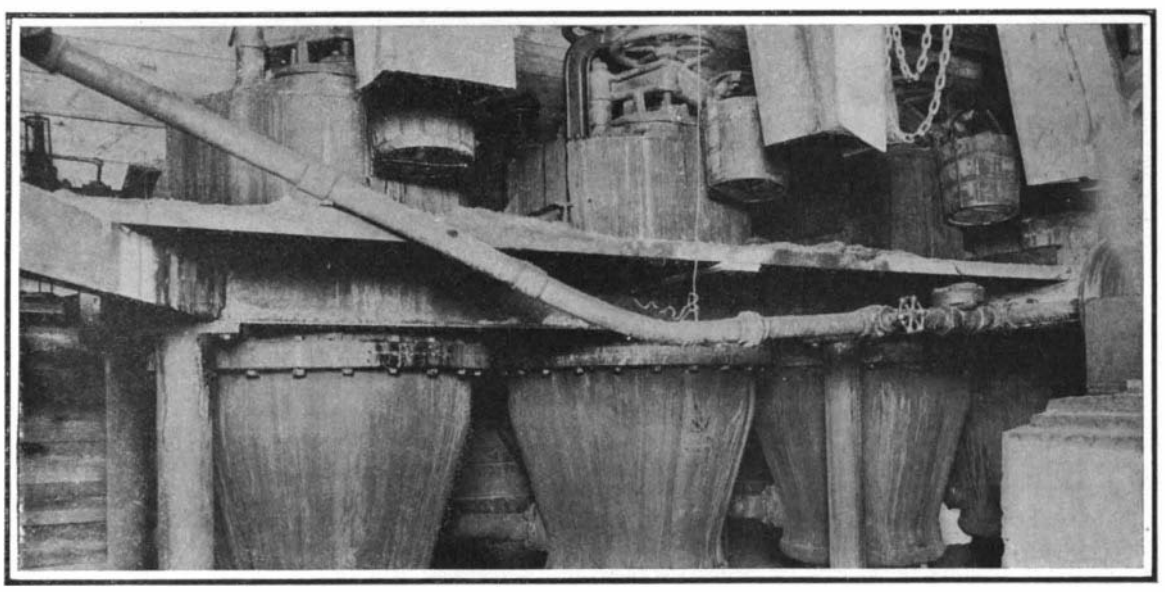
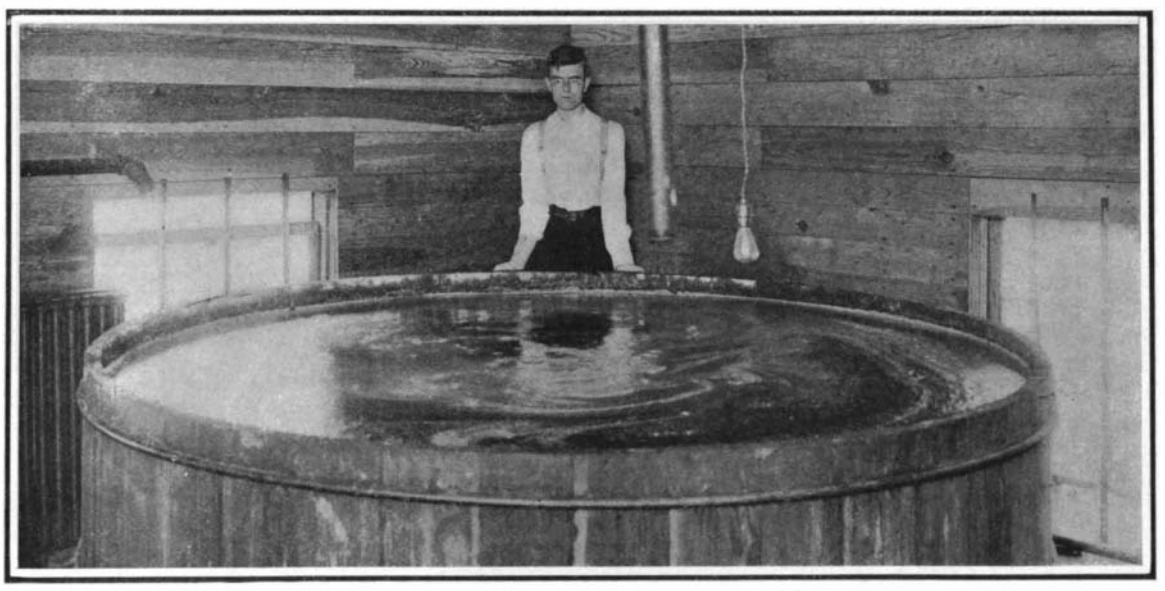
MAKING ALCOHOL FROM WOOD WASTE.

A middle West industry, for which a great future is promised, is that of the manufacture of alcohol from sawdust, shavings, slabs, and other refuse of the lumber mill.

