On Longitudinal Compression of Materials.

Results of Late Experiments upon the Resistance to Compression of various Substances of the Dimensions of one Cubic Inch.

Materials.	Weight in lbs.	Materials.	Weight in lbs.	Loss by freezing in 10-000 of an oz.
METALS.		STONES, &c.		
Cast iron, gun metal.	105-000	Granite, Putapsco,	11-200	
Wrought iron,	116-000	*Sandstone, Aquia Creek, . .	5-340	
begins to } yield, }	40-000	† " Seneca,	10-764	
Brass, fine,	164-800	" Aquia Creek, strata, } laid horizontally, }	8-332	
Copper, cast,	117-000	‡ Marble, Stockbridge,	10-382	8-8
Tin, cast,	15-550	§ " East Chester,	23-917	6-2
Lead,	7-730	|| " Symington, large crystals,	11-156	
WOODS.		" same, strata horizontal,	10-124	
Oak,	4-500	" same, strata vertical, . .	9-124	
Pine,	1-930	" same, fine crystals, . . .	18-248	
Elm,	1-290	" Italian,	12-624	
STONES, &c.		" Ice, Mass.,	22-702	9-9
Gneiss,	19-680	" Hastings, N. Y.,	18-941	11-8
Brick, hard,	4-368	" Montgomery co., Penn., . .	8-950	8-8
common,	4-000	" Baltimore, large crystal,	8-057	21-9
fire,		" " small crystal,	18-061	8-1

* Same as that of the Capitol, Treasury Department, and Patent Office, Wash., D. C.

† " " " Smithsonian Institute.

‡ " " " City Hall, New York.

§ " " " General Post Office, Washington, D. C.

|| " " " National Washington Monument.

Resistance of Stones, &c., to the Effects of Freezing.—Various experiments show that the power of stones, &c., to resist the effects of freezing, is a fair exponent of that to resist compression.

For the Journal of the Franklin Institute.

Report of Experiments on Gunpowder, made at the Washington Arsenal in 1843 and 1844. By Capt. ALFRED MORDECAI, U. S. Army.

The following selection of results and properties of gunpowder, the loss of force by windage, the effects of wadding, &c., &c., was made by Charles H. Haswell, Marine Engineer, for insertion in a new edition of his *Engineers and Mechanics' Pocket-book*, and as it was impracticable for him to appropriate any more space for this subject than that required for the essential elements involved in the general varieties of powder, &c., &c., he was constrained to give but a partial selection of the varieties of powder experimented with.

The report of Capt. Mordecai embraces the results of careful systematic observations effected with the aid of a cannon and musket pendulum, and is of a character not only to manifest his suitability for the labor so judiciously confided to him, but to reflect high honors upon the corps of which he is so distinguished a member.

Table of Results and Properties of Gunpowder, determined by the Experiments and Report of CAPT. A. MONDECAI, U. S. Army.
 24-POUNDER GUN.—Weight of ball and wad, 24-25 lbs.; weight of powder, 6 lbs.; windage of ball, .135 inch.
 MUSKET PENDULUM.—Weight of ball, 397.5 grains; weight of powder, 129 grains; windage of ball, .95 inch.

Kind of grain.	Composition.			Manufacture.		Relative quick-ness of burning.	Water absorbed by exposure to air.	Relative force. Standard = 1000.				Designation of powder in the experiments.
	Salt-petre.	Char-coal.	Sul-phur.	Where from.	Glazing.			24-Pounder gun.		Musket Pendulum.		
								Initial velocity in feet.	Force.	Initial velocity in feet.	Force.	
Cannon, large, small.	76 14 10			{ Dupont's Mills, Wilmington, Delaware.	Glazed.	77 275	Per ct. 2-27	Per sec. 1710	964	677	A 1	
Musket.					"	569 314	3-35	1659	935	720	A 3	
Rifle.					"	1134 214	.....	.....	.....	808	4	
Rifle.					"	6174 142	.....	.....	.....	907	5	
Musket.					"	5344 282	3-55	1668	940	728	E 5	
Rifle.	75 12-5 12-5			{ Esquerades, French, Dupont's Mills, Delaware.	"	1642	.....	.....	.....	834	X p 4	
Sporting.					"	13152	.....	.....	.....	943	p 5	
Cannon, uneven, large, medium.					Rough.	.....	.....	.....	.....	935	French.	
very large, even					"	166 183	2-09	789	780	.....	F	
Sporting.					"	103 182	1-91	1552	756	775	1	
Blasting, uneven.	77 13 10 } 70 15 15 } 76 13-7 10-3 }			{ Dupont's Mills, Delaware, Garesché, Delaware, Loomises, Hazard & Co., Connecticut, Waltham Abbey, England, J. Hall & Sons, Dartford, Eng., Bouchet, France, Stockholm, Sweden.	"	163 186	2-95	1527	861	768	2	
Cannon, medium, Rifle.					"	211 200	1504	948	740	762	0	
Sporting.					Highly glazed.	72308 100	4-42	1774	1000	1047	G 6	
Cannon, uneven.					Glazed.	295 212	.....	1660	936	.....	S	
Musket.					"	191 216	2-69	.....	.....	917	B 2	
Rifle.	76 15 9			{ Loomises, Hazard & Co., Connecticut, Waltham Abbey, England, J. Hall & Sons, Dartford, Eng., Bouchet, France, Stockholm, Sweden.	"	2378 204	.....	.....	.....	754	C 5	
Cannon, uneven.					"	.....	.....	.....	.....	820	6	
Musket.					"	174	.....	.....	.....	888	English.	
Rifle.					"	2832	.....	.....	.....	731	"	
Sporting.					"	11600	.....	.....	.....	865	"	
Cannon, uneven, Musket.	75 12-5 12-5			{ J. Hall & Sons, Dartford, Eng., Bouchet, France, Stockholm, Sweden.	"	.....	.....	.....	.....	980	"	
Sporting.					"	316	.....	.....	.....	835	French.	
Cannon, uneven, Musket.					Rough.	2410	.....	.....	.....	796	"	
Sporting.					Glazed.	.....	.....	.....	.....	742	Swedish.	
Musket.					"	.....	.....	.....	.....	.....	.....	

