Robert Hale

THE

Art of Shooting Flying

EXPLAINED.

THE

Art of Shooting Flying:

Familiarly explain'd by way of

DIALOGUE.

CONTAINING

Directions for the Choice of Guns for various Occaſions.

An Account of divers Experiments, diſcovering the Execution of Barrels of different Lengths and Bores.

With many uſeful Hints, for the Improvement of Young Practitioners, entirely new.

By T. PAGE.

The Second Edition, with Additions.

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Advertiſement.

THE Author is obliged for the favourable opinions he has received from many experienced ſportſmen of the firſt edition of this Pamphlet; and, at the requeſt of ſeveral, has here added ſome account of the compoſition and qualities of Gunpowder; alſo a method of finding the relative velocities of ſhot from guns of different lengths and bores to one another, and their abſolute velocities; ſo that the goodneſs of barrels, in regard to carrying the ſhot with force, needs be no longer a diſputable point; as every one will hereby be enabled to prove it with as much exactneſs as he can deſire.

Here is an account of various experiments made for that purpoſe: alſo the reſiſtance

reſiſtance of the air is conſidered on ſhot of different ſizes. He has avoided any algebraic ſymbols, thinking it better for the uſe of the greater part of his readers to write, inſtead of ſuch marks, words at length; and hopes he has explained the whole in ſo eaſy a manner, as will be comprehended by thoſe who are not acquainted with mathematical operations.

He has publiſhed the following letter, as the gentleman ſeems to differ from him in regard to the ſize of ſhot; which point, he hopes, is ſatisfactorily diſcuſſed at the latter end of the appendix, where he treats on the reſiſtance of the air on different ſurfaces.

THE ART OF SHOOTING FLYING EXPLAINED.

IN A

DIALOGUE

BETWEEN

AIMWELL and FRIENDLY.

FRIENDLY.

MR. Aimwell, your ſervant. I think it is as great a rarity to find you abroad as it is to find ſome people at home. And yet you often talk of ſhooting; but I don't ſee when you find leiſure.

AIMWELL.

The nature of my buſineſs, Sir, requires as much application of my hands as poſſible. Tis

true I am fond of shooting, and perhaps the more so as the exercise has been of great use to me, in carrying off some disorders which are frequently the consequence of too close application to a sedentary business: so that I think four or five hours in a week spent in this diversion is not thrown away, as it seems to give new vigour to the animal Spirits, and enables me to return to business with greater chearfulness.

FRIENDLY.

What you say seems very reasonable. I have thought for some time, a little of this exercise might afford me the like relief from study, as it does you from business; so that I have now prevailed on my father to indulge me in it, and am come with a design to purchase a gun of you.

AIMWELL.

Sir, I much commend your prudence in consulting your father, and waiting for his approbation; it seems to promise that you will not abuse this indulgence to the hindrance of your study, or the hurt of your constitution; for most things, and even the best, may, and do often become detrimental when used to excess.

FRIENDLY.

I think myself obliged for this hint, which shall not be lost on me. But I have something more

to

to claim from an old promiſe, which I ſhall eſteem a particular favour; that you will give me ſome inſtructions in the art of ſhooting flying, that I may be able to uſe the inſtrument I am going to purchaſe, to your credit as well as my own.

AIMWELL

Sir, the reſpect I bear to you and your family will readily diſpoſe me to any thing in my power to ſerve you. And as you are come to ſpend ſome weeks here, now the ſhooting ſeaſon is juſt coming on, I don't doubt but, if you will ſubmit yourſelf intirely to my directions, I ſhall put you in a method by which you may with practice become a markſman. But to attain that muſt be a work of time. I aſſure you, from the little leiſure I had to practice, it was ten years before I became a tolerable markſman: tho' indeed I had not the advantage of a good inſtructor. But from the experience I have had, I hope to put you in a readier way to this attainment.

FRIENDLY.

I ſhall be greatly obliged to you. But as to the gun, what length of barrel would you adviſe to begin with?

AIMWELL.

It is neceſſary for any gentleman who ſports much to have two guns: the barrel of one about

two feet nine inches, which will ſerve very well for the beginning of the ſeaſon, and for wood-ſhooting: the other about three feet three inches, for open-ſhooting after Michaelmas: the birds by that time are grown ſo ſhy, that your ſhoots muſt be in general at longer diſtances. But if you intend one gun to ſerve for all purpoſes, then a three feet barrel (or thereabouts) I think moſt proper.

FRIENDLY.

I have heard ſome of my acquaintance talk of guns of two feet ſix inches in the barrel that will kill at fifty or ſixty yards. Nay, I heard one aſſert, that he threw ſix ſhot into a quarter of a ſheet of paper at a hundred yards diſtance.

AIMWELL.

Well, Sir, I am not ſupriz'd you have heard of theſe great things. I am frequently told ſtories to the ſame purpoſe. But there is nothing gentlemen ſeem more prone to than impoſing on themſelves and others in the diſtances they ſhoot at. I know you have a taſte for mechanical experiments, and therefore don't doubt but you will make uſe of that way of reaſoning, as a ſtandard to regulate your judgment at firſt ſetting out, in this as well as other branches of knowledge And tho' in this art every thing will not admit of mathematical demonſtration; yet I ſhall not demand

mand your assent, but as it shall appear reasonable from experiments; and hope you will not forget something that is similar to it when you become a teacher of men. If you can call on me by six in the morning, I will attend you to a proper place, and try some experiments with guns of different lengths, to give you a sufficient idea of what can be done by guns in general, and to prevent your being imposed on by every idle prater on this head.

FRIENDLY.

I am already obliged for the favour of this conversation, and will attend at your time: 'till when, adieu.

AIMWELL.

Your servant.

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Dialogue II.

FRIENDLY.

GOOD-MORROW, Mr. ——

AIMWELL.

Sir, I hope you are well. You are very punctual, to be here rather before the time appointed.

FRIENDLY.

FRIENDLY.

I knew you were an early riſer, and am deſirous you ſhould think me diligent to receive your inſtructions: but am ready to wait your leiſure.

AIMWELL.

Sir, it gives me pleaſure to find you ſo alert; for as to ſluggards, there is nothing to be made of them. But come, Sir, I am ready. I ſee you have brought your ſervant with you, whoſe attendance may be uſeful: and I have a man who is a very good hand at ſhooting at a dead mark. For my part, I am not fond of it: for guns ſeem to recoil more at a fixed mark than at a flying object; and I am apt to lay my face ſo cloſe, as to get a ſmart blow on the cheek-bone, eſpecially if the barrel lies two ſtraight in the ſtock. I have choſe out ſeveral guns, from two feet ſix inches to three feet ſix inches, which I think is the greateſt variety requiſite for ſhooting flying. And here comes my man with a quire of large brown paper, chalk, a hammer, and nails. Pleaſe to let your ſervant take ſome of the guns, and pen, ink, and paper, for you to take down what I ſhall direct.

FRIENDLY.

Is it far to this Place?

AIMWELL.

AIMWELL.

We are just by it: you see my man, who went before, is nailing up a sheet of paper, and has chalk'd a place in the middle of it to take aim at.

FRIENDLY.

But pray of what use are those long splines?

AIMWELL.

They are two ten feet splines, for the greater ease and exactness of measuring the distances we shall try the guns at. He has measured the distance of six splines, and put down a mark there for twenty yards. Now, Sir, if you will pass over this distance two or three times, till you can do it pretty exactly at twenty paces, and the same when he has measured thirty, forty, and fifty yards, it will be of great use to you by and by to learn to judge of the true distances you shoot at; and therefore you may practice the same as often as you have opportunity.

FRIENDLY.

Pray what is your method of loading? I have been told that gunsmiths in general put in a large quantity of small shot, to make them fill the paper well that they shoot at.

