Scientific American Supplement, No. 598, June 18, 1887 eBook

Scientific American Supplement, No. 598, June 18, 1887

Contents

BOOKRAGS

Table of Contents

Table of Contents

Page 1

V. MINERALOGY.—Precious Stones of the United States.—A review of Mr. G.F. KUNZ'S recent report on this subject.

VI. Miscellaneous.—A Clinical Lesson at "La Salpetriere."—A portraiture picture by M. *Andre Brouillet*, of a clinic.—2 illustrations.

Inauguration of the statue of Denis Papin.—The statue to Papin erected in Paris by popular subscription.—1 illustration.

The Action of the Magnet in Hypnosis.—The nullity of the action of the magnet disclosed.

To Find the Day of the Week for any Year.—A new method devised by Lewis Carroll.

VII. *Naval engineering*.—Some Recent High Speed Twin Screws.—By E.A. *Linnington*.—An important paper on the subject of screw propulsion.—6 illustrations.

The Havre Maritime Exhibition.—Notes on the recently opened exhibition of ships and naval appliances at Havre.—1 illustration.

The New German Corvette Greif.—A recent addition to the German fleet illustrated and described.—1 illustration.

The Steamship Great Eastern.—A plea for the mammoth steamer.—Probabilities of her future usefulness.

Twin Screw Torpedo Boat.—The new sea-going vessel built by Yarrow & Co. for the Italian government.—Her extraordinary speed.

VIII. ORDNANCE.—Our Coast Defenses.—An interesting summary by Gen. H.L. ABBOTT of our means for defending our coasts.

The New Krupp Guns.—The dimensions of the largest guns in the world, now in process of construction at Essen.—2 illustrations.

IX. PHYSICS.—Colors of Thin Plates.—Report of a recent lecture by Lord Rayleigh.

X. *Technology*.—Recent Advances in Sewing Machines.—By *John* W. *Urquhart*.—A recent lecture before the Society of

Arts of London, giving an exhaustive review of the subject.—15 illustrations.

* * * * *

THE HAVRE MARITIME EXHIBITION.

The Havre Maritime Exhibition opened on the 7th of May.

Will this exhibition awaken general interest, or will it prove a local affair simply? This is a secret of the weeks that are to follow.

Should nothing chance to discourage the general interest that surrounds Havre, to dampen the enthusiasm of the public, or to act to the prejudice of the exhibitors, whose very evident desire is to show nothing but remarkable products in every line, the International Maritime Exhibition will prove a great success.

[Illustration: *The International marine exhibition at Havre*.—*The principal entrance*.]

Page 2

The people of Havre have two points of comparison that more particularly concern themselves: Their Maritime Exhibition of 1868, which, as far as exhibition goes, was a complete success, is the first. The financial results of it were not brilliant, but that was due to certain reasons upon which it is not necessary to dwell. On the contrary, the Rouen Exhibition of 1884 proved profitable.

The Havre Exhibition, under able management, can have only a like good fortune. It must be said that the people of Havre would be deeply humiliated should it prove otherwise.

A very appropriate location was selected for the Exhibition, in the busiest quarter of the center of the city. Its circumference embraces one of the finest docks of the port—the Commerce Dock, thus named because it could not be finished (in 1827) except by the financial co-operation of the shipowners and merchants of the city. For the purposes of the Exhibition, this dock is now temporarily closed to navigation.

In the various structures, wood has been exclusively employed. The main building, which alone has a monumental character, is Arabic in style, and is situated in the center of Gambetta Place, over Paris Street, which here becomes a tunnel. Two facades overlook the ends of this tunnel. A third facade, which is much longer, fronts Commerce Dock.

The edifice is surmounted by a spherical cupola that serves as a base to a semaphore provided with masts and rigging. On each side of the sphere there are two pendent beacons. Wide glazed bays open in the external facades, and allow the eye to wander to the south through Paris Street as far as to the outer port, to the summits of Floride, and to see beyond this point the bay of La Seine, Honfleur, and the coast of Grace. To the north, the most limited view has for perspective the City Hall, its garden, and the charming coast of Ingonville.

The principal facade, that which fronts Commerce Dock, from which it is separated solely by a garden laid out on Mature Place, is the most attractive and most ornamented. Here are located the restaurants, the cafes, the music pavilion, and a few other light structures.

Internally, this portion of the Exhibition comprises a vast entertainment hall, brilliantly and artistically decorated with tympans representing the three principal ports of commerce—Havre, Bordeaux, and Marseilles—and with pictures by the best marine painters. It is lighted by an immense stained glass window which fronts Commerce Dock and the garden, and which lets in a flood of soft light.

The galleries to the right and left, over Paris Street, are reserved for the exhibitions of the ministers of state and of the large public departments, and for models, specimens, plans, and drawings of war and merchant vessels, and of pleasure boats, and for plans of port, roadstead, and river works.

Two endless galleries run to the north and south of Commerce Dock, parallel with Orleans Wharf on the one hand and Lamblardie Wharf on the other.

Page 3

The northern gallery is connected by a foot bridge with the annex of Commerce Place, where is located the colonial exhibition, the center of which is occupied by a Cambodian pavilion, in which are brought together the products of Indo-China and Algeria. For half of their extent, the two galleries are separated from the dock by a promenade provided with seats and covered with a roof. On this promenade, it became necessary to make room for certain belated exhibitors whose products are not affected by the open air.

In Commerce Dock are to be seen, floating, specimens of every ancient and modern naval construction, French and foreign, among which are the state convette Favorite and an English three-master converted into a cafe boat. We find here, too, the giant and prehistoric oak of the Rhine, on board of the Drysphore.

Commerce Dock is divided into two parts by a foot bridge, which allows the visitors to pass from one side to the other without being compelled to tiresomely retrace their steps.

The main entrance to the Exhibition is opposite the portico of the theater, on Gambetta Place. A second entrance is found on Commerce Place in the colonies annex. The others, near the center, are on Orleans Wharf, opposite Edward Larue Street, and on Lamblardie Wharf, opposite Hospital Street and opposite Saint Louis Street.

The garden of the Exhibition and the galleries that surround it are illuminated at night by the electric light.—*L'Illustration.*

* * * * *

OUR COAST DEFENSES.

General H.L. Abbott delivered a lecture before the Academy of Sciences in New York, on the evening of March 21, a summary of which is given by the *Herald* as follows:

According to General Abbott, the country needs for its coast defenses:

Heavy guns;
Armor-clad casemates;
Disappearing gun carriages in earthworks;
Heavy mortars;
Submarine mines or fixed torpedoes; and
Fish torpedoes.

The lecturer said that this nation may be attacked in four ways: First, by fleet and army combined, as in our revolutionary war; second, by blockading the entrances to all our ports; third, by bombardment of our seaport cities from a long distance; fourth, by a fleet forcing its way into our harbors, and making a direct attack or levying tribute on our people.

The first is not now greatly to be feared. We are too distant from great powers, and too strong on land.

The second should be met by the navy, and is, therefore, outside a discussion of coast defenses.

The third is not probable, though it may be possible. The extreme range of 10 miles for heavy guns cannot be obtained from shipboard, and as an elevation of only 15 deg. or 16 deg. can be given, not over 5 to 6 miles range is attainable.

The fourth is the one which is possible, probable, even certain—if we have war before we have better defenses.

Page 4

The race between guns and armor began about thirty years ago, and there has been more development in ships and guns in that time than in the two hundred preceding years. The jump has been from the 7 in. rifle as the largest piece to the 110 ton Armstrong; in armor, from 41/2 in. of iron to the Inflexible with 22 in. of steel plating. The new Armstrong gun of 110 tons, tried only recently, with 850 pounds of powder and an 1,800 pound shot can pierce all the targets, and so far guns have the victory over armor. This gun developed 57,000 foot tons of energy, and will probably reach 62,000. Imagine the Egyptian needle in Central Park, shod on its apex with hard steel, dropped point downward from the height of Trinity steeple; it weighs 225 tons, and it would strike with just about the effect of one of the 110 ton gun's projectiles. Two of these guns are ready for the ironclad Benbow, and the Italians have several equally powerful of 119 tons from Herr Krupp. The most powerful gun in the United States, the 15 in. or the 12 in. rifle, has a muzzle energy of 3,800 foot tons.

Ships like the Inflexible are the most powerful afloat. A steel water-tight deck extends across the ship, and she has 135 water-tight compartments. Her guns and engines amidships have a protection of 24 in. of armor, and amidships she has a citadel carrying two revolving turrets, each containing two 80 ton guns. Her turret armor is 18 in. thick. She can make 14 knots, and she has cost $3,500,000. But she has a low freeboard, and the guns, therefore, get no plunging fire.

The French ship Meta has her heaviest guns mounted *en barbette*, high above the water line, giving a splendid plunging fire.

Either of these ships could enter any of our harbors and hold us at her mercy.

The entrance to the harbor of Alexandria, Egypt, is about 5 miles across. At the time of the bombardment the protecting fortifications were situated at the east end, in the center, and at the west end. On the west there were mounted 20 modern guns of great size and power, and there were 7 others at the east end.

Although the Egyptians fought bravely, they did very little harm to the English fleet, while on the second day the defense was silenced altogether. Following the bombardment—-as in Paris—came the reign of mob law, doing more harm than the shells had done; and it is a possibility that every such bombardment would be followed by such an overthrow—at least temporary—of all forms of law and order.

The ships that had silenced the Alexandria batteries—which had 27 heavy guns more than we have—could reach our coasts in 10 or 12 days, and we would have nothing to meet them.

Armor-clad casemates are beginning to take the place of masonry. A tremendous thickness of masonry is built up to the very embrasures for the guns in the steel-clad turrets. This (the Gruson) system has been adopted by Belgium, Holland, Germany, Austria, and Italy.

Page 5

In 1882 England had 434 heavy modern guns behind armored shore batteries; besides these at home, she had 92 in her colonies, of which 13 were in Halifax and 11 in Bermuda—for our express benefit.

What we have are brick and stone casemates and earthworks. A sample granite casemate, with iron-lined embrasure, was built at Fortress Monroe, and 8 shots were fired at it from a 12 in. rifle converted from an old 15 in. smooth bore. This gun develops only 3,800 foot tons of energy—a mere nothing compared with the 62,000 foot tons of the English and German 110 ton guns.

General Abbott showed most conclusive proof of the worthlessness of masonry forts in pictures showing the effect of the shots. The massive 8 feet thickness of granite was pierced and battered till it looked like a ruin. Not a man inside would have been left alive.

He also showed a “disappearing” gun in an earthwork, the gun recoiling below the level of the parapet and being run up to a firing position by a counterweight. In 1878 Congress stopped all appropriations for defenses, and nothing had been done since.

General Abbott said that we needed submarine mines or fixed torpedoes, which should be thickly interspersed about the channel and be exploded by an electric battery on shore. To prevent these torpedoes from being exploded by the enemy, the surface over them should be covered by plenty of guns. Heavy guns and mortars were needed to resist attacks by heavy iron-clads. Movable torpedoes were valuable, but only as an auxiliary—a very minor auxiliary—compared with submarine mines. We should be cautious not to infer that torpedoes made a satisfactory defense alone, as they must be protected by large and small guns, and they form only a part of the chain of general defenses.

* * * * *

THE STEAMSHIP GREAT EASTERN.

[Footnote: See Engraving in *supplement no*. 584.]

The history of the Great Eastern is full of surprises. It is always that which is most unlikely to happen to her which occurs. Not long since we recorded her sale by auction in Liverpool for L26,000. It was stated that her purchasers were going to fit her out for the Australian trade, and that she would at once be sent from Dublin to Glasgow to be fitted with new engines and boilers, and to undergo thorough renovation. Lord Ravensworth, in his address to the Institution of Naval Architects, spoke recently of the bright future before her in that Australian trade for which she was specially built. Yet at this moment the Great Eastern is lying in her old berth in the Sloyne at Liverpool, and unless something else at present quite unforeseen takes place, she will once more play the undignified part of a floating music hall. It seems that although she was certainly sold, as we have stated, the transaction was not completed. Her owners then cast about for the next highest bidder,

Page 6

who at once took her. He is, we understand, a Manchester cotton spinner, and he paid L25,500 for her. It is no secret that Messrs. Lewis made a considerable sum out of the ship last year, and the knowledge of this fact has no doubt induced her present owner to follow their example. The ship left Dublin on Sunday, April 3, under her own steam and in tow of two Liverpool tugs, the Brilliant Star and the Wrestler, and arrived in the Mersey without accident on Monday, after a passage of only thirteen hours. Mr. Reeves, formerly her chief officer, has been made captain. Mr. Jackson is still chief engineer. We cannot at present explain the fact that she went more than twice as fast as she has done recently, her engines making as many as 36 revolutions a minute, save on the assumption that while lying at Dublin much of the enormous growth of seaweed on her bottom died off, as will sometimes happen as a result of change of water. Her engines and boilers, too, have had a good overhaul by Mr. Jackson, and this may account in part for this improvement. It is much to be regretted that the scheme of using the ship for her legitimate purpose has not been carried out. It is not, however, yet too late. The Great Eastern was not a success in Dublin, for one reason, that a beer and spirit license could not be obtained for her. It is said that notice has been given at the Birkenhead police court that any application for a license of a similar kind will be opposed. Whether the ship will be as popular a resort without as she was with a license, we cannot pretend to say; and we may add that all our predilections are against her degradation to the status of a floating music hall. The greater her failure as such, the greater the chance of her being put to a better use; and it may help to that desirable end if we say here something concerning the way in which she could be rendered a commercial success as a trader.

It may be taken as proved that the present value of the ship is about L26,000. Mr. De Mattos gave, we understand, L27,000 for her, and he bought her by auction. The last sale gives nearly the same figures. If we assume that there are 10,000 tons of iron in her, we may also assume that if broken up it would not fetch more than L3 a ton at present rates; but even if we say L4, we have as a total but L40,000. To break the ship up would be a herculean task; we very much doubt if it could be done for the difference between L26,000 and L40,000; her engines would only sell for old iron, being entirely worthless for any other place than the foundry once they were taken out of her; as for her boilers, the less said about them the better. In one word, she would not pay to break up. On the other hand, by a comparatively moderate further outlay, she might be made the finest trading ship afloat. There are two harbors at all events into which she can always get, namely, Milford and Sydney. There are others, of course, but these will do; and the ship could trade

Page 7

between these two ports. By taking out her paddle engines, she would be relieved of a weight of 850 tons. The removal of her paddle engine boilers would further lighten her, and would give in addition an enormous stowage space. By using her both as a cargo and a passenger ship, the whole of the upper portion could be utilized for emigrants, let us say, and the lower decks for cargo, of which she could carry nearly, if not quite, 20,000 tons. She would possess the great advantage that, notwithstanding she was a cargo ship, she would be nearly, if not quite, as fast as any, save a few of the most recent additions to the Australian fleet. There is every reason to believe that she has been driven at 14 knots by about 6,000 horse power. We are inclined to think that the power has been overstated, and we have it on good authority that she has more than once attained a speed of 15 knots. Let us assume, however, that her speed is to be 13 knots, or about fifteen miles an hour. Assuming the power required to vary as the cube of the speed, if 6,000 horsepower gave 14 knots, then about 4,800 would give 13 knots —say 5,000 horse power. Now, good compound engines of this power ought not to burn more than 2 lb. per horse per hour, or say 4.5 tons per hour, or 108 tons a day. Allowing the trip to Australia to take forty days, we have 4,320 tons of coal—say 5,000 tons for the trip. The Etruria burns about this quantity in the run to New York and back. For each ton of coal burned in the Great Eastern about 15,000 tons of cargo and 3,000 passengers could be moved about 3-1/3 miles. There is, we need hardly say, nothing afloat which can compare in economy of fuel with this. Taken on another basis, we may compare her with an ordinary cargo boat. In such a vessel about 3,000 tons of grain can be moved at 9 knots an hour for 600 horse power—that is 5 tons of cargo per horse power. Reducing the speed of the Great Eastern to 9 knots and about 2,000 horse power, we have 9 tons of cargo moved at 9 knots per horse power; so that in the relation of coal burned to cargo moved she would be nearly twice as economical as any other vessel afloat.

The important question is, What would the necessary alterations cost? Much, of course, would depend on what was done. A very large part of the present screw engines could be used. For example, the crank shaft, some 2 feet in diameter, is a splendid job, and no difficulty need be met with in working in nearly the whole of the present framing. If the engines were only to be compound, two of the existing cylinders might be left where they are, two high-pressure cylinders being substituted for the others. If triple expansion were adopted, then new engines would be wanted, but the present crank and screw shafts would answer perfectly. The present screw would have to be removed and one of smaller diameter and less pitch put in its place. All things considered, we believe that for about L75,000 the Great Eastern

Page 8

could be entirely renovated and remodeled inside. Her owners would then have for, say, L100,000 a ship without a rival. Her freights might be cut so low that she would always have cargo enough, and her speed and moderate fares ought to attract plenty of passengers. Sum up the matter how we may, there appears to be a good case for further investigation and inquiry as to the prospects of success for such a ship in the Australian trade, and the opinion of merchants and others in Melbourne and Sydney ought to be obtained. Something would be gained even if the opinions of unprejudiced experts were adverse. We might then rest content to regard the ship as an utter failure, and not object to see her sunk and filled with concrete to play the part of a breakwater. Until, however, such an opinion has been expressed after full discussion, we must continue to regard the ship as fit for something better than a music hall and dancing saloon.—*The Engineer*.

* * * * *

THE NEW GERMAN CORVETTE GREIF.

Our cut represents the corvette Greif—the latest addition to the German fleet—on its trial trip, March 10. As other naval powers, especially England and France, have lately built corvettes and cruisers which can travel from 17 to 18 knots, while the fastest German boats, Blitz and Pfeil, can make only 16 knots an hour, the chief of the Imperial Admiralty decided to construct a corvette which should be the fastest vessel in the world. The order was given to the ship and engine corporation “Germania,” of Berlin and Keil, in April, 1885, the requirements being that the engines should generate 5,400 h.p., and that the vessel, when loaded, should have a speed of 19 knots, a point which has never been reached by any boat of its size. The hull is made of the best German steel of Krupp’s manufacture, and measures 318 ft. in length at the water line, with a breadth of beam of 33 ft., the depth from keel to deck being 22 ft. It draws about 11 ft., and has a displacement of 2,000 tons.

As the vessel is to be used principally as a dispatch boat and for reconnoitering, and as—on account of its great speed—it will not be obliged to come into conflict with larger and stronger men-of-war, no great preparations for protection were needed, nor was it necessary that it should be heavily armed, all available room being devoted to the engines, boilers, and the storing of coal; these occupy more than half the length of the vessel, leaving only space enough for the accommodation of the officers and crew at the ends. The armament consists of five Hotchkiss revolving guns on each side, and a 4 in. gun at each end, the latter being so arranged that each one can sweep half the horizon.

Page 9

The keel was laid in August, 1885, and the ship was launched July 29, 1886, on which occasion it was christened Greif. On the trial trip it was found that the slender shape of the vessel adapted it for the development of a very high rate of speed under favorable conditions, when it can make at least 22 knots an hour, so that the speed of 19 knots an hour guaranteed by the builders can certainly be reached, even when traveling at a disadvantage. In spite of its great length, the Greif can be easily maneuvered. When moving forward at full speed, it can be made to describe a circle by proper manipulation of the rudder, and by turning one screw forward and the other backward, the ship can be turned in a channel of its own length.

[Illustration: *The new German war steamer Greif*.]

A large and rapid cruiser, also for the German navy, is being built by the corporation “Germania”. This vessel is of about the same length as the Greif, has more than double its displacement, and will make 18 knots an hour, an unusual rate of speed for a vessel of its class. It will be launched by the last of the summer or early in the fall.

* * * * *

TWIN SCREW TORPEDO BOAT.

We give several illustrations of a sea going twin screw torpedo boat lately built for the Italian government by Messrs. Yarrow & Co., of Poplar. The vessel in question is 140 ft. long by 14 ft. wide, and her displacement approaches close on 100 tons. The engines are of the compound surface condensing type ordinarily fitted by this firm in their torpedo boats, excepting where triple compounds are fitted. The general arrangement is shown by the sectional plan. As will be noticed, there are two boilers, one before and the other aft of the engines, and either boiler is arranged to supply either or both the engines. Yarrow’s patent water tight ash pans are fitted to each boiler, to prevent the fire being extinguished by a sudden influx of water into the stokehold. There is an independent centrifugal pumping engine arranged to take its suction from any compartment of the boat. There are also steam ejectors and hand pumps to each compartment. These compartments are very numerous, as the space is much subdivided, both from considerations of strength and safety. Bow and stern rudders are fitted, each having independent steam steering gear, but both rudders can be worked in unison, or they can be immediately changed to hand gear when necessary. The accommodation is very good for a vessel of this class. Officers’ and petty officers’ cabins are aft, while the crew is berthed forward.