NOTE.—The report of Capt. Mondesai embraced a greater number of specimens, and furnished other elements. A selection only has been made of such qualities of powder, results, &c., as are considered essential for general purposes.

Table showing the Increase of weight in 1 lb. of various kinds of Gunpowder, exposed to Moisture for a period of 17 days.

Kind of powder.	Increase of Weight.	Kind of powder.	Increase of Weight.	Kind of powder.	Increase of Weight.
	Per cent.		Per cent.		Per cent.
A 1	2.77	E 5	3.55	F 2	2.95
B 3	3.35	F	2.09	G 6	4.42
B 2	2.685	F 1	1.91		

The powders A and B were slightly caked by this exposure; E much more so; the F's were not at all caked; and the G became hard caked on the surface after 6 days' exposure.

Table showing the Relative Force, by the Musket Pendulum, of various kinds of Gunpowder in good order, and of the same Powders dried, after Exposure to Air saturated with Moisture.

Kind of powder.	Powder in good order.	Powder dried after exposure to moisture.			Loss of force by the exposure.	Gain of force by the exposure.
	Initial velocity of ball.	Moisture absorbed.	Absorb'd moisture retained.	Initial velocity of ball.		
	Feet.	Per cent.	Per cent.	Feet.	Per cent.	Per cent.
A 1	1256	20.88	.83	891	29.06	....
A 4	1499	23.25	.29	1480	1.27	....
A 5	1648	27.05	.31	1516	9.98	....
E 5	1351	23.11	0.	1472	....	8.96
F 1	1404	20.83	0.	1315	6.34	....
F 0	1373	22.59	.20	1143	16.75	....
G 6	1856	19.53	0.	1472	20.69	....

The least dense powders return nearest to their original strength. The gain by the powder E 5 arose from the circumstance that the density of it in its original state was so great as to impede its combustion; hence, the grain becoming swollen by exposure to moisture, and its density correspondingly diminished, its combustibility was increased in a greater degree than its strength was impaired by the moisture.

In a large charge, like to that of a 24-pound gun, Captain Mordecai thinks the result would not be the same.

Table showing the loss of Force by Windage.

24-POUNDER GUN.

Powder.	Ball.	Initial velocity of ball in feet per second.			
		Without windage.	Windage. 135 inches.	Windage. 245 inches.	Windage. 355 inches.
Pounds.	Pounds.	Feet.	Feet.	Feet.	Feet.
4	24.25	1631	1450	1332	1197
6	24.25	1963	1702	1596	1465

A comparison of these results shows that 4 pounds of powder give to a ball without windage nearly as great a velocity as is given by 6 lbs. to a ball having 0.14 inch windage, which is the true windage of a 24-pound

ball; or, in other words, this windage causes a loss of nearly *one-third* of the force of the charge.

Table showing the loss of Force by the Vent of a Gun.

24-POUNDER GUN.

Powder.	Vent.	Veloc. of ball.	Powder.	Vent.	Veloc. of ball.
Pounds.	Inches.	Feet.	Pounds.	Inches.	Feet.
3	·175	1251	6	closed.	1705
3	closed.	1259	6	·25	1625
6	·25	1696	6	·175	1627
6	·175	1702	6	closed.	1612

These experiments show that the loss of force, by the escape of gas from the vent, is altogether inconsiderable, when compared with the whole force of the charge.

Table showing the Effect of different Descriptions of Wadding.