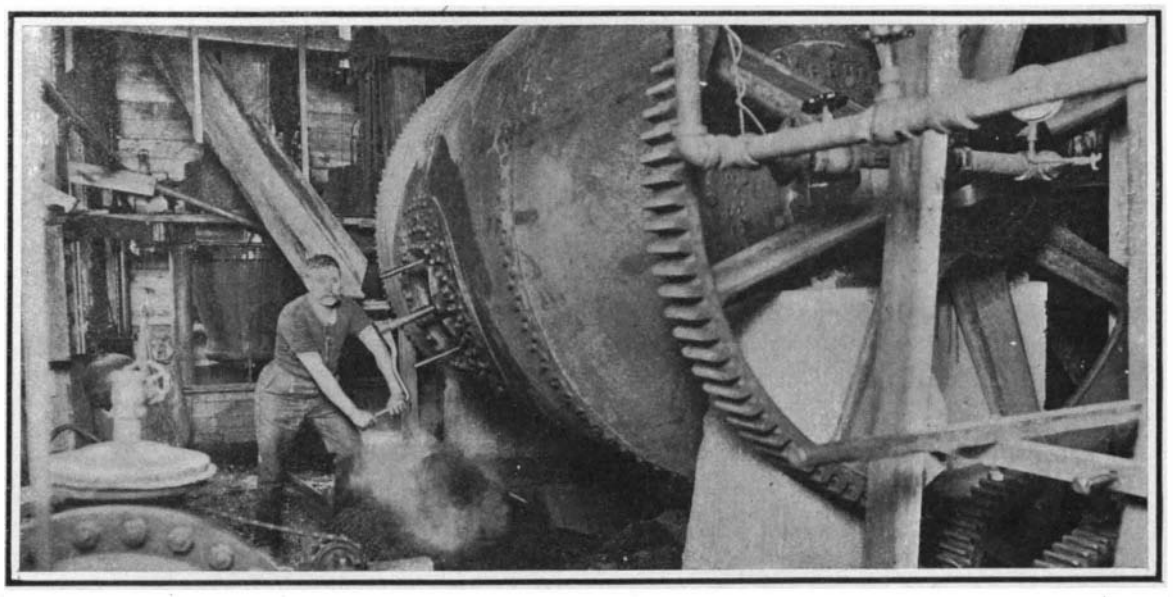
Rumors of improved methods and great economies in the manufacture of wood alcohol have been "in the air" for some time, and we have received a number of inquiries on the subject from subscribers and correspondents. We are glad, therefore, to be able to give now some details of the new process, for which patents have recently been granted to Mr. Malcolm F. Ewen and Mr. George H. Tomlinson of Chicago.



A diffusing battery of four units.



One of the large tanks in which the wood pulp is fermented.



The digesting machine which performs the functions of a mechanical stomach. It converts the starch of wood waste into sugar.

It has long been known that ethyl alcohol and other valuable by-products could be made from wood waste in laboratory experiments, and many processes have been developed, but practically none of them has reached the stage of economic success on a commercial scale.

One of these aroused the interest of Mr. John M. Ewen, better known as a constructional steel work engineer and manager of the Fuller Construction Company, builders of so many "skyscrapers." Although it was not found practicable commercially, Mr. Ewen was so much impressed with the possibilities of cheap alcohol from wood waste that he spared enough time and energy from his other great responsibilities to continue independent investigations, and it is largely owing to his personal and financial support that the present successful process has been developed, one of the patentees being his brother.

Lumbermen have long been alive to the necessity of finding a use for the appaling piles of waste they are compelled annually to destroy, if only as a means of additional profit, before the question of conservation of natural resources became of national interest. In addition, there are many and various uses to which alcohol is applicable with advantage, and from which it has hitherto been excluded by its cost.

All kinds of internal-combustion engines, for instance, can use alcohol as fuel with advantage over gasoline and with very little modification.

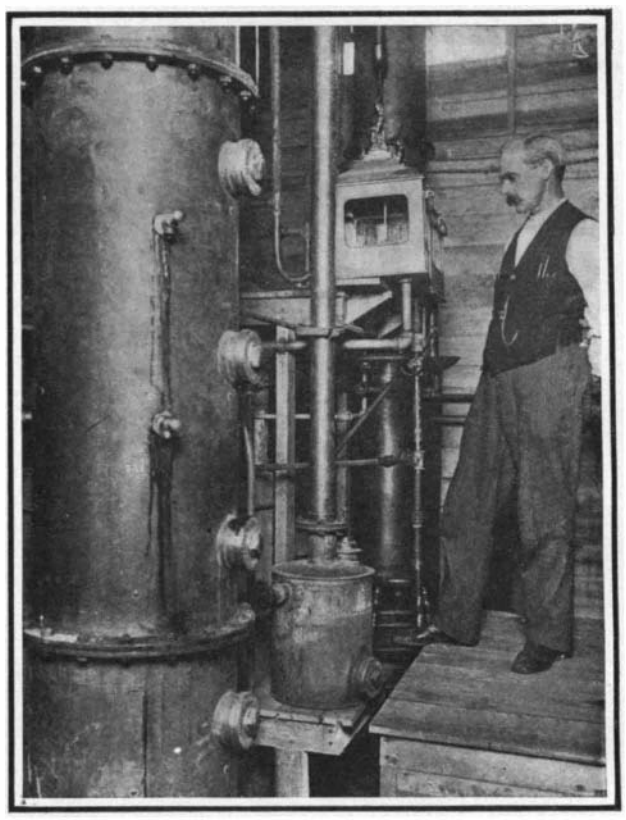
One of the greatest advantages of the production of a pure alcohol from wood, however, will be the release for food purposes of the millions of bushels of corn and barley now consumed in the manufacture of grain alcohol.

