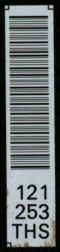

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THE HOLDING POWER OF NAILS IN DIFFERENT KINDS OF WOOD

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Prepared by H. A. Parker, June 1, 1897.

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The primary object of this work is to determine as nearly as possible, 1st, The relative merits of the various kinds of nails now in use as to their holding power in various kinds of wood; 2nd, The different depths to which these nails should be driven in the timber to produce the best results; 3rd, The effect of different methods of sharpening nails.

The amount of available information on this subject is not very extensive; the most valuable being a thesis prepared by F. W. Clay C. E. of Cornell University, 1895, a copy of which may be found in the January number of Engineering News, 1894.

The small amount of information on this subject is undoubtedly due to the apparent insignificance attached to such small matters. Yet, if we would consider for a moment the vast number of tons of iron manufactured annually into nails, we should be able to realize more fully what a little economy in this product might save to the purchaser.

There is much diversity of opinion as to the relative holding power of the ordinary cut nail and the smooth wire nail. Some are of the opinion that the wire nail will hold nearly double

that of the cut nail, while others believe the reverse to be true. The reason assigned for the belief that the wire nail holds better than the cut nail is that the diameter of nail is uniform throughout its length. The nail thus receives a pressure of the fibers of the wood normal to the surface of the nail; where as in the cut nail, which has two sides tapered, a little shock or jar will start the nail, which will then easily withdraw. Experiments, however, prove this idea false, as will be subsequently shown.

For the past two or three years the demand for the wire nail has greatly exceeded that of the cut nail, which is clearly evidenced by the fact that the majority of local retailers no longer keep the cut nail in stock; this is partly due to ignorance as to the merits in regard to the holding power of the two kinds of nails; and partly because the wire nail is nicer to handle, and a little less likely to split the fibers of the wood. The question as to whether the cut nail splits the wood more easily than the wire is somewhat extensively discussed by Mr. Clay in his thesis in which he shows, theoretically, that the wire nail has a greater tendency to split the wood than the cut nail. While the theory may be a correct one practical experience will not usually confirm it.

After a little consideration it is plain that it is impossible to obtain the exact amount of stress required to withdraw a nail from a piece of wood when subjected to direct tension because of the different conditions of the wood, such as seasoning fineness

of grain, and the methods of driving as well as that of drawing etc., thus causing some inaccuracies which would be impossible to avoid.

While it is argued by Mr. Clay that tests on direct tension are of little importance relatively, it appears to us to be a fair and just method of determining the relative value of the different kinds of nails as to their holding power.

Approximate and comparative tests were made which we believe sufficiently accurate for all practical purposes.

The apparatus used in testing was an Olsen testing machine. The manner of grasping the head of the nail was by means of two wedge shaped blocks: the nail being subjected as nearly as possible to direct tension. The load was gradually applied in each case. Following are results obtained by driving nails in white pine.

Size of nail	Depth driven in wood in in.	Total stress in lbs.	Ave. stress in lbs.	Ratio of stress to area in wood.
8d cut	2	250) 245) 220)	238	136
8d wire	2	190) 110) 120)	140	153
10d cut	2	235) 200) 250)	228	217
10d wire	2	150) 155) 145)	150	168

Comparison by area of nail driven in the wood is alone considered here, the comparison by weight being deemed unnecessary. It is generally believed that after the cut nail is once started it will withdraw much more easily than the wire nail after being started. But in the above tests it was found that after the cut nail was started it required all the way from 150# down to 50# until 1/2" from the end, while the wire nail required about 75# until 1/2" from the end. Below are results of tests made in dry red oak:

Direct tension.

Size of nail	Depth driven in wood.	Total stress in lbs.	Ave. stress in lbs.	Ratio of stress to area.
8d cut	2	785, 830, 785	800	633
" "	1	410, 410, 400	406	712
" "	1/2	175, 130, 150	168	618
8d wire	2	320, 330, 325	325	355
" "	1	150, 140, 160	150	328
" "	1/2	100, 85, 90	92	403

In the above tests the amount of stress required to withdraw the cut and wire nails after starting was nearly the same until within about 1/2" from the end. These experiments go to disprove the

statement made by Mr. Clay, that the cut nail after being started looses its holding power so much more rapidly than the wire nail. Following are results of only one test of each of the cut and wire nails of different sizes: Same timber as above. Direct tension.

Size of nail.	Depth driven in wood.	Total stress in lbs.	Ave. Stress in lbs.	Ratio of stress to area.
4d cut	1	190		
" wire	1	140		
6d cut	1	290		710
" wire	1	195		554
8d cut	2	780		622
" wire	2	320		354
10d cut	2	770		734
" wire	2	370		410

Size of nail	Depth driven in wood.	Total stress in lbs.	Ratio of stress to area.
12d cut	2 1/4	900	657
" wire	"	510	435
20d cut	3	1320	540
" wire	"	950	505
50d cut	"	1450	545
" wire	"	1050	447
60d cut	"	1620	560
" wire	"	1180	500

Tests on hard maple.