[Illustration: *Twin screw torpedo boat for the Italian government*.]

Page 10

The armament consists of two bow tubes built in the boat. There are two turntables, as shown in the illustrations, each fitted with two torpedo tubes. These, it will be noticed, are not arranged parallel to each other, but lie at a small angle, so that if both torpedoes are ejected at once, they will take a somewhat divergent course. Messrs. Yarrow have introduced this plan in order to give a better chance for one of the torpedoes to hit the vessel attacked. There are two quick firing three pounder guns on deck, and there is a powerful search light, the dynamo and engine being placed in the galley compartment.

We believe, says *Engineering*, this torpedo boat, together with a sister vessel, built also for the Italian government, are the fastest vessels of their class yet tried, and it is certain that the British Navy does not yet possess a craft to equal them. It is an extraordinary and lamentable fact that Great Britain, which claims to be the foremost naval power in the world, has always been behind the times in the matter of torpedo boats.

The official trial of this boat was recently made in the Lower Hope in rough weather. The following is a copy of the official record of the six runs on the measured mile:

```
   Boiler | Receiver | |Revolutions | | |Second
   Pressure.| Pressure.| Vacuum. | per Minute.| Speed.| Means.| Means.
-------------+----------+---------+------------+-------+----
---+------
     |lb. | lb. | in. | | | |
1 | 130 | 32 | 28 | 373 | 22.641| |
     | | | | | | 24.956|
2 | 130 | 32 | 28 | 372.7 | 27.272| | 24.992
     | | | | | | 25.028|
3 | 130 | 32 | 28 | 372 | 22.784| | 25.028
     | | | | | | 25.028|
4 | 130 | 32 | 28 | 377 | 27.272| | 25.138
     | | | | | | 25.248|
5 | 130 | 32 | 28 | 375 | 23.225| | 25.248
     | | | | | | 25.248|
6 | 130 | 32 | 28 | 377 | 27.272| |
     +------+----------+-----
----+------------+-------+-------+-------
Means.| 130 | 32 | 28 | 2741/2 | | | 25.101
          | | | | | | knots
-------------+----------+---------+------------+-------+----
---+-------
```

—*Engineering*.

* * * * *

SOME RECENT HIGH-SPEED TWIN SCREWS.

[Footnote: A paper recently read before the Institution of Naval Architects, London.]

By E.A. *Linnington*.

Page 11

One of the most interesting and valuable features in the development of naval construction in recent years is the great advance which has been made in the speeds of our war ships. This advance has been general, and not confined to any particular vessel or class of vessel. From the first class armored fighting ship of about 10,000 tons displacement down to the comparatively diminutive cruiser of 1,500 tons, the very desirable quality of a high speed has been provided.

These are all twin screw ships, and each of the twins is driven by its own set of engines and line of shafting, so that the propelling machinery of each ship is duplicated throughout. The speeds attained indicate a high efficiency with the twin screws. In all ships, but more especially in high speed ships, success depends largely upon the provision of propellers suited for the work they have to perform, and where a high propulsive efficiency has been secured, there is no doubt the screws are working with a high efficiency. The principal purpose of this paper is to record the particulars of the propellers, and the results of the trials of several of these high speed twin screw ships. The table gives the leading particulars of several classes of ships, the particulars of the screws, and the results obtained on the measured mile trials from a ship of each class, except C. The vessels whose trials are inserted in the table have not been selected as showing the highest speeds for the several classes. Excepting C, they are the ships which have been run on the measured mile at or near the designed load water line. On light draught trials, speeds have been attained from half a knot to a knot higher than those here recorded. No ship of the class C has yet been officially tried on the measured mile, but as several are in a forward state, perhaps the actual data from one of them may shortly be obtained. All these measured mile trials were made under the usual Admiralty conditions, that is to say, the ships' bottoms and the screws were clean, and the force of the wind and state of the sea were not such as to make the trials useless for purposes of comparison. On such trials the i.h.p. is obtained from diagrams taken while the ship is on the mile, and the revolutions are recorded by ruechanical counters for the time occupied in running the mile. Not less than four runs are made during a trial extending over several hours. The i.h.p. in the table is not necessarily the maximum during the trial, for the average while on the mile is sometimes a little below the average for the whole of the trial. The revolutions are the mean for the two sets of engines, and the i.h.p. is the sum of the powers of the two sets. The pitch of the screw is measured. The bolt holes in the blade flanges allow an adjustment of pitch, but in each case the blades were set as nearly as possible at the pitch at which they were cast. The particulars given in the table may be taken to be as reliable and accurate as such things can be

Page 12

obtained, and for each ship there are corresponding data; that is, the powers, speeds, displacements, revolutions, pitches, and other items existed at the same time. There are a few points of detail about these propellers which deserve a passing notice. In Fig. 1 is shown a fore and aft section through the boss. It will be observed that the flanges of the blades are sunk into the boss, and that the bolts are sunk into the flanges. The recess for the bolt heads is covered with a thin plate having the curve of the flange, so that the flanges and the boss form a section of a sphere. This method of construction is a little more expensive than exposed flanges and bolts, which, however, render the boss a huge churn. With the high revolutions at which these screws work, a spherical boss is extremely desirable, but, of course, the details need not be exactly as shown in the illustration. The conical tail is fitted to prevent loss with eddies behind the flat end of the boss, and is particularly valuable with the screws of high speed ships. The light hood shown on the stern bracket is for the purpose of preventing eddies behind the boss of the stern bracket, and to save the resistance of the flat face of the screw boss. The edges of the blades are cast sharp, instead of being rounded at the back, with a small radius, as in the usual practice—the object of the sharp edge being the diminution of the edge resistance. The driving key extends the whole length of the boss, and the tapered shaft fits throughout its length.

[Illustration: *Fig*. 1.]

These points of detail have been features of all Admiralty screws for some years.

The frictional resistance of screw propellers is always a fruitful source of inefficiency. With a given screw, the loss due to friction may be taken to vary approximately as the square of the speed. This is not to say that the frictional resistance is greater in proportion to the thrust at high than at low speeds. The blades of screws for any speed should be as smooth and clean as possible, but for high speed screws the absolute saving of friction may be considerable with an improvement of the surface. There is no permanent advantage in polishing the blades. No doubt there is some advantage for a little time, and, probably, better results may thereby be secured on trial, but the blades soon become rough, and shell fish and weed appear to grow as rapidly on recently polished blades as on an ordinary surface. These screws are of gun metal. They were fitted to the ships in the condition in which they left the foundry. It appears that within certain limits mere shape of blade does not affect the efficiency of the screw, but, with a given number of blades and a given disk, the possible variations in the form or distribution of a given area are such that different results may be realized. The shapes of the blades of these propellers are shown in Figs. 2, 3, and 4. It will be seen the shapes are not exactly the same for all the screws, but the differences do not call for much remark.

Page 13

[Illustration: *Fig*. 2., *Fig*. 3. & *Fig*. 4.]

Fig. 2 shows the blades for the A screw. C and D have the same form. Fig. 3 shows in full lines the blades of the B screw, and, though very narrow at the tips, they, like A, are after the Griffith pattern. The blades of E and F are of a similar shape, as shown in Fig. 4, and approach an oval form rather than the Griffith pattern. The particulars of these propellers would be considered incomplete without some reference to their positions with respect to the hulls. When deciding the positions of twin screws, there is room for variation, vertically, longitudinally, and transversely. For these screws, the immersions inserted in the table give the vertical positions. The immersion in A is 9 ft., showing what may be done in a deep draught ship with a small screw. Whatever the value of deep immersion may be in smooth water, there can be no question that it is much enhanced in a seaway. The longitudinal positions are such that the center of the screw is about one-fifth of the diameter forward of the aft side of the rudder post. The positions may, perhaps, differ somewhat from this rule without appreciably affecting the performance, but, if any alteration be made, it would probably be better to put the screws a little farther aft rather than forward. The forward edges of the blades are from 2 ft. to 3 ft. clear of the legs of the bracket which carries the after bearing. The transverse positions are decided, to some extent, by the distance between the center lines of the engines. As regards propulsive efficiency, it would appear that the nearer the screws are to the middle line, the less is the resistance due to the shaft tubes and brackets, and the greater is the gain from the wake in the screw efficiency, but, on the other hand, the greater is the augment of the ship’s resistance, due to the action of the screws. Further, the nearer the screws are to the hull, the less are they exposed. But experience is not wanting to show that the vibration may be troublesome when the blades come within a few inches of the hull. The average of the clearances between the tips of the blades and the respective hulls is about one-eighth of the diameter of the screw.

An interesting and noteworthy fact in connection with these propellers is the wide differences in the pitches and revolutions, though the products of the two do not greatly vary. Such differences are extremely rare in the mercantile marine for similar speeds, but in war ships they are inseparable from the conditions of the engine design. As a general rule, with (revolutions x pitch) a constant, an increase of revolutions and the consequent decrease of pitch allow a diminution of disk and of blade area—other modifying conditions, such as the thrust, slip, number, and pattern of blades, being the same. The screws for E and F are interesting, because, with practically the same speeds and slips, there is a considerable

Page 14

difference in the revolutions. It will be observed that F is a vessel of finer form and a little less displacement than E, and, therefore, has less resistance. Although E has the greater resistance and the screw the smaller pitch/diameter, the higher revolutions permit the use of a smaller screw. But from this example the influence of the high revolutions in diminishing the size of screw does not appear so great as some empirical rules would indicate. The screws for A and B are also worthy of attention. Although the ship A has a much greater resistance than B, the screw of the former is much the smaller, both in the blade area and the disk. A's screws, however, in addition to 22 per cent. more revolutions than B, have a much larger slip, and the blades have rather a fuller form at the tips. Compared with the practice in the mercantile marine, the revolutions of these screws are very high, and from the foregoing remarks it may appear that much larger screws would be required for a merchant ship than for a war ship of the same displacement and speed. There would, however, be several items favorable to the use of small screws. For a given displacement the resistance would be less in the mercantile ship, and with the lower revolutions the proportion of blade area to the disk could be increased without impairing the efficiency. Thus in passing from the war vessel to a merchant ship of the same displacement, there are the lower revolutions favorable to a larger screw, but, on the other hand, the smaller resistance, larger proportion of blade area, and the coarser pitch, are favorable to a diminution of the screw. The ship B has a very large screw at 88 revolutions, but the tips are very narrow. If the blade were as dotted for a diameter of 16 ft., the same work could be done with the same revolutions, but with a little coarser pitch and a little more slip.

There is something to be said for large screws with a small proportion of blade area to disk. For instance, two bladed screws have frequently given better results than four bladed screws of smaller diameter, neglecting, of course, the question of vibrations. Twin screws, however, should, as a rule, be made as small as possible in diameter without loss of efficiency. The advantages of small twin screws are the shorter shaft tubes and stern brackets, deeper immersion, and less exposure as compared with large screws. The exposure of the screws is usually considered an objection, but, perhaps, too much has been made of it, for those well qualified to speak on the subject consider that careful handling of the ship would, in most cases, prevent damage to the screws, and that where the exposure is unusually great, effectual protection by portable protectors presents no insuperable difficulty.

High speed twin screws.

Page 15

High speed twin screws.

	Ship A.	Ship B.	Ship C.	Ship D.	Ship E.	Ship F.
Length, ft.	325	315	300	300	220	250
Breadth, ft.	68	61	56	46	34	321/2
Draught on trial, forward.	26 ft 2 in	24 ft 6 in	....	15 ft 6 in	12 ft 10 in	13 ft 1 in
Draught on trial, aft.	27 ft 3 in	25 ft 6 in	....	19 ft 9 in	15 ft 2 in	14 ft 7 in
Displacement, tons.	9,690	7,645	5,000	3,584	1,560	1,544
I.M.S., sq. ft.	1,560	1,287	1,000	744	438	392
Speed of ship, knots.	16.92	17.21	18.75	18.18	16.91	17
I.H.P.	11,610	10,180	8,500	6,160	3,115	3,045
Revolutions per minute.	107.2	88	120	122.6	150.4	132.1
Pitch of screw.	19 ft 5 in	22 ft	18 ft 9 in	17 ft 6 in	12 ft 71/2in	14 ft 9 in
Slip. per cent	17.6	10	...	14.2	9.7	11.4
Diameter of screw.	15 ft 6 in	18 ft	14 ft 6 in	13 ft	10 ft 6 in	11 ft
Diameter of boss.	4 ft 4 in	4 ft 11 in	3 ft 9 in	3 ft 5 in	2 ft 9 in	2 ft 10 in
Number of blades	4	4	3	3	3	3
Blade area of one screw.	72	87	60	47	24	24
Shape of blade.	Fig. 2.	Fig. 3.	Fig. 2.	Fig. 2.	Fig. 4.	Fig. 4
Pitch / Diameter	1.25	1.22	1.3	1.34	1.2	1.34
Disk / Blade area	2.62	2.92	2.75	2.82	3.6	3.96

```
Immersion of       |  9 ft |  5 ft |       |  4 ft |  2 ft |  1 ft
screw.         |       |  3 in | ....  |  4 in |  9 in | 10 in
------------------------------------------------------------
--------
```

The slips of these screws vary from 10 to 171/2 per cent., which is certainly not an extensive range, considering the widely different working conditions. Slip, as an indication of the efficiency of the screw, is not only an interesting subject, but it is often one of importance. In these ships, however, there is nothing about the slips which would give rise to any doubts as to the fitness of the screws for their work.

Page 16

[Illustration: *Fig*. 5. & *Fig*. 6.]

The ancient fallacy that small slip meant a high screw efficiency was supported by the great authority of the late Professor Rankine. Experience proved that considerable slips and efficient screws were companions. The late Mr. Froude offered an explanation of this general rule in a paper read before this Institution in 1878, and gave a curve of efficiency with varying true slip. In Mr. R E. Froude's paper last year there was a form of this curve, with an arbitrary abscissa scale for the slip, devised to illustrate in one diagram the wide conditions covered by his experiments. In the screws now under consideration, the values of the pitch/diameter vary only from 1.2 to 1.34, and for these the abscissa values for the same slips do not differ much. Taking the mean value, and bringing the slips to a common scale, Fig. 5 is obtained, which would approximately represent the relation between the efficiency of any one of these screws and its true slip, if this curve were applicable to full sized screws propelling actual ships. The slips in Fig. 5 being real or true, are not the slips of commerce, which are the apparent slips, such as those given in the table. Let us endeavor to split up these real slips into the apparent slips and another item, the speed of the wake. We then at once meet with the difficulty that the wake in which the screw works has not a uniform motion. Complex, however, as are the motions of the wake, the screw may be assumed to work in a cylinder of water having such a uniform forward velocity as will produce the same effect as the actual wake on the thrust of the screw. It is then readily seen that the real slip is the sum of the apparent slip and the speed of the hypothetical wake. To make this clear, let V be the speed of the ship, Vs the speed of the screw, *i.e.*, revolutions x pitch, and V the speed of the wake; then—

Apparent slip = Vs — V.

Real slip = Vs — speed
of ship with respect to the wake.

"

= Vs — (V — V) = (Vs — V) + Vw.

"

= Apparent slip + speed of the wake.

If the apparent slip be zero, the real slip is the speed of the wake, and if the apparent slip be negative, the real slip is less than the speed of the wake. The real slip is greater than the apparent slip, and can never be a negative quantity. From Mr. Froude's model experiments, it appears that this speed of wake for the A class of ship amounts to about 10 per cent. of the speed of the A screw. If this value is correct, then the real slip is (10 + 17.6) per cent., or 27.6 per cent. This is shown in Fig. 6, where O is the point of no slip, being 17.64 from the point of real slip. Slips to the right of O are positive apparent slips, slips to the left are negative apparent slips. The vessel F would certainly have a wake with a speed considerably less than that of A's wake. From the model experiments, the wake for F is about one-half that for the A class, or, roughly,

Page 17

5 per cent. of the speed of the screw. For the ship F, O is the point of no apparent slip, and the real slip is (5 + 11.4) or 16.4 per cent. For E, the point of real slip is approximately the same as for F. For B and D, the positions on the curve would be about the same. The ship B has a higher speed of wake than D, but the screw D has the greater apparent slip. The influence of the number of blades on the scale for the slip has been neglected. If this efficiency curve were applicable to full sized screws propelling actual ships, and if the determination of the wakes were beyond question, then we should have a proof that our screws were at or near the maximum efficiency. But, as we know, from the total propulsive efficiencies, that the screws have high and not widely different efficiencies on these ships, we may argue the other way, and say that there is good reason to consider that at least the upper part of the curve agrees with experience obtained from actual ships. Now take Fig. 6 and consider the general laws there represented. Take the speed of the wake as 10 per cent. of the speed of the screw, which is probably an average of widely different conditions, including many single as well as twin screw ships. Then this curve shows that considerable negative slips mean inefficient screws; that screws may have very different positive slips without any appreciable difference in their efficiencies; and that very large positive slips and inefficient screws may be companions. For instance, a screw with a large positive slip in smooth water is frequently inefficient at sea against a head wind, which increases the resistance, and necessitates an increase of slip. I venture to say that these statements, taken in a general manner, are not at variance with experience obtained from the performances of screw ships. Before it is possible to satisfactorily decide if this curve applies in a general manner to full sized screws propelling ships, we require the results of trials of various ships where the screws are working about the region of no slip. Model experiments teach that the scale for the slip varies

with the design of the screw, and that with a given screw the speed of the wake (which decides the point of no apparent slip) varies with the type of ship and with the position of the screw with respect to the hull. Remembering these disturbances, it is not improbable that it may be possible to account for or explain what at first sight may appear departures from the curve. The diameters of the screws in the table are not compared with the diameters given by the method explained by Mr. Froude in his paper last year, for there are differences in the slips, the proportions of blade area to disk, and, to some extent, in the shapes of the blades, which are not taken into account in that method. Assuming, however, as Mr. Froude does, a constant proportion of blade area to disk, and a uniform pattern of blade, the determination of the diameter for a given set of conditions may, as a rule, be a complete solution of the problem of the design of a screw, but these assumptions do not cover all the necessities of actual practice, which make it extremely desirable to know something about the influence or efficiency of various proportions of blade area to disk, and of the form or distribution of a given area.

Page 18

During the discussion which followed, Mr. John said that, both as regarded the mercantile marine and the Royal Navy, there were few data to work upon, but few ships having been built with twin screws. Mr. Linnington's proportions of pitch to diameter of 1.2 to 1.34 was not invariably adhered to. He mentioned a couple of small twin screw vessels where the proportion of pitch to diameter came nearly to 1.5, and he remembered a few years ago the propellers in one of these vessels being changed and the pitch increased, the result being a very considerable improvement. He believed they might go with quick running twin screw engines to a larger proportion of pitch to diameter than they could with a single screw. He might instance the change in the Iris. She was first engined with the pitch equal to the diameter, and she gained two knots or thereabout when the diameter was reduced 2 ft. and the pitch increased 2 ft.

Admiral De Horsey said that he tried experiments with the single screw in the Aurora. She had a feathering serew, and when the sails were used to assist, they commonly altered the pitch of the screw according to the strength of the wind. The screw could be altered while it was revolving, and as the wind freshened they coarsened the pitch, and when they wanted to stop the engines they coarsened the pitch so as to bring the screw right fore and aft, so that they never altered the way of the ship in changing from steam to sail alone. The reason why twin screws had been adopted in the navy was that if one was damaged there was the other still available. But it gave them a still further advantage, as it enabled them to have a fore and aft bulkhead, which with a single screw was difficult. The mercantile marine had not as yet looked favorably on twin screws. Their finest and fastest ships were single screws, probably because, in very bad weather, the single screw was better.

Mr. Spyer said that in designing propellers for ships of war, they were obliged to attempt to obtain the highest possible speed, and that was not necessarily coincident with a propeller of maximum efficiency. On the other hand, for mercantile purposes, coal consumption was obviously of paramount importance, and the speed of any particular vessel must be obtained with the smallest possible amount of indicated horse power, and a propeller of maximum efficiency. Regarding the position of the propellers in a small pinnace, the propellers were shifted six or seven inches further out, and with about ten per cent. less indicated horse power she obtained three tenths of a knot more speed.

