THE MACHINERY OF THE VIENNA EXPOSITION.

BY HAMILTON A. HILL.

Group XIII.

For Group XIII. the Austrians provided an entirely separate building, which ran from its westerly entrance towards the east and parallel with the main Exposition building, for a distance of 2,625 feet. It was itself a very large structure, one hundred and sixty feet wide and covering an area of nearly ten acres. Even this space proved by far too small, and all that could by any reasonable construction be placed among agricultural or other special groups for which separate buildings were erected, was excluded from the general hall. The portion of the agricultural buildings devoted to machinery covered about three acres more. Many leading manufacturing establishments also preferred to erect their own structures and to make private exhibitions therein. These probably covered two acres more. So that the whole machinery exhibits, including boiler-houses, pumping-works and heavy machines not under shelter, covered an area of not less than sixteen acres.

The main hall consisted of a central roof, resting on a double line of arches, above which were the windows which lighted the interior. Upon each side of this central portion were wide aisles outside the arches, covered with lean-to roofs, which rested against the walls above the arches, but below the windows. Along the centre of this hall was set up a high iron frame-work which carried the shafting by which power was furnished to the numerous machines in motion from the various engines on exhibition. With the exception of a small line of cold-rolled shafting put up to drive the shoe machinery exhibited in the American department, there was no power carried into the side aisles. They were devoted to steam-pumps, hammers and machinery not in motion. As the dif-

ferent nations were arranged geographically, as in the Industry Palace, comparisons were easily made.*

The relative space occupied by each of the different nations is given in the note to page 76 of these reports.

In regard to the character of the various exhibitions, it may be said in general terms that the American display was more interesting, and attracted more notice than any other. While to Americans the prominent feeling was one of regret that a far greater number of our labor-saving inventions and machines were not there, foreigners were much amazed that among so small a number of exhibits there was so much that was original. The power of our American inventors of seeing the precise object to be attained, and of producing a machine which will attain that object in the most direct and simple manner, regardless of the way in which the same or similar things have been done before, was a matter of general comment.†

* The Exhibition building in London, in 1851, covered 800,000 square feet; in 1862, 971,288 feet. At Paris, in 1867, 1,581,725. The Exposition at Vienna, including the main building, the machinery hall, the east and west agricultural hall and the art-buildings, covered about 2,000,000 feet, or nearly 50 acres.

† The following extract from a report of Prof. Renleaux, Director of the Industrial Academy of Berlin, illustrates this point:—

"In the department of inventions there were displayed but a small number of very extraordinary novelties. In this department America held the first place. Her display of machinery was almost wholly original in its character. * * * * * Upon the whole it may be affirmed that England has in part lost her late and undeniable superiority, or that she is soon to lose it. The young and vigorous activity across the ocean * * * * * makes, with her original talent, the greatest progress. So that ere long we must look to the west rather than to England. * * * * * The American aims direct at the desired end, using those means which seem to him the most simple, whether new or well known. * * * * * The American constructs, in fact, in accordance with the strictest rules of abstract thought, looking on one side only to the end which he has marked out for himself., weighing on the other side the methods already in use, or producing new methods without feeling the influence of what has been done, and finally strikes direct for that object. * * * * * A proper consideration of this course of action suggests the most instructive hints for our institutions of technical science."

The terms of the award of the Diploma of Honor, given to Sellers of Philadelphia, is to the same effect. It was given,—

"For preëminent achievements in the invention and construction of machine tools, many of which have been adopted as patterns by the constructors of tools in all countries."

To the same effect is the declaration of Mr. Charles Hibbs, one of the artisan commission of Great Britain to the Vienna Exposition:

"There is in the American work such an evident adaptation of means to ends, such a direct aim at the *use* to be made of the weapon and its various parts, such a palpable thrusting aside of all considerations but those of serviceableness and durability, that the merest glance below the surface impresses one strongly with the thoroughly practical character of the transatlantic mind."

Of the quality of our work, as well as of its ingenuity, we had every reason to be proud. It is an undoubted fact that to-day the average character of our machines excels in this respect that of every other nation.*

The English exhibition of machinery was much smaller and more meagre than was to have been expected. It is possible the distance discouraged their manufacturers, but a more prominent reason would seem to be the degree to which the Germans are beginning to copy from them everything good brought to their notice. There is also observable, I think, less energy in pushing themselves and their productions than in former times. In this they present a great contrast to the Germans, who, especially since their late wars, seem to be awakening in every direction. As the German marine is said to be taking the place of the English in many waters, so in the matter of manufactures they are very ambitious of replacing the English, at least on the continent; and it seems to be the general testimony of the English observers that they will have to bestir themselves if they would prevent this.

Although this industrial activity has manifested itself, especially under the stimulus of the great events of the Austrian and Prussian wars, it is in reality principally a result of the system of thorough, universal and enforced education which has been established in the different countries of Germany for the better part of a generation, and which is now beginning to show itself in a class of workingmen far more sober, industrious, intelligent and educated than the average English workman. It is true they have not yet acquired all those details of manual dexterity which are the inheritance of some classes of Englishmen, but they are fast learning all that can be acquired by instruction from English foremen now employed in many of the continental establishments.