AIMWELL,

'Tis very true, indeed, they are often obliged to it, when gentlemen won't be ſatisfied with what is reaſonable for a gun to do; and it is a common practice in this country to load with a pipe-bowl of powder, and a bowl and a half of ſhot; and when they find they can't kill often, think they don't put ſhot enough, ſo put in more, and are obliged to leſſen the quantity of powder to prevent its recoiling; not conſidering this axiom, "that action and re-action are equal"— that upon diſcharge of powder the gun is forced back, as the ſhot is forwards, in proportion of the weight of ſhot to the weight of the gun; ſo that by putting in a larger load of ſhot, and leſs powder, you will be ſtruck more, and the bird you ſhoot at leſs: ſo that tho' you put many ſhot into the bird, they will not have force enough to kill, unleſs at a very ſhort diſtance. I have been told by a gentleman, who is reputed to ſhoot very well, that when he is diſpoſed to kill at very long ſhoots, he puts in a leſs quantity of ſhot than of powder, becauſe he thus finds them more efficacious. But if leſs of ſhot than powder will carry the ſhot cloſe enough for long ſhoots, they will certainly fly thick enough at ſhorter diſtances. To avoid the extremes, I uſe the beſt powder, and put in equal meaſures of that and ſhot, which in weight is nearly as one to ſeven, but uſually prime out of that quantity. To a barrel of a middle-ſized bore, whoſe diameter is about five-

five-eighths of an inch (which I look upon to be the beſt ſize for ſhooting flying) I put in two ounces of ſhot, No. 4. which are about 200 in an ounce, and an equal meaſure of powder. This is the charge I uſe in the field, and ſhall make uſe of the ſame in our trial: for it is prepoſterous to make uſe of a load expected to make a better ſhoot at a mark, than when you deſign to kill a bird.

FRIENDLY.

And what ſort of wadding do you beſt approve of? I have heard ſome ſay that tow is beſt; others cards ſtamped, to fit the ſize of the bore.

AIM WELL.

Tow, I think, is uncertain. If cards be uſed, the end of your rammer muſt be almoſt as broad as the barrel will admit of, to go down free, and quite flat at the end, to prevent the card from turning; and muſt be puſh'd down gradually, to give time for the air to paſs, otherwiſe it will be troubleſome. This is therefore not the quickeſt way. Old hat may be uſed in the ſame manner, which is rather better: and ſome ſay leather ſhreds are beſt. But I cannot yet find any thing better, or ſo ready, as thin brown paper, rubbed ſoft, and cut into pieces about one inch broad and two inches long; ſo that when it is once doubled, it is an inch ſquare. I punch a

ſmall hole at the corner of each piece, put a ſufficient quantity upon a key-ring, hang them into my button-hole, and tear off one as I want it. This being doubled, put it to the muzzle, and cloſe the corners up about your rammer (the end of which ought to continue of the ſame bigneſs for at leaſt half an inch, or rather ſomewhat ſmaller juſt at the end) and thruſt the paper thus put into the barrel gently down upon the powder. Your rammer will come back without danger of drawing the paper back, and will leave it clos'd againſt the ſides of the barrel, like a half cartridge. Put another in the ſame manner after the ſhot. When your gun is quite clean, it is neceſſary to put in a ſecond wad after the ſhot, to prevent its getting looſe.

FRIENDLY.

Do you ram your ſhot as much as your powder? I think I have heard ſome that pretend to experience ſay, that they ram the powder well but not the ſhot. What is your opinion of this?

AIMWELL.

After ſome experience you will find, if your gun is clean, and the wad thruſt but lightly down, that in walking the ſhot will be apt to get looſe: and if you diſcharge the piece in that ſtate, it will ſeem, by the ſmall reſiſtance it makes, as if there were no ſhot in it: and if you try one load

pretty

pretty ſmartly rammed over the ſhot, and another with the wad thruſt but lightly down, at a quire of paper, you will find the charge that is rammed will penetrate deepeſt, and that the ſhot will fly as regularly as the other which is not rammed.

FRIENDLY.

Well, Sir, it ſeems rational enough; and I ſhall follow your counſel, and try it the firſt opportunity, becauſe I think it a point neceſſary to be thoroughly convinced of.

AIMWELL.

The gun two feet ſix in the barrel is loaded; you ſee I have got a reſt to be the more exact in our trials: fire it at twenty yards.—Well ſhot.—Bring the paper this way, and draw three or four lines acroſs it with your chalk there. By this means you may eaſily count the ſhot-holes; which pleaſe to do, whilſt I load it again, and put down, —The gun two feet ſix inches long, the barrel ſix tenths and a half diameter, weight two pounds fourteen ounces, and weight of the whole gun ſix pounds two ounces.

The firſt ſhot at 20 yards	196	Medium 208
Second at ditto - -	220	
Firſt of ditto, at 30 yards	104	94
Second at ditto - -	84	

First of ditto, at 40 yards	35	Medium 29
Second at ditto - -	23	
First of ditto at 50 yards	16	- 20
Second at ditto - -	24	

By the ſhoots made with this gun, you may eaſily perceive it is difficult to make two ſhoots alike: and therefore no certain judgment can be made of its goodneſs by two or three ſhoots. For inſtance, the ſhoots here made at forty yards, are not much above half the number of ſhot there ought to be in proportion to thoſe at twenty and fifty yards, as you will ſee upon further trials.

No. 2. A barrel two feet nine inches, weight three pounds two ounces, weight of the whole gun ſix pounds five ounces; bore, ſix tenths and a quarter.

First ſhot, at twenty yards	218	Medium 220
Second, at ditto - -	222	
At thirty yards - -	115	11
Ditto - - -	123	
At forty - - -	68	64
At ditto - - -	64	
Ditto, with hat wad -	62	
Ditto, at fifty - -	40	38
Ditto - - -	36	

The powder and ſhot took up two diameters and three quarters each in the barrel.

No. 3.

No. 3. Of a gun whose barrel is three feet long, and two pounds fifteen ounces weight, the bore is six tenths and a half of an inch diameter, and is nearly a cylinder, 'till within three inches of the muzzle, which is opened a little; the weight of the whole gun five pounds thirteen ounces.

First shot, at twenty yards	238	Medium	229
Second, at ditto - -	220		
First, at thirty yards - -	48		54
Second at ditto - -	60		
First, at forty yards - -	36		53
Second, at ditto -	50		
Third, at ditto -	40		
Fourth, at ditto -	86		
First, at fifty -	40		43
Second, at ditto -	46		

No. 4. Of another gun, barrel three feet long, and six tenths and three quarters diameter; weight three pounds three ounces; and whole weight of the gun six pounds six ounces.

First shot, at thirty yards	120	Medium	125
Second, at ditto - -	130		
First, at 40 yards -	45		45
Second, at ditto -	46		
First at fifty yards -	26		32
Second, at ditto -	38		

No. 5.

No. 5. Of a gun the barrel three feet and two inches long, the bore six tenths and three quarters diameter; two ounces of shot loaded it, two diameters, and the same quantity in measure of powder; weight of the barrel three pounds twelve ounces; the whole gun seven pounds three ounces.

First shot, at twenty yards	216	Med. 260
Second at ditto - -	304	
First, at thirty yards -	142	127
Second, at ditto - -	96	
Do. without any wad betwixt shot and powder - - -	129	
First, at forty yards -	94	77
Second, ditto - -	60	
Ditto, with four hat wads betwixt the powder and shot -	70	
Ditto, with a single wad betwixt powder and shot -	94	
First of ditto, at fifty yards -	32	52
Second ditto - -	52	
Third ditto - -	74	

No. 6. Of a gun three feet six inches the barrel, weight three pound six ounces; weight of the whole gun six pounds eight ounces; two ounces of shot, and the same quantity of powder loaded it, two diameters of each.

