A big shell struck an armor plate over a 6-inch case-mate gun on the "Oslabia." The plate was bent back on the gun, jamming it in its carriage.

Two shells hit the "Orel's" conning-tower. The

former, striking near the edge, caused the plate to turn in slightly, evidently weakening the support of the adjacent plate, for when a shell struck it it was forced in till its outer edge was nearly clear of the inner edge of the former plate.

The foremast of the "Orel" was struck four separate times and remained standing.

A shell ricocheted and struck the edge of the roof of the conning tower, exploding as it struck. A flange

of iron which surrounds the aperture was bent inward and cut all the voice tubes leading from the conning-tower but one. The remaining one fortunately led to the central station.

One heavy gun, on the "Apraxin," I think, was struck fairly by a 6-inch shell. It made a dent that was noticeable in the bore. The gun was loaded and fired in spite of the dent. The shell seemed to iron out the dent and the fire was continued from that gun till the end of the day.

Sights and Gunnery.

All the telescopic sights used by the Russians in this battle were bought from Germany in the fall of 1904. They were of the prism variety. The cross-

wires were at an angle of 45 deg. to the horizontal. On each side of the cross were graduations and a table was supplied to each pointer telling him how much in divisions to allow for drift at each range. The aperture at the eye-piece was about 1/8 inch in diameter, and great difficulty was experienced by the pointers in keeping the target in view, particularly when the glasses got dim, as they did very shortly after the firing commenced. Many reverted to the old bar sights. The mounts were flimsy. Coal had been stowed everywhere, and the shock of firing and the explosion of shells stirred up the coal dust from corners and crevices, making it impossible for anybody to see either with or without the telescopes. The paint on the inside of the barrel of one telescope burned till the glass was spoiled for vision. Shells falling short deluged the ship in salt water and interfered with vision through the telescopes. Very few telescopes were hit by fragments.

The range was first measured by Barr and Stroud. Then trial shots were fired from a twelve-inch gun till the range was established. The range necessary for the twelve-inch gun was signaled to the whole battery.

The Japanese, in some cases at least, fired their broadside guns in volleys. The "Kasuga" fired thus on the "Ural." A volley fell once just astern of the "Orel," raising a perfect wall of water.

Miscellaneous.

There were two explosions in 6-inch turrets on the "Orel" and one in the forward 12-inch turret of the "Suvaroff."

The "Orel" had sixteen deck officers. Four were killed and nine were wounded in the first day's fight, leaving only three ready for duty the second day of the battle.

The after turret of the "Orel" fired 113 shells; only four were left in the after handling room when she surrendered. There were plenty forward but there was no way of transporting them to the after turret. The left gun in the forward turret was broken off and the lift for the right gun was smashed. Shells could be raised to the turret in the left lift and swung across to the right gun, but with difficulty.

The after turret had been struck on the edge of the embrasure just over one gun. The plate was bent down till the gun could only be elevated through a small arc, to 800 yards with the ship level.

The Japanese did not use their three-inch guns at all, apparently. It is thought that their magazines were used for larger caliber ammunition.

There was only one case of steering gear being disabled on the Russian ships. This was on the "Suvar-

off," and it is thought that if the ship's officers had been in the conning-tower instead of the staff, this defect could have been remedied, as the staff were in no wise familiar with the gear.

When the new guns were placed on some of the Russian ships engaged in this battle, the embrasures were not enlarged to accommodate the new guns, which consequently could not be used up to their full range.

The "Suvaroff" was provided with pipes from watertight compartments on one side to corresponding compartments on the other. The valves in these pipes were opened before going into action. When she got three holes below her water-line on the port side these pipes allowed the water to accumulate in equal quantity on the starboard side, and she shortly regained an even keel.

In the Russian light cruisers barricades were made of hammocks between open deck guns and much was said in praise of them as proof against fragments. The boats on one cruiser had the torpedo nets triced up under them, which all agreed was excellent preventive against flying splinters.

Many Russian sailors, when their ships sank, put on life preservers around their hips instead of placing them higher up, and turned heads down when they got in the water and were thus drowned. A great many corpses were seen the day after the battle floating with their feet bobbing up. Some pictures were taken of them by the Japanese but Admiral Togo had the practice stopped and the plates confiscated and destroyed.

