Correspondence.

A Much Needed Invention.

To the Editor of the SCIENTIFIC AMERICAN:

"There is no great loss without some small gain." Panics like that which the American people have recently passed through teach them the wisdom of economy. In fact, the poor and middle classes of this country are just beginning to practice the economy which is so prevalent in Europe.

One of the directions in which great economy might be brought about is that of tobacco smoking. We are a smoking people and spend millions of dollars annually in the satisfying of this appetite. The satisfaction obtained from cigar smoke might be obtained from pipe smoke for about one-tenth of the cost, and every old smoker knows that there is more "solid comfort" in a pipe.

Persons desirous of giving up the cigarette habit find it much easier to give it up for a pipe than for cigars. The one great obstacle in bringing about this vast economy and reform in smoking lies in the fact that few persons can smoke a pipe with comfort on account of its irritating or "burning" effect upon the tongue. If some one could invent a pipe which would prevent this, and which could be easily cleaned, he would secure for himself an independent fortune and for the smokers of the world a legacy worth untold millions.

AN OLD SMOKER.

Nickel Steel.

BY H. K. LANDIS, AM. INST. MG. E.

Although it was but a decade ago that this formidable alloy actually entered into competition with other high resistance metals, its existence was known in the latter part of the eighteenth century. In 1792 Christoph Gertanner said that "iron combines easily with nickel;" Faraday produced a nickel-iron alloy in 1820; Berthier, Fairbairn, and others also studied this interesting alloy. The first industrial application, however, was made by Wolf, a record of whose work will be found in the annals of Liebig of 1832. He produced from nickel-iron alloys beautifully embossed articles which are said to have been of superior excellence. In 1853 the attempt was made in the United States to make the nickel-iron alloys directly in a blast furnace, but the effort was not commercially successful, for the reason that the product had no constant composition, and that there was no commercial demand for it. It remained for the naval authorities at Washington to give the required impetus. Tests made both in Europe and this country demonstrated the toughening effect of nickel upon steel, and it was agreed that this alloy should be tried on the armor plates already contracted for, the government paying for the nickel consumed, and that the steel should contain 3 per cent of nickel. Commercial nickel steel contains 2 to 5 per cent of nickel. It was found that these heavy armor plates, destined to protect the sides and barbettes of our war vessels, were very superior to the ordinary steel plate, not only in the ballistic tests but also that they withstood the strains in heating, forging, and tempering very much better. Thousands of tons of nickel steel have been employed for this purpose alone, forming a nucleus about which the alloy has grown, until it emerged from the experimental stage as the "noblest Roman of them all," and to-day stands first among high specification steels.

Iron has a strong affinity for nickel, and alloys with it in all proportions very readily. It seems, however, from tests given further on, that the maximum results are obtained with 8 or 16 per cent of nickel. The following is the average composition of nickel steel as made in the United States:

Carbon..0·24–0·28 per cent.
Sulphur..0·02–0·03 " "
Manganese..0 60–0·70 " "
Phosphorus..0·01- 0 03 " "
Nickel..3 00–5·00 " "

It will be seen that the above corresponds to what is called a "mild steel," and yet the increase in strength due to nickel alone is probably 60 per cent of its strength without the addition of nickel, while the cost of the steel is but 1 to 1·5 cents per pound more, disregarding the small loss in manufacture. Most of the nickel steel is made in the furnaces of the Bethlehem Iron Company and the Carnegie Steel Company, where it is cast into ingots weighing from 50 to 100 tons, requiring the charge of two or three furnaces to fill the ingot mould. The "stock" from which the steel is made is metal of known purity, wash metal, some pig iron, pigs of ferromanganese, "scrap" from previous "heats," crop ends from forgings, lathe and planer chips from the machine shop, and finally nickel. The latter is added after the charge is melted and a short time before casting, as the oxide or metallic nickel unites very readily with silicates in the slag, thus involving considerable loss. The method of adding nickel varies. The smaller losses occur with metallic nickel shot, which is used for alloys containing over 5 per cent of nickel. The usual method is to use oxide of nickel mixed with charcoal and lime, made plastic with water, moulded into cubical bricks and dried thoroughly. When added to the bath of steel, now at a white heat, the carbon of the mixture reduces nickel oxide to metallic nickel, lime taking up any silica that may be in the adjacent charge, thus insuring an immediate alloy and at the same time preventing loss of nickel by the formation of silicate of lime. As one stands upon the furnace platform or floor, shielded from the intense heat (the metal is at about 3,000° Fah.) of the liquid steel by a crane girder column, and sees the incandescent metal rush through the "tap hole," down the "runner" to the "ladle," amid the bustle of workmen and the sharp puffs of traveling cranes, his mind naturally reverts to the days of Tubal Cain or to the German myth Mime, thence to the first manufacture of Damascan cementation steel, and following the series he sees in his mind's eye the white sides of those splendid American battleships, which are the crowning triumph of that development which has justly earned for our era the title of the "age of steel." The furnaces employed are of the open hearth type, and consist of an oblong, horizontal metal pan lined with refractory brick and clay, whose vertical sides are provided with doors at the front and back, and "ports" at the ends, through which the combustible gases enter and take their exit after burning. An arched roof completes the structure, the capacity of which varies from 20 to 50 tons, being usually 40 tons. The method of manufacture does not differ much from that practiced with other steels, except that a small variation in the content of nickel makes but a trifling variation in the properties of the steel. Carbon is the principal component to be gaged, the nickel and manganese being added in the required proportion as alloys. These are added just before tapping to prevent their going into the slag; nevertheless the slag always has a green appearance, caused by the formation of silicate of nickel.