At

At thirty yards - -	146	
Ditto - - -	177	Med. 148
Ditto - -	116	
Do. without wad over the ſhot	154	
Ditto, at forty yards - -	60	
Ditto - -	94	
Ditto - - -	101	
Ditto - -	70	79
Ditto - - - -	84	
Ditto, with a double wad	86	
At fifty yards - -	34	
Ditto - -	31	33
Ditto - - -	33	

No. 7. A barrel three feet three inches long, weight three pounds twelve ounces, tried in a rough ſtock.

At thirty yards - -	144	144
At forty yards -	59	Med. 76
Ditto, with a hat-wad -	94	
At fifty yards - -	33	38
Ditto - -	44	

No. 8. Another barrel three feet three inches long, weight three pounds ſeven ounces, and was fine bored; tried in the rough ſtock.

At forty yards - -	94	
Ditto - -	100	Med 97
Ditto, with hat-wad -	99	

No. 9. A five feet barrel of the ſame bore and load.

At fifty yards - -	53	Med. 58
At ditto - - -	64	

No. 10. A real Spaniſh barrel three feet eight inches long.

At thirty yards - -	110	Med. 103
Ditto - - -	96	
At forty yards - - -		60
At fifty yards - - -		25

The owner of this gun ſhoots well, and he ſays he frequently kills with it at ſeventy yards; but unleſs he put in more powder and ſhot, I think there is but little chance for killing at fifty yards with any certainty.

No. 11. One ditto three feet two inches, ſeven tenths diameter.

At forty yards - -	77
At fifty - -	28

No. 12. A four feet barrel, ſix tenths and a half diameter.

At forty yards -	84	Med. 77
Ditto - - -	58	
Ditto - -	73	

Ditto, after cutting eight inches off the barrel.

At forty yards	50	Med. 45
Ditto - -	32	
Ditto - -	54	

Upon

Upon ſuppoſition that a gun loſes half the quantity of ſhot every ten yards, (and it appears from the experiments to be nearly ſo) this gun has loſt about a yard diſtance in killing, to one inch taken off from the length of barrel: but the difference of the force with which the ſhot was thrown was ſcarcely diſtinguiſhable.

No. 13. The ſecond-beſt barrel, three feet three inches, Spaniſh faſhion, fixed into a block.

At forty yards - - -	71
Second ditto - - -	62
Third ditto, card over the powder, and paper over the ſhot - -	39
Fourth, without any wad over the powder	70
Fifth ditto, more wad over the ſhot	85
Sixth do. double wad over ſhot and powder	56
There were, at the firſt three ſhoots, put into the target, being a round of three feet diameter, which the papers were nail'd to - - -	446
The laſt three ſhoots which were made on the other ſide of the target, and the ſhot ſeem'd to be thrown in with nearly the ſame force on each	471

No. 14. A barrel, Spaniſh faſhion, weight four pounds two ounces; three feet ſix inches long.

At forty yards - - -	75

No. 15. A barrel, Spaniſh faſhion, weight three pounds four ounces; three feet ſix inches long.

At thirty yards -	110	
Ditto at ditto -	116	Medium 113
Ditto at forty -	64	

AIMWELL.

It appears from various other trials beſides theſe, which I have made, that the ſhot fly as regularly, or more ſo, and with as much force without any wad betwixt the powder and ſhot, as it does with wad only. 'Tis difficult to keep the ſhot from mixing with the powder; and when it does, that will affect it: but it proves thus much at leaſt, that it does not ſignify how thin your wad is betwixt the powder and ſhot, ſo it does but keep them from mixing. But the ſhot fly the thicker and ſtronger from having a pretty good wad cloſely ramm'd over them.

FRIENDLY.

I am well pleaſed with theſe experiments, as they have given me a better idea of the manner of barrels carrying ſhot than I could have imagined. I ſhall now be oblig'd for your opinion, whether Spaniſh barrels are really better than Engliſh ones of the ſame weight, as I find they are ſo eſteemed by many gentlemen.

AIMWELL

AIMWELL.

The repute of the Spaniſh barrels aroſe chiefly from their lengths, being in general about three feet eight or ten inches long, of a ſmalliſh bore, and that nearly a cylinder; by which means the force of the powder is continued longer upon the ſhot: and I have already ſhewn you, that length of barrel will do more than weight. I have try'd a great many Spaniſh barrels very carefully, and could never find them to carry the ſhot better than thoſe made in England of the ſame form and ſize (But the foreigners have found out our foible in that as in moſt other of their rarities: that is, if they are but far fetch'd, and dear-bought, they are ſure to pleaſe.) The Engliſh form of making them very ſtout at the breech, is in order to balance them better in hand, and make them come eaſier to ſight. It anſwers in that reſpect; but then it makes them much heavier, upon the whole: and a ſportſman will not chooſe to carry more weight than is neceſſary. I have already ſhewn you, that from the preſent method of ſhooting flying, we have no occaſion for guns to kill ſo far; and therefore ſhorter and lighter guns will better anſwer our purpoſe, as they are readier to come to ſight, and will kill far enough.

FRIENDLY.

I ſee you have a great variety of guns of different lengths of the Spaniſh form; which with

what you have ſaid, makes me think you rather give the preference to the Spaniſh form.

AIMWELL.

Indeed I do, for ſeveral reaſons. Firſt, I never ſaw a gun of the Spaniſh form burſt near the breech, tho' many of them are very ſmall or weak: therefore 'tis not neceſſary to add ſuch a quantity of metal on account of ſtrength; it can be only with a deſign to balance it the lighter forward. But as barrels of common lengths will balance very well, it anſwers no good or uſeful purpoſe to make barrels ſo ſtout at the breech. Again, they often draw thoſe barrels thinner forward about the middle, in order to make them the more handy, and to look neater; tho' I think it no addition to its beauty, and this will take off from the force the ſhot is carried out with: ſo that a barrel of the Spaniſh faſhion, continued with a more regular thickneſs will kill farther than one of a greater weight where there is more metal than is neceſſary at the breech, and too thin forwards. Another diſadvantage in a barrel ſo made, is, that it will be bigger and clumſier above the lock part, and the ſtock will not have ſtrength enough. For if you take notice, you will often find the ſtock ſplit with a little uſe from the breech to the foreſide nail, than in thoſe of the Spaniſh faſhion, where there is room to leave the ſtock ſtronger, without making it clumſey

ſey. But I would not have you imagine, that I approve of barrels too thin at the breech. I would have them of proper ſubſtance for ſtrength in every part, and ſo as to balance properly. I have experimentally ſeen a good killing barrel loſe much of its force in carrying ſhot, by filing it thinner; which ſhews that barrels ought not to be drawn ſo thin; ſince a tolerable ſubſtance is neceſſary both to carry the ſhot ſmartly, and for ſafety.

FRIENDLY.

Since you are ſo free and ready to inform me, if I am not too inquiſitive, pray explain to me why the bore you mentioned, of about five eighths of an inch diameter, is the beſt ſize for ſhooting flying? ſince the generality of barrels appear to me to be much larger.

AIMWELL.