An officer from one of the fast Russian cruisers said that during the night several torpedoes were fired at his ship at so short a distance that he could hear the coughing sound as the torpedo left the tube, yet she was not hit. The cruiser was running at twenty knots. Battleship officers put their faith in 12-inch shrapnel with fuses set at one-half second to one second, and claim that it beats the small gun for torpedo defense.

CHIMNEY DRAFT.*

By W. W. F. PULLEN, A.M.Inst.C.E., M.I.Mech.E.

The growing use of some form of mechanically-assisted draft in connection with steam boilers has materially tended toward a decline in the interest taken in the ordinary factory chimney; so much so, that it

Fig. 1.—To Explain the Production of Chimney Draft.

appears to have altogether dropped out of modern textbooks dealing with steam boiler practice.

I propose to show in this article that chimney design has some sort of scientific basis, and how far it may be expedient to introduce such things as fuel economizers with natural draft alone.

Let Fig. 1 represent the flue gas channel of a steam boiler, beginning with the furnace at A, and finishing with the top of the chimney at C, whose height above the fire-grate is H feet.

Let the mean density of the air be δ_a pounds per cubic foot, and the mean density of the gases in the chimney be δ_c , while suffix 0 will refer to freezing point.

The lifting effort or propelling force per square foot of section of the chimney will be the difference in weight of a column of chimney gas and of a column of atmospheric air H feet high. The latter is shown diagrammatically at AD, Fig. 1. The weight of a column of air

$$\begin{aligned} &= \text{volume of column} \times \text{density of air,} \\ &= \text{sectional area} \times \text{height} \times \text{density,} \\ &= 1 \times H \times \delta_a \text{ pounds.} \end{aligned}$$

And hence the propelling force due to 1 square foot of chimney

$$\begin{aligned} &= H\delta_a - H\delta_c \\ &= H(\delta_a - \delta_c) \text{ lbs.} \end{aligned} \quad (1)$$

Let P represent absolute pressure in pounds per square foot;

V represent the volume of 1 pound gas in cubic feet;

T represent the absolute temperature of the gas; then the equation

$$PV = RT$$

holds good with a gas at any temperature and pressure, where R is a constant for the particular gas in question. Hence it holds for the mixture of flue gases in the chimney.

As the density $\delta = \frac{1}{V}$, the above equation may be written:

$$\frac{P}{R} = T\delta \quad (2)$$

* Technics.

If a water gage be applied to different points in the flue and chimney, it will be found that the pressure nowhere differs from that of the atmosphere by more than 1 inch to 1 1/2 inches of water. An inch of water is equivalent to about 0.036 pound per square inch, and this is about 0.0024 of an atmosphere. Hence the absolute pressure of the flue gas nowhere varies by more than a quarter of one per cent, and therefore may be considered constant. Equation 2 may now be written:

$$T\delta = \text{a constant} = T_0\delta_0 = T_a\delta_a = T_c\delta_c \dots (3)$$

from which we derive

$$\delta_a = \frac{T_c\delta_c}{T_a}, \text{ and } \delta_c = \frac{T_a\delta_a}{T_c}$$

It should here be noted that in the former of these equations δ_0 is the density of atmospheric air at freezing point, which is 0.0809 pound per cubic foot. Also, that δ_c is the density of the chimney gases which contain CO₂—a denser gas than air—and consequently δ_0 in the equation involving δ_c will be the density of flue gases at freezing point, which is somewhere about 0.084

Absolute temperature T_c of chimney gases.

Fig. 2.—Curve Showing Relation Between Temperature of Chimney Gases and Weight of Coal Burnt Per Hour.

pound per cubic foot. The difference in these densities is not serious, but it will be well to use both of them, as the derived formulæ are to be found in some of the pocket-books.

To distinguish between these densities, it will be advisable to call that of the chimney gas at freezing point δ'_0 , and then

$$\delta_c = \frac{T'_0\delta'_0}{T_c}$$

Inserting those values of δ_a and δ_c in equation 1, we get the propelling force per square foot of the chimney section

$$= HT_a \left(\frac{.0807}{T_a} - \frac{.084}{T_c} \right) \text{ lbs.} \dots (3)$$

In Fahrenheit units and inches of water, instead of pounds per square foot, this becomes

$$\text{draft in inches of water} = H \left(\frac{7.64}{T_a} - \frac{7.95}{T_c} \right) \dots (3A)$$

which is an expression for the requisite height of a chimney if the temperatures of the atmosphere and chimney are known, together with the draft the chimney is required to produce. Generally, we do not know the draft required to burn a given number of pounds of coal per square foot of grate surface, and hence it is desirable to transform equation 3 or 3A into one that gives a relation between weight of fuel per unit of time, sectional area, and height of chimney.

lbs. of coal burnt, per square foot of effective chimney section, per hour.