The price of grain alcohol is at present $2.60 a gallon at 188 proof, of which $2.07 is internal revenue tax, the net wholesale price being only 53 cents. Corn worth 26 cents is required for the manufacture of a

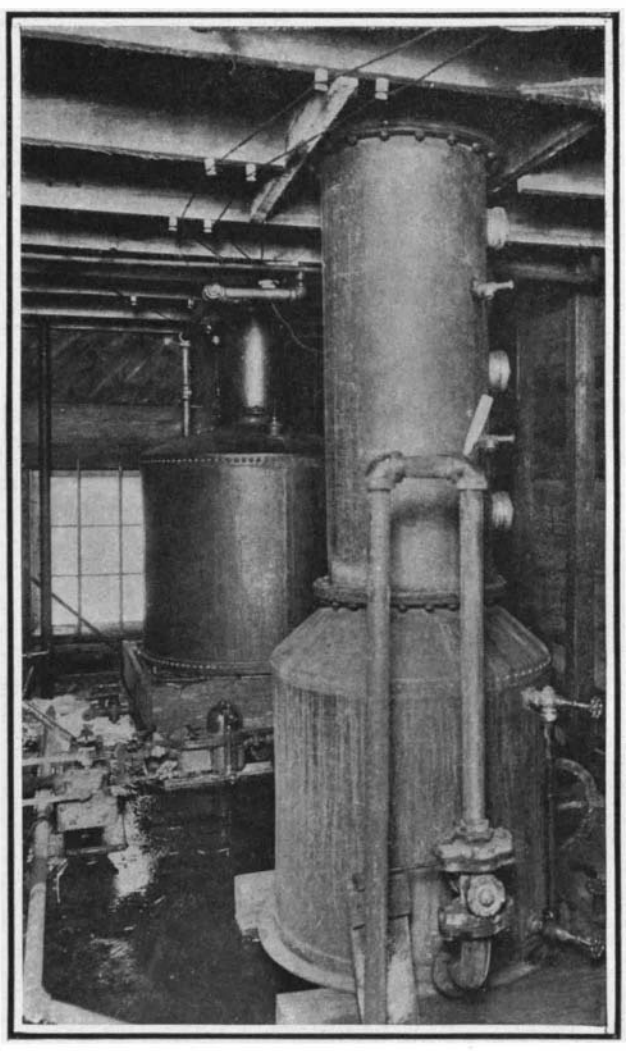
(*Continued on page 359.*)

TRIALS OF THE NEW "DREADNOUGHT"—"NORTH DAKOTA."

In view of the fact that the first two "Dreadnoughts" to be built for the United States navy are identical in everything except motive power, the "Delaware" being driven by reciprocating engines and the "North Dakota" by Curtis turbines, an unusual amount of interest has been aroused by the recent speed trials of these two ships. The "Delaware," which was built by the Newport News Shipbuilding Company, was tried out over the course off Rockland, Maine. She is equipped with Babcock & Wilcox boilers, and in the five trial runs for standardization of her propellers,



Reading the thermometers.



Still by which a fine grade of ethyl or grain alcohol has been made out of sawdust and slabs.

MAKING ALCOHOL FROM WOOD WASTE.

which were made over the mile course, she developed a maximum speed for one mile of 21.98 knots, a mean speed for the five runs of 21.44 knots; a maximum horse-power of 30,000, and a mean horse-power of 28,578.

The "North Dakota" is not only an exact duplicate of the "Delaware" in the form of her hull and in the displacement, but in common with that ship is equipped with fourteen Babcock & Wilcox boilers. Consequently, the Navy Department was in a position to make a most exact comparison of the efficiency of the respective motive power, all the conditions except

(*Continued on page 360.*)