'Tis very true that birding guns in general are of a larger bore: but if you judge of them by the ſize at the muzzle, they appear to be much larger than they really are; many of them being much opened at the muzzle, and gradually leſs for about a foot, and then continue nearly a cylinder to the breech. This form is uſed to make them carry the ſhot cloſer by letting them open gradually in coming out. The reaſon ſeems plauſible, and appears ſomtimes to have ſome effect, when open'd gradually

gradually a ſmall matter. But there is no reaſon to open them too much; for in that caſe the fire will have room to paſs off on each ſide all round the wad, when it comes to the part much wider and then loſe of its force, and may alſo mix with the outermoſt part of the ſhot, and cauſe them to ſcatter the more from a true direction. Many barrels are again open'd a little wider gradually towards the breech, in order to carry the ſhot with greater force, by firſt meeting with ſome reſiſtance, and then paſſing free: (and alſo that the whole quantity of powder may take fire quicker.) This has alſo appeared to me to anſwer the effect deſired; and yet I have met with barrels that have been as nearly a cylinder as poſſible in the bore, yet have carried the ſhot as round and as ſtrong as any other. For which reaſon, I practiſe opening them but very little, and gradually at each end, as I ſee occaſion; which method I find anſwers beſt. As to the ſize, 'tis certain there muſt be a ſized bore, which carries a particular load better than any other. Now, as ſhooting flying is very difficult for ſome to attain, and even the beſt markſmen have oftentimes their miſcarriages, they are willing to make uſe of as large a load as they can, without hurting themſelves: and therefore ſome will chooſe a large bore, thinking it will carry a larger load. 'Tis very true that it will require a larger load; but then the gun muſt be heavier in proportion to the load, or (as I have already obſerved) they will be

be hit harder, and the bird not ſo hard. If two ounces of ſhot, and the ſame meaſure of powder be thought ſufficient (and I think it is to ſhoot at any ſort of game) then a barrel, whoſe bore is about five eighths of an inch (or rather a little more) diameter, will be loaded about two diameters and a half of each, and the weight of the gun may be about ſix pounds. But thoſe who will ſhoot with two ounces and a quarter of the ſame meaſure of powder, muſt carry a gun of about ſeven pounds, which will ſeem heavy to moſt people after three or four hours walk. Indeed, I have known two ounces and a half, and three ounces of ſhot, made uſe of to a gun under that weight: but then a ſmaller quantity of powder was uſed, and conſequently could not be ſo efficacious as a ſmaller quantity of ſhot, and equal meaſure of powder: and if a ſmaller bored barrel is loaded too deep, tho' the gun be heavy enough, the ſhot will not be thrown cloſer than they would be with a proper load: that is, about two diameters and a half of each. And if a larger bore have not its proper load, it will not kill ſo ſmartly as the ſame load in a bore proper for the load. There are but few who will care to ſtand before a proper load for a barrel ſix eighths of an inch diameter, except poachers, who are covetous of killing every thing, and will ſtand the bruiſing for a ſmall advantage: but fair ſportſmen are not ſuch ſpit-hunters; they purſue for

for the ſake of diverſion, and to ſhow their dexterity.

FRIENDLY.

I am greatly obliged for this account of barrels, which is fuller and more ſatisfactory than I expected. And now I think I may venture to chooſe a gun. There ſeems to be one of the ſize and bore you recommended,

AIMWELL.

'Tis very true, Sir. But you are not yet judge enough to chooſe a gun. There is more to be obſerved than the ſize and bore of the barrel. That gun is made for a broad ſhouldered man: the ſtock is bent ſideways, as if you would lay the plate of the lock upon your knee, and with your hands could bend it: and the point or toe of the butt turns out a little to the right, ſo as to bring the breech of the barrel to his eye in a direct line with the muzzle, without conſtraint of bending down his head much, which a ſhort necked man cannot do without danger of hurting his face. If you pleaſe, give me leave to recommend this gun to you. The ſtock of it is of a middling bend and length, and quite ſtrait ſideways; which, as you are ſlender, and your neck ſomewhat long, will beſt ſuit you. The length of the butt from the breech is about fifteen inches and a half; and if a ſtraight ſpline is laid to the barrel, ſo as to touch

touch the muzzle and breech, and continued to the butt, you will find that the butt drops about three inches from that line, (and for a man who has a ſhort neck, it ought to drop about a quarter of an inch more) and at about three inches from the butt, where the face touches, about two inches and a half: and if he is broad and ſtout, and cannot reach his arms ſo forward, fourteen or fourteen inches and half in length from breech to butt may be ſufficient. Pleaſe to take hold of the gun, and balance it upon the fore finger of your left hand, (which is a proper ſituation for your left hand) then join your right hand with your fore finger, juſt to feel the trigger, your thumb upon the cock, and throwing it off a little ſpace from you in a horizontal direction, to prevent its rubbing againſt your ſhoulder. In taking up the gun, ſlip your thumb off the cock, and draw the butt to your ſhoulder, ſo as to feel it gently, and point the muzzle to any object; and if you find the breech in a line with the muzzle, without any conſtraint, it then lies very well to ſuit you. Now, if you obſerve, you will find an error, which many gunſmiths perſiſt in, is here remedied: the trigger is hung at a right angle with the pull of your finger, and as backward from the guard as it will admit of: whereas the trigger is frequently hung to form a right angle with that part of the ſtock where it hangs; in which caſe the finger draws at a diſadvantage,

being in drawing it forced close to the ſtock; which poſition ſhortens the lever, and cauſes it to draw off harder than in this, where you find the finger more naturally ſlips to the end of the trigger, and lengthens the lever: and 'tis neceſſary to take the advantage of this as much as may be, in order to have a good ſear-ſpring, without which the lock cannot move well nor ſafely; for if the ſear-ſpring is made too weak, in order to make it draw off eaſy, it will then be ſubject to catch upon the half cock; and if it draws off too hard, you cannot be certain of ſhooting any flying object. Another diſadvantage which attends the trigger being hung too forward, is, that the middle finger will be ſo near the guard as to receive a ſmart blow upon the diſcharge of the piece: I have ſeen many perſons who have had a callous ſwelling upon this finger, from being batter'd by the guard through this defect. I think it neceſſary to give you this hint, as you may ſometimes have occaſion to ſhoot with other guns, or to make choice of a gun elſewhere.

FRIENDLY.

I believe I ſhall fix upon this gun, as it ſeems very handy to me, and comes eaſy to ſight. But pray be ſo kind as to inform me, if you have any objection to a barrel of two feet ſix inches, more than its carrying the ſhot: for the gun we try'd of that length ſeem'd to carry the ſhot very ſmartly and cloſe at 30 yards.

AIMWELL,

AIMWELL.

Your obſervation, Sir, is true: it threw in ninety ſhot, on a medium at thirty yards, into a ſheet of paper, which one may venture to affirm would kill a bird if held right, and it may ſometimes kill at forty yards. But pleaſe to take notice, that the weight of it was ſix pounds two ounces: and if you compare the ſhoots with thoſe made with the three feet gun, whoſe weight was but five pounds thirteen ounces, you will find them ſo much ſuperior, that it muſt evidently kill farther with the ſame load: which, I think, is one objection to your propoſal. The next is, ſhould a ſhort gun go off by an accident whilſt you are loading it, you are more expoſed to danger, as you will more naturally lean over the muzzle; which, however, in ſhort or longer guns ought always to be avoided. What have once happened may happen again. A gentleman whom I knew very well, was out by himſelf a ſhooting, and juſt as he had loaded his gun (though he knew of no defect in the lock, 'till it was afterwards examined) it went off, and ſcalp'd him ſo as to leave the forehead bare to the ſcull. We may ſuppoſe he laid for ſome time ſenſeleſs. As ſoon as he recover'd a little, he ſaw his hat ſhot to pieces, and himſelf bloody: perceiving what had happened, he tied a handkerchief about his head, and walk'd home, and is now perfectly recovered.

FRIENDLY.

A narrow escape with life indeed; and I am greatly obliged for this caution. Indeed the frequent misfortunes which happen from guns, shew we cannot be too careful in the use of them: and I must agree with you, that we are not so much expos'd to such an accident as this from a long gun as from a short one.

AIM WELL.