Physical Properties.—Resistance to corrosion is its principal peculiarity. Numerous tests have been made, especially in sea water, which is very destructive to iron or steel, the results of which have demonstrated the fact that nickel steel when used alone would outlast the best of ordinary steels. This was proved by tests with propellers, torpedo netting, metal sheathing for vessel bottoms, etc. There seems some doubt, however, as to its applicability to boilers, where its high elastic limit would permit much lighter construction. Some experiments indicate that nickel steel corrodes rapidly in pure water and in the presence of various boiler compounds, while on the other hand an English authority cites an experiment indicating a corrosion of but one-half to three-quarters that of ordinary steels. When the boiler is made entirely of nickel steel, thus preventing electrolytic action, there is no doubt but that it is the best material yet applied to that purpose. The fracture faces are more fibrous than in ordinary steel, though there is no appreciable difference in color or luster of the polished metal.

Mechanical Properties.—Nickel steel is a noble metal, for while it has a remarkable resistance to applied stresses, yet it is almost as easily worked as soft steel, is not brittle while hot or cold, is not much affected by tempering or annealing as compared with carbon steel, and is remarkably homogeneous. We might first ask what effect nickel has on the properties of iron. This was shown in the results of experiments on nickel-iron alloys made at the Laboratory of Industrial Mechanics at Berlin and reported by that celebrated metallurgist Dr. Wedding. These alloys contained no carbon and but small percentages of several impurities—not over 0·2 per cent total. The results were, therefore, practically for pure nickel-iron alloys, and they showed that the maximum tension results were obtained with an 8 per cent nickel alloy, while the compressive and shearing strength had its greatest development with the 16 per cent alloy. The effect of nickel on iron was therefore to raise its tensile strength from 52,500 to 80,200 pounds per square inch; its elastic compressive strength from 29,440 to 186,748, and its shearing resistance from 42,242 to 102,410 pounds per square inch. This effect is not obliterated by the presence of carbon, as is seen in the deductions arrived at by Cholat and Harmet:

1. Ferro-nickel alloys: 2·5 per cent nickel, 0·1 per cent to 1·0 per cent carbon.—The elastic limit and ultimate strength are raised and contraction decreased as the proportion of carbon increased. Tempering develops these properties uniformly.

2. Ferro nickel alloys: 15 per cent nickel, 0·1 to 1·0 per cent carbon.—In the annealed specimens, strength and elasticity increased rapidly with the carbon content up to 3 per cent carbon, where the tensile strength was 213,400 pounds per square inch. Tempering in oil raised the elastic limit of this last steel to 166,400 and its breaking strength to 277,400 pounds per square inch. The minimum contraction corresponded very nearly to the highest elastic limit. Prolonged annealing slightly improved on the annealed specimen.

3. Ferro-nickel alloys: 25 per cent nickel, 0·1 per cent to 1·0 per cent carbon.—An interesting variation is here noted, for contraction and elongation rise with the carbon content, the tensile strength remains high, and the metal is not brittle. It seems that the high percentage of nickel held the carbon in a condition which could not be modified by tempering.