While, however, the continental factories are producing machinery in considerable quantities, and at very moderate cost, they are almost absolutely dead, so far as any originality or invention is concerned. To an American, the lack of ideas

* "I was surprised to find so small a space allotted to a nation (America) which, if not producing the best machines in the world, certainly stands second to none, and it must be admitted, turns out machinery of faultless workmanship of modern design, and tools of the newest and best description,—a fact which is proved by the number of continental manufacturers making tools exactly the same as their (American) patterns."—*Artisan Reports on Vienna Exposition, p.* 177. Manchester.

of their own is curiously manifest; nearly all of their forms, styles, and even details of construction, are borrowed from the English or the Americans. In fact, they seem rather to pride themselves on skilful copying, and in the Exposition they displayed, with an air of satisfaction, machines constructed exactly from American tools, which they must have taken to pieces for the purpose. Such was the case with a prominent Prussian house, which presented exact duplicates of the manufactures of some of our New England tool-makers. It is satisfactory to learn that the Prussian government, in placing their orders lately for some tools, passed by this establishment and gave the work to the American house, whose ideas it had stolen, to the extent of more than a million dollars. Were it not that we stand in much the same position in regard to copyright matters, as the Germans in inventions, we might with reason complain of the morals of these gentlemen. As it is, they meet any objections of American inventors with this comparison.* In searching for the cause of this great difference in inventive power between the Germans and other continental nations on the one hand, and the English, and still more the Americans on the other, the prominent influence appears to rest in the stimulus of our patent system. Of the influence of this constant possibility of wealth, through invention, we can form no conception till we see the work of countries whose industrial class is without it. It is stated, and with great probability, that two-thirds of our whole manufacturing capital in the United States is occupied in the production of objects covered by patents. The inventive power of our people, and the influence of our patent laws, as shown in our exhibits at Vienna, made a great impression on the continental mind. Had our authorities caused us to be adequately represented, and had we shown a fair amount of our peculiar labor-saving inventions, the impression would have been profound. As it is, through the means of the Patent Congress, an excellent opportunity was found for illustrating the matter, and the writer fully believes that they are awakening to the importance of the influence of an adequate recompense to invention as a stimulus to industry.

* In the Patent Congress, held at Vienna, this was the constant comparison most disagreeably advanced in reply to the arguments of those who were in favor of a patent system in Europe.

Among other points which were had in consideration, and on which an endeavor was made to obtain some information, was that of wages of mechanics in Europe, and in connection with this topic the prices at which their manufactures are sold. This last topic will have the more importance for us if, as is to be hoped, we shall before long, through the influence of the Centennial or otherwise, begin to regain the exporting business which we had before the war of the rebellion.

The following are the rates of wages ascertained in Austria and in other parts of Europe. In Austria the wages were reported to be as follows, the amounts reduced to American currency, at a premium of ten per cent:—

Engineers and mechanics per day,	$1 35
Cabinet-makers and joiners,	1 05
Plumbers,	48
Laborers,	40
Farm laborers per year, board, lodging etc., included,	27 00

Hours of labor per week, sixty to sixty-five. In the year, including Sundays, seventy-six holidays.

Cost of living in the large towns per year: Board, $200; Lodgings, $53; Clothing, $32.

In Vienna the wages in a large locomotive-works were given: Ordinary mechanics, $1.32; Best mechanics, $1.80.

The following were the rates of wages in different European countries, as gathered from workmen at the various stands. It is reduced, as above, to present values in American currency:—

England, skilled men in engine and machine-shops (nine hours),	$1 68
France, skilled men (ten hours),	1 05
Belgium (ten hours),	94
Switzerland (ten hours),	1 25
Italy,	1 14
Sweden and Norway (eleven hours),	1 19
Germany,	1 30
Bohemia (eleven hours),	1 00
Hungary (eleven hours),	1 56

NOTE.—See Artisan Reports (British) to Vienna Expositions. Manchester: 1873. Pages 44–199.

Group thirteen, was divided in the Exhibition catalogues into the following sub-divisions :—

1. Prime movers of all kinds.
2. Machines for transmitting power.
3. Machinery for working various kinds of material, iron and wood-working machinery, and machines and tools for every variety of special work, as spinning, weaving, etc., paper, sugar, ice, etc., etc.
4. Other machinery not included in the above, as blast engine-pumps, fire-engines, etc.
5. Materials and parts of machinery.
6. Railway machinery and apparatus, including locomotives.
7. Mountings, fittings, supplies, etc.
8. Vehicles not connected with rail.
9. Statistics of production, etc.

The writer will not attempt to describe the great mass of exhibits displayed at the Exposition, and included under these various heads. Attention will only be drawn to some of the leading points suggested by their study, and to a few machines which by their novelty or importance would be particularly deserving our notice. The great collection of special machinery in the third department could only be properly presented by specialists in each industry, and the writer, except in the cases of the general iron and wood-working tools, will not undertake to speak of them. Some are noticed by other writers in their special reports; others belong to industries on which adequate reports could not be obtained.