There is one more objection, which I think an over-balance to the advantage, if it be thought one, of a short gun's coming more readily to fight, which is: though a longer gun requires a little more care to bring it to the object, when it is once brought it is not so easily put aside as a short one, nor does a little variation of the muzzle carry the shot so wide from the object as the same variation of a short one does; which I think may be thus easily explained. Draw a line upon a sheet of paper, and from a point, with a pair of compasses, cut the line at two inches and a half, and three inches and a half: from the same points of intersection, set off one-tenth of an inch from the line, and draw lines from the first point through each of these; and at about twelve inches from the three and a half, you will find it will vary about half an inch from the first line, and the other, which intersects at a tenth distance from the line at

at the two inches and a half, will at the twelve inches be found to vary about three quarters of an inch. Now, if you count a foot for an inch, the one will have varied ſix inches, and the other about nine inches, at the diſtance only of twelve feet; which I think plainly ſhews that a ſmall variation of a ſhort barrel will cauſe a greater error, which will increaſe as the diſtance of the bird is farther from you. But if your barrel is too long and not ready to come to ſight; then your extraordinary lengths will not anſwer your expectations, as you may judge from the experiments we have made, that good barrels will not kill above a yard for an inch in length of barrel, from three feet to four feet in length; and therefore a barrel of three feet three inches, I think, anſwers the beſt.

FRIENDLY.

Well, Sir, you have ſufficiently ſatisfied me in all the queſtions I am at preſent able to aſk, as to the choice of guns: and I would not have been without this knowledge upon any account; as I am certain it will enable me to go on with eaſe and courage, and I ſhall ſooner become a proficient in the art of ſhooting flying. But, pray what is next to be done?

AIMWELL.

I ſhall now give you a ſhort leſſon, which will take you a long time to get: but I muſt firſt take the

the flint out of your gun, and put in a piece of wood of the ſame form, that you may not wear the ſteel of the hammer by frequently ſtriking it down. And now, Sir, take the piece, carry it upon your left arm, with the thumb of your right hand upon the cock, and fixing your eye upon any particular object, preſent the gun in the manner before directed, and in the motion of bringing it up cock it: do it pretty briſkly, but in no hurry, ſo as to confuſe yourſelf: in raiſing the cock take care that you preſent the muzzle as near as you can at once to the object, only rather below, that you may have a little matter to raiſe it, and as quick as you can: briſkly draw the trigger as ſoon as you have got an exact ſight at the object, and continue to keep your muzzle at it for ſome time after you have drawn the trigger, leſt your gun ſhould hang fire: which if it happen to do in a very ſmall degree, it will render your ſhot quite uncertain, eſpecially if your mark is moving towards right or left, or any way from the line: but by means of your keeping the gun in motion with the object, a ſhot may be ſometimes recovered, though it hangs fire. This you may practice in your room, or when you walk, at any object ſteady or flying; and do it as often as you can conveniently, till you can readily get the object, and draw down in proper time: by which means you will make a greater progreſs in one month than by the common method of ſhooting in a year or two.

It

It may not be amiſs now juſt to give you a hint concerning croſs-ſhooting: from the many experiments you have ſeen of guns carrying ſhot, you muſt have an idea how the ſhot ſpread at different diſtances.

A very good gun at twenty yards will ſpread the ſhot ſo, that in a circle of twelve or fourteen inches no bird can eſcape alive. Now, if the ſituation obliges you to ſhoot at a bird at this diſtance flying croſs, either to the right or left, if you take aim ſix inches before it, ſuppoſing the bird not to have mov'd from the time of your drawing the trigger to the ſhot's hitting it, the bird will be entered far enough into the circle of the ſhot to be ſecured: but as the bird is in motion, it muſt have moved ſome way before the ſhot can reach it: ſo that 'tis moſt likely the bird will meet the center ſhot; and ſhould you be ſomething longer in drawing the trigger, you will have the better chance from the rear ſhot. From the ſame reaſoning, if you take exact aim at the bird, and draw briſkly, you may kill it with the rear-ſhot: but by obſerving the above method, you have double the chance, as the bird muſt paſs through the whole diſk of the ſhot. I think I have already remarked, from the experiments we have made, that the ſhot delivered from a gun in general loſe or decreaſe half the quantity every ten yards, or thereabouts;

abouts; ſo that at forty yards there will not be thrown in above a fourth of what it would into the ſame ſpace at twenty yards. From which it appears, that if you take aim at a foot before a croſs ſhoot at forty yards, you will be the moſt likely to meet the bird with the center ſhot; and which by the by I look upon to fly the ſtrongeſt, and to be more efficacious at long diſtances than the diverging ſhot; for whether it be the ſhot ſtriking againſt each other, or againſt the air, at firſt coming out of the muzzle, or whatever be the cauſe of their diverging, I think it muſt in ſome degree retard their motion. But if there is a briſk wind, it will certainly bend the courſe of the ſhot; you muſt therefore conſider, whether the wind blows with the bird, or againſt it; if it blows with it, you need little more than obſerve the general rule, by reaſon the wind will help the bird forward nearly as much as it diverts the ſhot; but if it flies againſt the wind, the ſhot decline more than the bird is retarded, and therefore you ought to take aim at a greater diſtance before the bird.

Theſe hints may be of ſervice; and from theſe you may judge of all other diſtances. Yet practice only can make you a maſter in this critical point, as alſo in the oblique ſhoots. For inſtance: ſuppoſe a bird at any diſtance from you flies off in a diagonal line, you muſt take aim but

but half as much before it as you would do in a croſs ſhoot at the ſame diſtance; and in the ſame proportion at a greater or leſſer angle. The different marks are very prettily deſcribed by an ingenious gentleman of St. John's College, ſome years ago, in a poem call'd PTERYPHLEGIA, which is ſo fit for the occaſion, that I ſhall give it you in his own words.

" Five general ſorts of flying marks there are,
" The lineals two, traverſe and circular;
" The fifth oblique---which I may vainly teach;
" But practice only perfectly can reach.
" When a bird comes directly in your face,
" Contain your fire awhile, and let her paſs,
" Unleſs ſome trees behind you change the caſe.
" If ſo, a little ſpace above her head
" Advance the muzzle, and you ſtrike her dead.
" Ever let ſhot purſue where there is room;
" Marks hard before, thus eaſy will become.
" But when a bird flies from you in a line,
" With little care I may pronounce her thine.
" The unlucky croſs-mark, or the traverſe ſhoot,
" By ſome thought eaſy, yet admits diſpute.
" As the moſt common practice is to fire
" Before the bird, will niceſt time require;
" For too much ſpace allow'd the ſhot will fly
" All innocent, and paſs too nimbly by:
" Too little ſpace, the partridge ſwift as wind,
" Will dart athwart, and bilk her death behind.
" This makes the point ſo difficult to gueſs,
" 'Cauſe you muſt be exact in time, or miſs:

" Full forty yards, or more, to left or right,
" The partridge then obliquely takes her flight:
" You've there the advantage of a ſideling line;
" Be careful, nor her inward ſide decline.
" Thus in the mark is ſtiled circular,
" There's nothing more requir'd but ſteady care,
" T'attend the motion of the bird, and gain
" The beſt and farther lineal point you can;
" Carrying your piece around, have patience 'till
" The mark's at beſt extent, then fire and kill.

Dialogue III.

FRIENDLY.

WELL, Sir, for this week ſince I ſaw you, I have much practiſed the leſſon you gave me, and believe it will be of great uſe to me; for I find that I can already point the gun to any object very readily.

AIMWELL.

Sir, I don't doubt your application; and ſhall now put a flint into your gun, and recommend it to you to practice for ſome time the ſame method with a little prime, and then with a ſmall load of powder; which may not improperly be term'd, teaching you to ſtand fire, without the leaſt

leaſt ſtarting; which is a thing very material towards the becoming a good markſman. When you are perfect in this, you may ſhoot at a mark at twenty yards, with half a charge, or a little more. By degrees, as you find you can do it well, without any fear or uneaſineſs, repeat the ſame at thirty yards, with about three quarters of a charge.

FRIENDLY.

I am oblig'd for this leſſon. I ſhall call on you again in about a week; in which time I don't doubt but I ſhall be able to handle the gun pretty dexterouſly.