This latter property is very useful, as internal strains incident upon manufacture can be relieved by annealing without sensibly reducing the resisting qualities of the steel; in fact, such annealing tends greatly to toughen the material and increases its ability to resist shock or vibration to a remarkable degree. Where a low carbon (0·20 per cent C) steel will withstand 300,000 double stresses on an alternate stress machine, a high carbon (0·50 per cent C) will break at probably 400,000 and nickel steel at from 1,500,000 to 2,000,000 such double stresses, each stress being two-thirds of its ultimate strength, or very near its elastic limit. It is very common for tempered nickel steel to have a tensile strength of 200,000 pounds per square inch without being brittle. If we compare this with the 60,000 pounds for low carbon steel, we see that there is still plenty of room at the top, for most of the steel used to-day is low in carbon. Commander Eaton, U.S.N., says that our government first bought nickel to use in steel in 1890, that the first nickel steel plate was tested in 1893, in July, from which date all armor for United States vessels was made of nickel steel. As the armor plate industry has probably achieved the best results in nickel steel, the following tests made on plates exhibited at the Chicago Exposition by the Bethlehem Iron Company are presented. The analysis of this steel corresponds very closely to the average composition already given, except that the nickel content is 3 25 per cent.

MECHANICAL TESTS OF NICKEL STEEL ARMOR PLATES.

Elastic Limit. Pounds per square inch.	Ultimate Strength. Pounds per square inch.	Elongation. Per cent.	Contraction. Per cent.
86,000	142,000	11·50	45·0
72,000	117,200	14·25	45·0
96,800	120,000	13·75	62·0
78,800	110,000	16·25	58·5
64,000	117,600	17·00	45·9
65,000	118,900	16 66	42·2
74,000	142,800	13·00	28·2
74,000	143,200	12 32	27·6
51,000	91,600	22·75	53·2
51,000	91,200	21·62	53·4
53,000	85,200	21·30	49·5
48,000	86,000	21·25	47·4
......	276,000	2·75	4·0
......	246,600	4·25	6·0

When these results are compared with those of high carbon steel having a strength of 90,000 pounds per square inch, we can understand why simple steel plates break while nickel steel resists the ballistic tests. Low percentages of nickel do not interfere in the least with the ordinary processes of Harveyizing, tempering, forging or reforging, machining, or rolling, and give to the plates all the qualities of high carbon steel without its brittleness.

Outside of the application of this metal by the United States navy to armor, angles, rods, thin plates, engine shafting, hull plates, an experimental gun, the barrels of small arms, torpedo netting, etc., may be mentioned its application to bicycle frames and handle bars, steam boilers, and difficult steel castings. In fact, wherever a tough metal of high resistance and low corrodibility is wanted, this alloy is applicable. Its excellent mechanical qualities permit the weight of the parts to be reduced, leading to its application to motor carriages, flying machines, and suspension bridges, while its high resilience allows it to be used to advantage in car links, axles, crank pins, bridge pins, bicycle spokes, etc. We may look forward with a considerable degree of certainty to the extended use of this material in a wide variety of mechanical construction in the near future.

Swiss Exposition of 1896.

Consul Ridgely, of Geneva, reports, October 27, 1896: "The Swiss National Exposition, which was held at Geneva from May 1 to October 18 inclusive of last year, was conducted at a great financial loss. The confederation subscribed 1,000,000 francs and the city and canton of Geneva provided a guarantee fund of 500,000 francs. In addition, the exposition company issued 500,000 francs in stock, which was subscribed to by various patriotic citizens. All this has been swallowed up, and there is still an estimated deficit of from 100,000 to 300,000 francs, which is to be covered by the profits of a national lottery, to be drawn the last part of November. The financial failure of the exposition was due entirely to the spring, summer, and autumn of unprecedented bad weather. The exposition was inaugurated in a storm of wind and rain on May 1, and was closed on October 18, attended by the same unfavoring elements. During the entire season, there were only a few days of good weather, and the whole country became in consequence more or less dispirited. Thus it happened that Switzerland's greatest national industrial enterprise was a signal financial failure. In all other particulars, however, the exposition was a splendid success. The displays were thoroughly representative of the mechanical industry, as well as of the agriculture and art of the country, and were made on a scale of lavishness that would have done credit to a much larger and richer nation."

A School of Military Ballooning.