Page 19

Mr. Barnaby asked Mr. Linnington whether, in designing twin screws for a vessel of 8,000 i.h.p., he would make each screw, which would have to take 4,000 i.h.p., of the same diameter as a screw for a single ship of 4,000 i.h.p., of the same speed. Unfortunately in high speed vessels, from one point of view, the faster they went for a given power the smaller the diameter of the screw had to be, and the larger the pitch, so that in very high speed twin screw vessels the ratio of pitch to diameter would be found to come out very great indeed. In a twin screw torpedo boat, to be tried shortly, they had a ratio as high as 1.64. In the case of the Inflexible it was found, owing possibly to the position of the screw, that the whole of the plates immediately over the screws were damaged. Mr. Beckett Hill had been using, during the past three or four years, the twin screw steamers the Ludgate Hill, Richmond Hill, and Tower Hill. These were all over 4,000 tons register, and indicated, when at work at full speed, 2,500 h.p. Before he and his friends built these steamers, they built some very large tug boats on the twin screw principle. At the present moment, four of the fastest steamers building for the Atlantic service were to have twin screws. The great obstacle to the extension of the twin screw in the mercantile navy had been the fear that the projection of these screws would make the vessels very difficult to handle, but he had found no such difficulties. He had found it an advantage to put the point of the propeller as near the deadwood as he could, without actually touching it, and in the large steamers, as well as in the tugs, the distance was a few inches. As to the point of safety, he thought it a great advantage to have twin screws, and on two occasions twin screw vessels had met with accidents which, but for the twin screws, would have necessitated their putting back to New York for repairs. The Richmond Hill, on one occasion, met with an accident to her machinery two days after leaving New York; but she was able to come on with the second set of engines, and was only one day late in the passage. No difficulty had been found in the docking and undocking of these vessels, either in London or Liverpool, and while with single screw vessels they had sometimes to employ one or two dock boats to dock and undock them, they never had to do so with the twin screw vessels. These vessels were 400 ft. long, with 48 ft. breadth of beam—a very large size to handle in a river like the Thames. He noticed in the paper a propeller with a diameter of 15 ft. 6 in. to indicate 11,110 h.p., so that a great Atlantic steamer, which should indicate 11,000 or 12,000 h.p., and have a beam of about 65ft., would have her screws very well protected.

Page 20

Mr. White said that as soon as it was found that with twin screws they lost nothing in efficiency, ship owners generally were contemplating their adoption, an admirable example of which had been set in the vessels of the Hill line. In adopting twin screws, the question whether they should overlap was one that deserved very serious consideration, and it was interesting to know, from experience gained by the vessels of the Hill line, that there was no difficulty in the way of the projection of the screws. With a moderate power, and with vessels of considerable size, the screws were well sheltered: but in the large ships which were contemplated, where there must necessarily be larger screws, this might be different, and become a difficulty.

Mr. Linnington, in reply, said there was no reason to think that the twin screw at sea might not be as satisfactory, in comparison with the single screw, as it appeared in smooth water. As a matter of fact, one of the great advantages of twin screws was that at sea the condition of weather which would bring the single screw out of the water, and make it extremely inefficient, would have no appreciable effect on the twin screws. In vessels of deep draught especially, they were well immersed, and they were really more efficient at sea than in smooth water. In ships of full form, the longitudinal position of the screws was of importance; but in the ships referred to in this table the run was very fine, and the screws were well covered by the hull. He did not think, in such a case, any small difference in longitudinal position would affect the performance. If any alteration were made, it would probably be better to put the screws farther off. When the rudder was hard over, the blades of the screw should be about a foot clear of the rudder.—*Industries*.

* * * * *

RECENT ADVANCES IN SEWING MACHINERY.

[Footnote: A recent lecture before the Society of Arts, London.]

By *John* W. *Urquhart*.

The distinct improvements in sewing machinery to which I would invite your attention this evening have reference more particularly to the results of inventive effort within the past ten years. But although marked development in the machines has occurred in so short a time, it may be taken for granted that those advances are but the accumulated results of many years' prior invention and experience of stitching appliances.

The history of the sewing machine, and the decision of the great question, Who invented an apparatus that would unite fabrics by stitches? do not at present concern us. Many sources of information are open to those who would decide that extremely involved problem. But whether the production of the first device of this kind be claimed for England or for America, it is quite certain that no one man invented the perfect machine, and that those fine specimens of sewing apparatus shown here to-night embody the labors of many earnest workers, both in Europe and America.

Page 21

Most of us are familiar with the arrangements of an ordinary lock stitch machine, and an able paper by Mr. Edwin P. Alexander, embracing not only a good account of its history, but most of the elements of the earlier machines, has already (April 5, 1863), been read before you. This, and sundry descriptions of such apparatus in the engineering papers, confine my remarks to the more recent improvements in three great classes of machines. These are, briefly, plain sewing machines; sewing machines as used in factories, where they are moved by steam power; and special sewing machines, embracing many interesting forms, only recently introduced. We have thus to consider, in the first place, the general efficiency of the machine as a plain stitcher. Secondly, its adaptability to high rates of speed, and the provision that has been made to withstand such velocities for a reasonable time. And, thirdly, the apparatus and means employed to effect the controlling of the motive power when applied to the machines.

To deal with the subject in this way must, I fear, involve a good deal of technical description; and I hope to be pardoned if in attempting to elucidate the more important devices, use must be made of words but seldom heard outside of a machinists’ workshop.

It appears scarcely necessary to premise that the sewing machine of twenty years ago has almost faded away, save, perhaps, in general exterior appearance; that the bell crank arms, the heart cams, the weaver’s shuttles, the spring “take ups,” rectangular needle bars, and gear wheels, have developed into very different devices for performing the various functions of those several parts.

The shuttle is perhaps the most important part of a lock stitch machine. But what is a shuttle? So many devices for performing the functions of the early weaver’s shuttle have been introduced of late, that the word shuttle, if it be used at all, must not be accepted as meaning “to shoot.” We have vibrating shuttles, which are, strictly speaking, the only surviving representatives of the weaver’s shuttle in these new orders of machines; and stationary shuttles, oscillating shuttles, and revolving shuttles, besides the earlier rotating hook, in several new forms, difficult to name. But the general acceptation of the word shuttle, as indicating those devices that pass bodily through the loop of upper thread, is, I venture to think, sufficiently correct.

Many changes have been effected in the form, size, and movements of the shuttle, and we may profitably inquire into the causes that have induced manufacturers to abandon the earlier forms. The long, weaver’s kind of shuttle, originally used by Howe and Singer, had many drawbacks. Mr. A.B. Wilson’s ingenious device, the lock stitch rotating hook, was not free from corresponding faults. The removal of these in both has led to the adoption of an entirely new class of both shuttles and revolving hooks. It is well known that the lock stitch is formed by

Page 22

the crossing of two threads, one of which lies over, and the other under, the cloth to be sewn. This crossing point, to insure integrity of the stitch, must occur as nearly as possible in the middle of the thickness of the fabric. The crossing must also be effected while a certain strain, called tension, is imposed upon both threads. If the tension of one thread should outweigh that of the other, the locking point becomes displaced. If the tension be insignificant, the stitches will be loose. If the tension should vary, as in the long shuttle, there will occur faulty points in the seam.

In the earlier rotating hook the tension depended upon the friction developed between the spool and the hook. This tension, therefore, varied in proportion to the speed of the latter, and could never be constant. This was quite apart from the frictional resistance offered to the upper thread in passing over the cavity of the hook.

In the shuttle the tension was obtained by threading through holes in the shell, or beneath a tension plate, as in Howe’s machine. This tension, so long as the reel ran between spring centers, was never constant. The variation was chiefly due to the angular strain set up when unwinding from the reel. This strain varied according to the point of unwinding. It was light in the middle of the reel and heavy at either extremity. These drawbacks caused immense anxiety to the first makers of sewing machines, and numerous attempts to overcome them led to little improvement. With reference to high rates of speed, the older shuttle, requiring a long and noisy reciprocation, had its disadvantages.

The only effective remedy for these drawbacks was a radical one. It was necessary to substitute depth of reel for length. Hence, several attempts have been made to construct disk or ring shuttles. Many forms of those have been tried. They all depend upon the principle of coiling up the thread in a vertical plane, rather than in horizontal spirals. Some makers placed the disk in a horizontal plane, and caused it to revolve. Nothing could be worse, as will be seen, if we follow the course the enveloping loop must take in encircling such a shuttle. But a complete solution of the difficulty of employing a ring shuttle has been achieved in the oscillating form, invented by Mr. Phil. Diehl, and known as Singer's (Fig. 1). A short examination of it may profitably engage your attention. The shuttle itself is sufficiently well known, but certain features of it, and to which it owes its efficiency, appear to call for some explanation. Its introduction dates back some years, during which time it has undergone certain modifications.

[Illustration: *Fig*. 1.]

Page 23

It consists of a thick disk bobbin of thread, *h*, fitting loosely in a case constructed in the form of a bivalve, *a* and *d*. This case is furnished with a long beak, usually forming a continuation of the periphery. The beak is intended to enter and detain the loops of upper thread, and lead them so that they ultimately envelop the shuttle, a motion of the thread which is chiefly due to the oscillation of the shuttle in a vertical plane. The oscillating movement is to the extent of 180 degs. of the circle, which suffices to cast the loops freely over the shuttle. The center of oscillation is not coincident with the center of the shuttle; but it is nearly so with the periphery of the thread reel, and exactly coincides with the point where the under thread is drawn from the shuttle, *g*. The shuttle thread is thus entirely freed from any tendency to twist, an objection frequently urged against circular or revolving shuttles. It will be observed, also, that the body of the shuttle is extremely narrow. Bulging of the thread loops to one side or the other is thus obviated.

But the long beak in this description of shuttle serves an important purpose other than that of seizing the upper thread loops, otherwise a very short beak would be preferable. It adds so much to the efficiency of the machine that a little further explanation of it appears essential. In the old fashioned machines the thread required to envelop the shuttle was dragged downward through the cloth, while the needle still remained in the fabric. This necessitated the use of large needles with deep side channels, to enable the thread to run freely, and as a consequence the punctures that had to be made in the fabric were unnecessarily large, and could not in any case be entirely filled by the thread, a condition which is now recognized as essential in linen stitching and for waterproof boots.

The long beak in both shuttles and hooks offers an immediate solution of the old difficulty experienced with long shuttles. When the needle begins to rise, the shuttle commences to oscillate, through the loop, the motions so coinciding that the long beak, c, merely detains the loop until the eye of the needle has ascended above the cloth; then, and then only, does the envelopment of the shuttle commence, and the thread required for it flows downward through the puncture. The envelopment is completed before the needle has attained its highest point, and the consequent loose thread is immediately pulled up by a lever, called a positive take-up, before the needle begins to descend for a fresh stitch. In this way little or no movement of the thread is required in the cloth while the puncture made is occupied by the needle. The result is the capability of such apparatus to work with an incredibly fine needle—indeed, so fine as to be no thicker than the incompressed thread itself. This would have been considered quite impossible of accomplishment by our earlier machine makers. The advantage thereby gained in stitching linen goods, and in sewing leather, where every puncture of the needle should be quite filled by the thread, is at once apparent. Indeed, a rubber or leather sack, stitched in this way, will contain water without leakage—a very extreme test.

Page 24

Revolving Shuttles.—The class of shuttles known as revolving or rotating, and which really consist of a combination of the disk shuttle and the earlier rotating hook of Wilson, have been under trial by several makers for many years. If, for example, the oscillating shuttle we have just examined were to complete its circular movement, it would constitute a revolving shuttle, but would not be quite similar to those devices now known as such. The most remarkable device of this kind yet introduced is to be found in Wheeler & Wilson's machine known as No. 10 D, and invented by Mr. Dials last year. It consists, in fact, of a detached hook, and its inventor declines to class it with shuttles at all, styling it a detached hook. It consists of an exterior shell or skeleton of steel, capable of rotation in an annular raceway. Its detachment from the axis forms a striking exception to the general construction of interlocking apparatus in this company's machines. Under the beak of this curious device is found an oblong recess, into which fits loosely a carrier or driver, rotating with a differential or variable motion. The space between the carrier and the sides of the recess is sufficient to permit the free passage of the thread in encircling the shuttle, and the differential movement ingeniously releases the contact between the hook and carrier. The skeleton of this device is only one-sided, and does not really carry its bobbin in the course of its revolution. The bobbin is placed in a cup-like holder, which lies within the shuttle or hook body, and is retained in position by a latch hinged to the bed of the machine. The cup and bobbin are prevented from partaking of the rotatory movement by a steel spur projecting from the cup, and fitting loosely into a notch in the latch. Tension upon the under thread is obtained by passing it under a tension plate upon the bobbin cup. Twisting of the thread is by these means entirely obviated. In this apparatus, the disk-like appearance of the bobbin is partially lost in its considerable breadth, and there is thus a distinct departure from the lines of the ring shuttles before mentioned. The diagrams exhibit the hook in several positions during its revolution, and the position of the threads corresponding thereto.

[Illustration: FIG. 2]

Fixed Rotating Hooks.—Wilson's rotating hook for lock stitch machines, and Gribbs' hook for single thread machines, are both well known. In the year 1872, the Wheeler & Wilson company introduced a new hook, forming an improvement upon Wilson's original device (Fig. 3). Its chief peculiarity consists in the extension of the termination of the periphery, forming a long tail piece, quite overlapping the point, and serving as a guard, both to keep off the bobbin thread and to prevent collision between bobbin and needle.

[Illustration: FIG. 3.]

Page 25

This improved class of hooks are provided with a much deeper cavity than those first introduced, an arrangement permitting of the employment of a more commodious bobbin, which is generally covered by a cap, as in the revolving shuttle, but free to revolve. In some cases the cap carries a tension plate preventing its revolution with the hook. But beyond these improvements on Wilson's original device, the utility of the hook mainly depends upon two things quite apart from the hook itself. These are the dispensing with the old fashioned check brush and the use of a positive take-up.

Thus, in the original machine, the stitch was pulled up by the succeeding revolution of the hook. For while one revolution sufficed to cast it over the spool, a second turn was requisite to complete the stitch. In this way, to make a first stitch with such an apparatus required two turns of the rotating hook. The improvements mentioned enable the machine to complete a stitch with one turn of the hook—an important step in advance, when we consider that by the old method each length of slack thread must be tightened up solely through the fabric and the needle eye. But this particular arrangement bears so much upon the introduction of the positive take-up itself that further reference to it must be reserved until that device has been described.

Simple Thread Hooks.—The best known of these is Willcox & Gibbs. It has been so often described, that no further reference to it may be made. It continues to make the same excellent twisted stitch as it produced twenty-five years ago.

Of Vibrating Shuttles.—These are shuttles of the long description, moving in a segment of a circle. There are several varieties. The most novel machine of this kind is the vibrating shuttle machine just produced by the Singer Manufacturing Company. In this case the shuttle itself consists of a steel tube, into the open end of which the wound reel is dropped, and is free to revolve quite loosely. Variation of tension is thus obviated in a very simple manner. The chief point of interest in the machine is undoubtedly the means employed in transferring the motion from the main shaft to the underneath parts, an arrangement as ingenious and effective as any device ever introduced into stitching mechanism. It is the invention of Mr. Robert Whitehall, and consists of a vertical rocking shaft situated in the arm of the machine Motion is imparted to it by means of an elbow formed upon the main shaft acting upon two arms, called wipers, projecting from the rocking shaft, the angle formed by the arms exactly coinciding with that of the elbow in its revolution. This admirable motion will no doubt attract much attention from mechanists and engineers.

The Lock Stitch from Two Reels.—In the early days of the sewing machine, the makers of it often met with the question, “Why do you use a shuttle at all? Can you not invent a method of working from a reel direct?” The questioner generally means a reel placed upon a pin, just as the upper reel is placed. The reply to such a query is, of course, that to produce the lock stitch in that way is impossible—as indeed it is.

Page 26

But many ingenious machinists have pondered long over the problem, and several clever contrivances have been invented with a view to its solution. It may scarcely be necessary to say that the best manufacturers of sewing machines have conducted experiments with the same object in view, and the result has always been a return to the shuttle, with its steel bobbins.

Why is this, and how is it that a very big shuttle cannot be used, large enough, indeed, to accommodate any bobbin within itself? The answer is very simple. It has been done over and over again.

Since the whole bulk of the under thread must pass through the loop of the upper one, it, is quite clear that the size of that loop must be proportioned to the bulk of the shuttle. Thus, a small shuttle would, perhaps, be covered by an inch of thread, while our supposed mammoth shuttle might require ten times that amount. Now, let us consider that to sew an inch of thread into lock stitches frequently involves its being drawn up and down through both needle and fabric twenty times. This means considerable chafing, and possible injury to the thread.

But if we were to sanction the use of capacious shuttles, ten inches of thread must undergo this chafing and seesaw treatment, and under the above conditions every part of the ten inches must pass up and down two hundred times—treatment that might reasonably be expected to leave little “life” in the thread. But in spite of this tremendous drawback, there are machines offered for sale made with such shuttles.

For reasons that I have now pointed out, it is quite clear that a large shuttle or bobbin is by no means an unmixed advantage. Indeed, the very best makers of sewing machines have always striven to keep down the bulk of the shuttle, and in those splendid machines shown here to-night the use of the small shuttles is conspicuous. It may be contended that small bobbins frequently require refilling, which is quite true, but the saving of the thread effected thereby, not to mention that of the machine itself, amply compensates for the use of small shuttles. Apart from this, however, it is no longer necessary to wind bobbins at all. Dewhurst & Sons, of Skipton, and Clark & Co., of Paisley, have produced ready wound "cops" or bobbins of thread for placing direct into shuttles. Thus no winding of bobbins is necessary, and indeed the bobbins themselves are dispensed with. I believe that the slightly increased cost of the thread thus wound is the only present bar to the extensive introduction of ready wound "cops."

Of Thread Controllers.—One of the earliest difficulties encountered by the maker of a sewing machine was that of effectually controlling the loose thread after it had been cast off the shuttle. In some machines this slack thread amounts to six, in others to one or two inches. Howe got over the difficulty by passing his thread, on its way to the needle, over the upper extremity of the needle bar—the ascent of the bar, then, sufficed to pull up the slack. Singer improved upon this by furnishing his machine with a spring take-up lever, partially controlled by the needle bar.

Page 27

[Illustration: FIG. 4.]

Wilson, in the Wheeler-Wilson machine, had neither of those arrangements, but depended upon the succeeding revolution of the hook to draw up the slack of the preceding stitch. These devices were all far from perfect in their operation, chiefly because they commenced to act too soon. In each case the pulling up commenced with the rise of the needle, and the tightening operation subjected the thread to all the friction of rubbing its way through both needle eye and fabric. Now, an ideal take-up should not commence to act until the needle has ascended above the fabric, and one of the most important steps toward perfection in sewing machines was undoubtedly attained when such a device was actually invented. In effecting this, the means employed consists of a differential or variable cam, rotating with the main shaft. This controls the movements of a lever called the take-up, pivoted to the machine (Fig. 4). Not only has it been possible by these means to control the tightening of the stitch, but the paying out of the thread for enveloping the shuttle also, and both the paying out and pulling up are actually effected after the needle has ascended above the cloth. The introduction of the positive take-up, the first forms of which appeared in 1872, not only simplifies the movements of the shuttle or hook, but for the first time renders the making of the lock stitch possible, while the needle has a direct up and down motion. Thus, we find that in most of the swiftest sewing machines, the needle bar is actuated by a simple crank pin or eccentric, there being no loop dip or pause in its motion.

The diagram shows a positive take-up in three positions—at the commencement of the needle’s descent, during the detention of the loop by the beak, and during the casting off of the loop. The dotted lines indicate the path of the cam to produce these positions. The intermittent movements of the take-up have thus led to the abandonment of variable motions in both needle and shuttle, and particularly so in oscillating shuttle machines.

Wheeler & Wilson's Variable Motion.—But while the simple and direct movement is now preferred for shuttles, both oscillating and rotary, the revolving hooks of Wheeler & Wilson are provided with a differential motion, and the way it is effected appears sufficiently interesting to call for a short description.
When the rotating hook has seized the loop of thread, it makes half a revolution with great rapidity; its speed then slackens, and becomes very slow for the remaining half a revolution. In the first machines introduced, this was effected by means of a revolving disk, having slots in which worked pins attached to the main shaft and hook shaft respectively.