AIMWELL.

I believe you will ſoon make a progreſs in ſhooting; but I have juſt thought of a method, which I ſhall now inform you of, by the practice of which you may be able to become a tolerable markſman at your firſt going into the field. Get a target made of a piece of board; let it be round, and about three feet diameter; put a ſtaple into the edge of it to hang it up by; get a ſpline ten or twelve feet long, and to one end of it fix a hook to hang the target on, and near the other end make ſeveral holes to hang it to an iron pin, which is to be fixed up in a convenient place at a proper height, ſo as the target when hung on it is ſuſpended ſometimes a little

higher, and ſometimes lower than a point blank mark. This is to be put in motion like a pendulum, and you may ſhoot at it whilſt it is moving, either to the right or left, with about half a load, at twenty yards diſtance; and by the breadth of the target, you will eaſily ſee how the body of the ſhot went, either before or behind the mark, and the next ſhoot you may take aim accordingly. It will be neceſſary that you prepare ſome whitening, that you may with a bruſh cover your ſhots every time before you ſhoot again; and with a piece of charcoal, you may make a mark to take aim at. You may alſo ſometimes ſtand obliquely to it; by which means you make a very great variety of marks. When you have made this way of ſhooting very familiar to you, try it with about three quarters of a load at thirty yards; and by much practice of this method, you may become a better markſman at firſt going into the field than you would be without it by a year's practice in the field; becauſe you may hereby diſcover an error, that you perhaps would otherwiſe perſiſt in; and as you can repeat your ſhoots at any time when you have leiſure, as often as you like: which is not the caſe in the field; for ſport is ſo very uncertain, that you may go out ſeveral times and not get many ſhoots; ſo that, unleſs a man is very alert, and ſtrong enough to undergo a deal of fatigue, he can attain the art of ſhooting

ing flying but very ſlowly: whereas by this contrivance it becomes a ſcience, and may be practiſed with ſatisfaction by the curious, whether weak or ſtrong. The reaſon why you are to uſe but half a load at firſt, is, that it may not in the leaſt diſturb your poſition, or cauſe you to ſtart; which if you ſhould get a habit of at firſt (as you may do by overloading) you will find it difficult to attain to any certainty: for you muſt be very ſteady, and endeavour to keep the gun to the mark after you have drawn the trigger, as has before been obſerved, and the ſhot will fly thick enough at twenty yards to make your obſervations from; and you may encreaſe your load, and the diſtance you ſhoot at, by degrees, as you find it convenient: but never be covetous of overloading, though you want to kill at long diſtances, for that will not anſwer your expectations.

It may not be improper in this place to take notice of the force of powder. As there is an amazing difference in the ſtrength of powders, it is neceſſary that you try your powder, and increaſe or decreaſe its quantity, in proportion to its weakneſs or ſtrength. There are ſmall machines for this purpoſe, with a lock ſomething like a piſtol, which are convenient, as they are portable. But I lately

lately contrived one, which ſeems to be much more ſatisfactory. I ſhall endeavour to deſcribe it to you, as follows. It was made of forged iron, one inch and three quarters ſquare, and two inches and a half long, with a ſhank about two inches long, on which part was filed a coarſe ſcrew, to fix it into a block by. A round ball was made of forged iron, about one inch and ſeven tenths diameter, and weighed twelve ownces. At the top of the iron was a hollow, made to receive about a third part of the ball, and fitted it very cloſe. In the middle of this hollow a hole was drill'd, about three tenths of an inch diameter, and one inch and a quarter deep, which held eighteen grains of powder: a place was ſunk on one of the edges of the ſquare for a pan, and a touch-hole drill'd. Thus compleated, it was ſcrew'd into a block, to point a little higher than an angle of forty-five degrees, that the ball might lay the ſteadier in the hollow. After this I made the following experiments.

	Yards
Some Dutch powder, large grain'd, threw the ball - - -	1 1-half
Some powder bought at the grocers, at 16d. per pound, near - -	4
Battle powder - - -	8 1-half
Double ſtrong ditto - -	8 1-half
Beſt double ſtrong ditto - -	12

The

The experiments were tried firſt with the ſtrong powder, which increaſed at the ſecond trial about a yard and half, and third trial near a yard more. After which, the iron being a little warm'd, the trials with the ſame powder came pretty nearly alike, and each ſort was tried three or four times: the ball was alſo carried very nearly in the ſame line. From which circumſtances I conclude this the beſt method of proving gunpowder that I have yet met with.

If you have a deſire to be acquainted with the nature and compoſition of gunpowder, and the good and bad qualities attending it, I recommend to your peruſal the tracts on New Principles of Gunnery, by the late ingenious Benjamin Robins, Eſq; wherein, by a new contrivance, he has not only determined the force of any quantity of gunpowder, but alſo the velocities of balls diſcharged from barrels of ſeveral lengths, in a moſt accurate manner. He alſo makes it appear, that the incurvated track of balls to the right or left, or otherwiſe from the line, is occaſioned partly from the reſiſtance of the air on the inequalities of the ſurface, and partly from a whirling motion the bullet has acquired in coming out of the barrel. I think it is not unlikely, that the great difference of our ſhoots made with the ſame quantities of ſhot from the ſame piece may

may be from the ſame cauſes, as ſome of the ſhot are not very round, and ſome of them may acquire a greater degree of that whirling motion than others in parting from each other, which will continually increaſe the deflection as they go on from the line. If this be the caſe, we ſhould not endeavour to throw them with more force than is neceſſary; becauſe, he proves, that the reſiſtance of the air will increaſe in a much greater proportion to the force added than has hitherto been ſuſpected, and will conſequently increaſe the deflection of thoſe ſhot which have received ſuch a motion. Upon the whole, therefore, I think, that if you uſe the beſt double ſtrong powder, two-thirds of the quantity will have as much force as the full charges of common powder, and be ſufficient to kill at 50 yards, which is as great a diſtance as a ſportſman will in general attempt to ſhoot at, and indeed greater than he ought to ſhoot at: for if we will make the lives of poor birds our diverſion, we ought to put them to as little miſery as we can; and therefore ſhould not ſhoot without being certain they are within our reach, ſo that the ſhot will fly thick enough to kill them outright. I therefore recommend it to you to begin with that quantity of the beſt powder, and not increaſe it, unleſs you find it neceſſary.

I have

I have now given you all the hints I can recollect ſerviceable for the improvement of a young practitioner; but it muſt be from much exerciſe that you will become a markſman. As to your conduct in the field, you will have opportunities of going out with different perſons, who will differ much in their opinions: I ſhall therefore leave it to your own judgment to deal on every occaſion as experience may direct.

As you are going to leave this part of the country to-morrow, and the ſhooting ſeaſon is juſt at hand, I ſhall diſmiſs you with the following hints, always neceſſary to be remembered.

Take care to keep your powder from getting damp, which will weaken it in proportion to the quantity of moiſture it receives.

Before you take the field, examine that your barrel be clean and dry, and clear the touch-hole with a feather, which you may leave remaining in it until you load; and oil the ſprings of the lock.

Take with you flints, a turnſcrew, and a worm upon your rammer.

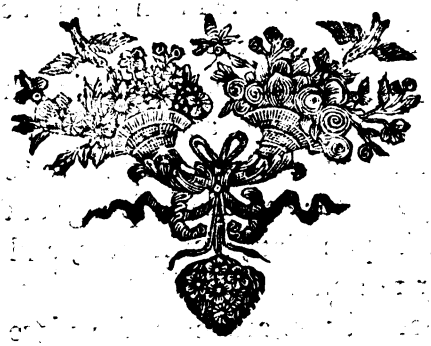
Load not 'till you are near the place of action. It will not be amiſs to fire off a little powder firſt, to warm the barrel; if you do not, it is neceſſary to put in a little more powder for the firſt load.