Fig. 3.—Curve Showing Relation Between Height of Chimney and Weight of Coal Burnt Per Hour.

Returning for a moment to equation 3: if we divide the left-hand side by δ'_c , we thereby express the propelling force in feet of head of hot gases in the same condition as those in the chimney. Let h be this head; then

$$\begin{aligned} h &= \frac{\text{lbs. per sq. ft.}}{\delta'_c} = \frac{HT_a}{\delta'_c} \left(\frac{\delta_a}{T_a} - \frac{\delta'_c}{T_c} \right); \\ &= \frac{HT_a}{T_c\delta'_c} \left(\frac{T_c\delta_c}{T_a} - \delta'_c \right); \\ &= \frac{HT_a\delta'_c}{T_c\delta'_c} \left(\frac{T_c\delta_c}{T_a\delta'_c} - 1 \right). \end{aligned}$$

Canceling $T_c\delta'_c = T_c\delta'_c$, we have

$$h = H \left(.96 \frac{T_c}{T_a} - 1 \right) \dots (4)$$

The velocity produced in the hot gas in virtue of the head of h feet will be given by $h = \frac{v^2}{2g}$ if there are no

resistances which cause a loss of head. These resistances include that of the mass of fuel on the grate, and the friction of the gases against the sides of the flue and chimney. The former is by far the greatest resistance, and is the only one that need in general be considered. Mr. Kent, in America, has deduced from experiment that $\frac{v_c^2}{2g}$ is a fair value for this loss of head; so that

$$h = \frac{v_c^2}{2g} + 6 \frac{v_c^2}{2g}.$$

Substituting in equation 4, we have

$$v_c = \sqrt{\frac{2}{7} H \left(.96 \frac{T_c}{T_a} = 1 \right)}.$$

Let E = effective sectional area of the chimney, then the weight of gases discharged per second is

$$E v_c \delta_c;$$

and, substituting $\frac{T_c \delta_c}{T_a}$ for δ_c from equation 3, we have

$$\text{lbs. of gas per sec.} = E v_c \frac{T_c \delta_c}{T_a}.$$

Putting in the equivalent of δ_c and T_a , we have

$$\text{lbs. of gas per hour} = 3,600 E v_c \times \frac{.084 \times 493}{T_a}.$$

Chimneys may have to accommodate twice the theoretical quantity of air, or 24 pounds per pound of coal—that is 25 pounds of flue gases per pound of coal; hence the weight of coal burned per hour

$$\frac{\text{pounds of gas per hour}}{25}$$

Substituting from the equation immediately above, and for the value for v_c previously found, we find

$$\text{lbs. coal per hour} = 600 \frac{E}{T_c} \sqrt{\frac{2gH}{7} \left(\frac{.96 T_c}{T_a} = 1 \right)} \quad (5)$$

To obtain a fair idea of how T_c affects the rate of burning, we must plot a curve. We could, of course, find by differentiation what value of T_c will permit of the maximum amount of coal being burnt, but the result (1080 deg. F., when $T_a = 520$) is altogether misleading.

For plotting the curve, Fig. 2, we shall take E equal to unity; $H = 100$ feet, and $T_a = 520$ deg. F.

The chief feature of the curve in Fig. 2 is that, while the maximum draft occurs with chimney temperature of about 1,100 deg. F. absolute, it does not vary sensibly between the temperatures of 800 deg. F. and 1,600 deg. F. absolute, or between 340 deg. F. and 1,140 deg. F. on the ordinary scale. Hence the determination of the chimney temperature required to produce the maximum amount of combustion is misleading in the extreme.

It should be noted here that a leakage of air through the brickwork into the flues reduces the chimney temperature, and consequently the draft, besides giving the chimney more work to do.

In equation 5, put 520 for T_a and 960 for T_c , and we obtain

$$\text{Pounds of coal per hour} = 16.7 E \sqrt{H} \quad (6)$$

The effective sectional area E of the chimney is taken as equal to the gross sectional area minus (perimeter $\div 6$) square feet. This is tantamount to saying that there is an air skin, 2 inches thick, sticking to its interior surface; and there is probably a great deal of truth in the statement.