[Illustration: FIG. 5.]

In the later and more improved machines, the variable device is much simplified (Fig. 5). The main shaft, leading to the rotating hook, is separated into two portions, the axis of one portion being placed above that of the other. A crank pin is attached to each, and these pins are connected together by a simple link. An examination of the device itself shows that, while the motion of the main shaft portion is uniform, that of the hook shaft is alternately accelerated and retarded.

Page 28

The picture on the screen gives a general view of the No. 10 D machine, in which these motions are embodied, and showing the position of the positive take-up affected by those motions, a position which is preferred for very high speeds in this machine, especially for threads possessing little elasticity.

Motions of the Feeder.—The speed attained by the fastest sewing machines is due more to the reduction and simplification of the movements than to any other improvement. Heavy concessions and reactions have been replaced by direct motions, and cams have been excluded as much as possible. Mr. A.B. Wilson's famous invention of the four motion feeder depended upon both gravity and a reacting spring for two motions. Singer improved upon it by making three of the motions positive, a spring being used for the drop. But a really positive four motion feeder was long sought by inventors.

Hitherto the reaction of the feeder—that is, its descent and recession—was generally attained by means of a spring. The drop and ascent are now effected by means of a separate eccentric in Singer's machine. Uncertainty of action in the feed, once a cause of much inconvenience, may now be said to be overcome. A peculiarity of the four motion feeder in Wheeler & Wilson's machine is an arrangement enabling the operator to feed in either direction at will.

Not less worthy of note are improvements that have been made in wheel feeders. The wheel feed was originally much used for cloth sewing machines, especially in Singer's system. But in recent years the drop or four motion feeder has entirely superseded it for such purposes. The wheel feed still holds its own, however, for sewing leather, especially in the "closing" of boot uppers, in this country. Singer's original wheel feeder was actuated by a friction shoe riding upon the flange of the wheel. The friction grip, however, had certain faults, owing to the tendency of the shoe to slip when the surfaces became covered with oil.

[Illustration: FIG. 6.]

A later form of Howe’s machine used a pair of angular clutches, embracing the flange of the wheel. In both Singer’s and Wheeler & Wilson’s latest styles of machines this arrangement is simplified and improved by the use of a single angle clutch, which is found to work even when the surfaces are freely oiled (Fig. 6).

Any motion of the free extremity of the lever upon which the biting clutch is formed binds the latter upon the flange of the wheel, which then advances so long as the lever continues to move in that direction. When the stitch is completed, the clutch is allowed to recede, and is pulled back by a reacting spring. The bite of the clutch is given by the two opposite corners.

The feed wheel itself is free to revolve in a forward direction, but is prevented from rocking backward in Singer’s machine by an ingenious little device, recently introduced. It consists of a small steel roller, situated within the angle formed by an inclined plane and the flange of the wheel, and constantly pulled into the angle by a spiral spring. Any backward tendency of the wheel binds the roller more firmly in the angle and stops the wheel. Former feed wheels were checked by a brake spring or block, which retarded the motion of the whole machine when heavily adjusted.

Page 29

Feeders for Button Hole Sewing Machines are almost invariably of the wheel type, but in this case the cloth is usually carried by a clamping device, and moved in a pear-shaped path by means of a cam cut in the feed wheel, as shown in the samples of this wonderful kind of mechanism exhibited here to-night.

The Compensating System of Construction.—Compensation for wear is a part of the mechanist's art that appears just as essential to him as compensation for variation of temperature is to a maker of chronometers. In the construction of sewing machines to be run in factories by power at their utmost speed, such a system is of the greatest importance. An effective *system* of compensation has been eagerly sought by the best machine makers ever since the introduction of fast speed sewing.

Compensation has been attempted here and there in the machines for many years, but no sewing apparatus could be said to be so compensated until the cone compensator came into use, a device which has been taken advantage of by various makers. Save in the shuttle race itself there is not a part of the oscillating shuttle machine subject to serious wear that cannot be instantly adjusted to full motion by the turning of a screw, while wear in the shuttle race can be compensated for in the usual way. This effective system depends upon the union of two mathematical forms, long used in mechanism—the *cone* and the *screw*. In screw cones we possess a perfect compensator, and it is surprising that parts of mechanism so hung appear subject to very little wear. Another advantage, too, is gained by the introduction of screw cone bearings; the friction is always greatly reduced by their use. In every case the fine adjustment of the cones is securely maintained by locknuts (Fig. 7).

[Illustration: FIG. 7.]

But the screw cone system is not the only compensator used in sewing machinery; where it cannot be easily introduced, other devices have been employed.

The well known tapering needle bars of former years have been superseded by cylindrical needle bars. The Wheeler & Wilson Company appear to be the first who utilized the engineer's shifting box as an antifriction device for round needle bars. They packed their bars round with felt rings, and compressed the whole by a screw cap.

In the Singer machines the same excellent device has been adopted, hemp packing and screw bushes being used (Fig. 8); *f* and *g* show the direct action on the needle bar. This method of forming needle bar bearings, partially of metal and partially of felt or hemp, has afforded the most surprising results.

[Illustration: FIG. 8.]

When the bars are of hard or finely polished steel, no perceptible wear can be detected in them, even after they have been in daily use in factories for twelve months, whereas bars not so bushed might show considerable wear in that space of time. The packing, to be effective, should be sufficiently close to prevent as much as possible friction of the steel with the cast iron needle bar ways. Lubrication of the steel is insured by keeping the hemp packing moistened with oil.

Page 30

Cylindrical needle bars, when combined with an effective system of brushing, have proved themselves superior to every other form of slide for lock stitch machines. But their introduction is by no means a thing of yesterday. They were used freely in sewing machines as far back as 1860, but were never very successful until united with the lubricating brush. Some makers go a step further, and elaborate the system by the introduction of steel brushes, easily renewable.

Every effort is now made to reduce, as much as possible, not only the extent of movement of the parts in high speed machines, but the weight of the parts themselves. Indeed, so far has this been carried that, in some of the Wheeler & Wilson machines now shown, the needle bars consist really of steel tubes. Small moving parts are made as light as possible, but rigidity is secured by the free use of strengthening ribs. Many of the parts are of cast iron, rendered malleable by annealing, and finally casehardened. Such parts are found to be quite as durable as if made of forged steel, and are, of course, less costly. As to the automatic tools now used in the construction of the machines, it may be said that scarcely a file, hammer, or chisel touches the frame or parts while they are being assembled to work together. The interchangeable system of construction is, of course, the only one possible for the accurate production of the millions of sewing machines now manufactured annually.

High Arm Construction.—Sewing machines, as now constructed, exhibit a rather short and very high arm, a form of framework that has been found to contribute in no small degree to the light running capabilities of fast speed machines. While it reduces the length of the various parts concerned in the transference of the motive power, it adds to their rigidity and diminishes their weight, maintaining at the same time the capacity of the machine to accommodate the largest garments beneath the arm.

But the specific improvements in plain sewing machines, to which I have had the honor of drawing your attention, do not exhaust the list, and, time permitting, it might be considerably augmented. Nor must it be inferred that advancement has taken place exclusively in those systems of sewing machinery now before us.

Accessories to Sewing Machines.—The number of special attachments that have been successfully adapted to plain sewing machines has multiplied so rapidly of late, that only one or two of the more notable can be spoken of on this occasion. Perhaps the most generally useful of these is the trimmer, an arrangement consisting of a vibrating knife, which trims off the superfluous edge of a seam as the machine stitches it. These are in extensive use in the factories at Leicester, Nottingham, and elsewhere, while Northampton and Norwich use the same device for paring the seams in boot upper manufacture. The chisel-like knife is usually actuated by a cam rotating with the main shaft, and one or two of the usual forms of this attachment are to be seen here this evening on both lock and loop stitch machines.

Page 31

When machines are moved by the foot, there are many objections to running the whole machine while winding the shuttle reels. We have, therefore, several useful devices for releasing the balance wheel of the machine from the main shaft, while winding. These are to be found both on Wheeler & Wilson's manufacturing machine and upon Singer's highly finished "Family" machine, which also carries a most ingenious automatic reel winder, capable of doing all the work itself, and ceasing to act as soon as the bobbin is filled.

The setting of the needle in a sewing machine was once quite a task. Ofttimes it had to be adjusted by chance, in other instances by certain guiding marks upon the needle bar. It is gratifying to know that all this has been done away with, and that the needle has only to be inserted into the bar, and fastened by turning a small screw. These are styled self-setting needles, and are usually so arranged that they cannot be adjusted wrongly as to the position of the eye.

In the Willcox & Gibbs machine, and in Singer's single thread machine, shown here, we have an intermittent tension arrangement, which clamps the thread at the right moment, and differs from ordinary tension devices, inasmuch as it may be said to be automatic. The feeder, too, on these machines is of excellent design, while the arrangements that have been introduced into the Willcox & Gibbs straw hat sewing machine are surprisingly effective in spinning up a hat from a loose roll of braid. Speaking of straw hat machines, mention should be made of Wiseman's hand stitch apparatus, as improved by Messrs. Willcox & Gibbs, and shown here this evening. This machine employs two needles, and makes a stitch resembling hand work at intervals, producing a short stitch at the center of the hat, and automatically widening the space between the stitches as the distance from the center increases. The machine itself is of wonderful ingenuity, and must be examined to be understood.

The stitch making itself is, I believe, quite new, and is also of much interest. A pair of needles, the width of a stitch apart, rise from beneath through the material. One of these is an ordinary machine needle, threaded; the other is a barbed needle. After rising above the surface, the loop of the threaded needle is seized by a "threader," and thrown into the barb of the barbed needle. The needles then descend, and the feed occurs, being the length between stitches. Upon the ascent of the needles again against the material, the loop is both given off the barb and is entered by the threaded needle, completing the stitch.

Of Button Hole Machines.—The mechanism of button hole machines is so intricate, that I can only attempt on this occasion to partially elucidate the construction of one of them, recently introduced, namely, Singer's, which automatically cuts, guides, and stitches the work.

[Illustration: FIG. 9.]

Page 32

Fig. 9 exhibits the stitching made by this machine upon the edge of the button hole. Fig. 10 represents the right and left hand loopers and loop spreaders, and for the stitch making. They rock from right to left with an intermittent motion obtained from a cam. The left hand looper carries the under thread and interweaves it with the upper, forming the stitch, originally invented, I believe, by Mr. George Fisher, of Nottingham, and reinvented for the button holing machine by D.W.G. Humphreys, of Massachusetts, U.S.A., in 1862. The loop spreaders are moved by a roller carried upon the looper frame. Fig. 11 exhibits the feeding arrangement, both sides of the feed wheel, the driving lever, and the shape of the path given to the carrying clamp by the heart cam cut in the upper surface of the feed wheel. The picture on the screen represents the upper portions of the machine, exhibiting the conveying clamp, the to and fro dipping motions of the needle bar, and the parts conveying motion to the arrangements beneath the bed plate. These are shown in Fig. 12, and represent the feed and looper cams, the feeding and looper levers, and the stitch forming mechanism already shown. A most ingenious device in this machine is the arrangement for automatically lengthening the throw of the feed while stitching around the eye of the button hole. It is effected by means of a cam, which imparts more or less leverage to the feed arm by the intervention of a “shipper” lever, hinged to the feed lever itself. The space of time at my disposal obliges me to recommend a personal examination of the machine itself, to fully understand its various motions and its action in working a button hole.

[Illustration: FIG. 10.]

[Illustration: FIG. 11.]

[Illustration: FIG. 12.]

Mention may be made of Singer's special button hole machine for making the straight holes used in linen work, and in which a shuttle is employed. Of Wheeler & Wilson's ingenious button hole machine for the same purpose, I am enabled to show a diagram, in which it will be observed that the feeding arrangements are placed above the bed plate, and are no doubt thereby rendered easily accessible.

Application of Power to Sewing Machines.—There was a time when a cry arose to the effect that the introduction of mechanical sewing would lead to divers calamities, physical and mental. The ladies were to become crooked in the spine, and regular operators were to become regular cripples. It is scarcely necessary to ask, Has this been so? The operators of to-day are, I think, superior in physical attainments to their sisters of the needle and thread fifty years ago.

Page 33

Within the past few years a revolution has taken place in the moving of sewing machines. Domestic machines will probably always be driven by foot power, spring, electric, and water motors notwithstanding. But the age of treadles in the great manufacturing trades is a thing of the past. It was not necessary for Parliament to step in and protect the workers, as was frequently suggested by alarmists. The commercial interests of manufacturers themselves were at stake. Machines driven by power could do 25 per cent. more work than those moved by foot. The operators, relieved of the treadling, maintained a much better working condition; and altogether the introduction of power driving, once well tested, became a necessity. Power sewing machinery was speedily devised and introduced by several of the first manufacturers, controllers of the speed of the machines followed, and two or three splendid systems of stitching by steam power were soon widely known.

By the kindness of three of the best manufacturers of power sewing machinery, I am enabled to show to you, this evening, the best known systems, arranged just as they are fitted in many large factories, as also a sketch of the arrangements of Wheeler & Wilson’s system. We have in the first place a light shafting carrying a band wheel opposite to each machine. By the use of a powerful electromotor, the shafting is caused to rotate at the rate of 400 revolutions per minute by electricity. The current is generated by the Society’s dynamo machine, and is conveyed here by copper cable. I do not know of any instance of sewing machinery in a factory being driven by an electromotor, but such means of conveying motive power appears admirably adapted for that purpose, when the stitching room happens to be far removed from the main shafting or engine. But with regard to motors for sewing machines, when special power has to be fitted down for that purpose, my own experience leads me to speak in favor of the admirably governed “Otto” gas engines made by Crossley Bros. These are especially steady, a feature of no small moment in moving stitching machinery of various kinds.

Much attention has been devoted to the invention of controllers of the motive power supplied to sewing machines. The principle of the friction disk has found most favor. In many cases two of these plates, fast and loose, are placed upon the main shaft, and their separation and contact controlled by the treadle. The great sensitiveness of the friction attachment employed by the Singer company is due chiefly to the transference of the friction plates to the axis of the machine itself (Fig. 13). Their contact and separation are controlled by a lever worked by a very slight movement of the treadle. But the chief point of interest in this device lies in the combination with the lever of a brake, enabling the operator, by a simple reversal of the treadle's motion, to instantly suspend the rotation of the machine. The forked lever, in fact, acts simultaneously in throwing off the motion and applying the brake. The speed is always in direct proportion to the pressure exerted upon the treadle, and a single stitch can be made at will. Fig. 14 shows the friction wheel separated, the portion a being fast, and e loose.

Page 34

[Illustration: FIG. 13.]

[Illustration: FIG. 14.]

The Wheeler & Wilson company do not confine themselves to any particular controller, but prefer the form shown here this evening (Fig. 15), in which two bands and an intermediate pulley are employed. The first band is left rather loose, and the machine is set in motion by the tightening of this band through the depression of the treadle. The speed varies in proportion to the pressure applied, and the sensitiveness of the arrangement is increased by a brake device coming into play by the reversal of the treadle as before.

[Illustration: FIG. 15.]

Messrs. Willcox & Gibbs depend upon a similar device shown in three varieties to-night.

Speed of Power Sewing Machines.—The fastest practicable speed of a machine worked by the foot appears to be 1,000 stitches per minute. Most operators can guide the work at a much higher rate, especially in tailoring or on long seams. The average speed upon such work is 1,200 stitches per minute; but many lock-stitch machines are run at 1,500 and 1,800 per minute, and even at much higher rates. There is always a limit to be imposed upon speed by the guiding powers of hand and eye; it is this limit, and not the capability of the machine, that confines the rate of driving. Willcox & Gibbs' single thread machines are run in many instances at 3,500 stitches per minute. We have before us a single thread Singer machine (appropriately named the "Lightning Sewer") and a Willcox machine, moving at the enormous rate of 4,500 stitches per minute, and producing good work. But it is doubtful whether such very great velocities can ever be advantageously employed. Upon collar work, and in sewing boot uppers, the rate seldom rises above 1,200 with advantage. If the machines be speeded too high in any trade, the operator never uses the excess, and it only proves a drawback. I seen the heaviest and hardest kind of navy boots stitched at 1,500 to the minute upon Singer's lock-stitch machines. Wheeler & Wilson's No. 10 D machine has been run by them, I am informed, as high as 2,500 to the minute. Loop-stitch machines, when well made, can be actually run as high as 6,000, but 4,500 is, I believe, the maximum yet used for this class of machine, even experimentally. There can be no doubt that lock-stitch machines can be run as high as 3,000. The actual speeds of the lock-stitch machines shown here upon the power stand average 1,300; those of the chain stitch machines vary from 1,200 for the sack sewing machine to 4,500 for the small or single chain stitchers. Any of the latest styles of either lock stitch or single thread machines can be run far faster than any known expert operator can possibly guide the work under it.

It is very improbable that such speeds will ever be exceeded. The limit has no doubt been reached. Very high speed is generally a delusion, and either results in indifferent work, or actually retards its progress. Some idea of the speed of the single thread machines now shown may be gathered from the fact that, running at 4,500, and making eight stitches to the inch, they accomplish over fourteen yards of sewing every minute.

Page 35

Of special machines of interest, and which are too unwieldy to be shown here, I am enabled to exhibit a few photographs.

One of the most novel of these is the “Twin” machine, designed by the Singer company for the connecting together of the Jacquard cards used in lace machines. The operation was formerly performed by hand. It is now done by machine at less cost. The cards are placed upon a feeding drum, and fed beneath a pair of needles. The laces forming the connection between the cards are fed above and beneath, in line with the needles, and the whole is easily stitched together. An extension of the same device is the multiple machine, in which four needles and shuttles are used, sewing all the four seams at one operation. This method of linking the cards is considered better than similar work done by hand.

Of Wheeler & Wilson’s new factory, at Bridgeport, and of the Singer company’s great new factory near Glasgow, I am enabled to exhibit photographic views.

Before drawing my remarks to a close, I would briefly indicate the nature of the various machines shown upon the power benching. Of the Singer system, there are four. A drop-feed oscillating shuttle machine for manufacturing purposes; a wheel-feed oscillating shuttle machine, furnished with a trimmer, used chiefly in stitching leather and boot uppers; double chain-stitch machine, used for sack making, now shown for the first time; and a single thread “Lightning Sewer,” fitted with a trimmer for hosiery work. Of Wheeler & Wilson’s system, there is a drop-feed manufacturing machine with the new detached hook and latest improvements; a No. 10 machine with the usual hook, a wheel feed and trimmer, and a smaller machine of the same type with drop feed. Of Willcox & Gibbs’ system, there is the ordinary single-thread machine for manufacturing, a single-thread machine, with a trimmer, as used in the hosiery trades, and a machine specially used for straw hat making.

We have here a small Singer machine, riding upon the edge of two pieces of carpet, a carpet machine weighing ten pounds. When the handle is turned, it stitches and travels over the edges, uniting them faster and more securely than six hand sewers; and several others, representative of the family type of sewing machine, besides Wheeler & Wilson’s hemstitch machine, the working of which is of much interest.

I would now invite those of you who seek a better acquaintance with those curious and novel machines to freely examine and test the various types to be found upon the power benching and upon stands. One or two operators will come forward and show some of the capabilities of the machines upon actual work, in which the making of a straw hat will perhaps show what can be done in a few minutes by quick speed and expert fingers; but these performances must not be regarded in the light of competitive tests between the manufacturers showing them, and are intended merely to show the utility of motive power driving.

Page 36

In conclusion, I desire to thank those gentlemen at the head of the leading firms of sewing machine manufacturers for the trouble they have taken to arrange for your inspection specimens of their excellent systems, and I have much satisfaction in expressing my obligations to them for ready assistance in the preparation of my paper.

* * * * *

Power machines and treadle machines were exhibited by Messrs. Willcox & Gibbs, Messrs. Wheeler & Wilson, and the Singer Manufacturing Company. The motive power was provided by an electrical motor, supplied by Mr. Moritz Immish. The Howe Machine Company exhibited a model of the first machine made by Elias Howe, and also one of the most recent Howe machines. Mr. Newton Wilson showed a model of the Saint sewing machines, constructed from Thomas Saint's patent specification, 1790, and Mr. Carver showed the Standard sewing machine.

* * * * *

THE NEW KRUPP GUNS.