Beginning with the topic of prime movers, we speak first of boilers. Thirty-five of these were exhibited at Vienna. Those in use, which, contrary to the plan in Paris, were furnished by the various nations, each for their own motive-power, were placed in detached buildings on the north side of the machinery-hall, and the steam was carried under ground to the various engines which used it. To prevent accidents from explosion, the various boilers were all placed in pits, properly walled up and roofed over with neat buildings, whose gable-ends towards the machinery-hall were open. A breast-high

balustrade ran across the front, over which the working of the boilers could be easily studied.

The boilers themselves embraced all the prominent types, cylinder, flue, tubular, and those known as tubulous, or containing the water within small tubes. The cylinder boilers were mostly variations of what is known as the French, or elephant, which consists of one cylinder of large diameter, connected by large tubes, or pipes, with two more smaller ones above it.* The flue-boilers were best represented by the Galloway and Adamson exhibits. The former are well known by the cross-tubes, of a long tunnel shape, which extend across the flues. The latter are similar, except that the cross-tubes are not all perpendicular.

The tubular boilers were represented by one of the ordinary American type, in our department, contributed by Pitkin & Co., of Hartford, Ct., by some of a nearly similar character in use by the Germans, and by those exhibited by Cater & Walker, of England. The latter received the products of combustion after they had passed under the boiler into a smoke-box in the body of the cylinder near the rear end, whence they passed by a number of longitudinal tubes to another smoke-box near the front, and were finally delivered into the smoke-stack, at the rear, by another series of tubes.

Among the tubulous boilers were those of Howard & McNichol among the English, and Belleville among the French. The McNichol is used particularly in connection with paper-pulp machinery, and was designed for the purpose of carrying the very high pressures desirable.

One striking variation from our practice was in the large diameters of the boilers used, especially by the English. The boilers spoken of above (Galloway's, Adamson's and Cater's) were five feet in diameter.

Another point, especially marked among the Germans, was the manner in which they added to their main boilers supplementary boilers, or heaters, into which the water first passed. In some cases small boilers; in others, coils or

* A number of these boilers are in use in one of our large mills in Massachusetts. Of them the Agent said that, in a test, they showed the poorest results of any boilers tried, but in practice had proved about the most economical and the least trouble some.

special tubular boilers, containing nearly as much heating surface as the main boiler, were placed in the flues. By thus causing the colder water to meet first the coolest gases, they undoubtedly use their heating surface to the best advantage. The writer was unable to learn whether they had had enough experience in this practice to have encountered the difficulty which has made trouble with us; to wit, the rapid rusting of the heaters containing the cooler water.

As no experiments nor tests were made, little knowledge could be gained of the comparative merits of different systems of boilers. It is suggested here, that should the Philadelphia Exposition include exhibits of working-boilers, as did the Vienna, that it would be advisable that the United States government should detail a number of officers to make thorough experiments therewith.

A large number of engines were to be seen in the Exposition grounds, probably over a hundred and twenty, including marine, winding and blowing engines, portable engines in the Agricultural Hall, and stationary ones, of various types, in the Machinery Building. Some of these were very large. A pair of rolling-mill engines, exhibited by the Prag machinenbau actien gesellshaft, had cylinders 43 by 81 inches, and were calculated for a piston-speed of 850 feet per minute.

An upright compound blowing engine, by the Societé Cockerill, of Liege, had a blowing-cylinder 118 inches in diameter by 7 feet $4\frac{3}{8}$ inch stroke; the steam-cylinders being 28.74 and 41.73 inches diameter. This is the one hundred and third engine of its type built by the Company.

A number of steamboat engines were shown, of different sizes, adapted to the coast, river and lake traffic of Europe. With one exception, we believe, these were compound; that is, after using the steam at high pressure in one cylinder, it is exhausted into another larger cylinder at much lower pressure. These engines were, many of them, for side-wheel boats; and those for this purpose were all, or nearly all, oscillating; the cylinders being situated perpendicularly, or at an angle under the wheel-shaft. Of the dozen or more portable engines, the majority were exhibited by the English, who have a large and flourishing exporting trade

extending to all parts of the world. Austria, Hungary and Russia afford to them a market something like that which we find in the same region for our mowers and reapers.

These portables were very thoroughly built, with large boilers and very large fire-boxes. The engines were almost universally steam-jacketed. Of the eighty or ninety engines in the Machinery Hall by far the majority were slide-valve, with a cut-off on the back of the main valve. Of these, the better class were arranged to alter the cut-off valve by hand. A few were governed by the automatic variations of the cut-off valve, either through a link or through a movement of the eccentric. In three cases of the latter type of engines the governor was placed on the main shaft, in one way or another, the shaft being also the governor shaft, and the momentum of the balls being resisted, of course, by springs.

Quite a considerable proportion of these engines were built with the Corliss style of frames, which seem to be much in favor in Europe; and some eight were fitted with the Corliss valve and cut-off, with such variations as the experience of different makers suggested.*

Although the Corliss cut-off and valve have been adopted by at least two English engineering firms, there were no exhibits by them, except of slide-valve engines, and it may be stated generally that the English look much more universally than we, to simplicity and endurance as the first qualities in their machines. The continental builders have quite generally adopted this type for engines, for such purposes as cotton and woollen-mills, and other situations where economy is a serious consideration.