The School of Military Ballooning, under the charge of officers of the Royal Engineers at Aldershot, Eng., has done much to increase the practicability of balloon service in war, says the Army and Navy Journal. Steel tubes are used for carrying compressed hydrogen for inflation, and hydrogen of the purest quality is manufactured from zinc and sulphuric acid by electrolysis. These tubes are safe under a strain of 101 atmospheres. Three wagons are required to transport tubes carrying a charge of 11,000 cubic feet of gas, but new patterns, tubes and wagons have been adopted, which will reduce the transportation to two wagons. "Gold beater's skins" are used for the balloon, and they are so light that the balloon with 2,500 feet of surface and carrying 10,000 cubic feet of gas weighs only 170 pounds. The material is so strong that a closed balloon of large size has ascended 7,000 feet without bursting. The present material is not subject to the disadvantages of the varnished silk and cloth balloons of olden times, which were subject to cracks, became often overheated, were easily torn, and permitted the gas to leak away. The top valve of the balloon is now made very light and strong, of an aluminum alloy, and is perfectly gas-tight. The cords of the balloon are made of Italian hemp, a fine brass thread being woven into the cord for security in thunder storms. It weighs one pound to the hank, and will stand 500 pounds strain to the yard without breaking. The rings are of American hickory and the wickerwork of the car is excellent. Every balloon wagon has half a mile of wire rope attached to it which is available for holding the balloon captive. There is also a telephone conductor; and connection with the wagon is neatly made on a screw bar, so that in whatever direction the pull of the balloon may be the wire rope will never come into contact across the drum.

The London Standard, from which we obtain these particulars, says: "Some of the hand records taken in the free balloon excursions are extremely precise and full of serviceable details. The photographs, even those of small size, usually contain details of value. Soldiers within a range of two miles on each side of the line of flight can be detected with a hand lens. The coming trials of the capabilities of balloons for taking part in military engineering operations in warfare will be fraught with interest and novelty, whether they be successful or not. The first trials will probably be directed toward the application of captive and carrying balloons in assisting or preventing operations in trenches. The ditch forms the protection to the working sappers; and the artillery projectiles cut into the rear of the trench and drive the debris to the rear of the work. The object of a balloon attack, therefore, might be to plant, say, a 500 pound charge of high explosive in rear of the trench, so that when exploded it would blow the debris into it, overwhelming the men or exposing them to the enemy."

THE OPERATION OF THE SELF-BINDING HARVESTER.

BY E. J. PRINDLE.

It is marvelous how quickly the practical self-binding harvester has been produced. The young men of to-day can remember when the sickle was in common use for harvesting, at least on the smaller farms. The better equipped farmer had the cradle. Then came the form of harvester having a platform on which the grain fell as it was cut, and from which it was raked by an attendant when a proper quantity had accumulated. The harvester was followed by men who bound the bundles by hand. On some machines two men were carried who bound the bundles as they were formed. Improvements were steadily made until the first successful self-binders were produced, requiring four or six horses, and being unreliable to such an extent that it required the attention of several men to run them.

Fig 2.

And now we have harvesters cutting and binding automatically, easily managed by one man, and some of them so light that two ordinary horses can draw them. To the uninitiated they seem an unintelligible mass of intricate machinery. But like most machines, the principle is comparatively simple, even of that almost human contrivance the cord knotter. Fig. 1 is a transverse cross section of a self-binding harvester. The grain, as it falls from the sickle, is caught on the horizontal traveling belt, K, which carries it to the two inclined belts, L and M, between which it is elevated to the packer, B, which throws it against the cord. The cord runs from the twine box through the eye of the pivoted needle, or binder arm, D, and from thence past the knotter, U, to the holder, F, which clamps the end of the cord. The packer forces the grain into the bight of the cord until the trip arm, G, is forced back far enough to operate the clutch, which sets the cord knotter in motion. The needle is thrown up through the column of grain, carrying the cord by the knotter and into the holder. At the same time, the compressor arm, E, compacts the bundle between itself and the needle. There is now a loop of cord surrounding the bundle, and having its ends caught in the holder, the knotter being between the bundle and the holder.

To make the operation of the cord knotter clear, a series of photographs is reproduced, showing the same knot being tied by hand in the same manner. In Fig. 2 the general arrangement is shown. The twine runs from the ball through the holder, by the knotter, around the bundle and back to the holder, leaving a second strand passing the knotter, which is here replaced by two fingers of the hand. In tying the knot, the fingers sweep back, over the cord, Fig. 3, continue around in a nearly horizontal plane, Fig. 4, and separate so that one passes above and one below the strands of cord, Fig. 5. The fingers are then forced together, grasping the strands between them, after which they are drawn back, Fig. 6, carrying a loop of the two strands up through the circle formed by the previous motions of the fingers, Fig. 7. This completes the knot, as shown in Fig. 8.