Condenser, C. J. A. Gottlieb 938,476
Cooling system, L. L. Bogue 938,814
Copy holder, I. H. P. Colleen 938,978
Corn shocker, I. T. Leager 938,595
Corner pieces, machine for cutting and trimming the edges of, C. J. Lysaght 939,144
Corner pieces, machine or apparatus for creasing the edges of, C. J. Lysaght 939,145
Corset clamp, S. E. Florsheim 938,567
Cotton chopper, Armstead & Kelley 938,626
Cotton gathering and gleaning machine, O. C. Houghton 938,864
Couch fabric, C. H. Gail 938,569
Countersink attachment, S. Lindstrand 938,673
Crane, horn, T. J. Beetham 938,739
Crank, safety, C. C. Ilg 939,027
Crate, G. E. Richmond 938,705
Crow call, C. H. Perdew, Sr. 939,080
Crusher head, R. Bernhard 938,546, 938,953
Curtain and shade hanger, combined window, J. W. Henley 938,485
Curtain hook, McCall & Taft 939,064
Curtain pole, C. C. Schell 938,792
Curving machine, sheet material, C. N. Frey 938,751
Cushion for the bottoms of chair legs, etc., W. Maier 938,883
Cushion wheel, A. Ellis 938,834
Cuspidor, G. R. Teschel 938,912
Cuspidor, D. V. Haddock 939,013
Cut off, water spout, G. Henkel 938,665
Cutting machine, sheet material, A. F. Preston 938,788
Dental instrument, E. L. Chott 938,640
Desiccating machine, E. R. Fillmore 939,126
Desk, N. E. Fealy 939,125
Die stripper, J. H. Ames 938,940
Dish washing apparatus, E. Aldrich 938,622
Display apparatus, J. Gaynor 938,571
Display can, sheet metal, J. Xavier 938,736
Door and window fastener, sliding, F. H. Schlapbach 939,174
Door hanger, G. T. Buddle 938,823
Doors, combined roller support and casting for edgewise movable, M. Kurtzon 938,493
Doors, screen, etc., means for hanging, T. Gill 939,004
Doubletree, G. M. Frink 939,002
Draft equalizer, A. V. Burke 938,637
Drier, H. W. Shepard 939,175
Drill, W. C. Whitney 938,534
Driven mechanism, operating device for, R. D. Tittle 938,726
Driving and reversing mechanism, F. A. Thurston 938,800
Driving mechanism, friction, R. & J. Lusse 939,046
Drum and cymbal beater, bass, A. C. Schipper 938,899
Dust collector and separator, E. H. Frickey 938,656
Dust collector and separator, O. Porbeek 938,702
Dye, vat, P. Fischer 938,565
Dye, yellow, P. Fischer 938,566
Dyeing apparatus, hat, F. Bauer 938,738
Egg cabinet and testing attachment, F. J. Balgie 938,629
Eggs, preserving, W. H. Burns 938,965
Elastic wheel, M. Schnabel 938,901
Electric furnace, Rochling & Rodenhauser 939,095
Electric machine brush, dynamo, H. S. Miller 938,604
Electric machine, dynamo, A. L. Cushman 938,558
Electric switch, G. W. Hart 938,664
Electrical distributing system, A. S. Hubbard 938,865
Electrical wiring on stand pipes, hood for, J. Potterton 939,165
Electricity, generating, H. S. Blackmore 939,183
Electromagnetic device, E. A. Brofos 938,740
Electromechanical device, G. H. Rowe 938,708, 938,709
Elevating and lowering apparatus, E. P. Dandridge 938,986
Elevator locking mechanism, G. F. Steedman 938,520
Embroidery machines, perforating or pricking apparatus for, C. Moriggl 938,884
Engine. See Internal combustion engine.
Envelop clipping machine, C. E. Campbell 938,741
Eraser, J. S. Thurman 938,725
Eraser, ink, F. M. Holder 928,667
Evaporating apparatus, S. M. Lillie 939,143
Eyeglass mounting, S. J. Clulee 938,744
Fan, pump, and the like, centrifugal, J. Kirby 939,140
Fans, blade of centrifugal, O. B. Jacobsen 939,136
Faucet and spigot attachment, J. E. McLean 939,069
Faucet, compound, F. B. Hunter 938,868
Feed water heater, G. H. Gibson 938,573
Feed water purifier, F. Grieve 939,110
Fence clamp, woven wire, J. Fisher 938,564
Fiber cleaning machine, L. L. Summers 938,722
File holder, W. O. Shank 938,519
Filling machine, J. F. Haller 938,482
Filter, R. S. Browne 938,636
Filter, L. W. & M. Andres 938,947
Fire alarm, W. Goodchild 939,128
Fire escape, A. Anderson 938,625
Fire extinguisher and signaling system, automatic, Hewitt & Nolen 938,859
Firearm, G. S. Lewis 939,142
Fish tape coupling, F. A. Swan 938,723
Fishing reel line guide, W. A. Austin 938,948
Flash light, J. Anderson 938,945
Floor scraping machine, S. Drew 938,652
Fluid controlling apparatus, H. Sieben 938,613
Fluid pressure combination lock, W. J. Hofstatter 938,487
Flushing apparatus, P. S. Millice 938,683
Flushing apparatus, T. W. Christy 939,123
Flushing tank, C. M. Franzheim 938,468
Folding chair, W. W. Dozier 938,832
Folding strap or brace, G. C. Locklin 938,674
Foot rest, H. S. Phillips 938,697
Furnace, J. C. Osborne 938,693
Furnace mechanical charging apparatus, blast, L. Geuze 938,572
Fuse, electric time, McPhee & Gillies 939,155
Fuse holder, J. E. Graybill 938,477
Game, H. E. Hire 939,024
Garment, Small & Shelton 939,176
Garment supporting strap, E. Morris, Jr 939,058
Gas burner, W. F. Cobedesh 938,745
Gas, manufacturing, C. B. Tully 938,919
Gas plant, peat, J. D. Oligny 938,691
Gearing, A. D. Williamson 938,805
Gearing, G. O. Leopold 939,042
Gearing, J. G. Morrison 939,153
Gearing, A. D. Williamson 939,179
Glass cylinders, drawing, H. A. Schnelbach 939,101
Glass tank gathering pool, A. L. Schram 938,518
Go-cart, E. C. Moore 938,498
Grab or draft hook, D. A. Busch 938,551
Grader and drag, road, E. B. Fritchman 939,003
Grain cleaner and separator, F. Grotenrath 938,576
Grass catcher, H. B. McGrath 939,068
Grinder, portable and detachable disk, J. C. Ward 939,115
Grinding and polishing roll. A. Bevan 938,547
Grinding machine, G. Larson 939,038
Grinding machine, lens, F. Buchhop 938,459
Grinding mill, J. Walker 938,923
Grinding solid odies, machine for, A. J. Ericsson 938,466
Grip device, intermittent, R. D. Tittle 938,727
Gun, J. R. Crabtree 938,983
Gun cleaning means, R. A. Fessenden 938,836
Guns, device for emptying the magazines of repeating shot, T. Hardy 938,851
Hair drying apparatus, W. A. Soles 939,106
Hair pin, B. L. Scott 938,715
Hair waver or curler, J. R. Bux 938,552
Hammer and sight, combined, A. M. Powell 939,085
Harvester, beet, H. V. Lee et al 938,881
Harvester, cotton, C. N. Goodwin 938,998
Hat holder, W. R. Evans 938,998
Hatch or manhole cover, water tight, M. A. Laubeuf 938,593
Hay carrier, S. P. Lerch 938,775
Hay press, N. Piquette 938,701
Hay press sweep, N. Piquette 938,700
Hay rack, E. J. Wells 938,928
Hay rake and loader, O. J. Olson 939,157
Hay rake and loader, combined, O. Boyer 938,959
Head adjusting mechanism, C. L. Grohmann 938,479
Headlight bracket and mechanism for turning same, automobile, F. H. Aubeuf 938,456
Heater. See Feed water heater.
Heel sweep, reversible and adjustable, J. H. Brockman 938,963
Hinge, Larkin & Woody 938,669
Hinge for doors, spring, E. C. Scruggs 938,797

