on each. If the ropes are long and stretchy, you will go down instead of up.

To my knowledge, the Gossett System (as distinct from the Gossett Block) was not designed with additional safety in mind, but greater safety just naturally results from the climber feeling more at ease, expending less effort, and enjoying greater freedom of action. With more energy and agility, the climber is less likely to experience difficulty and will be better able to help another climber who is having difficulty. Since the Gossett climber is free of an awkward constraint, he should be more willing to practice his skills on a static line outside a cave.

The idea of practicing rope climbing brings up a subject I hope to write about in a later issue of the NYLON HIGHWAY. Would you like to hear about a rope climbing practice machine that feeds a continuous loop of rope through an overhead pulley? Its speed is adjustable from zero to fast enough to poop a monkey.

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[1] Remember that when unclipping a Jumar to pass a knot, lip, etc., you are left with <u>one point</u> of solid contact on the rope. Accidents have resulted because this one point proved unreliable, especially on muddy ropes. Jumars have also been know to fail structurally. M Many cavers using Jumars carry a spare while climbing. This is connected to the seat and used when a maneuver necessitates removing a Jumar from the rope. The spare is placed on the rope above the knot, lip, etc., THEN the top climbing Jumar is taken off the rope and moved above the obstacle. Once it has been crossed, and the two climbing Jumars are back on the rope, the spare Jumar is removed from the rope. <u>YOUR</u> extra effort might save some cavers the extra effort of hauling your shattered carcass out into the sunlight. --Ed.

On Rappel?

Whee-Ha!!

from THE GURLEY (AL) HERALD
JUNE 12, 1902

CHAMPION ROPE-SLIDER.

Fearless Sailor Slips Down 1,500 Feet from a Tethered Balloon - Other Daring Performances.

Wrapping his legs around the long tether of the captive balloon at the Chutes, when the big gasbag was high in the air, Simeon Nicks, a jack tar, slid to the ground as gracefully and as unconcerned as though he were descending to the deck of a vessel after straightening out a tangle aloft. It was the longest slide on record in Los Angeles, and it is thought a similar feat never before has been performed, says the Los Angles Times.

Nicks is "out for the stuff", he says, and when he found he could gain some notoriety that would prov profitable he volunteered to drop from the clouds on a string.

When he went up in the balloon at six o'clock in the evening he was dressed in an ordinary suit of clothes and carried in his hands a ten-inch section of garden hose, slit up the side, that fitted snugly over the $1\frac{1}{4}$-inch Italian hemp rope that keeps the balloon from straying into the empyrean. Accompanying him were Aeronaut Hudson and the little son of Prof. Baldwin. At a height of about 200 feet Nicks clambered out of the basket, and with a sailor's twist of his legs around the pliable hemp he began to slide downward. Then he checked himself, and remaining stationary, he rose with the balloon until it had reached a height of 1,500 feet. Then he began to slide, slowly at first, and gradually increasing his speed until the rope spun by him at a terriffic rate. Regulating his speed at will he sometimes came to a full stop, when he would release his hand-hold and lean back as though he were in an arm chair. The friction of the rope on the calves of his legs created a burning sensation, but was not sufficient to scorch his trousers, and his hands, being protected by the hose, were not affected in the least by the long descent.

When Nicks dropped to the ground he was as calm and unruffled as though he had just assisted in weighing anchor preparatory to leaving port.

This is not the first long slide the sailor has taken. Eight years ago he slid sown a three-inch wire cable into the shaft of the Silver King mine in British Columbia. Thirty-eight hundred feet below was a cage containing a number of miners. The cabel had broken, and it was necessary for some one to go down the rope and repair the damage before the men could be rescued. Nicks volunteered and succeeded in splicing the cable.

**Thanks to
Bill Torode**

The 1977 Vertical Section meeting was held in Alpena, Michigan, starting about 4:35 p.m., Wednesday, August 3. About 45 people were present, including the five Executive Committee members (Kyle Isenhart, Chairman, Kirk MacGregor, Secretary, Bill Cuddington, Allen Padgett, and Pete Strickland), and a number of non-members of the Section.

Kyle Isenhart opened the meeting by introducing the Executive Committee members and summarizing the Vertical Section's activities since the 1976 Convention. These included: Cheryl Jones editing two issues of NYLON HIGHWAY; most committee members reviewing material for these two issues in accord with the motion in NYLON HIGHWAY #6, page 12; Kyle contacting Bluewater (several times), Recreational Equipment Incorporated, and Eastern Mountain Sports about equipment safety in accord with the motion in NYLON HIGHWAY #6, page 13; and Bill Cuddington and a number of helpers running the 1977 Vertical Contest. Cheryl Jones followed with the Treasurer's Report, which is reproduced following these minutes.