The question of the adoption of steam-jacket was examined by the writer. The English makers, with one exception, had their cylinders on this principle, on every engine which pretended to be built with an eye to economy.† Even their portables were, with the exception of Garrett & Sons', designed

* The extent to which this engine has been adopted by the continental builders, who have copied it from the English makers, is another example of the necessity to our inventors of a better patent law in Europe. It is true the jury, in this branch, had the grace to give to Mr. Corliss one of the nine diplomas of honor accorded to the United States, although he himself exhibited nothing.

† Mr. Bourne, an eminent English authority, in the last edition of his work on steam-engines, goes so far as to assert that the advantages of any considerable rate of expansion are wholly lost without the use of the steam-jacket.

in this way. It is to be borne in mind, that the leading English firms have for a long time been in the habit of consulting the scientific men of their technical schools, and have adopted the principle of steam-jacketing after a most thorough understanding of its advantages, which are a subject of the most exact mathematical demonstration, depending upon the degree of expansion. Following their lead, the principle has become one of general adoption among the English engineers. It has equally come into use with the leading continental manufacturers, who study economy of fuel, and we believe all the variable engines of the Corliss type and many with slide-valves, were thus built. The marine and boat engines, it is needless to say, were all designed in this way.*

The marine engines were, in addition to this, with one exception, on the compound principle. The attention that this subject is now receiving from our steam engineers, the fact that it is in use on all the principal transatlantic lines, and that the United States navy and some of our leading lines have adopted it, led the writer to look into the subject as carefully as circumstances would permit.

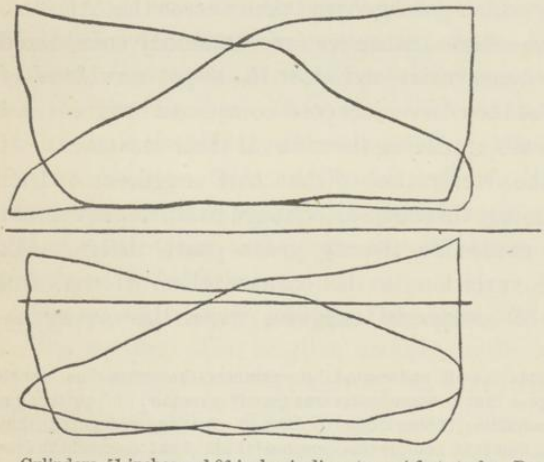
The steamer by which passage was taken across the Atlantic, was one of a line whose managers are commonly considered among the most conservative and slow to adopt new ideas of any in Europe, but they have accepted compound engines, and are, as fast as possible, placing them in all their steamers. It was said to be the declaration of the chief engineer of their line, that after going through all changes and improvements which had been made for twenty years past, their books showed but little variation in the consumption of coal until the introduction of compound engines, when the saving ap-

* Although the principle is well understood by engineers, the writer has met so many persons who suppose that a steam-jacket was merely a method of protecting a cylinder from outside radiation, (better done by felt and cleating or lagging), that he ventures to explain, that it is not for this purpose at all, but to correct the loss from condensation of steam within the cylinder, which condensation is a consequence of the cooling effect of a rapid rate of expansion when the cut-off valve is closed. The expansion of a volatile liquid by means of an air-pump will freeze water; in the same way the expanding steam robs part of itself of its heat, and condenses it into water, thus diminishing the pressure more than it should, and at the end of the stroke robbing the cylinder of heat by again turning the water condensed on its surface into steam, which flows directly into the exhaust without doing any work, leaving the surface of the cylinder cool to be warmed by the fresh steam at the cost of fresh condensation. The steam in the jacket supplies the heat to prevent this, at a less loss than if thus wasted in the cylinder.

peared at once to be very great. The following will give an idea of the form of indicator-card which was made and the power developed in actual every-day work, during the passage spoken of. The consumption of coal was reported on the day in question, at thirty-eight tons for an indicated horse-power of 1,800, besides which all the steam used in the vessel for heating, cooking, running pumps, etc., is to be allowed for. The boilers in the vessel with this engine were unquestionably much too small for the most economical working, having a heating surface of only 7,100 feet, or about four square feet per horse-power.

The builders of this class of engines claim on trial trips much greater economy than was here shown, as low in fact as one and one-half pounds of coal per indicated horse-power per hour. And the Messrs. Randolph & Elder, the great pioneers of this system, have publicly declared their expectation of getting the economy reduced to one pound.* The character of cards taken from this class of engines is illustrated by the set of cards here inserted.

INDICATOR-CARDS OF A MARINE ENGINE.



Cylinders, 51 inches and 86 inches in diameter — 4 feet stroke. Revolutions, 54½ per minute.
Coal used in twenty-four hours, 38 tons. Steam in boilers, 54 lbs.