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gallon of alcohol, and the process costs another 6 cents, the actual cost of production being therefore about 32 cents.

The Standard Alcohol Company, owners of Messrs. Ewen and Tomlinson's patents, produces a gallon of equally pure alcohol from 5.7 cubic feet of sawdust, hitherto considered valueless, but costing, if bought for manufacturing purposes, at the outside 26 cents a ton. The cost of conversion and distillation is about 4 cents a gallon, and the total cost of materials, process, barrels, etc., does not exceed 10 cents a gallon.

The comparative cost of producing denatured alcohol is still more in the Standard Company's favor.

Wood and other vegetable fibers, as is generally known, contain a large proportion of starchy matter, which can be converted into sugar by treatment with acids. This process goes on constantly in the human body, the stomach being unable to digest starch but using its nutritive constituents when converted by the digestive juices into sugar.

The same change must be brought about in the wood waste before fermentation for the generation of alcohol is possible.

For this purpose the wood waste in the Standard Company's process is introduced into the cylindrical "digester" shown in our illustration, the door closed, and a mixture of steam and sulphurous acid introduced by an internal spray pipe while the machine is revolved. The acid acts on the starch in the wood, and at the same time the heat volatilizes the turpentine and other resinous matter in the woods used. The digester is lined with a special kind of brick to resist acid.

Upon completion of the digestion, the steam and gases are exhausted under water, which absorbs the surplus acid and liquefies the turpentine.

The treated material is then removed from the digester, and carried by conveyers to the diffusion batteries, upon the screens of which it is deposited. There it is washed by clean water, which passes through all the cells in series, becoming a stronger and stronger sugar solution. The cells are so arranged that each is filled in turn, and each in turn, when it has been washed longest, receives the fresh water, after which it is emptied of the washed residues. The liquor is next neutralized with lime, any acidity preventing fermentation, pumped into a tank and allowed to settle, the clear liquid being then pumped to the distillery fermenting tanks. A special yeast, similar to brewers' yeast, is added, and fermentation begins, from this point, the process being no different to that of making grain alcohol.