Nothing is being talked about at present in Germany but the guns of great caliber that are manufacturing at the celebrated works on the banks of the Ruhr. As our neighbors appear to be elated over this wonderful work, it is expedient to examine the subject, in order to see whether their applause is legitimate.

We have known for a long time that the artillery *materiel* devoted to the defense of the German coasts consists of a long, stationary 53/4 inch gun; of long 73/4 inch hooped steel guns, closed by a cylindrico-prismatic wedge; of an 8 inch mortar; and of guns of 113/4 and 15 inch caliber. The 113/4 inch gun is 22 feet in length, and, including the closing mechanism, weighs 79,200 pounds. As regards the projectiles that this weapon throws, the *ordinary* shell is 33 inches in length, and weighs, all charged, 656 pounds, and the *exploding* shell, of the same length, weighs, all charged, 1,160 pounds. The initial velocity of the latter is 1,600 feet with a maximum charge of 148 pounds of powder.

The 15 inch gun is 32.8 feet in length, and weighs 158,400 pounds. Its projectiles are 3.67 feet in length. The *ordinary* shell, charge included, weighs 1,400 pounds, and the exploding shell, under the same circumstances, 1,700 pounds, that is, more than three quarters of a metric ton. The initial velocity of this last named projectile is 1,650 feet with a maximum charge of 1,650 pounds of powder. We also know that Mr. Krupp has two models of guns of 131/2 inch caliber, and of a length equal to 35 times the caliber, say 39-5/12 feet. The lighter of these models (which was shown at Anvers) weighs no less than 264,000 pounds, carriage not included. Its cylindrico prismatic closing mechanism (*Rundkeilverschluss*) alone weighs 82,500 pounds. This is the weight of a 53/4 inch hooped steel gun!

[Illustration: FIG. 1.—NEW 52 FOOT KRUPP GUN AND A GERMAN FIELD PIECE FIGURED ON THE SAME SCALE.]

Page 37

We now learn that the Essen works have just begun the manufacture of a 314,600 pound gun. This piece, called “40 cm. kanone L/40,” will, of course, be of 15.6 inch caliber, but it will differ from the one above described in that its length will be equal to 40 times the caliber, say 52 feet, or to the space occupied on the maneuvering ground by a field piece drawn by six horses (Fig. 1). This gun will be provided with two kinds of projectiles. One of these, called *light*, will be 31/2 feet in length, weigh 1,628 pounds, and be capable of taking an initial velocity of 2,410 feet and of piercing, on its exit from the chamber, either a hammered iron plate 33/4 feet in thickness or two united plates 13/4 and 23/4 feet in thickness.

The shell called *heavy* will be 53/4 feet in length, and weigh 2,310 pounds, say more than a 43/4 inch siege piece! The charge employed will be 1,067 pounds of brown, prismatic Dunwald powder. Ten hundred and sixty-seven pounds—nearly half a metric ton, more than the weight of a field piece without its carriage! With this enormous charge, the heavy shell will be capable of an initial velocity of 2,100 feet and of piercing, on its exit from the chamber, either a hammered iron plate 4 feet in thickness or two united plates 2 and 2.88 feet in thickness.

The *Cologne Gazette*, from which we borrow most of the data just presented, adds that the “40 L/40” piece will be the largest cannon in the world, but that it will not long enjoy the privilege of such pre-eminence. It appears, in fact, that Mr. Krupp is preparing to manufacture a gun of 171/2 inch caliber, weighing 330,000 pounds. The projectile for this monster will be 6 feet in length, say the stature of a full grown man, and will weigh no less than a ton and a half. A man of medium stature will measure a little less than this projectile (Fig. 2).

It is possible that all these figures have been slightly exaggerated by the ultra-Vosges journals, who doubtless intend to make an impression upon us; but we shall not dwell upon that point.

As regards the penetrating power of the large "40 L/40" gun, the German press observes that in 1868 artillery was incapable of piercing in one-hundredths of an inch what it is now piercing in tenths of an inch. The principle was formerly admitted, it says, that a shell should by right have a thickness equal to its caliber. Now, "the largest cannon in the world" perforates a plate whose thickness is three times the diameter of the gun's bore. What great progress! exclaim the German journals, and how jealous the French and English are going to be! Jealous of that? Why, indeed? We are not the least in the world so. How could we be? In the first place, we have a gun of very great caliber—a 131/4 inch steel coast and siege piece. This weighs 37 tons, and is 363/4 feet in length. Its projectile weighs from 924 to 1,320 pounds, according to its internal organization.

Its conoid head is very elongated, and by reason of this elegant form it always falls upon its point, even at falling angles of an amplitude approaching 60 degrees. The charge used varies from 396 to 440 pounds, according to the nature of the powder. As for the ballistic properties of the piece, they are very remarkable. Its projectile has an initial velocity of 2,132 feet, and the maximum range is from 10 to 11 miles, say the distance from Paris to Montgeron by the Paris-Lyons-Mediterranean railroad, or from Paris to Versailles. Finally, the accuracy of this gun is much greater than that of the 91/2 inch steel one. Now, the accuracy of this latter is such that it is impossible for its projectiles to miss a ship under way, and that we are sure of playing with it against the enemy that game whose device is “We win at every shot!” Well, we do not hesitate to say that these results appear to us to be satisfactory—we mean quite sufficient—and that there is no need of looking for a better gun. If there were, French industry would be capable of producing weapons of any caliber desired. As regards this, there is, so to speak, no limit; moreover, taking into account merely the terrestrial conditions of the problem, we may be satisfied that the great works of our country are more powerfully equipped than those of Essen, and consequently better able to forge large pieces of steel.

Mr. Krupp, it is said, is very proud of his two power hammers, which he has named Max and Fritz. But, on the whole, these two apparatus are only fifty ton ones, and have a fall of but ten feet. Now, Creusot and St. Chamond each has a hundred ton steam hammer with a fall of 16 feet, accompanied with four furnaces and four cranes.

[Illustration: FIG. 2.—3,300 POUND PROJECTILE OF A KRUPP GUN IN COURSE OF MANUFACTURE.]

But why proceed to the manufacture of monstrous guns, like those that Mr. Krupp has just produced, or meditates producing in the future; guns of such a caliber can be used only in special cases—in battery on the coast or on board of a ship. It is not with *materiel* of this kind that war is waged; it is with field pieces. Our ultra-Vosges neighbors well know this.

One of the reasons that the war that very recently threatened us did not break out, was because the Germans could not fail to see that their field *materiel* was not as powerful as ours; that the shell of our 31/2 inch gun weighs 171/2 pounds, while that of their heavy 31/2 inch gun does not weigh 15. Now, this difference has its value.

Hunters well know what importance it is necessary to attach to the number of the ball that they use.

This granted, it is well to observe that the net cost of the “40 cm. kanone L/40” must not be less than $300,000 or $400,000. Now, on the interest of such a sum we could have from ten to fifteen complete batteries, that is to say, comprising, in addition to the sixty or eighty guns, all the necessary accessories, such as carriages, limbers, caissons, harness, *etc*.

Page 39

Frankly, between the two acquisitions, there is no hesitation possible.

Finally, if we must say so, we do not think that foreign powers, when they believe it their duty to provide themselves with *materiel* of great caliber, will think of supplying themselves from the Essen works, on account of the memorable accidents due to the imperfection of guns coming from this celebrated establishment. The list of burstings that have occurred, not only in Germany, but also in Russia, Bohemia, Italy, Turkey, and Roumania, is already a long one. To speak here only of what occurred in France in 1870-71, it is certain that out of seventy German guns of large caliber in battery against the southwest front of the wall of Paris, thirty-six—say more than half—were put out of service during the first fifteen days of the bombardment, and that too through firing merely; and it was the opinion of Mr. De Moltke himself that the German siege batteries would have been reduced to silence, had the defenders been able to hold out for a week longer. It is equally certain that, during the course of the Loire campaign, eighty guns of Prince Frederick Charles' were put out of service by the sole fact of their firing. Summing up the history of these many accidents, the Duke of Cambridge asserted to the House of Lords (April 30, 1876) that *two hundred* Krupp guns burst during the Franco-German war. Have the engineers of the Essen works improved their processes of manufacture since that epoch? It is permissible to doubt it, seeing that, very recently, the Italian navy refused to take from Mr. Krupp some 151/2 inch guns whose tubes were but very imperfectly welded.

Must the numerous accidents mentioned be attributed to defects in the metal employed? Were they due to defective hooping? Were they due to some one of the numerous inconveniences inherent to the cylindrico-prismatic system of closing (*Rundkeilverschluss*)?

They were doubtless owing to such causes combined.—*La Nature*.

*   *   *   *
    *

COLORS OF THIN PLATES.

The Right Hon. Lord Rayleigh lately delivered a lecture at the Royal Institution upon “The Colors of Thin Plates,” a term which he explained was applied to thin films of substances, such as oily films on the surface of water or the equally familiar soap bubble. Although the reflection of colors from the surface of a soap bubble is probably the most noticeable, yet the “plate” which lends itself most readily for experiment is a film of air confined between two sheets of glass. If a ray of white light be reflected from the surface of the film upon a screen, the so-called Newton’s rings, a series of colored concentric rings, are obtained. If, instead of reflected light, the ray of light transmitted through the film of air be allowed to fall upon the screen, the same phenomenon is observable, but the effect

Page 40

is very considerably minimized, owing to the great preponderance of white light, which overlies as it were the colored rings. Even in the first instance, as the lecturer was able to show later on, the colors are not nearly so intense as they may be obtained, owing to some white light being reflected from the surfaces of the two sheets of glass. With regard to the appearance of the phenomenon, it is observed that the part which corresponds to the thinnest part of the film is considerably darker than the rest of the spectrum; around this is a bright ring of white, succeeded by constantly increasing concentric rings of different colors apparently repeating themselves. Lord Rayleigh also obtained the same results with a film of a solution of soap and glycerine, but in this case the dark portion was observed at the top of the spectrum, the other colors arranging themselves in order in the soap film thinned by the force of gravitation, thus showing that the colors vary according to the thickness of the film. Another form of the experiment called forth a considerable amount of applause from the audience. Lord Rayleigh caused a gentle stream of air to play obliquely upon a soap film, so that the part struck was moved forward and the whole film rotated. Then with the alteration of the force of the current of air, which of course regulated the centrifugal force, alternating thicknesses of film were obtained, causing a varying display of beautiful colors and combinations of colors.
This last experiment also tended to prove that the bands of color are not arranged in a certain order, but vary according to the thickness of the film, a conclusion arrived at by Brewster, who observed that if a film reflecting certain colors be carefully inverted so as not to disturb the gravity, the colors reflected are also inverted. Lord Rayleigh explained the phenomenon by referring to Young's wave theory of light. He regarded the film as having two surfaces from which light is reflected, an anterior exterior surface and a posterior interior surface.
If a ray of light be thrown upon the film, a part

of the light is reflected from the first surface, but the greater part is transmitted, and some of this is reflected from the second surface, passes back through the film, and is combined with the light reflected from the first surface. If then the light reflected from the second surface be in the same state of vibration as that reflected from the first surface, the effect of their combination will be to increase the amount of light reflected from the first surface, but if otherwise, the effect will be a partial neutralization of the light reflected from the first surface. That is to say, if the retardation of the light which is reflected from the second surface, owing to its twice traversing the thickness of the film, be equivalent to a wave length of the vibration of the light, it will increase the intensity of the light reflected from the first surface. If, however, the retardation

Page 41

be only equivalent to half a wave length, the intensity of the light will be decreased. Thus, then, with a ray of monochromatic light it will be seen that the effect of difference in the thickness of the film will be to alter the intensity of the reflected ray, but with a white light composed of several colors the result will be more complicated. As each color has a different wave length in vibration, it will be seen that each color will act independently of the others, and a certain thickness of film which, upon the combination of the two reflected rays, will cause one particular color to be intensified, will at the same time cause the other colors to be more or less obscured.

Thus as the thickness of the film is altered different colors preponderate, causing the appearance of rings or bands, according to the nature of the experiment. The dark appearance on the screen corresponding to the thinnest part of the film is probably due to refraction of the ray of light reflected from the second surface, consequent in its passing from a rare into a denser medium, and again from the denser medium into the rare, which refraction Lord Rayleigh considers to effect a retardation equivalent to half a wave length. Lord Rayleigh supported this theory of the formation of Newton's rings by several interesting experiments. A beam of light was intercepted by two of Nicol's prisms, one of which acted as a polarizer and the other as an analyzer of the light, so that no light was able to pass through both on to the screen. Between the two prisms a double refractive lens was now placed, in this case a double concave lens of selenite, when the same series of concentric rings observed with the film of air was obtained on the screen, only much more intense, while a wedge of selenite gave the bands of color in the same order as with the soap bubble.

But perhaps the most striking proof of the dependence of the colors upon the thickness of the film was shown by the reflection of a beam of light from a piece of mica composed of twenty-four very attenuated plates overlapping each other. With each layer a marked gradation in color was visible.

The remainder of the lecture was devoted to an explanation of the determination of the chromatic relations of the colors of the spectrum. Lord Rayleigh at this point made a rather startling statement that any color can be produced by two other colors. As an example of such a formation, a ray of white light was passed separately through a solution of yellow chromate of potash and an alkaline litmus solution, throwing respectively a yellow and violet-blue color upon the screen. When the ray was made to pass through the two solutions successively, an orange-yellow color was obtained upon the screen, which color Lord Rayleigh asserted to be made up of red and green rays. To prove this, the ray of white light was decomposed by means of a prism, and the decomposed rays passed through the two solutions. The one solution was

Page 42

found to exclude all the yellow and orange rays from the spectrum, while the other excluded all the blue and violet rays, so that when the ray had passed through both solutions, only the red and green rays were left. If, instead of allowing the decomposed ray of light to pass through a slit, and thus obtain definite bands in the spectrum, the ray was passed through a circular hole, the red and green colors overlapped each other on the screen, forming by their combination the identical orange-yellow color obtained with the primary white light. It was then stated that if three definite positions be taken in a spectrum in the red, green, and violet bands respectively, and these positions be represented by the corners of an equilateral triangle (Clerk Maxwell's triangle), it has been mathematically determined in what position within this triangle the colors of Newton's rings would fall. Lord Rayleigh, by means of a diagram and the selenite wedge, showed that the relations to the three standard colors in practice were identical with the position assigned them by theory.

In conclusion, the lecturer showed a piece of glass, the surface of which had been decomposed, a ray of light transmitted through which showed upon the screen patches of very pure color. These he considered to be due to the glass consisting of a number of thin plates, some of which had been removed by the decomposition.

* * * * *

BELT JOINTS.

From time to time, serious accidents have taken place, and the progress of work stopped, by the sudden snapping of driving belts in machinery, and, as a general rule, it is found that the collapse is attributable either to faulty leather or insecure joining. A great improvement of the leather intended for belts has been brought about during the last few years, by the introduction of improved processes for currying and the subsequent treatment. Paterson has worked successfully a patent for rendering belt leather more pliable, and lessening the tendency to stretch. Under this treatment the leather is either curried or rough dried, and then soaked in a solution of wood, resin, and gum thus, or frankincense, first melted together, and then dissolved, by the application of heat, in boiled or linseed oil. The leather, after this process, is soaked in petroleum or carbon bisulphide containing a little India-rubber solution, and is finally washed with petroleum benzoline. Should the mixture be found to be too thick, it is thinned down with benzoline spirit until it is about the consistency of molasses at the ordinary temperature. The leather so prepared is not liable to stretch, and can be joined in the usual way by copper riveting, or the ends can be sewn. A good material for smaller belts, and for strings and bands for connecting larger ones, is that recently patented by Vornberger, in which the gut of cattle is the basis. After careful

Page 43

cleansing, the gut is split up into strands, and treated with a bath of pearlash water for several days. The strands are then twisted together, and after being dipped in a solution of Condy's fluid, are dried. They are then sulphured in a wooden box for twenty-four hours, after which the twisting can be completed. They are by this process rendered pliable, and can be used in this state for stitching the leather ends of larger belts, or can be stiffened by plunging them into a bath of isinglass and white wine vinegar. After drying they are susceptible of a fine polish, emery cloth being usually employed, and the final "finish" is given to the material with gum arabic and oil.

Canvas and woven fabrics, coated with India-rubber, are also now being used for driving belts and for covering machine rollers. As this material can be made in one piece, without the necessity of a joint, it is uniform in strength, and is recommended as a substitute for leather belts requiring joints. A patented material of this description is due to Zingler, who boils the canvas or similar woven fabric under pressure in a solution of tungstate of soda for three hours. It is then transferred to a bath of acetate of lead solution, and drained, dried, and stretched. When in this condition it is coated, by means of a spreading machine, with repeated layers of a composition consisting of India-rubber, antimony sulphide, peroxide of iron, sulphur, lime, asbestos, chalk, sulphate of zinc, and carbonate of magnesia. When a sufficient thickness of this composition has been applied, it is vulcanized under pressure at a temperature of 250 deg. F., or a little higher. The material produced in this manner is said to have the strength and durability of the best leather belts. Attempts have recently been made to obtain a glue suitable for joining the ends of driving belts, without the use of metal fastenings or sewing, and Messrs. David Kirkaldy & Son have reported favorably on such a belt glue, which is being introduced by Mr. W.V. Van Wyk, of 30 and 31 Newgate street, E.C. In the

test applied by them, a joint of this "Hercules glue," as it is called, in a 4 in. single belt was stronger than the solid leather. When a tensile stress of 2,174 lb., equivalent to 2,860 lb. per square inch of section, was applied, the leather gave way, leaving the joint intact. Belts fastened by a scarf joint with this glue are said to be of absolutely the same thickness and pliability at the joint as in the main portion of the belt, and thus insure freedom from noise and perfect steadiness. The instructions for use are simple, and it requires only fifteen minutes for the joint to set before being ready for use.
From a rough chemical analysis of the sample submitted to us, we find that it consists of gelatine, with small amounts of mineral ingredients. Josef Horadam, some few years ago, patented in Germany a process for preserving glues from decomposition, by the addition of from 8 to 10 per cent. of magnesium or calcium chlorides. The addition of these salts does not impair in any way the strength of the glue, but prevents it from decomposing, and it may be that the "Hercules glue" is preserved in a similar manner.

Page 44

A cement of this nature, if thoroughly to be relied
on, must be of great value, although the great variation
in the quality of leather, apart from the difficulty
hitherto experienced of securely connecting the ends
together, opens a wide field for a material of uniform
composition, and capable of being made in one piece
in suitable lengths for driving belts and other machine
gear.—*Industries*.
* * * *
*

INAUGURATION OF THE STATUE OF DENIS PAPIN.

A large crowd was present recently at the inauguration
of the statue of
Denis Papin, which took place in the court of the
Conservatoire des Arts et
Metiers, under the presidency of Mr. Lockroy, Minister
of Commerce and the
Industries.

[Illustration: DENIS PAPIN.]

In the large hall in which the addresses were made
there were several municipal counselors, the representatives
of the Minister of War, Captains Driant and Frocard,
several members of the Institute, and others.
A delegation from the Syndical Chamber of Conductors,
Enginemen, and Stokers, which contributed through
a subscription toward the erection of the statue,
was present at the ceremony with its banner. Mr.
Lanssedat, superintendent of the Conservatoire, received
the guests, assisted by all the professors. Mr.
Lanssedat opened the proceedings by an address in which
he paid homage to the scientists who were persecuted
while living, to Denis Papin, who did for mechanics
what Nicolas le Blanc did for chemistry, and to those
men whose entire life was devoted to the triumph of

the cause of science.

After this, an address was delivered by Mr. Lockroy, who expatiated upon the great services rendered by the master of all the sciences known at that epoch, who was in turn physician, physicist, mechanician, and mathematician, and who, in discovering the properties of steam, laid the foundation of modern society, which, so to speak, arose from this incomparable discovery.

Speeches were afterward made by Mr. Feray d'Essonnes, president of the Syndical Chamber of Conductors, Enginemen, and Stokers, and by Prof. Comberousse, of the Central School, who broadly outlined the life of Papin.

Along about four o'clock, the Minister of Commerce and the Industries, followed by all the invited guests, repaired to the court, and the veil that hid the statue was then lifted amid acclamation.

Papin is represented as standing and performing an experiment.

Upon the pedestal is the following inscription:

DENIS PAPIN
BORN IN 1647, DIED ABOUT 1714,
INVENTED THE STEAM ENGINE
IN 1690

NATIONAL SUBSCRIPTION, 1886.