The mechanical knotter, shown inverted in Fig. 9, consists of a fixed finger on a rotatable shaft, and a finger pivoted to the shaft and pressed against the fixed finger by a strong spring. The pivoted finger carries a friction roller, U'', on its rear end and is raised as the knotter rotates by the action of this roller on a cam fixed on the frame of the machine. The fixed finger has a purely rotary motion, and when the knot has reached the stage represented in Fig. 5, the knotter simply holds the strands of cord, and the expulsion of the bundle draws the circle of cord over the fingers, thus having the effect of drawing the strands through the loop.

The holder consists of a disk having notches which catch the cord and carry it between the disk and a spring-pressed lever which fits against the face of the disk, thus clamping the cord.

After the knot is tied the cord is cut between the knotter and the holder, leaving the new end of cord thus formed in the holder, the rotation of whose disk has caught the portion between the needle and the knot. A small piece of cord two or three inches long is

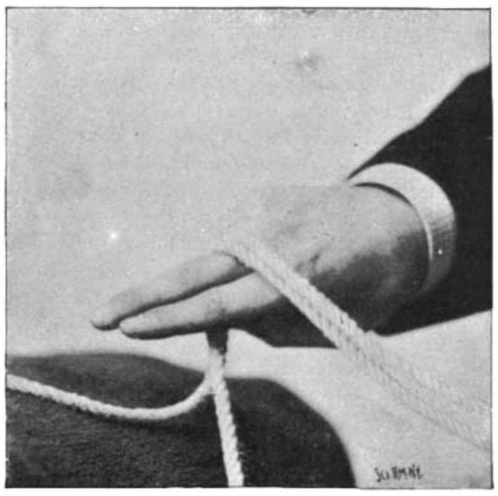

Fig. 3.

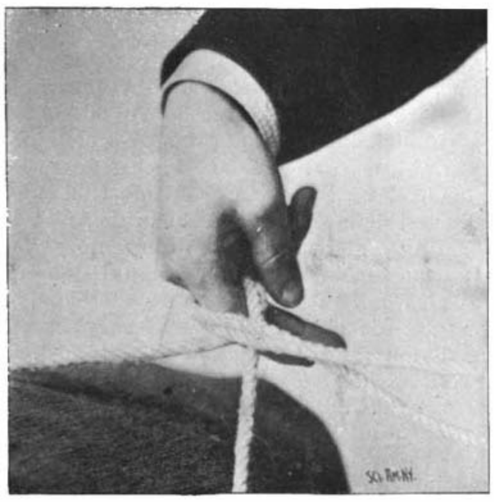

Fig. 4.

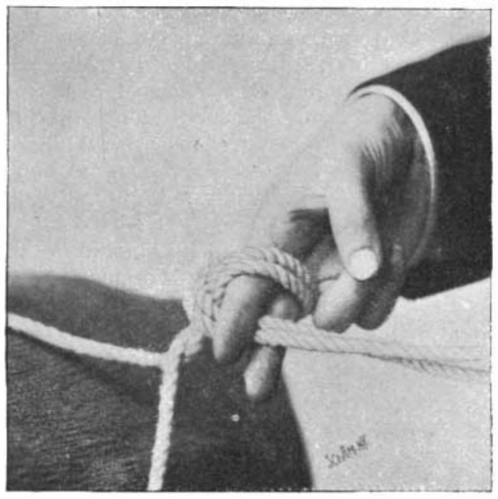

Fig. 5.

Fig. 6.

Fig. 7.

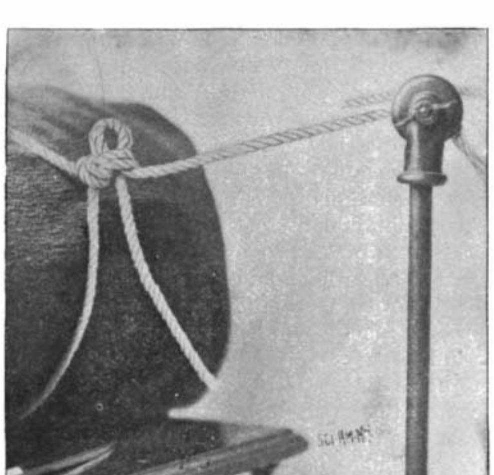

Fig 8.