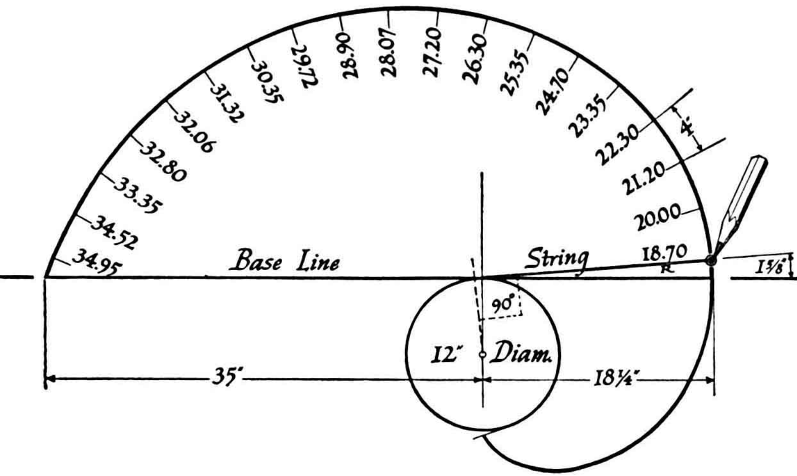
were almost impossible to obtain with frequency. Furthermore, a strong bow of that pattern was especially prone to kick. If the handle were greatly lengthened to decrease that annoyance, the working limb might become so short and broad as sometimes to result in a paddle bow. The elliptical bow saved greatly in the width of wood, but, like the other two forms, it was found to lose weight by use in the field on a hot day and to usually follow the string. Believing that such a let-down indicated a want in theory, Jan designed mathematically a series of bows with varying rates of stress from uniform at full draw to the opposite extreme. Bows made up on these patterns showed that the more correct they were at full draw the more they let down during shooting on hot days. However, at a certain point in the descending scale they went wrong again and started to follow the string in near the dip.

Inasmuch as nearly all bow designs have been calculated on the straight bow bent to full draw, Jan suspected that the let-down was due to the strains caused by bracing. Study was therefore made of the strains while the bow was resting braced and the strains resulting from the jolt of shooting. Quoting: "A whip-ended bow just resting braced is under a stress of 65% of full draw out towards the tip. If the bow is fully stressed at full draw this means that the tips are under a load of 65% of capacity all day! This is too much for wood to stand, particularly in hot weather. The same bow when shot takes a shock load of about 130% of full draw in the outer quarter of the limb. Handbook values indicate yew wood will stand a momentary stress of 119% of a safe yield strength. In a bow of circular bend these values are slightly reduced, but they are still so great that if the bow be stressed 100% at full draw, the outer quarter of the limbs will be broken down during the braced strains. In other words, a bow should not be stressed uniformly at full draw, but with a gradual and considerable decrease towards the tips.

Yew is tough stuff. It isn't likely to break, but if it is over-stressed it breaks down in a self-relieving manner. In other words, it follows the string to a point where all stresses are reduced to a safe value. The cast, too, loses in proportion. This perhaps explains why so much can be gotten away with, without its becoming apparent. A bow was then designed to withstand these braced strains and still to conserve width of limb as much as possible. Graphical plotting of all the variables narrows down to the curve used. It is a combination of adjusted sections and modified involute curve, bending most sharply at mid-limb and stiffening both towards the handle and towards the tip. The stiffness towards the handle is to dodge excessive width and the stiffness towards the tip is to ease the braced strains back into the body of the limb."

Jan prefers the rectangular section as being strongest for its weight, although some convexity of the back is permissible to match the grain. Nothing is gained by a corresponding concavity of the belly.



The above drawing shows the layout of an involute derived from a twelve-inch cylinder, which experience has shown to be a satisfactory size.

For practical application in bowyery the following numerical tables have been computed. They are figured for yew of an average modulus of elasticity, but they can be used for dagame and osage as well; that is, the bows will be correctly shaped though of different weight.

Table I gives the thickness in thousandths of an inch—in each column—at stations on the bowlimb four inches apart for different $\frac{R}{T}$; radius of bend over thickness. Table II is a similar reckoning of widths. Table III shows the weight to be expected from any combination of the columns of the first two tables.

INVOLUTE BOW

THICKNESS I

$\frac{R}{T}$	57.8	56.7	55.6	54.5	53.5	52.5	51.5	50.5	49.5	48.5	47.6	46.6	45.7	
	T0	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	
0	394	403	412	421	430	438	447	456	465	474	484	494	504	0
4	407	416	425	434	443	451	460	469	478	487	497	507	517	4
8	466	476	486	496	505	515	525	535	546	556	567	579	591	8
12	499	510	520	530	541	551	562	573	585	596	607	619	632	12
16	522	533	544	554	565	576	587	599	611	622	635	647	660	16
20	544	555	566	577	589	600	611	623	635	648	661	674	687	20
24	566	578	590	602	614	625	637	650	663	675	689	703	717	24
28	645	658	671	683	696	709	722	735	749	772	776	790	805	28

WIDTHS II

	W0	W1	W2	W3	W4	W5	W6	W7	
0	320	345	370	390	410	430	450	470	0
4	478	524	572	620	668	715	763	811	4
8	635	697	761	825	887	952	1.015	1.080	8
12	770	846	924	1.000	1.077	1.152	1.230	1.309	12
16	895	985	1.075	1.165	1.255	1.344	1.432	1.523	16
20	973	1.070	1.169	1.265	1.362	1.460	1.556	1.655	20
24	1.000	1.100	1.200	1.300	1.400	1.500	1.600	1.700	24
28	973	1.070	1.169	1.265	1.362	1.460	1.556	1.655	28

$E = 10^6$ WEIGHT III

	T0	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	
W0	21.4	22.7	24.1	25.5	27.	28.7	30.4	32.1	34.1	36.	38.2	40.5	W0
W1	23.5	25.	26.5	28.	29.7	31.6	33.4	35.4	37.5	39.7	42.	44.6	W1
W2	25.6	27.2	28.9	30.6	32.4	34.4	36.5	38.6	40.9	43.3	45.7	48.7	W2
W3	27.8	29.5	31.3	33.1	35.1	37.3	39.5	41.8	44.3	46.9	49.7	52.7	W3
W4	29.9	31.8	33.7	35.6	37.8	40.2	42.5	45.	47.7	50.5	53.5	56.8	W4
W5	32.1	34.	36.1	38.2	40.5	43.	45.6	48.3	51.1	54.2	57.4	61.	W5
W6	34.2	36.3	38.5	40.7	43.1	46.	48.6	51.5	54.5	57.7	61.1	65.	W6
W7	37.3	38.6	40.9	43.3	45.9	48.8	51.6	54.7	58.	61.3	65.	69.	W7