Prime not too full.

Ram down your powder very gently, with a ſingle wad of ſoft paper over it; and pretty tight with a double wad over the ſhot.

When you have fired, load again as briſk as poſſible before the barrel cools, as the heat will expel any dampneſs from the powder, and increaſe its force.

Be careful, yet not timorous.
Raiſe your piece gently to the object.
Take time, and never ſhoot without aim.
Be ſilent, and avoid the ſun.



APPENDIX.

HAVING in my first edition of Shooting Flying recommended to the curious the perusal of the Tracts on New Principles of Gunnery, by the late ingenious Benjamin Robins, Esq; it has been requested, that in my next edition I would select from that work such parts as may be thought useful to sportsmen, in discovering the real velocities with which shot are thrown from barrels of different lengths and bores, with various charges of powder and shot. I shall, therefore, first give a short account of the nature and properties of gunpowder; then proceed to give the rules for finding the potential or greatest range of bullets, at forty-five degrees of elevation, of pieces of various lengths and bores, estimated in vacuo; from which will be shewn how much the velocity will be increas'd or decreas'd, by lengthening or shortening the barrels: and then to elucidate the whole from experiments, as nearly as the nature of such computations will

admit: for a rigorous and geometrical determination is incompatible with the ſubject; it being almoſt impoſſible to make two experiments alike, without ſome variation, though near enough for our purpoſe to diſtinguiſh the goodneſs of guns uſed by ſportſmen, amongſt whom are ſuch frequent diſputes. And firſt of gunpowder.

Gunpowder is a compoſition of ſalt-petre, ſulphur, and charcoal. The ingredients are firſt to be finely powdered, then moiſtened with fair water, vinegar, ſpirit of wine or urine; and afterwards all muſt be well beat for a long time, taking care to wet the maſs frequently to prevent its taking fire; and, laſtly, ſqueezing it through a ſieve to granulate it.

The charcoal and ſulphur eaſily take fire and kindle the nitre; and the ſpirit of nitre being thereby rarified into vapour, ruſhes out with an exploſion.

'The proportions of the ingredients of gun-
'powder are various; but that which has been
'approved by experience, and ſeems now to be
'generally allow'd the beſt, is, that in any quan-
'tity of powder three-fourths of it ſhould be
'ſalt-petre, and the remaining one-fourth con-
'ſiſting of equal quantities of ſulphur and char-
'coal. The moſt expenſive part of the compo-
ſition,

'sition, and conſequently the part in which pow-
'der is moſt liable to defect, is the ſalt-petre.'

'Salt-petre is of itſelf an uninflammable ſub-
'ſtance: for if it be placed in the moſt violent
'fire, it only melts, and never flames, provided no
'combuſtible matter be previouſly blended with it.
'But though unmixed with other bodies it will
'neither flame nor burn, yet if it be joined with
'combuſtible ſubſtances, it greatly augments the
'violence of their burning: powder then being
'a mixture of ſulphur and charcoal (which are
'inflammable ſubſtances) with ſalt-petre (which
'in itſelf is not) if the ſalt-petre be too much
'in quantity, when compared with the other two,
'their burning may not be ſufficient to conſume
'the whole of the ſalt-petre; whence the fire
'may be leſs violent. On the other hand, if
'the ſalt-petre be leſs than what the burning of
'the other two ſubſtances can eaſily conſume,
'the fire will be leſs active and exploſive than
'it ought to be.'

'Hence it appears, that the goodneſs of pow-
'der is not to be eſtimated from the quantity
'of ſalt-petre only contained therein; although
'that ſubſtance ſeems to be the baſis of the elaſ-
'tic fluid in which its force conſiſts. Nor is it
'the due proportion of the materials only which
'is neceſſary to the making of good powder: an-
'other

'other circumſtance not leſs eſſential, is the mix-
'ing of them well together. If this be not effectu-
'ally done, ſome parts of the compoſition will
'have too little force; and in either caſe there
'will be a diminution in the ſtrength of the
'powder.'

'Gunpowder fired exhibits by its exploſion
'the effects of an elaſtic fluid; whether it be
'air or not, I ſhall not take upon me here to
'determine; but this is certain, it acts like air in
'a condenſed ſtate. This fluid ſeems to be de-
'rived from the ſalt-petre alone; for neither the
'brimſtone nor charcoal yields it when fired ſe-
'parately: and ſalt-petre is known to be a ſub-
'ſtance imbibed from the air by the earth; for
'the ſame parcel of earth, by being properly
'ly expoſed to the air, will furniſh ſalt-petre over
'and over again for ever.'

'Now as bad powder uſually contains ſome
'common ſalt in it, by reaſon of the little care
'taken in refining the nitre; and as common ſalt
'imbibes moiſture in a ſtronger degree than ni-
'tre; it is not difficult to conceive how bad pow-
'der ſhould in a moiſt ſeaſon be more impregna-
'ted with moiſture than good, and conſequently
'loſe more of its force.'

'As powder when wet will not fire at all, ſo
'every degree of moiſture will leſſen its force.
'If

'If, therefore, powder be expoſed to the greateſt 'damps without any caution, or if common ſalt 'abound in it, the moiſture it imbibes may per- 'haps be ſufficient to diſſolve ſome parts of the 'nitre, which is a laſting damage that no dryneſs 'can retrieve; but if proper care is taken in pre- 'ſerving powder, and the nitre it is compos'd of has 'been well purged of the common ſalt, it will 'retain its force many years.'

'But the moiſture of the atmoſphere will in- 'creaſe the weight of powder even in a room 'where a fire is kept; it is therefore neceſſary to 'dry the powder in damp weather before you uſe 'it; but ſome care is required in drying damp 'powder; for there is a degree of heat, which 'though not ſufficient to fire the powder, will 'yet melt the ſulphur, and deſtroy the texture 'of the grains; nay more, there is a heat with 'which the ſulphur will flame and burn away 'gradually, and yet the powder will not explode. 'Of this any one may ſatisfy himſelf, by heating 'a plate of iron red hot, and then throwing on a 'few grains of powder by intervals, during the 'time of its cooling; for by this means he will 'find, that at a certain time the ſeparate grains 'that fall on the iron will not explode, but will 'burn with a ſmall blue flame for ſome ſpace of 'time, the grains ſtill remaining unconſumed.'

'Standard

'Standard gunpowder, ſuch as is or ought to 'be made for the uſe of the government, fired 'in any ſpace, acts nearly in the ſame manner 'as a quantity of air would do, which was a 'thouſand times more denſe than the common 'air we breathe; and which in that condenſed 'ſtate filled the ſame ſpace that was taken up by 'the unfired powder.'

Hence it follows, that the preſſure of the powder on the ſhot grows perpetually weaker and weaker, as the ſhot are impelled forwards; the inflamed powder taking up more room, and conſequently its elaſticity being diminiſhed.

Mr. Robins diſcovered, 'in a piece near four 'feet in length, charged with half an ounce of 'powder, and the ball about an ounce, that the 'velocity communicated to the bullet during the 'three firſt inches of its motion, was full half 'the velocity which it acquired in its whole paſ-'ſage through the barrel; and that the elaſticity 'or force of the powder in the firſt three inches 'of its expanſion, was at a medium near eight 'times greater than in the laſt two feet of the 'barrel; that from theſe circumſtances, the whole 'maſs of powder might be ſuppoſed to be kin-'dled before the bullet was ſenſibly moved from 'its place.

'That

'That if the charge of powder in a twenty-four pounder takes up one foot of the cylinder before it is fired, and the whole length of the cylinder be nine feet, then when the bullet arrives at the mouth of the piece, the powder extends through nine times the ſpace it did at firſt, and conſequently exerts but one-ninth of its original preſſure; and the longer the piece is, in proportion to the extent of the charge, the more is the action of the powder diminiſhed.'