Alpena, 1977: Minutes

Kyle then indicated that the presence of advertisements in NYLON HIGHWAY #7 raised questions about what the Section's future policy on such ads should be. On behalf of the Excutive Committee, he moved that:

> Advertisements are allowed in the NYLON HIGHWAY provided that all potential advertisers are treated fairly, no advertiser is allowed more than one page of ad per issue, and all ads are clearly distinguishable as such. The Editor-Treasurer sets rates, decides what constitutes clearly-distinguishable ads, may limit maximum ad size to less than one page, and sets standards of good taste for ads.

About ten minutes of discussion followed. Some people questioned the desirability of having ads at all, especially since Section dues alone cover the cost of producing the NYLON HIGHWAY, while others felt that the added income was a good thing. Cheryl said that she put the ads in NYLON HIGHWAY #7 as an experiment, with the idea that the profits from the $1.00 per column-inch (or $16.00 per page) charged there could be used either to reduce Section dues or to finance Section projects. When the motion was put to a show-of-hands vote, it was carried 21 to 5.

A bit of discussion of some details of editing the NYLON HIGHWAY followed, during which Richard Schreiber suggested that ads that are split up into a lot of little pieces and scattered through a magazine should be avoided, and Cheryl agreed.

Kirk MacGregor then pointed out that the present situation of the Section Secretary makes the preparation of good minutes of Section meetings impossible. As it is, the Secretary may not know he or she is supposed to prepare the minutes for a meeting until after it is over (as happened when Kirk became Secretary in 1976), and tape recordings may not be available. On behalf of the Executive Committee, Kirk moved that:

> The duties of the Secretary of the Vertical Section include tape recording the Section's annual meeting (or arrange for someone to record it) and submitting an accurate, written copy of the minutes of the meeting to the NYLON HIGHWAY within five weeks of the meeting. When the Secretary changes at a meeting, the outgoing Secretary is responsible for the minutes, the new Secretary is not.

The motion carried unanimously.

After suggesting that the Vertical Section is more or less getting into endorsing certain pieces of equipment, and criticizing this on the grounds that it raises questions of liability if someone is injured on endorsed equipment, and discourages innovation in ropework, leading to loss of North American leadership in the field, Kirk moved that the Vertical Section does not endorse equipment or otherwise attempt to act as an "Underwriters' Laboratory" of ropework. The Section's function is presenting the available facts and the abailable interpretations of them with no attempt to hide any controversy that may exist. Richard Schreiber seconded the motion. About 20 minutes of discussion followed.

Feeling that it was inappropriate, Kyle opposed the expression involving "Underwriters' Laboratory". After a bit more discussion, Richard moved that the motion be amended by deleting "or otherwise attempt to act as an Underwriters' Laboratory of ropework." This was seconded, and carried by a vote of 26 to 1. The final version of the motion read that:

> The Vertical Section does not endorse equipment. The Section's function is presenting the available facts and the available interpretations of them with no attempt to hide any controversy that may exist.

The motion carried 24 to 3.

Following this, Bruce Smith made a plea for Section members to help the Section by encouraging vertical cavers to join, Richard summarized the fate of the BOG motion described in NYLON HIGHWAY #7, page 8, and Foxy Ferguson moved that the Editor-Treasurer be included in meetings of the Section's Executive Committee.

Foxy's suggestion provoked several minutes of discussion during which it was noted that Treasurers are normally on Executive Committees; that the position of Editor-Treasurer doesn't really officially exist in the Vertical Section at this time (it just actually exists!); that the Executive Committee is empowered by the Section Constitution to officially create the position and to make it policy that the Editor-Treasurer is invited to Committee meetings; and that the Committee was in favor of doing this. It was decided to leave the matter for the Committee meeting after the Section meeting.

Stating that costs for photocopying and mailing articles for review by the Executive Committee had totalled $36.82 for the NYLON HIGHWAYs #6 and #7, and that this very close supervision by the Committee indicated a lack of support for the Editor such that he or she might better be called just "typist", Cheryl Jones moved that:

> The following motion is repealled: Materials to be published in the NYLON HIGHWAY will be reviewed by the Vertical Section Executive Committee. Those items not unanimously agreed upon by the Committee will be published with the dissenting arguments appended. Further, a similar arrangement for NSS NEWS articles dealing with vertical work will be recommended to the Board of Governors.

Bruce Smith seconded the motion. During about fifteen minutes of discussion on this motion and related subjects, a vote was taken and the motion was carried 12 to 9. Thus, the motion in NYLON HIGHWAY #6, page 12, no longer applies.

The last part of the meeting was concerned with elections. Eight people were nominated for the Executive Committee. Bill Cuddington, Kyle Isenhart, Kirk MacGregor, Allen Padgett, and Bill Steele were elected. While the ballots for the Committee election were being counted, the election for NYLON HIGHWAY Editor was held. Cheryl Jones won by acclamation.