Every kind and form of wood has been used, but always with the same results, a purer alcohol being obtained than that which is generally obtained from grain. Every stage of the process has been carried on under supervision of U. S. government inspectors, and the usual licenses have been taken out.

Tests have been performed by other companies with their own staff in the Standard Company's plant, excluding everyone who has been connected with former experiments, entirely confirming the Standard Company's results, and resulting in contracts for the use of the plant under license.

The utility of this process to lumbermen will immediately be appreciated. The refuse burned will be eliminated; and if a hundred tons of wood waste a day is produced at a mill, 1,200 to 1,500 gallons of alcohol may be made from it, supplying a large quantity of power for other purposes, and still leaving the refuse with its fuel value but little diminished. The resins are extracted from pine and similar woods in the process, but the residue discharged from the diffusion battery in the alcohol process may be made into briquettes or charcoal, forming a desirable fuel salable at a good profit. Smaller mills making less than 50 tons of waste

(*Concluded on page 360.*)

Hog scraping machines, beater for, W. Gussenhoven 938,761
Horse blanket, J. W. Peirce 938,787
Horse releaser, Stires & Smith 938,721
Horseshoe, J. H. Hershberger 938,858
Horseshoe, P. von Stettina 938,907
Hose coupling, W. F. Koper 939,036
Hose coupling, I. I. Rose 939,096
Hose coupling, J. E. Ward 939,195
Hose coupling and gasket therefor, J. E. Ward 938,731
Hose coupling, train, A. H. McMasters 939,070
Hub attaching device, I. S. West 938,804
Hunting knife, G. P. Riggs 939,091
Hydrocarbon burners, feed system for, J. N. Leach 938,670
Ice cream mold gaging attachment, J. A. Aubry 938,628
Ice making apparatus, D. J. Havenstrite 938,853
Infant's band, J. Gundel 939,012
Internal combustion engine, G. V. Benson 938,633
Jar tray, W. A. Lorenz 938,675
Jewelry box, L. E. Brown 938,964
Journal box, G. Frowen 938,841
Journal box torsion lid, T. H. Symington 938,523
Key, J. Blaszczyk 939,184
Kiln, C. A. Matcham 939,049
Kinematograph and like instrument, E. A. Ivatts 939,135
Knitting machine latch needle, R. W. Scott 938,795
Knob, door, H. S. Lockwood 938,776
Knob spindle, swivel, J. R. Fletcher 939,191
Knockdown box, W. J. Neebes, Jr 938,887
Knockdown box, W. L. Howland 939,026
Labeling machine, F. O. Woodland 938,807
Labeling machine, can, G. F. Russ 938,897
Ladder, J. W. Caldwell 938,638
Ladder, ironing board, and clothes rack, combined step, J. Watt 938,924
Lamp, H. F. Smith, reissue 13,033
Lamp burner, W. E. Gard 938,754
Lamp burner, incandescent, A. A. Jahnke 939,137
Lamp holding attachment for miners' caps, C. R. Anderson 938,942
Lamp, incandescent gas, J. Maas 938,602
Lamp socket, cluster, R. B. Benjamin 938,632
Lamps, adjustable suspension cord for electric, T. W. Trotter 938,802
Last lock, F. J. Shainsey, Sr. 938,903
Lasting machine, C. F. Pym ..... 938,512 to 938,514
Lathes, feed for, C. L. Libby 939,043
Leather shredding mills, attrition plate for, G. E. Sovereign 938,798
Lifting and lowering apparatus, J. V. Vickscll 938,728
Lifting apparatus, J. H. Gilman 938,755
Lifting jack, L. Willour 938,806
Lime and apparatus therefor, burning, H. L. Doherty 938,987
Linotype and other type casting machines, matrix for, C. A. Albrecht 938,938
Liquid cooler, J. D. Hendrix 939,021
Liquid fuel burner, C. A. Bratten 939,121
Liquids, filling, storing, and discharging inflammable, Clauss & Lewisson 938,977
Litter carrier trip mechanism and reaction stop, W. Gutenkunst 938,579
Lock, H. G. Voight 938,921
Lock, H. F. Weidel 938,926
Lock, H. Eckhardt 938,991
Locomotive ash pan, R. W. Clark 938,824
Log conveyer, Grogan & Henson 939,011
Loom, J. Nazarian 938,886