To an American the most remarkable among these engines were those designed for paddle-wheel steamers for the river and the lake traffic of the continent. These were oscillating

* See note on next page.

engines, of which mention has already been made, with their cranks at right angles, the steam passing from the high-pressure cylinder into an intermediate receiver. To illustrate the extent to which this form of engine has come into vogue of late years for a class of steamers quite like those of our coasts and rivers, mention may be made of constructions of Escher, Wyss & Co., of Zurich. This firm, though situated far from any

NOTE. — The following table, prepared at the instance of the Engineering Department of the Navy, will show the results of practical experience on this question :—

Table exhibiting for comparison, the cost of the power, in pounds of steam per horse-power per hour, of a number of compound and non-compound two-cylinder engines; the quantities, as ascertained by indicator measurement, being corrected by adding, in the case of the non-compound engines, the known condensations in the cylinders, for their several measures of expansion as determined by the experiments of the Navy Department; and in the case of the compound engines, the quantity condensed in the steam-jackets, as estimated upon the basis of an experiment made with the pumping-engine of the Brooklyn Water-Works in 1860.

DESCRIPTION OF ENGINE.	Pounds of steam consumed per hour per total horse-power.*	Pounds of steam condensed in the steam-jackets per total horse-power.†	Pounds of steam condensed per total horse-power.‡	COST OF THE POWER IN POUNDS OF STEAM PER HORSE-POWER PER HOUR.			Pounds of steam consumed per total horse-power.§
				Total.	Indicated.	Net.	
The 60×36-in. Navy Engines,—							
Of the U. S. S. Guerriere,	23.67	–	4.99	28.66	35.70	40.56	–
U. S. S. Delaware,	25.96	–	4.00	29.96	36.40	41.03	–
U. S. S. California,	24.50	–	5.10	29.60	35.40	41.00	–
U. S. S. Congress,	25.95	–	4.40	30.35	35.55	40.85	–
The 50×42-in. Navy Engines,—							
Of the U. S. S. Alaska,	23.40	–	4.10	27.70	35.30	41.40	–
U. S. S. Benecia,	23.50	–	4.30	27.80	35.20	40.30	–
The 36×36-in. Navy Engines,—							
Of the U. S. S. Resaca,	23.80	–	5.00	28.80	34.80	43.00	–
U. S. S. Swatara,	23.00	–	4.20	27.20	33.70	38.60	–
The Compound Engines,—							
Of the Steamer ——,	15.9	2.18	–	18.08	22.53	27.16	29.18
Steamer Italy,	16.7	2.18	–	18.88	21.49	26.10	31.57
Steamer Spain,	16.6	2.16	–	18.76	21.85	26.54	32.77
Steamer City of Bristol,	16.2	2.11	–	18.31	21.01	25.85	28.07
Steamer Gracia,	18.3	2.32	–	20.62	21.97	26.31	–
Steamer Patagonian,	15.9	2.04	–	17.94	21.16	25.99	29.42
Steamer Batavia,	17.6	2.27	–	19.87	24.78	30.09	34.14
Steamer Egypt,	17.7	2.28	–	19.98	24.89	29.42	32.00
Mean of the 60×36-in. Engines,	25.02	–	4.62	29.64	35.76	40.86	–
50×42-in. Engines,	23.45	–	4.20	27.75	35.25	40.85	–
36×36-in. Engines,	23.40	–	4.60	28.00	34.25	40.80	–
Mean of the Navy Engines,	23.95	–	4.47	28.46	31.75	40.83	–
Compound Engines,	16.86	2.19	–	19.05	22.46	27.18	31.02

* Inclusive of the quantity condensed in the production of the power.

† Calculated upon the basis of an experiment with the engine of the Brooklyn Water-Works.

‡ Due to all causes other than the production of the power.

§ Developed in the lower-pressure cylinder, inclusive of the quantity condensed in the steam-jackets.

navigable water, except their own little lake, by their experience, their good workmanship, and above all, by the reputation which their engines of this style have acquired for their economy, have contrived to gain a trade which extends all over Europe, onto the Rhine and the Danube, and to the Black and Mediterranean seas, and even to South America. From 1860 to May, 1873, they built one hundred and thirty steamboat engines; of these ninety-one were compounded.

Of the stationary engines a very small exhibition was made by the English, and although compound engines are largely in use with them, their leading manufacturers did not generally appear. Of the two engines built especially for economy, one by Galloway, was on the compound principle. The French had only two stationary engines, of which one was compounded. A portable, whose size and weight would entitle it to rank among the stationaries, was also compounded, the cylinders being in the steam-dome.

In the German department were several compound engines.

The compound upright blowing engine, exhibited by the Cockerill works of Liege, in Belgium, was the most striking machine in the Exposition; it has been described on page 413 of this report. But few compounded engines were shown by the Austrians or other nations of eastern Europe, though they were not without examples.

In reviewing this whole subject, it seems probable that as the economy arising from the introduction of steam-jacketed compound engines into the marine of this country is perceived, and as our large manufacturers investigate the advantages of this type of engines, as shown in Europe, that these improvements will be demanded here and will be carefully studied into by our engine-builders, and that economy in steam during the next twenty years, will be sought more by these modifications, and less by complicated and expensive-running valve-gear.

A few general facts may be noticed in regard to the engines of all the European nations. Wherever their governors or their valve-gear were driven by gears, one of the pair was always made with inserted wooden teeth. Nearly all the engines carried their piston-rods completely through the cylinder, so that the heads were as far as possible supported

on the rods. The valve-stems were, in the majority of cases, arranged in the same way. The larger portion of the engines on view were fitted with condensers, and a favorite position for them was directly behind and in line with the cylinder, the prolongation of the piston-rod from the rear of the latter serving as the pump-rod. Beyond these minor points there was very little to be seen that would be particularly interesting or suggestive to an American builder.