The minimum height of a chimney in populous districts is governed by the local authorities and the height of neighboring buildings. It is seldom permitted to be less than 70 feet, and this is sufficient to burn 15 or 16 pounds of Welsh coal per square foot of grate per hour.

Now the gases coming from a Lancashire boiler at this rate of combustion would be not less than 600 deg. F., or, say, 1,060 deg. F. absolute. Referring to Fig. 2, it will be seen that we get practically as good a draft when the chimney gases are at 860 deg. F. absolute or 200 deg. lower, the difference corresponding to about 10 or 12 per cent of the total useful heat supplied by 1 pound of good coal, or, in other words, there would be a probable saving of 10 per cent by introducing an economizer, while the draft would be unimpaired, except for the slight amount of extra friction of the gases against the economizer pipes.

When the wear and tear is considered, the saving would probably be greater than that suggested above.

In Fig. 3 we have a curve giving the rate of combustion to be expected with good coal and different heights of chimneys up to 100 feet. If inferior coal is used, then a greater height will be needed, even to the extent of from 50 to 100 per cent extra. Anthracite requires a chimney nearly twice as high as that given in Fig. 3.

TUBES IN CEMENT.

The tubes or piping of cement which are now manufactured appear in numerous forms of section. Besides the round piping we also meet with piping of an oval section. The circular piping is generally used for diameters which are below 20 inches, while for the large sections the oval form is preferred. To give it a greater steadiness upon the bottom where the piping is laid, the exterior contour is often given a flat base instead of being circular like the internal bore. Such piping can be readily placed upon a flat surface and will keep well in place. As at present constructed,

the cement piping is formed of an agglomerate mixture consisting of cement and an inert element, sand or gravel. A mortar is made by mixing these two constituents. For the cement we can take Portland, Roman cement, or others. The mixture is quite variable in the proportions which are used, and should be made according to the following rules: First, to have a compact beton, the gravel should be double the amount of sand. Second, the solidity is lessened when we only use cement and gravel, excluding the sand. Third, by diminishing the quantity of gravel too much the expense is increased. The best proportion for average use seems to be 1 part cement, 1.8 sand, and 4.4 gravel. After deciding the proportion to be used, we next carry out the mixing of the materials. A kind of mixing crusher can be employed, in which narrow rollers work in a vat containing the mixture. We can also use mixers composed of a hollow, cylindrical vessel in which turns a shaft provided with paddles. Such an apparatus takes some 7 horse-power, and it forms 24 cubic yards of beton per hour. Once the mass is mixed it is put in an iron mold of appropriate form, consisting of the outer form and an inner core corresponding to the diameter of the piping. The mixture is put in the free space and is packed down with a tamping rod. The process somewhat resembles the manufacture of gas retorts. The forms are placed vertically or laid down. For some time it has been desired to substitute a mechanical process for the hand method, which is expensive, but machines which have given good results are scarce as yet. They have somewhat the same form as the molds just described. Beton is run into the inner space. The core is set revolving, while the mass is compressed by a screw-press. The tube is then taken out of the mold and at the end of three or four hours is treated with a fluosilicate containing magnesia. To protect the tubes from corrosion by acids it is a good plan to coat the inside with a mixture of tar and asphalt.

A NEW TYPE OF HYDRAULIC PRESS FOR INDENTING AND HEADING CARTRIDGE CASES FOR QUICK-FIRING GUNS.

In the accompanying illustration is shown a new and interesting type of hydraulic press, which has

A NEW TYPE OF HYDRAULIC PRESS FOR INDENTING AND HEADING CARTRIDGE CASES OF LARGE SIZE FOR RAPID-FIRE GUNS.

been specially designed for one of the leading British ordnance manufacturers for the indenting and heading of cartridge cases of quick-firing ammunition. This press has been constructed in accordance with the patents of the Vauxhall & West Hydraulic Engineering Company, Limited, of Luton, who make a specialty of this class of work for the manufacture of explosives, and this installation possesses several special features. The machine is adapted for dealing with the cartridge cases of large-size quick-firing ammunition, and is designed to work with the greatest rapidity. After a case has been cupped and drawn to the required dimensions, as regards internal and external diameters,

A. Formation of cartridge when inserted in the press. B. First indentation. C. Second indentation. D. "Heading," the case complete.

and the mouth trimmed as shown in the sketch, A, in order to finish the work it is necessary to reform the metal in the solid end of the case, so as to provide a projecting flange for the ejector and a central indent for the primer. To complete this work three distinct operations are necessary, known respectively as "first

indenting," "second indenting," and "heading," the formation of the case after each particular operation being shown in the figures B, C, and D.