Loom magazine, weft replenishing, H. Wyman 938,540
Loom shuttle picking mechanism, I. E. Palmer 938,785
Loom stop motion, O. A. Sawyer 938,712
Loom weft replenishing mechanism, O. A. Sawyer 938,711
Mail bag catching and delivering apparatus, T. F. Curtis 938,985
Mail pouch delivery apparatus, C. W. Broughton 938,821
Mainspring winder, G. W. Bowers 938,818
Manifolding pad, B. O. Maxwell 939,148
Marine table, A. H. Pence 938,695
Marker, self-feeding, A. G. Gunn 938,846
Match safe, F. Shille 939,100
Matches, combined original package and safe for, F. F. Theobald 938,913
Mechanical movement, G. W. Hart 939,193
Metal box or case, folding, F. Trieschman 938,916
Metal molding, P. T. Kenny 938,768
Metal plates, apparatus for pressing parts of large dimensions from, M. A. Bourgeois 938,816
Metal working machinery, C. E. Von Norman 938,803
Metal working machines, stop for carriages of, B. M. W. Hanson 938,483
Metals, ores, etc., working, O. Frick 938,752
Metallic bodies, method of and apparatus for testing and sorting, J. A. Switzer 939,109
Metallic leaf, package roll of, W. H. Coe 939,189
Metallic tie and rail fastener, L. McFarland 939,067
Metallurgical process, A. G. Betts 938,634
Milk, fibrous desiccated, J. A. Just 939,139
Milk pasteurizer and filter, C. C. Stambaugh 939,107
Milk, utilizing dried, J. A. Just 939,138
Milking appliance, Henrichsen & Hemmingsen 938,857
Milking vessel, S. W. Gerster 938,658
Mine ventilator, M. T. McDonough 938,781
Mines, apparatus for recording bell or like signals, especially applicable to, J. Russell 938,516
Mines, priming charge for, L. Cahuc 938,553
Mirror, electric mouth, B. E. Turney 938,525
Mixing receptacle, hand, A. Hallenberg 939,017
Moistener, antiseptic finger, Sauer & Potter 939,098
Molding machine, C. Mills 938,684
Molding machine, C. W. King 939,030
Molding machine, V. E. Knecht 939,032
Mop head and wringer, combined, L. J. Moody 938,685
Motion, mechanism for converting rotary into reciprocatory, J. Myrholm 939,063
Motor controller, electric, F. Diehl 938,649
Muffler, G. C. Hicks, Jr. 938,860
Nailer, automatic clench, P. R. Glass 938,474
Nautical instrument, C. A. McCallister 938,780
Navigation apparatus, W. J. Chance 938,972
Necktie fastener, W. J. Reed 938,606
Necktie holder, Ferguson & Hay 938,749
Necktie support, N. D. Nelson 938,687
Nest and brooder, combined trap, Miller & Hallenbeck 938,603
Nut lock, J. McIlwain 938,503
Nut lock, J. E. Robinson 938,515
Nut lock, C. H. Roff 938,707
Nut lock, Lawson & Wheeler 938,880
Nut lock, A. C. Woodruff 938,932
Nut lock, G. B. Martin 939,048
Nut lock, H. P. Davies 939,124
Nut making machine, F. R. & C. E. Long, 938,598, 938,599
Oil burner, W. S. Jenks 939,029
Ordnance, ammunition hoisting apparatus for heavy, Dawson & Horne 938,560
Ore matter, means for the concentration by amalgamation of values of metallic, R. Luckenbach 938,676
Organ, reed, L. A. McCord 939,065
Outlet box, J. T. Meleady 938,682
Package tie, Lee & Gray 939,040
Packing, hydraulic, F. Hymans 938,870
Packing ring, C. R. Maples 939,047
Paints, manufacture of, R. S. Perry 938,505
Panel board, A. E. Blackman 938,635
Panic bolt, H. G. Voight 938,526
Pantographs, electric control for, A. T. Ziegler 938,936
Paper bag machine, O. Hesser 938,486
Paper bag making machinery, S. Duerden 938,653
Paper box for packing paints, etc., F. E. Cornell 938,981
Paper, producing translucent, H. Kuhn 938,877
Pasteboard with paper, etc., machine for coating, W. Kellner 938,586
Paper, producing translucent, H. Kuhn 938,877
Pasteboard with paper, etc., machine for coating, W. Kellner 938,586
Pasteurizing apparatus, A. A. Pindstofte 939,162
Peeling machine, apple, R. Buchl 938,822
Pen, fountain, M. W. Moore 939,057
Penholder, W. B. Grover 938,760
Pencil holder, pocket, J. O. Heinley 938,764
Pencil point sharpener, A. W. Elsner 938,835
Pencil sharpener, E. H. Humphrey 939,183