The meeting ended about 6:20 p.m., with about 35 people still present. (Our thanks go to Dan Murphy, the Convention staffer working with the Section, who allowed us to go thinking that we were running up overtime bills with every minute we stayed past 5 p.m., even though we weren't, and thus prevented the meeting from lasting even longer!)

NSS VERTICAL SECTION -- TREASURER'S REPORT
July 29, 1977

INCOME:

Membership dues	$215.14
Subscriptions	150.00
Subscription-Exchange	9.00
Advertisements	34.00
Back Issues Sales	76.00
TOTAL	$484.40

PAID OUT:

Postage	$119.79
Office supplies and N.H. materials	80.29
Phone	7.20
Printing of N.H. #6	50.00
Printing of N.H. #7	60.00
Photo Copying	27.10
Printing of Dues Reminders	6.36
TOTAL	$350.74

TREASURY now contains....................$377.06

After watching the movie, JOURNEY TO THE CENTER OF THE EARTH, the Executive Committee met and decided that the Editor-Treasurer must be invited to all Committee meetings, though he or she is not presently a Committee member and does not have a vote on the Committee. Officers for the coming year were selected: Kirk MacGregor as Chairmen, and Kyle Isenhart as Secretary.

Kirk MacGregor
Outgoing Secretary
Vertical Section

Membership 77-8

James A. Anderson (13551)a
Steve Attaway (16583)a
Tony Barron (16017)
Bill Bauman (6069)
John Barnes (17192)a
Richard Breisch (9352)*
Ken Brolsma (14102)*
Loretta Brolsma (14103)*
Don Broussard (9514)*
Larry Caldwell (15403)
Doug Carter (6946)a
James M. Chester (6946)*
William Combs (12513)
Sara Corrie (5002)
Bill Cuddington (2177)*
Miriam Cuddington (13078)*
Joe Domnanovich (13287)
Don Davison (12239)
John Evans (13390)a
Bill Foot (13420)
Foxy Ferguson (8660)
Mike Gfroerer (11991)
Charles Gibbs (10089)*
Brenda Gossett (14507)a
Jim Gossett (595)*
Marilyn Gossett (950)
Cliff Graber (13888)
Dick Graham (9694)
Bruce Herr (5576)
Cato Holler (7078)a
Jocie Hooper (18298)a
Spencer Hoover (13531)
Dave Howells (9264)
Steve Hudson (11444)*
Kyle Isenhart (12327)*
William Jasper (7609)
Steve Joseph (15558)
Ernst Kastning (8608)
Dan Molter (16152)
Harold Molter (14370)
Bill Mixon (5728)*
Lyle Moss (16233)a
Dan Murphy (9956)
Roger McMillan (9659)*
Logan McNatt (11274)
Kirk MacGregor (9801)*
Cheryl Jones (14479)
Vance Nelson (12853)
Larry Novikoff (10565)
Allen Padgett (10371)*
Karen Padgett (13184)*
W. Bruce Peirano (12216)
Delbert Province (8752)
Richard Schreiber (6782)
Bill Sconce (6819)
Robert Scoville (11040)
Linda Sims (10539)
Mike Sims (10538)
Randy Slater (12662)
Bruce Smith (12458)
Paul Smith (14385)
Bill Steele (8072)a
Peter Strickland (8298)*
Darrel Tomer (2985)
Robert Thrun (8979)*
Robert Wood (13555)
Ron Zuber (14283)
William Halliday (812)

* Denotes Charter Member
a Denotes New Member

Channelling the Foot Gibbs

The teeth of the foot cam jaw are ground out from the thick portion of the jaw to the first tooth which is into the rope under full load. The center of the teeth are removed, using a rat tail file and steel wool, to produce a smooth polished channel, whose cross section mimics the curvature of 7/16" rope (or the teeth may be totally removed with a flat file). This allows the foot cam to break easily, permitting the rope to be dropped very soon after starting to ascend. Channelling the cam jaw also enables one to back down easily without having to use hands on the foot cam. The channel produced will resemble that produced in the knee cam jaw by long periods of wear.

<u>Channelling Theory</u>

As the rope is compressed by the cam jaw, it becomes ellipsoidal in cross section, with pressure being applied by a few cam jaw teeth. As the pressure is released, the rope rebounds to a less eccentric ellipsoidal cross section and applies force to the tooth immediately above the uppermost tooth which is engaged under full load. This causes difficulty in breaking. By channelling the cam jaw, a grab or break situation is created. The rebounding rope contacts no part of the cam jaw except smooth metal. When starting to climb or backing down, the foot should be held close to the rope and the lower leg should ride parallel to the rope to further enhance the breaking action by minimizing shell-rope friction.

-- Excerpt from "The Davison System", NYLON HIGHWAY #2.