The inauguration is due to the initiative of Mr. Lanssedat, for it was he who in 1885 suggested the national subscription, which was quickly raised.

Denis Papin was born at Blois on the 22d of August, 1647. He was the son of a physician. After the example of his father and of several of his relatives, he studied medicine and took his degree; but his taste for mathematics, and especially for experimental physics, soon led him to abandon medicine.

Page 45

It was in 1690 that he published in the *Actes* of Leipsic the memoir which will forever and irrevocably assign to him the priority in the invention of steam engines and steamboats, and the title of which was: “New method of cheaply obtaining the greatest motive powers.”

In 1704, Papin, poor and obliged to do everything for himself, finished his first steamboat; but for want of money he was unable to make a trial of it until August 15, 1707. The trial was made upon the Fulda and Wera, affluents of the Weser.

The operation succeeded wonderfully, and, shortly afterward, Papin, being desirous of rendering the experiment complete, put his boat on the Weser; but the stupid boatmen of this river drew his craft ashore and broke it and its engine in pieces.

This catastrophe ruined Papin, and annihilated all his hopes. The great man, falling into shocking destitution, broken down and conquered by adversity, returned to England in 1712 to seek aid and an asylum.

Everywhere repulsed, he returned to Cassel about 1714, sad and discouraged; and the man to whom we owe that prodigy, the steam engine, that instrument of universal welfare and riches, disappeared without leaving any trace of his death.—*Le Monde Illustre.*

* * * * *

DECORATION.

THE STUDY OF ORNAMENTS.

[Footnote: *Authorities consulted in preparing this paper:* “Analysis of Ornament,” Wornum; “Truth, Beauty, and Power,” Dresser; “Lectures on Art.” F.W. Moody; “Hopes and Fears for Art,” Wm. Morris; “Ornamental Art,” Hulme; “Manuals of Art Education,” Prang.]

By MISS MARIE R. GARESCHE, St. Louis High School.

Decoration is the science and art of beautifying objects and rendering them more pleasing to the eye. As an art, individual taste and skill have much to do with the perfection of the results; as a science, it is subject to certain invariable laws and principles which cannot be violated, and a study of which, added to familiarity with some of the best examples, will enable any one to appreciate and understand it, even if lacking the skill and power to create original and beautiful designs.

The study of decoration offers many advantages. It cultivates the imagination and the taste; it develops our capacity for recognizing and enjoying the beautiful in both nature and art; it adds to the pleasure and refinement of life. Practically, its importance can hardly be overestimated, as it enters into almost all the industrial pursuits. We can think of but few classes of objects, even the most simple, in which some attempt at ornamentation is not made.

Ornament is one of the principal means of enhancing the value of the raw material. A piece of carved wood, or an artistically decorated porcelain vase, worth perhaps many hundred dollars, if reduced to the commercial value of the material of which they are composed would be valued at but a few dollars or cents. The higher the ornamentation ranks, from an artistic point of view, the greater becomes the value of the article to which it is applied. Knowledge of good designs is thus evidently important, to the purchaser of the object ornamented as well as to the designer who planned it. This can only be attained by cultivation.

Page 46

To know and appreciate the best ornament should be an aim set forth in any scheme of general education. This knowledge and appreciation can be obtained by studying the application of the laws and principles of ornamental art as exemplified in the works of masters, and also by endeavoring to apply these principles in designs of our own creation.

PRINCIPLES OF ORNAMENT.

We can only arrive at a knowledge of these principles by a consideration of the object. In other words, nature and history must be studied. First, *nature*, for she is the primary source and origin of all good ornament, whether ancient or modern; and if, as in everything else, we would not become servile imitators and weak copyists, we must go to the fountain head. Second, *history*, for by the study of the ornament of past ages we will not only become acquainted with the highest developments of which ornamental art is capable, but will moreover broaden our views as to its object and scope, and will stimulate our own imagination and invention, by leading us to the contemplation of the myriad beautiful and protean forms it has assumed, when surrounding conditions, such as religion, climate, temperament, nationality, *etc*., have been different. Knowledge of historic ornament will also prevent the imposition on the public, so common in our day, of weak and unworthy productions which claim to be based on classic originals, and which constitute a great stumbling block to the progress and appreciation of good art. The result is somewhat analogous to that produced upon conscientious but ill-informed minds, who make every effort to appreciate and enjoy the spurious productions of a great author, not knowing that they are not genuine.

POSITION AND SCOPE OF ORNAMENTAL OR DECORATIVE ART.

I. *Object of Ornamental Art.*—The object or purpose of ornament, as in the other fine arts, is to please. In music and poetry this enjoyment is conveyed to the mind through the ear; in the decorative and pictorial arts, through the eye. Generally, the meaning that we find in such productions, the appeal that they make to the understanding or feelings, is as great a source of interest to us as their intrinsic beauty. Poetry and vocal music are greatly dependent for their effect upon the meaning they convey in words; painting and sculpture, upon the ideas or sentiments they suggest. In all four, however, and most decidedly in music unaccompanied by words, the appeal is frequently made almost exclusively to the aesthetic sense, the mind or intellect remaining almost dormant under the impression. Gems of rhythmical verse, such as Poe's "Bells," "The Raven," Whistler's "Symphonies in Color," nameless forms in statuary, expressionless save in the mere beauty of their proportions and curves, and, as has been stated, nearly the entire field of

Page 47

instrumental music, are cases in point. In the ornamental and decorative arts, as well as in architecture (from which they are indeed inseparable), beauty alone, in like manner, should be the principal aim and purpose. In the former, of course, it is indispensable that such should be the case, as they are entirely subordinate and accessory in their nature, their only *raison d'etre* being to beautify or render more agreeable objects already created for some purpose.

It must not be imagined that such artistic impressions—viz., where the appeal is made almost solely to the aesthetic sense, regardless of the reason, judgment, or feelings—are necessarily of a lower order. Their effect is almost analogous to that which nature herself produces upon us—the starry heavens, the mighty ocean, the tender flower. The impression, whether the object belongs to the domain of nature or art, may be a merely sensuous one; and if it stops there, as it certainly does for the majority of people, it ranks without doubt far below productions where the aesthetic element is only used to stimulate and heighten the appeal to the mind or the feelings. But if it extend beyond, and makes the sensuous impression but the parting link to the contemplation of ideal, abstract beauty, without the intermediate aid of the heart or the reason, it is the shortest and quickest road toward the realization of the infinite, and makes us indeed feel that it is but a short step "from nature up to nature's God." Thus architecture, which embodies, more than any other of the space arts, principles of abstract beauty, has been with reason called the noblest of them all.

However, ornamental and architectural forms frequently do convey a meaning, which we term symbolism in art. If this symbolism does not detract from the first object of ornament—viz., to beautify—it is perfectly legitimate and proper. It is impossible to fully appreciate many phases of art, as, for instance, the Egyptian and the early Christian, if we leave out of sight the symbolism which pervades them.

While beauty, or capacity for pleasing the eye, may be very definitely said to be the aim of ornamental art, it is difficult to arrive at a universal standard as to what constitutes beauty. What pleases one person will not always please another. The child loves glittering objects and gaudy combinations, which the mature taste of the man declares extravagant and unharmonious. Savages decorate their weapons, utensils, and their own persons with ornaments that appear uncouth and barbarous to civilized people.

Besides these differences in taste, which are due to different degrees of mental development, and which can consequently be easily disposed of, we find among highly civilized and cultured nations, at different periods, a great diversity of tastes. These varying and sometimes apparently conflicting products of ornamental art we designate as styles, *viz*., Egyptian style, Greek style, Gothic style, *etc*. So marked are the differences between them that we can sometimes tell at a glance to what period and to what style a small fragment of decoration belongs.

Page 48

Notwithstanding these differences, which at first may appear very great, a careful study of the best styles—those that achieved the greatest and most lasting popularity—will reveal the fact that they are all based upon certain fundamental laws and principles, and that all are good, bad, or indifferent according as they conform to or violate these principles. These essentials having been preserved, the opportunities for the exercise of individual or national taste are almost boundless.

II. *Position of Ornament*.—The position that ornament occupies is necessarily a secondary one, as it cannot exist independently, but is always applied to objects created for some purpose entirely independent of their capacity for pleasing. This gives us one of the great underlying principles that should characterize all ornament, *viz*., *it must be subordinate to the object which it adorns, and must not detract from its use*. We often see this rule violated in personal, household, and architectural decoration—windows so overloaded with projecting cornices and lattice work as to almost exclude light and air; knife handles carved so elaborately that it is impossible to grasp them firmly; styles of dress in form or color that impede the motions of the wearer, and make the clothes, rather than the personality of the wearer, the most noticeable feature. From this principle there is but a step to another: *All ornament should be modest and moderate*. It must not obtrude itself, and a great profusion and ostentation in its application is always a sign of degeneracy and bad taste. Of course some objects, from their nature, position, and use, will admit of greater and more elaborate ornament than others.

Ornament, being entirely subordinate, should not conceal the construction of the object. In architecture it should follow the leading lines of the building, and should emphasize, or at least suggest, the construction. If architectural in character, it should so enter into the construction of the building that it could not be taken away without injuring it.

We must feel that a column, no matter how beautiful, is supporting something. A floor, always a plane surface, must not be tiled or decorated in any way to express relief. This would apparently destroy the essential constructive quality of a floor, *viz.*, flatness. For the same reason, all shams, such as painted arches, pillars, *etc.*, are not legitimate. As long as they do not actually exist, they are evidently not necessary to the construction, and have no purpose save an imaginary decorative one, and in the words of Owen Jones, *construction must be decorated—not decoration constructed*.

III. *Scope of Ornament.*—The scope of ornamental art is almost boundless. It is applied to objects large and small, adapted to the most various uses, constructed of the most different materials. As the ornamentation is always to be subordinate to the object, considerations regarding size, use, position, material, *etc.*, must govern it. An ornament that would be admirable applied to one object, might be detestable if applied to another. A design cannot be made without reference to its future application.

Page 49

First: The material must be considered. Heavy and hard materials, such as wood and stone, will not admit of as delicate curves and lines as textile fabrics, such as cotton and woolen goods, laces, *etc*.

Second: The manner in which the article is to be made, whether by weaving, cutting, carving, casting, *etc*.

Third: The position the object is to occupy. If elevated or otherwise remote from the eye, elaborate finish and minute detail are useless. Ornamental art, from time immemorial, has attained its greatest excellence and exercised its greatest influence in connection with architecture.

In fact, the study of ornament is inseparable from that of architecture. It is upon architectural forms that the greatest artists have in all ages expended their greatest efforts and skill, and in a treatise on historic ornament they are decidedly the most interesting and important object of study.

IV. *Material of Ornament*.—The two great sources of ornament are geometry and nature. The latter includes the former; for not only must natural forms, in order to be available as material for ornament, be first conventionalized, or reduced to regular, symmetrical, geometric outlines, but any and all designs, whether the unit of repetition be geometric or conventional, must be founded upon geometric construction. This refers to the regularity, repetition, and distribution of parts; so that every good design, if reduced to its principal lines of construction, would exhibit but a few geometric lines and inclosing spaces. Many designs are not only geometric in their basis or plan, but make use of geometric figures as the units or materials of design. Such designs, however, rank lower than those in which natural forms conventionalized are taken as the subjects of repetition; and as the ornament rises in the scale toward perfection, even the geometric basis becomes less and less apparent, and sinks into a decidedly subordinate position; so that in many of the most perfect specimens it can be traced only in a few leading lines of the composition. Its presence, however, is necessary, and is the foundation, if not the most important element, of beauty in the design.

RELATION BETWEEN NATURE AND ORNAMENTAL ART.

While the natural world, including leaves, flowers, animals, *etc*., is the greatest source of ornament, it is generally the opinion of the best authorities, derived from the study of the best styles and by a consideration of the principles of fitness and propriety which underlie the entire physical and moral world, that natural forms in ornamental and decorative art should not be literally copied or imitated. That is the aim of painting, sculpture, and the other representative arts, where the object is to present something to the eye which will suggest at once the actual presence of the object. To produce that effect, the object, whether animal or vegetable, is represented as much as possible in the actual circumstances of its existence, surrounded by the necessary conditions of its well-being and growth. A frame is placed around it, to shut it off as much as possible from other surroundings, and thus help us delude ourselves that we are in the presence of the real thing, either as it would impress us through our senses or our imagination.

Page 50

But in ornamental art the case is entirely different. As it is to be applied and consequently subordinated to something, and does not exist for itself, it would be impossible, except in very rare instances, to introduce in a design a natural object in a realistic manner and not violate some important law of its growth or the conditions of its well-being. For instance, to exactly repeat a certain rose, with all the accidents of its growth, many times in a carpet is not natural. Nature never repeats herself. Moreover, to tread on that which is supposed to suggest to us real roses is barbarous. It would really be outraging and distorting nature while pretending to be her faithful disciple and imitator.

We not only derive from nature the most important materials for our designs, but also the various modes of arranging this material. Various modes of repetition—radical, bilateral, *etc*.—were all probably suggested by some natural arrangement observed in flowers, leaves, *etc*. Of these different arrangements it is curious to note that the bilateral is more characteristic of the higher forms of nature and the radiating of the lower. The leading principles of ornament—symmetry, proportion, rhythm, contrast, unity, variety, repose, *etc*.—are all exemplified in natural forms. The latter have also suggested many of the most important architectural forms. The Gothic cathedral, with its clustered columns branching and forming pointed arches overhead, was probably suggested by a grove of trees with overarching branches and boughs. The idea of the column was derived from the papyrus plant, a species of reed growing in the river Nile. The bud or flower suggested the capital of the column; the stalk, the shaft; and the bulbous root, the pedestal. The blue vault of the sky undoubtedly suggested the dome, *etc*.

The following are a few of the leading principles of ornamental art as set forth by Owen Jones in his

Grammar of Ornament, a fine work, magnificently illustrated, whose perusal could hardly fail to delight the most indifferent:

“All good ornamental art should possess fitness, proportion, harmony, the result of all which is repose.”

“Construction should be decorated. Decoration should never be purposely constructed.”

“All ornament should be based upon geometrical construction.”

“Harmony of form consists in the proper balancing and contrast of the straight, the inclined, and the curved.”

“In surface decoration all lines should flow out of a parent stem. Every part, however distant, should be traced to its branch or root. Natural law.”

“All junctions of curved lines with each other, or with straight lines, should be tangential to each other. Natural law.”

“Natural forms, as subjects of ornament, should not be imitated, but should be conventionalized.”

HISTORIC ORNAMENT.

Page 51

The origin of all attempts at decorating or beautifying objects lies in the universal love of mankind for the beautiful. Once the necessaries of life provided for, man instinctively, the world over, turns his attention toward gratifying this feeling, by improving and decorating the forms around him—his arms, utensils, dwelling, or his own person. The history of every nation proves this, and no matter how rude, and even ugly, their efforts may seem to us, we are bound to recognize in them the same motives that actuated the builders of the Parthenon or of St. Peter's at Rome. This awakening and gratification of the aesthetic sense seems to be the first advance from a condition of mere animal existence, in which food, shelter, and comfort are the only considerations, to tastes and desires that are higher and, consequently, more impersonal.

The term historic ornament is applied to the various styles of ornamental art which have flourished at various periods in the world's history, from the Egyptian, dating from the 14th century B.C., to those that exist at the present day. Their number is, consequently, almost unlimited, and we will confine ourselves to the consideration of a few of the principal ones only—those that have achieved the most enduring fame, or those that exercised the most marked influence upon succeeding styles.

In considering the various styles, we must always bear in mind that, with the exception of the Egyptian, all show very markedly the influence of the styles that preceded them, being very often merely an outgrowth or development of a preceding one. Thus the Greeks borrowed many forms from the Egyptians. The Romans simply adapted and elaborated the Greek style, *etc*. So that while each style is usually known by certain prominent characteristics, it does not follow that these characteristics are peculiar to it alone.[1] They may be found in other styles, though not to such a great extent. While similar features will thus be seen to run through many styles, each will usually be found to possess an individuality of its own. Every nation, like every individual, possesses different wants and capabilities, and will develop itself accordingly. Differences in religion, climate, manners, customs, *etc*., will cause differences in their art and literature, the most lasting monuments of their morals, taste, and feelings.

[Footnote 1: “Rudiments of Architecture and Building,” through courtesy of H.C. Baird.]

It is rather by the study of the art and literature of a people that we arrive at a true knowledge of them than from the perusal of mere historic facts concerning them—when they lived, who conquered them, *etc*.

THE STYLES.

ANCIENT OR CLASSIC. 1400 B.C.—300 A.D.

Egyptian.—Characteristics:
symbolic, severe,
simple,
grand, massive. Conventional forms of lotus,
papyrus,
etc. Oblique lines.

Page 52

Greek.—Characteristics:
aesthetic, simple,
harmonious,
beautiful. Conventional forms, anthemion,
acanthus.
Ellipse.

Roman.—Characteristics:
elaborate, rich, costly.
Conventional
forms, acanthus scroll, monsters. Circle.

MEDIEVAL. 300 A.D.—1300 A.D.

Byzantine.—Symbolic,
rich, elaborate. Conventional
forms,
principal architectural feature—dome.

Saracenic.—Gorgeous
coloring, graceful curves.
Forms
entirely geometric. Arabesque, geometrical
tracery,
interlacing.

Gothic.—Imposing,
grand. Pointed arches, clustered
columns,
vaulted roof, spire buttress. Forms both natural
and
conventional. Stained glass.

MODERN OR RENAISSANCE. 1300 A.D.—1900 A.D.

Renaissance.—Mixture
of classic and mediaeval
elements.
Result not generally good.

Cinquecento.—AEsthetic,

revival of true classic
principles.
Beautiful curves, fine proportions
and
distribution. Conventional animal and plant
forms.
Human figure.

Louis Quatorze.—Sparkling, glittering. Absence of
color, want of symmetry.

I. ANCIENT OR CLASSIC ART.

Ancient art is also known as classic, a term which, in architecture, sculpture, painting, and music, is almost synonymous with *good* and *admirable*. Taken as a whole and at its best, classic art has never been surpassed. The designs of the Greeks, Romans, and Egyptians, and even the forms of their buildings, are still copied at the present day.

The horizontal line is a marked feature of classic art. It is visible in the leading lines of their architecture, in the frequency of horizontal borders, friezes, *etc*. It accords admirably with the constructive features of classic architecture, and thus conforms to the important decorative principle that ornament should emphasize rather than disguise construction.

1. *Egyptian Art*.—The oldest of which we have any record dates from 1800 B.C. Egyptian art is symbolic, that is to say, the forms were chosen not so much on account of their beauty as for the purpose of conveying some meaning. The government of Egypt being almost entirely in the hands of the priests, these symbols were generally of a religious character, signifying power and protection. The principal ones were: The lotus, signifying plenty, abundance; the zigzag, symbolic of the river Nile; the winged globe or scarabaeus, signifying protection

and dominion, usually placed over doors of houses; the fret, type of the Great Labyrinth, with its three thousand chambers, which was, in its turn, symbolic of the life of a human soul.

Page 53

The column originated with the Egyptians. It was at first heavy, broad compared to its length, and was usually covered with hieroglyphics. The architecture of Egypt, of which the principal forms are pyramids, sphinxes, obelisks, and temples, is characterized by massiveness of material, grandeur of proportion, and simplicity of parts—a style well suited to its flat, sandy soil, though it would look heavy and out of place in a country where nature had herself supplied the elements of grandeur and massiveness in the form of lofty mountains or mighty forests. Egyptian art greatly influenced all the succeeding styles, and to this time is unsurpassed in many of its qualities.

2. *Greek Art.*—The next great historic style is the Greek. Its spirit differed entirely from the Egyptian, being aesthetic and not symbolic. Its sole aim was to create beautiful forms, without any thought of attaching to them a meaning. It adopted many Egyptian forms, such as the lotus, fret, and scroll, but divested them of all symbolism or significance. The most characteristic feature of Greek ornament is the anthemion, a conventionalized flower form resembling our honeysuckle bud, which was usually alternated with the lotus or lily form bud. The Greeks also borrowed the column and flat arch from the Egyptians, but changed it to a more slender, graceful form. The three principal orders of Greek architecture are named from the style of the column used that characterized them, *viz.*, the Corinthian, the Doric, the Ionic. Of these the Doric is the simplest and the Corinthian the most elaborate.