The following are examples of the prices of engines of different makers; price in United States currency, at ten per cent. below gold:—

	Diameter of Cylinder. (inches.)	Stroke. (inches.)	Price in U. S. Currency.
Small English engine, well finished.	4	8	$186 00
	6	12	266 00
The 12-in., with steam-jacket, .	12	24	760 00
Same, semi-portable boiler included,	4	8	399 00
	6	12	585 00
German build (Berlin), semi-portable, ...	6	10	827 00
	9	13	1,142 00
A French (Paris) semi-portable, .	6	10	770 00
	9	13	1,212 00
A variable cut-off, very well built, with steam-jackets. Condenser extra.	14	32	2,460 00
	18	40	3,130 00
	34	60	8,877 00

Iron Working Tools.

Of tools for working iron there was a large display in the Machinery hall. As we have already stated, the American department, although very limited in extent and in the number of exhibitors, was still the most interesting portion of the mechanical exposition, and contained more that was original than all the rest. The tools of Sellers, of Philadelphia; of Messrs. Pratt & Whitney, of Hartford, Ct.; Brown & Sharpe, of Providence, R. I.; and Styles & Parker, of Meriden, Ct., were universally praised for their workmanship as well as their originality. Massachusetts, though undoubt-

edly the largest producer of machine-tools of any State in the Union, had none whatever on exhibition, with the exception of a case of twist-drills, from the Morse Twist-drill Co. of New Bedford. The high reputation these drills have acquired throughout Europe is an excellent illustration of the character of our best grades of work. It is well known to many, that the manufacturers of these drills are enabled to import the highest and most expensive quality of steel, paying upon it a duty of fifty per cent. and all expenses, turn it into drills, reëxport it to Europe, and sell it in the foreign markets in competition with any manufacturers there;—a most instructive commentary upon our labor-saving machinery! It is the more to be regretted that our State had no display there, as many of our tools are better suited in price, as well as in character, to the German market, than those which were taken there from other States.

We quote for comparison a few prices of machine-tools, accompanied, as far as they could be ascertained, with the weights. Prices as before in American currency at ten per cent. below gold:—

Machine-Tools, Prices, Weights, etc.

A Prominent German House.

Lathes.				Planers.			
Swing (inches).	Length of bed (feet).	Weight (lbs).	Price, American Currency.	Width (inches).	Length they plane (feet).	Weight (lbs).	Price.
12½	6½	–	$354 00	30	7⅔	–	$823 00
20	9	–	750 00	46	14	–	1,863 00
24	12	–	946 00	90	28	–	8,932 00
40	24	–	2,266 00	–	–	–	–

Another Leading German Maker.

13	6½	1,830	$374 00	25	4	3,112	$599 00
17½	9	3,570	546 00	34	7½	9,384	1,007 00
22	13	5,700	823 00	52	11½	17,480	1,740 00

Machine-Tools, etc.—Continued.

ENGLISH HOUSE, CONSIDERED RATHER ROUGH WORK.

LATHES.				PLANERS.			
Swing (inches).	Length of bed (feet).	Weight (lbs).	Price, American Currency.	Width (inches).	Length they plane (feet).	Weight (lbs).	Price.
12	6	1,344	$272 00	24	4	–	$522 00
16	10	3,920	474 00	36	8	12,880	1,022 00
20	12	5,040	638 00	54	12	24,640	1,852 00
24	14	7,400	894 00	–	–	–	–

ANOTHER ENGLISH HOUSE, OF HIGH REPUTATION FOR WORKMANSHIP.

12	6	–	$489 00	–	–	–	–
16	10	–	654 00	–	–	–	–
20	10	–	859 00	–	–	–	–
24	16	–	1,062 00	–	–	–	–

A PHILADELPHIA FIRM—FOR COMPARISON.

16	9	2,000	$450 00	24	5	4,000	$650 00
20	10	3,600	765 00	36	8	7,000	1,100 00
–*	–*	3,700*	875 00*	–	–	–	–

A FIRM IN NEW YORK STATE.

16	9	2,050	$375 00	–	–	–	–
20	10	2,700	625 00	36	12	12,000	$1,300 00
24	12	5,000	825 00	–	–	–	–
30	16†	8,500	1,350 00	–	–	–	–

* Same with gap. † Hardened boxes and bearings from $70 to $90 extra.

NOTE.—With the exception of the first list, all foreign lathes above cited are made with a gap.

The following extract from the "London Engineering" will be interesting, as giving a foreign estimate of our machinery:—

"It will be seen from what we have said, that the American exhibits of machine-tools are of special interest, and that they are decidedly characterized by great originality of design. In this

respect they are, in fact, distinguished beyond any other collection of tools at Vienna. * * * The workmanship, too, of the various machines shown is excellent, and every care appears to have been taken to insure accuracy. The only fault, in fact, which we have to find with the American machine-tools is, that some of their frames are not what they should be. With a few exceptions, and notably Messrs. Sellers,—whose frames are excellent,—our American friends are apt to run a little wild in the matter of frames, and we miss in their designs the solidity and simplicity which distinguish the productions of our leading English firms. Hollow or cored frames are not so largely used in the United States as they are now with us; and the ribbed frames which are adopted, although probably amply strong enough for their work, are apt to be distinguished by many unnecessary curves and twists. This is especially noticeable with the legs for supporting the smaller machines."