6d cut	1	320
" wire	"	190
8d cut	1 1/2	830
" wire	"	440
10d cut	2	1050
" wire	"	550
12d cut	2 1/4	1210
" wire	"	700
20d cut	3	2050
" wire	"	1100

Following are results of tests made in different kinds of wood. Direct tension.

Kind of timber.	Size of nail.	Depth driven in wood.	Ave. of 3 tests total stress.	Remarks.
White ash	10d cut	1 1/2	873	The barbed nails were corroded some on the surface which would tend to slightly increase their holding power.
" "	" wire	"	530	
" "	" barbed	"	890	
Hard maple	" cut	2	925	
" "	" wire	"	410	
" "	" barbed	"	908	
Black walnut	" cut	"	608	
" "	" wire	"	318	
Birch	" cut	1	540	
"	" wire	"	335	
Hickory	" cut	"	830	
"	" wire	"	460	
White oak	" cut	1 1/2	1052	
" "	" wire	"	602	
Cherry	" cut	"	628	
"	" wire	"	312	
White wood	" cut	"	448	
" "	" wire	"	226	
Bass wood	" cut	"	182	
" "	" wire	"	110	

A number of experiments were made with nails sharpened in different ways to determine if possible the best mode of sharpening.

Following are results:

FIG. 1 CUT

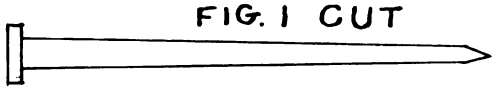


FIG. 2 CUT

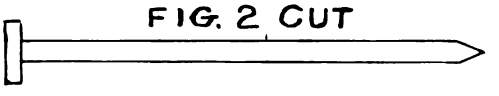


FIG. 3 WIRE

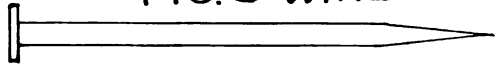
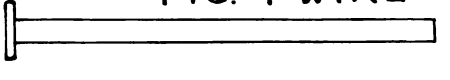


FIG. 4 WIRE



Size of nail	Depth driven in wood	Total stress in lbs.	Stress in same piece ord'n sharpened.	Remarks.
12d cut	2 1/4	1195	1210	Sharpened as in Fig. 1
" "	"	1630		" " " " " 2
12d wire	"	560	510	Sharpened as in Fig. 3
" "	"	365		" " " " " 4

These results, which are the average of three tests except as noted in remarks, show an increase of holding power when the nail is sharpened as in Fig. 2 over the ordinary form of about 50%, while the wire nail sharpened as in Fig. 4 shows a decrease of nearly 40% over the ordinary method of sharpening.

In order to determine the effect of driving at an angle when subjected to direct tension, wire nails were driven at an angle of thirty degrees with the vertical, with the following results:

Size and depth of nail.	Total stress in lbs.	Average.	Remarks.
10d Dep. 2	520) 480) 475) 330)	405	Driven at an angle.
10d Dep. 2	410) 440)	410	Driven straight.

Since tests on direct tension are of comparatively little value except as a means of comparing the holding power of various kinds of nails a series of tests on shearing were made. First two pieces of white oak boards 7/8" thick were nailed together with following results:

Size of nail.	No. of nails.	Shearing stress in lbs.	Remarks.
6d cut	1	350	
" "	2	590	The nails
" "	3	1040	sheared off in
" "	4	1150	each case.
" "	5	1500	
6d wire	1	470	In this case
" "	2	720	the nails withdrew
" "	3	900	from the board.
" "	4	1280	

Next a piece of white wood 1 1/2" thick was nailed to a plank of red oak 2" thick.

Size of nails.	No. of Nails.	Shearing stress in lbs.	Remarks.
10d cut	2	1080	Sheared
" wire	"	1350	Withdrew
40d cut	1	1200	Sheared
10d cut	2	1150	" driven at an angle of 30°
" wire	"	1600	Withdrew " " " " "
12d wire	"	1700	" driven straight.
20d "	"	2040	One nail withdrew from oak the other split the white wood board.

In all of the tests conducted the nails were driven in and immediately withdrawn, so that nothing definite can be said in regard to the effect which time will have on the holding power of nails. Neither was the variation of surface considered, which would effect the holding power to a greater or less degree.

From the above experiments, and from the information which could be obtained from other sources, we may conclude: (1) Cut nails have nearly double the holding power that wire nails have; (2) the barbed wire nail has about the same holding power as the cut nail; (3) the holding power of nails is nearly proportional to the depth driven in the wood; (4) sharpening on the flat sides of the cut nail increased its holding power; (5) if the wire nails were without points their holding power would be diminished about 40%; (6) the resistance to shearing is practically the same whether the nails are driven straight or inclined slightly; (7) dry hickory has the greatest holding power of the various

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kinds of wood tested; (8) for all ordinary purposes the cut nail is greatly superior to the wire nail.

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