For harmony of proportions, elegance of form, and simplicity of detail, Greek architecture and ornament has probably never been surpassed. These qualities are admirably displayed in the Parthenon, a temple in Athens, dedicated to Venus. Though in ruins, it is still one of the greatest attractions to travelers in Greece. A very fine collection of fragments taken from it is to be seen in the British Museum. They are known as the Elgin marbles.

The most flourishing period of Greek art, as will be found in the history of almost all nations, was identical with the most flourishing period of its literature and general welfare.

3. *Roman Art.*—In the 6th century B.C. the Greeks, already on the decline, were conquered by the Romans, a nation hardier and more powerful, though ruder and less civilized than themselves. The conquerors recognized this, and immediately set to work to copy or steal from their vanquished foes everything that might enhance the beauty and splendor of their own city. Greek artists were transported to Rome and placed in charge of the most important public works. Roman art is, consequently, but a development or adaptation of the Greek. It is noticeable, however, that it almost completely ignored the most characteristic and popular of the Greek forms—for example, the anthemion—and adapted those, such as the acanthus and the scroll,

Page 54

which had been considered of minor importance among the Greeks. They added another to the three orders of the Greek architecture, *viz*., the Composite, the most elaborate of all, being a combination of the Ionic and the Corinthian. This leads us to consider the leading features of Roman ornament—richness and profusion. With the acanthus and scroll as their principal units of design, they elaborated and enriched every form that would admit of it. The most elaborate Greek example cannot compare in this respect to the simplest Roman. The Roman style of architecture was very similar to the Greek, though more massive in its proportions, probably on account of the larger number of people to be accommodated. The details were also bolder and the curves fuller. They used the round arch to a great extent. The column of Trajan and the Forum are fine examples of their architecture.

II. MEDIAEVAL ART.

The Roman empire, after having reigned as mistress of the world for upward of five centuries, commenced to show signs of decay. Its people had gradually lost the sturdy spirit of independence, endurance, and courage which had characterized their forefathers, and had degenerated into a race of effeminate slaves and cowards. Ostentation became the feature of their art; immorality and luxury, of their mode of living. They thus fell an easy prey to the rude but vigorous barbarians of the North. The latter, rude and uncivilized as they were, extended the contempt they had for the nation they had conquered to their works of art as well, and mutilated or destroyed them whenever they could lay hands on them.

This spirit of antagonism was strengthened upon their conversion to Christianity, and everything that savored of paganism in art or literature was severely proscribed. For the heathen forms, whose only aim and object was beauty, were substituted religious symbols, the cross and other implements of the passion, the lily, the fish, the aureole, *etc*., whose object was to recall to the faithful the mysteries of religion. Gradually, however, as the artistic feelings of the new people became awakened, principles of beauty commenced to be regarded, and, while symbolism remained an important feature of European art until the period of the Renaissance, and even then was not entirely superseded, magnificent artistic results were obtained.

1. *Byzantine Art*.—The principal of the early mediaeval art developments was the Byzantine. It flourished principally in the eastern part of Europe. In the west it was known, with a few variations, as the Lombard and the Norman. All three are often included under the term Romanesque.

Page 55

Byzantine art was essentially Christian in its spirit and motives. It used religious symbols extensively, but incorporated in its ornament a few pagan elements, such as the acanthus and the scroll. Natural forms were always conventionally treated. Its coloring was rich and gorgeous. The principal features of its architecture were the dome and round arch. The plan of the churches was often in the form of a Greek or Latin cross, with the dome placed over the intersection of the two arms. The church of St. Sophia, in Constantinople, is the most magnificent example of Byzantine architecture and ornament. Although now a Mohammedan mosque, it is, probably, in the motive and spirit that actuated its construction, the most Christian building in the world.

2. *Saracenic Art.*—Developed from the Byzantine by the Moors and the Saracens. It differs from it, however, in one important respect. While the Byzantine makes use of numerous conventionalized plant and animal forms, the Saracens and Moors were forbidden by their religion, the Mohammedan, to copy in any manner the form of any living thing, animal or vegetable. They were thus limited entirely to geometric forms, which, however, often fall insensibly into flower and leaf forms. Interlacing bands and curves of intricate pattern, and exhibiting the peculiar Moorish curve, are very characteristic of Saracenic ornament. Inscriptions were frequently interwoven in this tracery.

The coloring was gorgeous, consisting principally of blue, red, and gold.

The principal arches used were the pointed and the horseshoe arch. The Alhambra Palace in Spain is the most famous example of Saracenic ornament and architecture.

3. *Gothic Art.*—Gothic art grew out of the Byzantine, all the symbolic elements being

retained. It is divided into many different varieties.

In the earliest the round arch was used, but the later and more perfect styles having employed the pointed arch almost exclusively, the latter became characteristic of Gothic art generally. It is a style of architecture and ornament usually applied to churches, and well adapted to moist and cold climates on account of the sloping roof. Clustered columns, the spire or belfry, the arched roof, and the division of the interior into nave, transept, and choir, are leading features. Natural as well as conventional treatment of plants is another important characteristic.

[Illustration]

The Gothic style flourished principally in England, France, and parts of Germany. Nearly all the principal cathedrals and churches in these countries, and many in our own, are built after this style. The most beautiful example in this country is St. Patrick’s Cathedral, in New York. The finest specimen in the world is probably the Cathedral of Cologne, which was commenced in the 14th century, but was not completed until many years later.

III. MODERN ART.

Page 56

In the 15th century a remarkable revival occurred in literature and the fine arts, showing a decided tendency to return to the old classic ideas of the Greeks and Romans. After an almost complete neglect, which lasted for centuries, artists and men of letters turned their attention to the long neglected relics of pagan civilization as worthy of study for their intrinsic beauty alone. Symbolism was relegated to a minor position, and beauty was once more cultivated for its own sake. This epoch is termed the Renaissance—which literally means a rebirth or revival.

1. *Renaissance Style.*—The term Renaissance is also applied to one of the early styles which came into vogue at this time. It flourished principally in southern Europe. It is not a pure style, but marks a transition period from the old popular Gothic and Saracenic forms to the revivified classic. It naturally exhibits a queer mixture of conflicting elements—classic and mediaeval thrown together without much regard to propriety or fitness. It still showed traces of symbolism.

2. *The Cinquecento Style.*—The Renaissance reached its most perfect development in the Cinquecento or the 15th century style. It followed the Quatrocento or 14th century style. Entirely untrammeled by symbolism, and with the whole field of classic and mediaeval ornament to glean from, its aim was to develop a perfect style of ornament. The best examples of this period are founded on the soundest principles of ornamental art. Nothing that could be turned into an element of beauty was neglected. Animals, real and fictitious, flowers, leaves, fruit, the human form, *etc*., were conventionalized and made to contribute their part to enhance the beauty of the whole. Some of the principal characteristics of the Cinquecento style are the delicate arabesque scroll work, the profusion and beauty of the curves, its admirable variations of standard classic ornaments, such as the anthemion and scroll. The coloring,

also, was one of its most pleasing features. This style flourished principally in Italy and France. Farnese Palace and the tombs of the Medicis are noted examples.

3. *The Louis Quatorze*.—This style succeeded the Cinquecento, but was far inferior to it. It arose in Italy, and while preserving generally the materials of the style that preceded it, it added as characteristic features the scroll and the shell. Its principal object was to create brilliant and startling effects in light and shade. Color was, in consequence, decidedly secondary, gilding being used everywhere. The Palace of Versailles, near Paris, is a gorgeous example of this style. Everything in it is glittering and sparkling. Mirrors are everywhere placed to intensify this effect. This style was followed by the Louis Quinze, inferior to it in every respect, and in which symmetry, at least in detail, seems to be carefully avoided. It still further degenerated into the Rococo, the most extravagant and exaggerated of all the historic styles, and which prevailed in the latter part of the 18th and the beginning of the 19th century.

Page 57

The present century cannot boast of any great characteristic style in either architecture or ornament. Whether it is only in a course of development, and what will be the results, time only can show. All styles are now in vogue, hence the importance of accurate knowledge on the subject. To be able to judge of and appreciate the best, and to profit by the labors of those gone before us, at the same time imparting individuality and character to our own design, should be the aim and object of the study of decoration, and it should enter into any scheme of general education and culture.—*Journal of Education*.

* * * * *

THE MONTAUD ACCUMULATOR.

This accumulator is of the Plante type, and is modified so as to obtain a more rapid formation, a larger surface, and a symmetrical distance of the plates from each other. If into an alkaline bath saturated with litharge (added in excess) we plunge two lead electrodes and pass in a current of suitable tension and intensity, there is deposited upon the anode a layer of peroxide of lead varying in thickness with the intensity of the current, and more or less rich in oxygen according to the intensity of the bath, while the cathode is covered with a stratum of reduced lead. The liquid of the bath supplies material for both deposits, while in galvanoplastic operations the anode supplies it to the cathode. The principle of the formation consists in introducing in an efficacious manner currents of a great intensity, and thus abridging its duration.

Of two plates thus treated, the one becomes positive, and is covered with a thick layer of peroxide of lead. On leaving the bath it undergoes various preparations and several washings, and is then fit to be mounted along with others to form an accumulator ready to be charged and to work. The second, or negative, plate is covered with a thick sponge of lead. It is carefully washed, preserved in water with exclusion of air, and submitted to a very considerable pressure. After this operation it presents the appearance of ordinary sheet lead, but though the physical porosity has disappeared, the chemical porosity is intact, and this alone comes into play in accumulators. When a negative plate is constructed in this manner, it is ready to be combined with the positives to form an accumulator.

The inventor has sometimes put into the bath at the positive pole negative plates prepared as just described. They become very easily peroxidized, but they have the grave defect of requiring two preparations in place of one. To secure an accumulator against any leakage from plate, the solderings and the entire plates must be submerged in the liquid, so that nothing projects up out of the acidulated water except two strong rods for making contact. These rods are covered with an insulating varnish from their origin to above the point where they issue from the liquid.

Page 58

The plates are of a rectangular form (Fig. 1).
They are sloped out at one corner, and as two plates
in juxtaposition are cut together, when they are separated
the sloping out of the one serves for the handle of
the other. This handle is doubled back on the
plate which is suspended in the bath, so that the part
which has to be soldered does not undergo any preparation.
A hole pierced in this corner of the plate serves
to receive a square rod of lead, which connects the
plates together and supports one of the poles or contacts
of the accumulator. At the point of soldering
the doubled-down handle gives a double thickness,
and the margins of the plate are folded in such a manner
as to insure their solidity.

[Illustration: FIG. 1.]

The sloped out corner affords the free space necessary
for the rod of the opposite pole, and one and the
same plate may be indifferently connected either to
the + or the — at the right or the left.
The plates are made of four different sizes:
No. 1, 19 of which serve for an accumulator of 1 square
meter; No. 2, 21, 25, or 29 of which serve for accumulators
of 2, 3, and 4 square meters; No. 3, which with 21,
25, or 29 plates composes accumulators of 5, 6, and
7 square meters; and No. 4, which with 21, 23, 25,
27 or 29 plates forms accumulators of 8, 9, 10, 11,
and 12 square meters.

As the plates are entirely submerged in the liquid
their entire surface is active, and the entire surface
being absolutely flat, it is sufficient to preserve
their respective distance at any one point in order
to have it everywhere alike. The weight of the
plate depends on the intended duration of the plate
and its capacity. As for the negative plate, its
thickness is the most important factor of its capacity.
The proportion has yet to be established for daily
practice. The inventor uses in practice positive
plates of 0.002 meter in thickness. On the other

hand, the negative plates have a body of only 0.001 meter in thickness, their greater thickness being due only to the deposit of compressed lead. The rod which fixes the plate to each pole (Fig. 2) is formed of a special alloy of lead and antimony, not attacked by acid. This gives rigidity to the rod, and hinders it from binding when the accumulator is taken out of its case. The copper piece which surmounts it is fitted at its base with an iron cramp, which is fixed in the lead, and above which is a wide furrow with two grooved parts, which being immersed in the lead hinders the copper from slipping round under the action of the screw. The rod is square, and is cast in a single piece. Against one of its surfaces the ends of the connected plates press flatly up. A square form has been selected to give more surface for soldering. The soldering is autogenous (as in the lead chambers at vitriol works). The soldering, as well as the entire plates, is entirely immersed in the liquid, and to prevent any leakage an insulating varnish, perfectly proof against the acid and the current, is laid over the rod from the part soldered upward.

Page 59

[Illustration: FIG. 2.]

If it is wished to lift the accumulator from its chest for any verification, hooks passing between the plates seize hold of the rods, and thanks to the rigidity of the antimony lead, they effect the removal of the apparatus without bending the rods in the least. All the parts of the plates must be kept at exactly the same reciprocal distances, and a difference of only 0.001 meter between two points is sufficient to affect the yield considerably. For an insulating material, wood, when plunged in dilute acid, is preferred by the inventor. He makes a comb of wood, the teeth of which vary according to the thickness of the plates to be lodged between them. Fig. 3 represents a comb having 15/10 of a millimeter for the negative plates and 25/10 for the positive plates.

[Illustration: FIG. 3.]

This appliance, which is 0.01 meter in thickness and 0.02 meter in width in the back, is made very cheaply by machinery. The weight of the accumulator bears entirely upon the back of the combs, which are all placed back downward, and the number of which varies according to the size of the plates. Small combs of wood clasp the plates at their extremities, and make the entire accumulator quite compact and manageable. The entire accumulator is shut up in a wooden chest, which the outer teeth of the comb serve to insulate from the leaden chest, and to prevent any loss of electricity along the sides.

Fig. 4 shows the arrangement of the side combs. A single glance at this figure shows that it would be difficult to have more surface without having recourse to curved, undulated, or folded plates, in which the distances are variable, and consequently defective. In the Montaud accumulator, the weight is simply proportional to the intended duration. For the notion, “So much capacity and so much yield per kilo.,” Montaud substitutes the notion, "So much capacity or yield per square meter, the weight not being taken into consideration." These Montaud accumulators are classified as follows: They have from 1 to 12 square meters of surface, and the number corresponding to the surface indicates its weight of useful lead, its manner of charging, its capacity, and its manner of discharge.

[Illustration: FIG. 4.]

According to the inventor's experiments, the square meter of active surface can receive a charging current of 10 amperes, and furnish on discharging a current of the intensity of 20 amperes. For a "No. 10" accumulator we have an active surface of 10 square meters, a charging current of 100 amperes, and on discharging a current of 200 amperes. A square meter of lead of the thickness of 0.001 meter weighs about 11 kilos.

Page 60

As both surfaces of the lead are utilized, their weight is reduced to 51/2 kilos. A No. 10 therefore requires 55 kilos. of useful lead. It will be seen that to increase the thickness of the sheet of lead merely augments the duration of the accumulator, without affecting its capacity or its manner of charging and discharging. Nos. 1, 2, 3, and 4 may be placed in vessels of stoneware, glass, or ebonite, or in boxes of pitch pine, painted with three coats of gum lac and lined with sheet lead. Nos. 5 to 12 are only sent out in pitch pine boxes lined with lead. The box is supported on feet of porcelain of the shape of a mushroom. If a drop of water falls upon this foot, it cannot give a communication with the earth, since, falling upon the broad part of the mushroom, it will glide off without running along the foot, which serves as the stalk of the mushroom. A slip of glass is placed under each foot; the part which supports the mushroom is covered with an insulating varnish, which prevents the formation of climbing salts and preserves the screws from rust. A common layer of insulating varnish is applied under the head of the mushroom.

As regards the advantages of the Montaud accumulator we notice, first, its longevity. Dr. D'Arsonval points out that the accumulators of the Plante class have a great advantage over the Faure type as regards duration, and that the most striking quality of the Montaud accumulator is its longevity. The inventor has in his possession positive plates, five to six years old, completely peroxidized, though there remains in the interior a thin core of metallic lead sufficient to give passage to the current. The adhesion of the peroxide is such that to detach it, it must be beaten with a hammer upon an anvil. The next four points—i.e., the rapidity of charge; the yield, much greater than that of any other system in proportion to its surface; its small weight in comparison with its yield; and its capacity, which for an equal weight is greater than that of any other accumulator. In his experiments in September, 1885, Dr. D'Arsonval obtained with an accumulator of 2 square meters of surface:

Useful capacity	40	ampere hours.
Total	62	" "
Surface	2	square meters
Charge	10	amp. per sq. meter.
Discharge	20	" " "
Useful weight of lead	10	kilos.

Representing a total capacity of six ampere hours per kilo., and of a discharge of 5 amperes per kilo., or a total capacity of 81 ampere hours per square meter, and a useful capacity of 20 ampere hours per square meter. Subsequently the modification of the negative plate has greatly improved these figures, which will certainly become much more advantageous in future. The total capacity of an accumulator having exactly 13/4 meters of surface has become 87 ampere hours, which if referred to an accumulator of 2 square meters of surface, would give the following results:

Page 61

Useful weight of lead per
sq. meter 51/2 kilos.
Total capacity of useful lead
per kilo 9.1 amp. hr.
Total capacity per sq. meter
50 "
Useful capacity of per kilo
of useful lead 6.23 "
Useful capacity per square
meter 34.30 "
Current of charge per square
meter 10 amp.
Current of charge per kilo,
of useful lead 2 "
Current of discharge per sq.
meter 20 "
Current of discharge per kilo,
of useful lead 4.56 "

The next advantage of the Montaud accumulator is the ease with which it can be taken out of its box and repaired without special tools and experience. A capital defect in this respect has hitherto much interfered with the use of accumulators. In case of accidents, several kinds of which are possible, it is found very difficult to rectify the apparatus. The Montaud accumulator is much less liable to accidents, on account of the firmness and compactness of its construction, and if any accident happens, the repairs are simple and easy. Lastly, the stout framework secures the apparatus from any accident due to a disproportionate charge or discharge. The peculiarities of the combs and rods already described solve this problem. On September 8, 1885, Dr. D'Arsonval, professor at the College of France, wrote as follows: "The Montaud accumulator is of the Plante type, and is extremely well conceived from a mechanical point of view. The wooden combs prevent the plates from coming in mutual contact, and give the apparatus great solidity. The process of formation is ingenious and rapid. To give 1 square meter a capacity of 20 ampere hours, there is required only a quarter of an hour's treatment.

"To obtain the same result by Plante's method, months are required. The entire experiments have been effected with No. 2, which has a surface of two square meters. This apparatus, if charged to saturation, gives 62 ampere hours as its total capacity, and, as in the Plante, this capacity constantly increases with use. The normal rule for the charge is 10 amperes per square meter, and for the discharge double this quantity. This apparatus has always given me on discharging 40 amperes at the E.M.F. of 1.85 volts during 60 or 65 minutes. The charge is effected in two hours up to 20 amperes, without any appreciable loss of electricity.

"The points to be aimed at in an accumulator are longevity and energy, or, rather, rapid yield per kilo. From both points of view accumulators of the Plante type (and consequently those of Montaud) are far superior to those of the Faure type. My opinion, therefore, is that the Montaud accumulator is very practical, that it is a great improvement on the Plante type, and that it can compete successfully with the other systems in use."—*Revue Internationale de l'Electricite*.

*   *   *   *   *

Page 62

ELECTRIC REGISTERING APPARATUS FOR METEOROLOGICAL INSTRUMENTS.

Mr. E. Gime, whose name is not unknown to our readers, sends us a description of a certain number of meteorological apparatus to which he has applied a peculiar method of registering that it is of interest to make known.

[Illustration: FIG. 1.—DIAGRAM OF GIME'S TELEMAREOGRAPH.]

Mr. Gime in the first place has devised a "telemareograph," that is to say, an apparatus designed to register at a distance the curve of the motions of the tide in a given place. The structure of this device, shown diagramatically in Fig. 1, is very simple. It is divided into two distinct parts—a transmitter and a registering apparatus. The transmitter consists of a long glass tube, A, closed at one end and communicating through the other with a receptacle filled with mercury. A barometric vacuum is formed in this tube. The level of the open receptacle corresponds exactly to the level of the lowest tide.

[Illustration: FIG. 2.—THE APPARATUS WITH THREE REGISTERING STATIONS.]

Pieces of iron wire projecting sufficiently in the interior to establish good contacts with the column of mercury are fastened one millimeter apart to the inner surface of the tube. These iron contacts are connected with the divisions of a rheostat, R, arranged in a tight compartment surrounded with paraffine, near the tube.

