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

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**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*.]

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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.

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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.

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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.

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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,

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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

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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

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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.

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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*.]

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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*.

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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

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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.

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[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

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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*.

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*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, | 26 ft | 24 ft | | 15 ft | 12 ft | 13 ft
forward. | 2 in | 6 in | .... | 6 in | 10 in | 1 in
| | | | | |
Draught on trial, | 27 ft | 25 ft | | 19 ft | 15 ft | 14 ft
aft. | 3 in | 6 in | .... | 9 in | 2 in | 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 | 19 ft | 22 ft | 18 ft | 17 ft | 12 ft | 14 ft
screw. | 5 in | | 9 in | 6 in | 71/2in | 9 in
| | | | | |
Slip. per cent | 17.6 | 10 | ... | 14.2 | 9.7 | 11.4
| | | | | |
Diameter of | 15 ft | 18 ft | 14 ft | 13 ft | 10 ft | 11 ft
screw. | 6 in | | 6 in | | 6 in |
| | | | | |
Diameter of | 4 ft | 4 ft | 3 ft | 3 ft | 2 ft | 2 ft
boss. | 4 in | 11 in | 9 in | 5 in | 9 in | 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 | | | | | |
---------- | 1.25 | 1.22 | 1.3 | 1.34 | 1.2 | 1.34
Diameter | | | | | |
Disk | | | | | |
-------- | 2.62 | 2.92 | 2.75 | 2.82 | 3.6 | 3.96
Blade area | | | | | |
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.

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[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,

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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.

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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.

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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.

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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*.

\* \* \* \*
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**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.

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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

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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.]

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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.

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*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.]

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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.

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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.

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[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.

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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.

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*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.

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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.

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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.]

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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.

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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.

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[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.

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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.

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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.

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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.

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**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.]

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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.

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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*.

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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*.

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**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

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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

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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

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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.

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**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

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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.

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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.*
\* \* \* \*
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**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.

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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.

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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

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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.

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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.

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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.

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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.**

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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.

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*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.

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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,

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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.

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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.**

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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.

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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*.

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**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.

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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.

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[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.

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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:

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 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.*
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**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.

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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.*
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**A CLINICAL LESSON AT “LA SALPETRIERE.”**

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[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*.

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[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.

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*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.

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**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.

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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.

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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.”

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**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.

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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.

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**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.

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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*.

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