Percolator, C. A. Stelle..... 938,906
Percolator, simple syrup, S. T. Hensel..... 939,131
Phenol halogen phthalein compound, W. R. Orndorff 939,075
Phonogram, F. C. Applegate..... 939,120
Phonograms, making, F. C. Applegate..... 939,119
Phonograph records, holder and index for, Alexander & Knickerbocker..... 938,809
Phorometer, J. E. Cogan..... 938,463
Piano actions, tool for applying bridles to, A. G. Crawford..... 938,826
Piano pedal connection, adjustable, H. Meyer 939,053
Pick, C. H. Blow..... 938,955
Picker stick attachment, W. D. Park..... 938,694
Picture apparatus, moving, H. Voege..... 938,729
Picture exhibiting machine, F. H. Richards. 938,895
Picture machines and stereopticons, controlling switch for moving, T. Taira... 939,110
Pins, etc., machine for manufacturing grooved, A. L. Mowry..... 939,061
Pipe coupling, G. W. Curry..... 938,984
Pipe coupling, E. Marek..... 939,146
Pipe lines, device for passing cables through, H. A. Greenan, reissue..... 13,032
Pistols, etc., automatic safety appliance for, J. Tambour 939,111
Piston, T. Hall..... 938,481
Planing machine, W. A. Robertson..... 939,093
Planter, corn, V. F. Pavey..... 939,159
Plow, F. R. Mosher..... 938,686
Plow, C. Christensen..... 938,975
Plow attachment, C. W. De Kay..... 938,647
Plow attachment, P. Flynn..... 938,839
Plow, gang, L. A. Hubert..... 939,132
Plow sweep, S. H. Carpenter..... 938,639
Plumbing joint fitting and attachment, W. J. & P. M. Forster..... 939,001
Popcorn popper, M. H. Hoffman..... 938,666
Post card, souvenir, R. Hasbrouck..... 938,763
Poultry hanger, L. F. Henig..... 938,765
Power generator, C. C. Tuch..... 938,918
Power tacker, portable, M. D. Phelan..... 938,508
Press, S. L. Carter..... 938,462
Press feeding mechanism, automatic, L. C. Krummel 938,876
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a day may profitably combine to operate a joint distillery for the conversion of their refuse into alcohol.

Whereas it may be not a little alarming to the prohibitionists to suggest that a drinkable alcohol may be so cheaply made from sawdust, much as one may deprecate the manufacture of artificial wines and liquors and adulteration with alcohol, it is at least satisfactory that the product of the new process is actually purer than that made from grain.

TRIALS OF THE "NORTH DAKOTA."

(*Continued from page 352.*)

that of the motors being identical.

The five trials of the "North Dakota" over the mile course gave the following speeds: 22.25, 21.48, 22.13, 21.51, and 23.13, the average speed working out at 21.83 knots. She thus not only exceeded the mean speed of the "Delaware" by 0.39 knot, but the turbines exceeded the reciprocating engines by over 5000 horse-power. The maximum number of revolutions of her propellers was 286 a minute, and it was found that 263 revolutions were sufficient to maintain the contract speed of 21 knots.

In the four-hour test under full power the "North Dakota" made 21.71 knots for the first two hours, and 21.64 knots in the third hour. On the fourth mile the failure of a tube in one of the boilers necessitated the shutting down of four out of the fourteen boilers; but even under this greatly reduced power, the speed of the ship was exactly 21 knots.

A feature which, from the military standpoint, is of the greatest importance is the remarkable steadiness of the ship, even when the turbines are being pushed to the limit. Throughout the greater part of the length of the ship it was scarcely possible to tell, from any vibration, that the engines were in motion. This is a feature which is particularly appreciated by ordnance officers; since the vibration which is noticeable on ships driven by reciprocating engines is more or less disturbing to the gun sights. The "North Dakota," which is considerably the largest warship yet built for our navy, has been constructed in record time; and the Fore River Company is to be congratulated on the fact that, had it not been for delays in the furnishing of armor, they would have cut down the record for construction even more than they have. Her dimensions are: Total length, 518 feet 9 inches; beam, 85 feet 2½ inches; draft on trial, 27 feet; displacement on trial, 20,000 tons. She is the most completely armored ship afloat. Her main belt, 7 feet 6 inches wide, tapers from 10 inches at its bottom edge to 12 inches at its top edge. Above this, extending to the gun deck, is a second belt 8 feet wide, tapering from 10 inches at its bottom edge to 8 inches at the top. The 5-inch guns have a protection of 5 inches of armor, and the main turrets and barbettes are protected by 11 inches.

The lines of the ship are particularly fine, in fact, as fine as those of our armored cruisers. She will prove to be a splendid vessel when heading into a heavy sea; for not only has she freeboard, due to her forecastle deck, of 27 feet, but she is given a very pronounced outward flare, which should serve to lift her comfortably over the waves, and enable the ship to be driven at full speed in heavy weather. An innovation is the placing of the officers' quarters forward under the forecastle deck and in the superstructure immediately abaft of the two forward turrets.

The battery is mounted on the longitudinal axis of the ship, a disposition which originated with our Construction Department, and is being followed by some foreign navies. The placing of all the guns on the center line enables the whole battery to be trained on either beam, giving the ship a broadside discharge either to port or starboard of ten 12-inch guns. This arrangement, it is true, weakens the end-on fire, which, in

(*Concluded on page 361.*)

Home-Made Experimental Apparatus

In addition to the following articles, the Scientific American Supplement has published innumerable papers of immense practical value, of which over 17,000 are listed in a carefully prepared catalogue, which will be sent free of charge to any address. Copies of the Scientific American Supplement cost 10 cents each.

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