This rheostat is interposed in the general circuit. It is connected through one extremity with the line, and through the other with a disk of copper, which has a surface of one square meter, and is immersed in the sea.

The line, L, insulated like an ordinary telegraph wire, is prolonged as far as to the registering station.

The registering apparatus consists of a solenoid, S, that acts upon a soft iron core suspended by a cord from the extremity, *x*, of the beam of a balance. This cord passes between the channels of two rollers designed, despite the motion of the beam, to keep the core in a vertical position in the center of the solenoid.

The opposite arm of the balance carries a sliding weight, *i*, that moves over a graduated scale and is designed to balance the core, N, in a certain position in regulating the motions of the curve. At its extremity it carries a style that bears against the drum, T, on which the paper is wound that is to receive the mareometric curve.

The solenoid, S, is interposed in the general circuit, being connected on the one hand with the line, L, and on the other with a very constant battery of an electromotive force proportioned to the resistance of the circuit.

Through the electrode that remains free, the battery is grounded with so great care that no variation in resistance can be produced thereby. If the station is near the sea, the conductor of this electrode may be run to a copper disk, having the same surface as the one at the transmitting station. With this description, the operation of the apparatus may be easily understood.

Page 63

At low water, the pressure of the atmosphere balances a column of mercury rising in a glass tube to a height proportionate to such pressure. In measure as the level of the water rises, the pressure on the mercury in the receptacle increases, and causes the metal to rise in the tube. The higher the level of the sea, the less becomes the sum of the resistances of the rheostat, since the column of mercury puts in short circuit all the divisions of the rheostat, whose contacts are comprised in the height of the column.

From these variations in the resistance of the circuit naturally result variations in the current from the battery, B, at the registering station. To the variations in intensity of the current in the circuit there correspond variations in the attraction of the solenoid for the core that transmits these motions to the balance that carries the registering style, which latter amplifies or reduces them.

The same transmitter suffices for various registering stations arranged in series, as shown in Fig. 2.

The variations in the resistance of the circuit, due to variations in the temperature, and the variations in the height of the column of mercury, due to atmospheric variations, *etc*., are, according to the inventor, of no importance.

It would evidently be possible, on the same principle, to construct an apparatus for registering the indications of a thermometer at a distance.

Such is the principle of Mr. Gime's apparatus. We do not believe that they are entirely closed to criticism. What, in fact, are the conditions essential for their proper working? Evidently: (1) the constancy of the battery used; (2) a rigorously accurate adjustment. This latter condition, is easily realized; but the same is not the case with the former. Of what elements shall this constant battery be formed?

Mr. Gime recommends the use of the Latimer-Clark elements. Every one knows that the Latimer-Clark element is now the best standard of electromotive force; but let us not forget that this is on condition of its being employed in open circuit. Now, it is not a question here of an open circuit, nor even of infinitely weak currents, since in the line we have a solenoid whose core must set in motion a whole system of connected pieces. We do not see any possibility of employing Latimer-Clark elements; on the contrary, it seems to us indispensable to select piles of large discharge, since the solenoid, S, will attract nothing at all unless a notable quantity of energy is expended in it.

Is there a pile of this kind so constant as not to render a rigorously accurate adjustment illusory? Therein lies the entire question, and for our part we hesitate to pronounce ourselves in the negative.—*La Lumiere Electrique.*

* * * * *

A CLINICAL LESSON AT “LA SALPETRIERE.”

Page 64

[Illustration: THE SALON OF 1887.—A LECTURE IN THE DISPENSARY AT LA SALPETRIERE.—Painted by M. Andre Brouillet.—M. Dochy. Engraver.]

[Illustration: A CLINICAL LECTURE AT "LA SALPETRIERE."]

We reproduce the picture of Mr. Andre Brouillet, which was in the Salon of 1887; and that the subject may be better understood, we give the accompanying sketch and description. This picture is very interesting, not only from an artistic point of view, but also as a representation of students and spectators of all ages admirably grouped around a great master of science when most interested in his work. We borrow from *Matin-Salon* Mr. Goetschy's explanation of the picture:

"The hall in which the lesson is given is lighted by two large windows opening on one of the courts of the hospital. The Professor stands at the right of the picture, his head uncovered, one hand close to his body and the other extended slightly in a gesture which is familiar to him, his audience being before him. At his side is Mr. Babinski, chief of the clinic, supporting a person afflicted with hysteria. Near the latter stands a nurse and assistant who watches every movement of the patient. This is Mother Bottard, a good, intelligent, and devoted woman, who is well known to all those present.

"The auditors have arranged themselves at the students' tables, some seated on the chairs and stools which furnish the room, and others standing, but all following closely the teaching of the master, and at the same time watching the *subject*. The picture is full of life and motion, and yet is very exact. The head and shoulders of the subject are beautifully and correctly drawn. The artist has brought together many men who are well known in literature and science."—*Le Monde Illustre*.

* * * * *

[NATURE.]

TO FIND THE DAY OF THE WEEK FOR ANY GIVEN DATE.

Having hit upon the following method of mentally computing the day of the week for any given date, I send it you in the hope that it may interest some of your readers. I am not a rapid computer myself, and as I find my average time for doing any such question is about 20 seconds, I have little doubt that a rapid computer would not need 15.

Take the given date in 4 portions, *viz*., the number of centuries, the number of years over, the month, the day of the month.

Compute the following 4 items, adding each, when found, to the total of the previous items. When an item or total exceeds 7, divide by 7, and keep the remainder only.

The Century Item.—For old style (which ended September 2, 1752) subtract from 18. For new style (which began September 14) divide by 4, take overplus from 3, multiply remainder by 2.

The Year Item.—Add together the number of dozens, the overplus, and the number of 4's in the overplus.

Page 65

The Month Item.—If it begins or ends with a vowel, subtract the number denoting its place in the year from 10. This, plus its number of days, gives the item for the following month. The item for January is “0;” for February or March (the 3d month), “3;” for December (the 12th month), “12.”

The Day Item is the day of the month.

The total thus reached must be corrected by deducting “1” (first adding 7, if the total be “0"), if the date be January or February in a leap year; remembering that every year divisible by 4 is a leap year, excepting only the century years, in new style, when the number of centuries is *not* so divisible (e.g., 1800).

The final result gives the day of the week, “0” meaning Sunday, “1” Monday, and so on.

EXAMPLES.

1783, *September* 18.

17 divided by 4 leaves “1” over; 1 from 3 gives “2;” twice 2 is “4.”

83 is 6 dozen and 11, giving 17; plus 2 gives 19, *i.e*. (dividing by 7), “5.” Total 9, *i.e*., “2.”

The item for August is “8 from 10,” *i.e*., “2;” so, for September, it is “2 plus 3,” *i.e*., “5.” Total 7, *i.e*., “0,” which goes out.

18 gives “4.” Answer, “*Thursday*.”

1676, *February* 23.

16 from 18 gives “2.”

76 is 6 dozen and 4, giving 10; plus 1 gives 11, *i.e.*, “4.” Total “6.”

The item for February is “3.” Total 9, *i.e.*, “2.”

23 gives “2.” Total “4.”

Correction for leap year gives “3.” Answer, “*Wednesday*.”

LEWIS CARROLL.

* * * * *

PRECIOUS STONES OF THE UNITED STATES.

To the recently distributed government report on the mineral resources of the United States for 1885.[1] Mr. G.F. Kunz contributes an interesting chapter in which is recorded the progress made during that year in the discovery and utilization of precious stones.

[Footnote 1: Mineral Resources of the United States: Calendar Year 1885. Washington: Government Printing Office. 1888.]

In the summer of 1885, a remarkably large pocket containing fine crystals of muscovite, with brilliant crystals of rutile implanted on them, was found at the Emerald and Hiddenite Mining Company’s works, at Stony Point, N.C., and was sold in the form of cabinet specimens for $750. While the soil overlying the rock was being worked, nine crystals of emerald were found, all of which were doubly terminated, and measured from 1 inch to 3-1/8 inches in length and 1-2/3 inch in width. One of these crystals is very perfect as a specimen, being of a fine light green color, and weighing 83/4 ounces. It is held by the company at $1,500, and the nine crystals together at $3,000. Another of these crystals, doubly terminated, measures 21/2 inches by 11/12 of an inch, and is filled with large rhombohedral cavities, which formerly contained dolomite. The only crystal from this collection that has been cut into a gem was found in a pocket at a depth of over 43 feet. In color it is of a pleasing light green, and it weighs 4-22/32 carats. No crystal of a finer color has as yet been found in the United States, and the gem is held by the company at $200.

Page 66

During the recent mining, the largest fine crystal of lithia emerald ever found was also brought to light. It measures 23/4 inches by 3/5 of an inch by 1/3 of an inch. One end is of a very fine color, and would afford the largest gem of this mineral yet found, and one which would probably weigh 51/2 carats. With this there was a number of superior crystals and some ounces of common pieces of the same mineral. The company estimates the value of this entire yield of hiddenite at about $2,500.

There was also found a quantity of quartz filled with white byssolite, forming very attractive specimens and valued at $250.

A number of beryls of a fine blue color, resembling the Mourne Mountain specimens, were found near Mount Antero, Chaffee County, Col. One of these was 4 inches long and 3/8 of an inch across, with cutting material in it. The other crystals measured from 1 to 11/4 inch in length, and from 1/5 to 1/3 inch in width.

The large beryl mentioned by Mr. Kunz in the Mineral Resources for 1883 and 1884 has afforded the finest aquamarine of American origin known. It is brilliant as a cut gem, and, with the exception of a few internal hair-like striae, is absolutely perfect. It weighs 1333/4 carats, measures 1-2/5 x 1-2/5 x 4/5 inch, and is of a deep bluish green, equal to that of gems from any known locality.

Mr. G.F. Breed, manager of the Valencia Mica Company, has cut nearly one hundred aquamarines, ranging from 1/2 carat to 4 carats in weight, and of a light blue color, from white beryls found in the company’s mica mine at North Grafton, N.H.

A number of fine, deep golden-yellow, blue, and green beryls, equaling any ever found, have been taken by Mr. M.W. Barse from his mica mine between New

Milford and Litchfield, Conn. Some fine blood-red garnets from this same locality have been cut into gems.

The largest phenacite crystal ever found is owned by Mr. Whitman Cross. It was discovered at Crystal Park, Col., weighs 59 pennyweights 6 grains, and measures 1-4/5 inch in length and 1-1/5 inch in thickness.

Thousands of garnet crystals, found at Ruby Mountain, near Salides, Col., have been made into paperweights and sold to tourists. Those that weigh a few ounces sell for about ten cents each. One was sold that weighed 14 pounds. Apropos of garnets, the discovery, in the heart of New York city, of as fine a crystal as was ever found on this continent, and weighing 9 pounds 10 ounces, may be mentioned as a matter of peculiar interest.

Several thousand dollars' worth of the wood jasper of Arizona has been cut into paper weights, charms, and other objects, or polished on one side for cabinet specimens. Numbers of these articles are now being cut and sold to tourists along the line of the Atchison, Topeka, and Santa Fe Railroad.

The compact quartzite of Sioux Falls, Dakota, is being quarried and polished for ornamental purposes. It is known and sold as "Sioux Falls jasper," and is really the stone referred to by Longfellow in his Hiawatha as being used for arrow heads. This stone takes a very high polish, and is found in a variety of pleasing tints, such as chocolate, brownish-red, brick-red, and yellowish. For the two years previous to 1885, $15,000 worth of it was sold.

Page 67

A remarkable mass of rock crystal has been received by Messrs. Tiffany & Co. from a locality near Cave City, Va. Although this mass weighs 51 pounds, it is but a fragment of the original crystal, which weighed 300 pounds, and which was broken in pieces by the ignorant mountain girl who found it. The fragment, as it is, will furnish slabs 8 inches square and from 1/3 to 1 inch thick. The original crystal would have furnished a ball from 41/2 to 5 inches in diameter, and almost perfect. A number of fine agates of various kinds were found by Mr. F.C. Yeomans at the same locality.

The meccanite from Cumberland, R.I., is often spotted with white quartz. It has been cut into oval stones several inches in length, which take a fine polish. This quality, coupled with its hardness, makes it a desirable ornamental gem stone.

Mr. Kunz records the discovery, by himself, in the largest mass of the Glorieta Mountain (Santa Fe County, N.M.), of pieces of peridot of sufficient transparency to afford gems one-fifth of an inch in length.

Large quantities of turquoise from Los Cevillos, N.M., have been sold, both as cabinet specimens and gems; but, unfortunately, many of those of the finest color have been found to be artificially colored.

Malachite in large masses has been found at the Copper Queen mine at Bisbee, Oregon. One of these masses weighed 15 pounds and others were quite as large. All were of good enough quality and large enough for table tops.

In conclusion, Mr. Kunz says that “the National Museum collection of gems, formed by Prof. F.W. Clarke, is now one of the most complete, for species, in the United States, and as many of the gems are of more than average merit, and all can have access to them, this is one of the best opportunities afforded the student in this country."

*   *   *   *
  *

THE BRAZIL NUT.

[Illustration: THE BRAZIL NUT.]

Every one is acquainted with the hard-shelled, triangular fruit called the Brazil nut, but there are, perhaps, but few who know anything about the tree that produces it, or its mode of growth. The Brazil nut tree belongs to a genus of Lecythidaceae of which there is only one species, *Bertholletia excelsa*. This tree is a native of Guiana, Venezuela, and Brazil. It forms large forests on the banks of the Amazons and Rio Negro, and likewise about Esmeraldas, on the Orinoco, where the natives call it *juvia*. The natives of Brazil call the fruit *capucaya*, while to the Portuguese it is known as *castana de maranon*.

The tree is one of the most majestic in the South American forests, attaining a height of 100 or 150 feet. Its trunk is straight and cylindrical, and measures about 3 or 4 feet in diameter. The bark is grayish and very even. At a distance, the tree somewhat resembles a chestnut. Its branches are alternate, open, very long, and droop toward the earth. The leaves are alternate, oblong, short petioled, nearly coriaceous, about 2 feet long by 6 inches wide, entire or undivided, and of a bright green color. The flowers have a two-parted, deciduous calyx, six unequal cream-colored petals, and numerous stamens united into a broad, hood-shaped mass, those at the base being fertile, and the upper ones sterile.

Page 68

The fruit is nearly orbicular, and about 6 inches in diameter, and has a hard shell about half an inch thick, which contains from 18 to 24 triangular, wrinkled seeds that are so beautifully packed within the shell that when once disturbed it is impossible to replace them. When these fruits are ripe, they fall from the tree and are collected into heaps by troops of Indians called *Castanhieros*, who visit the forests at the proper season of the year expressly for this purpose. They are then split open with an ax, and the seeds (the Brazil nuts of commerce) taken out and packed in baskets for transportation to Para in the native canoes. The "meat" that the Brazil nut contains consists of a white substance of the same nature as that of the common almond, and which is good to eat when fresh, but which, by reason of its very oily nature, soon gets rancid. Besides its use as an article of dessert, a bland oil, used by watchmakers and artists, is obtained from the nut by pressure. Brazil nuts form a considerable article of export from the port of Para, whence they are sometimes called Para nuts.

The Brazil nut tree remained for a long time unknown to European botanists, although the fruit has been from a very remote epoch consumed in large quantities in certain southern countries of the New World. The first description of the tree we owe to Humboldt and Bonpland, who established the genus and species in the botanical part of the account of their voyage. The genus is dedicated to the illustrious Berthollet.

"We were very fortunate," say these authors, "to find some of these nuts in our travels on the Orinoco. For three months we had been living on nothing but poor chocolate and rice cooked in water, always without butter, and often without salt, when we procured a large quantity of the fresh fruits of the *Bertholletia*. It was along in June, and the natives had just gathered them."

The formation of a large woody fruit, often in the shape of an urn, from which the top spontaneously separates in the form of a lid, is one of the characteristics of the order Lecythidaceae, which includes the *Couronpita Guianensis*, or “cannon ball tree”; the gigantic *Lecythis ollaria*, or “monkey-pot tree,” whose great woody pericarps serve as drinking vessels; and the *Lecythis Zabucajo*, whose fruit is known in the market as sapucaia nuts, and is greatly superior to the closely allied Brazil nuts as regards flavor and ease of digestion.

All the trees of this order are natives of South America, and especially of Guiana.

* * * * *

THE ACTION OF THE MAGNET IN HYPNOSIS.

Mr. Tamburini some time ago observed that, during a period of lethargy, the approach of a magnet produced in persons affected with hysterical hypnosis a series of modifications of the respiratory functions and of contractility.

Page 69

From some very careful experiments made by him and Mr. Righi in common, upon the lady who was the principal subject of his observations, it results that (1) it makes no difference whether the magnet be presented by its poles or its neutral line; (2) that any mass of metal whatever acts like a magnet; (3) that an electromagnet produces exactly the same effect whether it be or be not excited by a current; and (4) that a glass tube filled with cold or warm water likewise produces analogous effects, which disappear when the water is raised to the temperature of the human body.

It seems, therefore, that the magnetic properties of the magnet count for nothing in the phenomena observed.—*Journal de Physique*.

* * * * *

THE SCIENTIFIC AMERICAN SUPPLEMENT.

PUBLISHED WEEKLY.

Terms of Subscription, $5 a Year.

Sent by mail, postage prepaid, to subscribers in any part of the United States or Canada. Six dollars a year, sent, prepaid, to any foreign country.

All the back numbers of THE SUPPLEMENT, from the commencement, January 1, 1876, can be had. Price, 10 cents each.

All the back volumes of THE SUPPLEMENT can likewise be supplied. Two volumes are issued yearly. Price of each volume, $2.50, stitched in paper, or $3.50, bound in stiff covers.

* * * * *

PATENTS.

* * * *

*

THE SCIENTIFIC AMERICAN

ARCHITECTS AND BUILDERS EDITION.

$2.50 a Year. Single Copies, 25 Cents.

Page 70

This is a Special Edition of THE SCIENTIFIC AMERICAN, issued monthly—on the first day of the month. Each number contains about forty large quarto pages, equal to about two hundred ordinary book pages, forming, practically, a large and splendid Magazine of Architecture, richly adorned with *elegant plates in colors* and with fine engravings; illustrating the most interesting examples of modern Architectural Construction and allied subjects.

A special feature is the presentation in each number of a variety of the latest and best plans for private residences, city and country, including those of very moderate cost as well as the more expensive. Drawings in perspective and in color are given, together with full Plans, Specifications, Costs, Bills of Estimate, and Sheets of Details.

No other building paper contains so many plans, details, and specifications regularly presented as the SCIENTIFIC AMERICAN. Hundreds of dwellings have already been erected on the various plans we have issued during the past year, and many others are in process of construction.

Architects, Builders, and Owners will find this work valuable in furnishing fresh and useful suggestions. All who contemplate building or improving homes, or erecting structures of any kind, have before them in this work an almost *endless series of the latest and best examples* from which to make selections, thus saving time and money.

Many other subjects, including Sewerage, Piping, Lighting, Warming, Ventilating, Decorating, Laying out of Grounds, *etc*. are illustrated. An extensive Compendium of Manufacturers' Announcements is also given, in which the most reliable and approved Building Materials, Goods, Machines, Tools, and Appliances are described, and illustrated, with addresses of the makers, *etc*.

The fullness, richness, cheapness, and convenience

of this work have won for it the Largest Circulation
of any Architectural publication in the world.

MUNN & CO., Publishers, 361 Broadway, New York.

A Catalogue of valuable books on Architecture, Building,
Carpentry, Masonry, Heating, Warming, Lighting, Ventilation,
and all branches of industry pertaining to the art
of Building, is supplied free of charge, sent to any
address.

*   *   *   *
    *

BUILDING PLANS and SPECIFICATIONS.

In connection with the publication of the BUILDING
EDITION of the SCIENTIFIC AMERICAN, Messrs. Munn &
Co. furnish plans and specifications for buildings
of every kind, including Churches, Schools, Stores,
Dwellings, Carriage Houses, Barns, *etc*.

In this work they are assisted by able and experienced
architects. Full plans, details, and specifications
for the various buildings illustrated in this paper
can be supplied.

Those who contemplate building, or who wish to alter,
improve, extend, or add to existing buildings, whether
wings, porches, bay windows, or attic rooms, are invited
to communicate with the undersigned. Our work
exends to all parts of the country. Estimates,
plans, and drawings promptly prepared. Terms
moderate. Address

Page 71

MUNN & CO., 361 Broadway, New York.