In respect to the weight of frames, it is remarkable that while our New England makers uniformly agree in declaring that the excessive weight of English tools is wholly unnecessary, they have yet, for the last ten years, been constantly adding to the weight of their machinery; and are still far behind the manufacturers of Philadelphia and Wilmington, and even those of the Western States. It was the declaration of two distinct manufacturers of the Middle States to the writer, made within a few days, that New England tools had a very unfavorable reputation in their part of the country. This reputation arose, no doubt, from the fact that New England tools are too light for the heavy work required of them in the Middle States. Our tools are heavy enough for much of the work in New England, but should some firm, of good reputation for workmanship, add largely to the weight and strength of their tools, they would bring back to Massachusetts a class of orders now wholly given in other directions.*

Passing by the United States department of the Machinery hall, the visitor from America would have found elsewhere very little that was new or instructive. A few general remarks are suggested by a review of the productions of other nationalities. Lathes are very generally built with a gap under

* See weights of Philadelphia and New York tools, p. 421.

the face-plate, so that a larger swing can be had when the tool is desired for facing. When not wanted for this purpose, the gap is filled with a block, which slides in, having upon it a continuation of the ways. Gears are not cut, even on the best tools of the makers of highest reputation, on the theory that the outer scale is the best portion to resist wear. The working-handles about the machines are of horn, turning loose upon their centres. Planers are much more universally built with double heads than with us, even those of comparatively small size. Those in the Exposition were also universally fitted with a cord, or other arrangement, for mechanically lifting the tool so as to clear its point in running the platen back. Many tools for slot-drilling were exhibited, and this appears to be a tool in much more general use than with us, in European shops.

Overhead travelling-cranes were in use in the Exposition, and the whole work of removing the exhibits, to and from the cars which brought them, was done with these. The writer found, also, the new and well-arranged machine-shops, in England at least, generally fitted up in this way. The cranes were largely used also in foundries and in lumber-yards, and universally in the freight-yards of railways. As is generally known, these travelling cranes consist of two parallel rails supported overhead on walls or piers from forty to sixty feet apart, on which travels a truck. This truck is composed of two beams with wheels under the ends on which another truck traverses from one side to the other. This last truck carries the hoisting apparatus. Most commonly they were driven by a high speed hide-cord, passing through them from one end of the building and so arranged as to give all the motions through friction-gears at will.

Very fine examples of the material for conveying power by wire-rope were also on exhibition, with plans of localities where the same has been applied. A set of wheels were shown of over twenty feet diameter, with the rope used. This form of conveying power, which is admirably adapted to the purposes of water-power, has not received the attention in New England which it deserves. It is largely used in Europe, and from 50 to 500 horse-power is conveyed to distances of nearly a mile. In some cases smaller powers are led off in various directions

from intermediate stations on the way. It is estimated that to convey, say 25 horse-power, costs by wire-rope eight cents per foot; the same, by belt, $1.40 per foot.

Of the few tools which deserve attention for their novelty, one was a locomotive double-wheel lathe, in which the wheels are supported and turned on their own axles. On the head-stocks of the lathe are cast brackets, bearing V-shaped adjustable boxes, in which the journals of the axles revolve. Around the rear of these boxes, on a portion of the bracket which is turned for the purpose, revolve the face-plates, driven by a powerful gearing. These face-plates are made in two parts, in order to get over a collar on the bracket which holds them in place, they merely serving as drivers to the wheels. A pin set up against each end of the axle prevents end motion. This lathe was exhibited by the Saechsische Maschinen-fabric of Chemnitz (formerly Richard Hartmann & Co). The same firm displayed a drill and slotting-machine, adapted for heavy work. The drill-spindle, which lies horizontally, has an automatic feed; the carriage which holds it, slides up and down upon the side of the standard which supports it, and the standard itself moves horizontally on its bed. The last two motions serve for drilling slots, either horizontally or vertically, and also for adjusting the tool in front of heavy work for drilling. Several tools were exhibited by Johann Wagner & Co., of Dortmund, for railroad work. One of these was a very heavy milling machine, with travelling-head, for milling the ends of rails. Another, a similar machine, carrying a saw for sawing off the ends of rails, cold; still another,—a tool with three horizontal drills, the drills having a short transverse motion and self-feed, for drilling oval holes near the ends of rails. By expansion gears, the distance of the holes from each other can be varied.

The same firm exhibited some tools adapted to planing the spokes of locomotive wheels and to drilling the rims from the inside. Other tools were shown by Sharp, Stewart & Co., and others, for planing the inside of the rim and like operations. As such tools would not be applicable to our modes of work, a description is not necessary.