Powder.		Kind of wad.	Velocity per second.
Kind.	Weight.		
	Grains.		Feet.
G 2	77	{ Ball wrapped in the cartridge paper, the whole } crumpled into a wad and inserted over the p'dr. }	1308
"	77	1 felt wad on powder and 1 on ball, . . .	1377
"	77	2 felt wads on powder and 1 on ball, . . .	1346
French sporting, }	77	2 felt wads on powder and 1 on ball, . . .	1482
	77·17	1 elastic wad on powder and 1 on ball, . . .	1096
"	77·17	2 pasteboard wads on powder, . . .	1169
"	77·17	2 felt wads on powder, . . .	1200
"	77·17	2 felt wads on powder, . . .	1088
G 6	77·17	2 elastic wads on powder, . . .	1100
"	77·17	2 pasteboard wads on powder, . . .	1079
"	77·17	2 felt wads on powder, . . .	1193
"	77·17	2 felt wads on powder, . . .	1106
"	77·17	2 felt wads on powder and 1 on ball, . . .	1190
"	77·17	{ Ball wrapped in the cartridge paper, as in the } first experiment, . . . }	1237

The *felt wads* were cut from the body of a hat, weight 3 grains.

The *pasteboard wads* were $\frac{1}{10}$ -th of an inch thick, weight 8 grains.

The *cartridge paper* was $3 \times 4\cdot5$ inches, weight 12·82 grains.

The *elastic wads* were "Baldwin's indented," a little more than $\frac{1}{10}$ -th of an inch thick, weight 5·127 grains.

The most advantageous wads are those made of thick pasteboard, or of the ordinary cartridge paper.

Comparison of the Force of a Charge in various Arms, as determined by Experiments in Small Arms. of Rifle Calibre.

Kind of Arm.	Lock.	Powder. A 5.	Windage.	Ball's Weight.	Velocity.
		Grains.	Inches.	Grains.	Feet.
Common rifle, . . .	Percussion.	100	·015	219	2018
" " . . .	"	70	·015	219	1755
* Hall's rifle, . . .	Flint.	70	·000	219	1490
* Hall's carbine, . . .	Percussion.	70	·000	219	1240
* Jenks's carbine, . . .	"	70	·000	219	1687
Cadet's musket, . . .	Flint.	70	·045	219	1690
Pistol, . . .	Percussion.	35	·015	218·5	947

* Loaded at the breach.

Practical Deductions of Captain Mordecai, suggested by his Experiments.

Proof of Powder.—The common epreuves are of no value as instruments for determining the relative force of different kinds of gunpowder.

In the proof of gunpowder a cannon pendulum should be used.

In a 24-pounder gun, new cannon powder should give, with a charge of 6lbs., an initial velocity of not less than 1600 feet to a ball of medium weight and windage.

For the proof of powder for small arms, a small ballistic pendulum is best adapted.

The initial velocity of a musket ball (18 to the pound), of 0.05 inches windage, with a charge of 120 grains, should be:

With new musket powder, not less than 1500 feet.

With new rifle powder, not less than 1600 feet.

With fine sporting powder, not less than 1800 feet.

Manufacture of Powder.—The powder of greatest force, whether for cannon or small arms, is produced by incorporation in the “cylinder mills.”

Effect of Wads.—In the service of cannon, heavy wads over the ball are in all respects injurious.

For the purpose of retaining the ball in its place, light *grommets* should be used.

On the other hand, it is of great importance, and especially so in the use of small arms, that there should be a good wad over the powder for developing the full force of the charge, unless, as in the rifle, the ball has but very little windage.

Effect of the Size of the Grain.—Within the limits of the difference in the size of grain, which occurs in ordinary cannon powder, the granulation appears to exercise but little influence on the force of it, unless the grain be exceedingly dense and hard.

Effect of Glazing.—Glazing is favorable to the production of the greatest force, and to the quick combustion of the grains, by affording a rapid transmission of the flame through the mass of the powder.

Effect of Using Percussion Primers.—The increase of force by the use of primers, *which nearly closes the vent*, is constant and appreciable in amount, yet not of sufficient value to authorize a reduction of the charge.

Bore, Weight of Charges, and Ranges for U. S. Small Arms.

Kind of arm.	Bore.	Windage of ball.	Powder.	Ball.
	Inches.	Inches.	Grains.	
Musket, . .	.69	*.05	120	397.5 grains. Wad, 10.2 grs.
“ . . .	.69	†.04	110	410.2 “ “ 10.2 “
Rifle, . .	.54	.525	75	218.5 “ “ 8.4 “
Pistol, . .	.54	.525	35	218.5 “ “ 5.5 “
“ . . .	.54	.525	30	218.5 “ “ 5.5 “

* 0.05679 lbs., or 18 to the pound.

† 0.05861 lbs., or 17 to the pound.