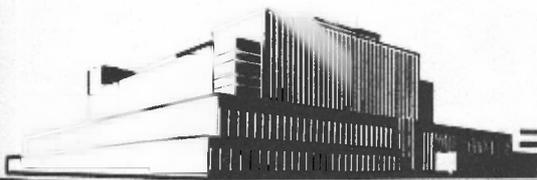


# NEW NAIL TREATING PROCESS INCREASES HOLDING POWER

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UNITED STATES DEPARTMENT OF AGRICULTURE  
FOREST SERVICE

In Cooperation with the University of Wisconsin

## NEW NAIL TREATING PROCESS INCREASES HOLDING POWER<sup>1</sup>

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Everyone who has used wood may have observed wide differences in the ease with which nails can be pulled from it. Some of the causes of difference in nail holding are splitting or mutilation of the wood in driving as affected by the nail point, moisture changes in the wood, and the degree of frictional resistance between the nail surface and the wood. An understanding of the influence of these factors enables one to account for many of the observed differences in behavior of nails in resisting withdrawal from wood and serves as a basis for improvements which will overcome some of the more apparent deficiencies.

The holding power of nails centers largely around the frictional contact of the nail with the wood fibers, hence the improvement of the surface by increasing its frictional resistance offers an excellent opportunity for enhancing nail-holding power. Such a surface condition may be obtained by a treatment developed at the Forest Products Laboratory for nails and other metal fastenings for wood.

The improved surface is obtained by a chemical treatment that produces microscopic pitting or etching of the nail surface, thereby increasing its frictional resistance. To the unaided eye the pitted surface of the F.P.L. nail appears practically the same as the original in that there is no apparent roughening. What has actually happened, however, is a breaking up, by means of pits or minute etchings, of the smooth surface areas between striations left by the dies in the process of drawing wire in nail manufacture.

### Tests

A number of tests made on wire nails and staples having this newly developed type of surface gave decidedly higher values for resistance to withdrawal than were obtained with similar fastenings having plain, cement-coated, or grossly roughened surfaces. A comparison of the resistance to direct withdrawal of the F.P.L. nail with that of a plain or a cement-coated nail may be made from table 1:

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<sup>1</sup>Published in Barrel and Box and Packages, July 1932.

Table 1.--Average holding power of 7d wire nails driven 1-1/4 inches and pulled immediately from dry wood of different species

Species <sup>1</sup>	Side holding			Ratio to plain		
	Plain	Cement-	F.P.L.	Plain	Cement-	F.P.L.
	nail	coated	treated	nail	coated	treated
	nail	nail	nail	nail	nail	nail
	Pounds	Pounds	Pounds	Percent	Percent	Percent
Sugar maple.....	374	.....	716	100	.....	191
Yellow birch.....	220	.....	613	100	.....	278
Ponderosa pine.....	75	140	216	100	187	288
Lowland white fir..	72	201	221	100	279	307

<sup>1</sup>No comparison between species should be made from this table, since the specimens do not represent the average quality of each species.

Where specimens were nailed and allowed to season for several months before testing, the treated nail again gave higher values than either plain or cement-coated nails. With staples the treatment proved similarly effective.

Methods previously advocated for increasing the nail-holding power have consisted, in the main, of surface coatings or of grossly roughened surfaces produced either by mechanical or chemical means. Surface coatings often have the disadvantage that they may be removed in handling, or their effectiveness otherwise lost through disintegration with time. The grossly roughened surfaces which may be produced in various ways are, through a slight loss of intimate contact with the wood fibers, less effective than the microscopic pitting resulting from the new F.P.L. treatment.

#### Treatment

The desired pitted condition of the F.P.L. nail is obtained as follows: The nails and staples, or the wire from which they are to be made, are subjected to the action of a 2 percent solution of ferric chloride in water in the presence of mercuric chloride or salts of other metals, particularly of those falling below iron in the electrochemical series. On removal from the solution, the materials are allowed to dry in a warm atmosphere after which they are exposed at a temperature of approximately 100° C., and a relative humidity of about 80 percent. The

nails, staples, or wire are immediately immersed in water in order to fix the adhering iron oxide.

The treatment has not yet been carried out on a large scale, but its commercial application would appear to present no particular difficulty. A suitable vat for the initial dipping is necessary. A batch of nails, for instance, may be held in a perforated wooden container, lowered into the ferric chloride solution and allowed to remain from 5 to 10 seconds, a time sufficiently long to thoroughly wet the surfaces of the nails. (This step is essentially the same as the pickling treatment commonly practiced in steel and wire mills where the rod is dipped and cleaned in an acid solution preparatory to drawing into wire.) A dry, hot chamber to receive the wet nails should be provided adjacent to the dipping vat. After drying, etching is accomplished in a relatively short time by subjecting the nails to a hot, humid atmosphere. The hot drying chamber may serve a dual purpose in this respect if it is provided with an inlet for live steam. The object of drying the fastenings before subjecting them to the hot, humid atmosphere is to minimize scale formation and thereby secure a finer pitting effect.

After 1-1/2 hours in the 80 percent relative humidity chamber the nails may be removed in the perforated wooden containers and immersed in boiling water. During this treatment oxidation of the iron oxide to the magnetic oxide occurs, giving a black appearance to the nails. Part of the oxide is loosely held and should be buffed off not only to improve the appearance of the fastener, but also to more fully expose the pitted surface to frictional contact with the wood. The treating solution, being of acid character, must necessarily be kept within a pH range of 3.2 - 5.0, and observation of this property may readily be made by the use of a potentiometer or other suitable indicator.