The Deutsche Werkzeugmaschinen-fabric of Chemnitz, exhibited a novel machine for planing on an arc of a circle

either convex or concave, adapted to crank boxes, etc. It resembled a heavy upright drill. The spindle was very heavy, and carried at its lower end a slotted arm, in which could be fixed a holder with cutting tool, with such radius as the work demanded. This spindle received a reciprocating turning motion by means of a proper gear, passing through such an arc of a circle as it was set to, and there reversing itself and turning back, with a quick, return motion. It also had a self-acting down feed. In this way the tool would plane round the portion of a circle of any given diameter it was set to, within the radius of the arm. The horizontal table for the work was adjustable in all directions.

A common machine in the Exposition, and in the English work-shops, was a frame of gang-drills for drilling a line of holes at once. These were generally driven by a long screw, running along the top of the spindles and gearing, into a skew gear on each of them.

A very fine bolt-heading machine was exhibited by De Bergue & Co., of Manchester. The rods being cut up after heating, by knives on the machine, were dropped into holes in the rim of a heavy revolving wheel, which carried them successively under the punch which headed them, after which they were dropped out below. The details of the tool were well worked out, and the production was guaranteed at forty-five bolts per minute.

A machine for planing the teeth of heavy gears, was shown among the tools of the Chemnitz Werkzeugmaschinen-fabric. The arrangements for adapting it to the size and form of gears were good. The tool-holder in this machine oscillates on a centre, and the form of the tooth to be cut is determined by an arm which follows the surface of a copy or guide.

This short list, it is believed, includes nearly all the tools in the Exposition which would be really new to a New England visitor, and which would be likely to be of any value to us. It is not impossible that there are tools like them already in use among us. To the writer they were most of them new, and have been thought worth a brief mention.

Wood-Working Machinery.

If, in iron working tools, Massachusetts had no representation at the Exposition, we were more fortunate in wood-working machinery. The special machines exhibited by Mr. Baxter D. Whitney, of Winchendon, for pail-making, jig-sawing, planing, for turning, etc., attracted a crowd whenever they were in motion. Quoting again from English testimony in speaking of the pail machinery :—

"Apart from the ingenuity displayed in the conception of this manifold machine, the manner in which it has been carried out reflects the highest credit upon Mr. Whitney. Every one of his exhibits indeed shows the hand and mind of a master, and every other exhibitor of wood-working machinery can, and doubtless will, learn a good deal from these tools."

A dove-tailing machine, shown by Mr. G. Hall, of Florence, was also much admired, and a band-saw of Richards, London & Kelley, of Philadelphia, attracted attention from its workmanship. Beyond these there were only exhibited some collections of the ordinary wood-working machinery of the United States. Of these it was declared in the "Engineering":

"Most of the other machines exhibited fall so far below, even a liberal standard of average merit, that we can scarcely believe that they are to be accepted as the representatives of this branch of industry in the United States."

The writer has quoted this statement from a paper certainly disposed to be favorable to the productions of our country, and it is, indeed, the conclusion of an article in which praise has been accorded to many ingenious details in the machinery. The remarks apply mostly to exhibits from other States than our own, but are quoted from a feeling that the lesson may be brought home to ourselves. It is pretty certain that there has not with us been that improvement in weight and style, nor in workmanship, within these latter years, in wood-working machinery, that there has in iron. Improvements in design, and a perfection of workmanship, are to be found in work made in other parts of the United States, which we cannot equal.

It is a question how far tools of this class will gain in productive power, through increased weight and accuracy of workmanship, but the writer cannot doubt that there is a demand for something of each, much beyond the average of our New England wood-working machinery.

Beyond the American department there was in this department little of interest, except in the English; and those machines which were the best in their design and arrangement, are by a firm who are said to have had a leading American manufacturer as superintendent. The machinery was solid and heavy, and contained nothing of value which cannot be found in a better form in, for instance, the productions of Richards, London & Kelley, of Philadelphia. A few special machines were shown, adapted to the continental market, for making parquetry floors. These consisted of a hand-matcher with a vertical spindle, the work carried by the cutter on a horizontal sliding table, and of a surfacing machine, which is simply a lathe with a large face-plate.

Perin's band-saws attracted attention among a collection of otherwise inferior wood-working machinery in the French department. Some of these were very heavy, and adapted with side rollers for re-sawing lumber. Beyond the French there was nothing of value in wood-working machinery in the Exposition.

In reviewing the whole subject it may be said, of the matter of steam-engineering, that the questions of steam-jacketing and compounding should receive careful attention on the part of our engineers, but that many crude and unsuccessful experiments have been made in the United States which have failed from imperfect understanding of the conditions of success, and the subject should be approached through a thorough study of the work and the publications of the English engineers. And the writer does not doubt that, when the principles at the bottom of the system are here well understood, the ingenuity of our people will suggest many improvements over present forms.

In iron, and especially in wood-work in machinery, although our machines are most admirable for ingenuity and convenience, there is need of a more thorough study of the work of outside manufacturers on the part of our makers. Massa-

chusetts having been the first of the United States to build up a manufacturing business in these departments, she is too much confined to her original forms and styles. Perhaps, too, her manufacturers are too closely devoted to the details of their business. Time devoted to travel, and an investigation of the ideas of others, is not lost. Perhaps it is one of the best results of international expositions that it brings manufacturers of each district to study the best work of every other.

HAMILTON A. HILL.