As will be seen from the illustration, the press is of most substantial construction, comprising a massive head and base in a specially toughened mixture of cast iron. The top entablature of the press constitutes also the main cylinder, which is inverted, and carries an inverted ram attached to the crosshead guides, with adjustable slippers working on the main columns of the press.

To the lower surface of the crosshead is attached an anvil block, the lower end of which is arranged to carry a revolving die plate, and is provided with a specially hardened steel end. The base of the press is a massive cored casting, through which passes an ejector ram, which is suspended with its cylinder in the pit below the press, as may be seen in the illustration. On the upper surface of the base is carried the rotating table in a chamber machined for this purpose. The table is a gun-steel forging, and in its turn supports the die plate, which is also a forging of special steel, the two being centered by a hard-steel spindle passing through the base of the press. The table and die block can be rotated to 180 deg., and the block is fitted with two dies diametrically opposite to each other, so arranged that when one die is under the center of the main ram, the other is over the ejecting ram, adjustable stops being provided to insure accurate alignment in each position.

The return of the main ram is carried out by two cylinders and rams, arranged one on each side of the base, these cylinders being connected direct to the hydraulic pressure main, so that the side rams exert a constant upward pressure on the crosshead, and thus raise the latter whenever the valve of the main cylinder is open to exhaust. The table is rotated by means of the vertical jigger cylinders and wire rope arrangement seen in the position to the left of the press, and by this arrangement is given a very wide margin for adjustment, and at the same time automatic provision for taking up any slack in the working parts.

The complete cycle of operations by the press is as follows:

The main ram is at the top of its stroke while the ejecting ram is at the bottom of its stroke, and the die block is in its correct position. A capped, drawn, and trimmed cartridge, A, is placed in the die block over a mandrel. The die block is then rotated by means of the jigger cylinders through 180 deg., which operation brings the case under the center of the main ram. The revolving die plate on the under side of this ram holds three dies, two for indenting and one for heading. These are revolved until the first indenting die is over the cartridge case, when pressure is admitted into the main cylinder, the ram descends, forcing the metal at the solid end of the base into the die, and producing the shape shown at B. The main cylinder is now open to exhaust, the ram ascends sufficiently to allow the second indenting die to be brought into position and the stroke repeated, producing the formation shown at C. The third movement of the same description produces the form at D.

During this operation of the main ram the case that has been finished by the previous operation has been ejected by the ejector ram, and a fresh case replaced in position in the other side of the die block, so that the heading is completed, the block is rotated through 180 deg., and the finished case is ready for ejection, while a fresh one is ready for heading and indenting.

The weight of the press is approximately 55 tons. There is one special feature of great importance embodied in the design, viz., that all ram packings can be replaced, or examined in any part of the press without dismantling any portion of the machine or the severance of a single pipe joint.

GROWTH OF FOREIGN COMMERCE OF THE UNITED STATES DURING DECADE 1896-1906.

The foreign commerce of the United States has grown much more rapidly during the last decade than its population. Completed figures for the fiscal year 1906, just presented by the Bureau of Statistics of the Department of Commerce and Labor, show that while the population has grown since 1896 but 20 per cent, imports have grown 57 per cent and exports 109 per cent. The classes of imports which show the greatest gains are manufacturers and manufacturers' materials. Manufactures imported show an increase of 42 per cent, and manufacturers' materials imported show an increase of 95 per cent. On the export side agricultural products and manufactures show the largest gains. Agricultural products exported show an increase during the decade of 70 per cent, and manufactures an increase of 163 per cent.

This increase has occurred in the trade with all of the grand divisions of the world, but is especially marked in the trade with Asia and Oceania. Imports from Europe show an increase of 50 per cent, those from North America of 80 per cent, those from South America of 30 per cent, from Asia and Oceania 80 per cent, and from Africa 13 per cent. Exports to Europe show an increase of 78 per cent, those to North America an increase of 164 per cent, to South America 107 per cent, to Asia and Oceania 232 per cent, and to Africa 41 per cent.

The actual gains in the decade are, in imports, 447 millions, and in exports, 861 millions; in manufactures imported, 61 millions; in manufacturers' materials imported, 288 millions; in agricultural products exported, 400 millions, and in manufactures exported,