'If the ſame piece be fired ſucceſſively with different charges of powder, the preſſure of theſe different charges upon the bullet, in any given part of the barrel, is nearly in proportion to the quantity in each charge.'

'If two pieces of the ſame bore, but of different lengths, are charged with the ſame quantity of powder, the longer the piece, it will, rigidly ſpeaking, communicate the greater velocity to the bullet. However, unleſs their lengths are extremely diſproportioned, the velocities of their reſpective bullets will differ but little: for inſtance: if a muſket barrel, of a common length and bore, be fired with a leaden bullet, and half its weight in powder, and if the ſame barrel be afterwards ſhortened by one half, and be again fired with the ſame charge; the velocity of the bullet in this ſhortened barrel

'will be about one-ſixth part leſs than what it 'was when the barrel was entire: and if, inſtead 'of ſhortening the barrel, it be increaſed to twice 'its cuſtomary length (when it will be near eight 'feet long) the velocity of the bullet will be 'hereby augmented by more then one-eighth 'part; and the greater the length of the piece 'is, in proportion to the diameter of the bullet, 'and the ſmaller the quantity of powder, the 'more inconſiderable will theſe alterations of 'velocity prove. So that increaſing or dimi-'niſhing a twenty-four pounder, for inſtance, 'by a foot in length, with its cuſtomary charge 'of powder, occaſions no greater change than 'one-fortieth part in its velocity.

From the above mentioned principles it follows, that the actual velocities, with which bullets are impelled from their reſpective pieces, are hence eaſily aſſign'd; whence the potential random, or their greateſt ranges at 45 degrees, eſtimated in vacuo, may be readily known. I ſhall here lay down ſome practical rules for that end, without entering into their demonſtration.

RULE.

'If a leaden bullet be fired with its weight of 'powder from a piece of 90 diameters long, its 'potential random will be 60,000 yards; and if 'both the powder and the length of the piece 'are

'are together increaſed or diminiſhed in any 'proportion, the potential random will be in-'creaſed or diminiſhed in the ſame proportion. 'Thus with half the weight of the bullet in 'powder, and a piece of 45 diameters long, the 'potential random will be 30,000 yards, and 'with a fourth of the weight of powder, and a 'piece of 22 one-half diameters, its potential 'random will be 15,000 yards.

'To find the potential random to any given 'piece, bullet and charge, proceed thus; firſt 'find what length of piece (eſtimated in diame-'ters of the bullet) and what potential random 'correſponds in the preceeding rule to the given 'charge of powder; call this potential random 'A: then if the length aſſigned by the rule is 'the ſame with the length of the given piece, 'this number A is obviouſly the potential ran-'dom ſought. But if the length of the given 'piece be more then the length deduced from 'the rule, then take the difference of the tabu-'lar logarithms of theſe two lengths, and mul-'tiplying this difference into A (the logarithm 'of 10 being ſuppos'd unity) and then adding 'the reſulting product to A, the ſum will be the 'potential random requir'd. If the given piece 'falls ſhort of the length deduced from the rule, 'inſtead of exceeding it, then the product of the 'difference of the logarithms into A muſt be ta-

'ken from A, and the remainder will be the po-
'tential random ſought.'

Suppoſe it be required to determine the potential random of a piece thirty inches long, and ſix-tenths bore, carrying a bullet three quarters of an ounce weight, equal to 336 grains, with 80 grains of powder; 80)336(4,2: here the weight of ball is four and near two-tenths the weight of the powder; and by the rule, 90 by 4,2 is,

4,2) 90,0 (21 diameters
And 4,2)60000,0(16666 yards, which call A.

Whence a piece of 21 diameters in length, with this charge, would have a random of about 16666 yards. The barrel in queſtion being 30 inches is 50 diameters, ſubtract the logarithm of 21 from the logarithm of 50.

The

The logarithm of 50 is 1,6989700
Logarithm of 21 is 1,3222193

,3767607
The difference multiplied by A 16666

22605642
22605642
22605642
22605642
3767607

6279,0938262
To which add A 16666

The potential - 22945 random ſought

	Diameters		
A piece of 36, is	60	24259	Yards.
Ditto of 42, is	70	25380	
Ditto of 48, is	80	26347	
Ditto of 60, is	100	27962	

Now let us ſuppoſe the killing diſtance of the piece of two feet ſix to be 40 yards, if we divide its random by 573, it will give that number 40: and if all the other randoms are divided by the ſame, their quotients will bear the ſame proportion.

Thus

		Diameters.	Yards.
Thus the barrel	2 feet 6	50	40
	3 feet	60	42 1-5th
	3 feet 6	70	44 1-5th
	4 feet	80	46
	5 feet	100	49

And theſe are the proportions of their killing diſtances, or velocities, from pieces of theſe lengths with the ſame bore and load. And barrels of any different ſized bores, with the ſame proportion of powder to the weight of the bullet, and the ſame lengths in diameters of the bullet, will have the ſame ranges.

Hence a piece of ſix-eighths bore will require a bullet of one-twelfth of a pound, equal to 584 grains; and 132 grains weight of powder, and 50 diameters, equal to 37 1-half inches, will be required to give the ſame range, or the ſame velocity, with the barrel of 30 inches in length, and ſix-tenths bore. So that of a piece of ſix-eighths bore, with the load mentioned, and only 30 inches long, the random would be 17,349 yards, and its proportional killing diſtance only 30 yards: but as this load of powder is greater than any man can bear to ſtand againſt, with double the weight of the bullet in ſhot, its velocity will ſtill be much decreaſed by leſſening the quantity of powder: ſo that 90 grains weight of powder to the ball of 584 grains, with a piece of

of 90 diameters, would range only 15,932 yards, its killing diſtance in proportion with the others being only 27 yards.

The following is the difference in the lengths of barrels of theſe two bores to give the ſame velocities, occaſioned by the difference of the diameters; with the proportions of powder and ball to each ſize.

Diameters.		ſix-tenths bore.			ſix-eighths bore.	
50	of	2 feet 6	is	3 feet	1	
60	-	3 0	-	3	9	
70	-	3 6	-	4	4	
80	-	4 0	-	5	0	

Hence the length of pieces of any fixed bores muſt be ſo many diameters in length, and the ſame proportions of powder and ball, to give them the ſame velocities.

In the former edition I endeavoured to prove, by comparing ſhoots made at ſeveral diſtances, that a barrel of a common length will not increaſe or decreaſe above a yard in diſtance for one inch of barrel, in regard to its carrying of the ſhot cloſer, &c. and by the above calculations it will not make above two yards difference in the velocity, for three inches of barrel.

From

From the above rules, the potential random of pieces of any lengths or bores may be found: but this on a ſuppoſition that all barrels of the ſame lengths and bores, with the ſame charge, will throw a bullet with equal velocity.

Mr. Robins aſſerts, that he has had ſeveral barrels made for that purpoſe, of different metals and weights, yet of the ſame dimenſions of length and bore, and found no ſenſible difference in their range. However this may be with bullets, it is well known by experienced ſportſmen, that there are great differences in the velocities of ſhot thrown from barrels of the ſame lengths and bores. I ſhall, therefore, next point out the methods by which their real velocities may be known, and make ſome experiments ſufficient to determine the ſame.

The firſt method I ſhall propoſe for this purpoſe, is that contrived by Mr. Robins, for determining the real velocities of bullets, by firing them at a pendulum. Such a pendulum I made, according to the following eaſy and cheap conſtruction.

To a piece of flat iron, about a foot long, having a pivot at each end, I rivetted the end of a flat iron rod, about fifty-four inches in length, ſo as to form a T. At the bottom of the rod were three

three holes, about three inches from each other, to which was faſtened, by three ſtrong wood-ſcrews, a piece of plank-wood about fourteen inches ſquare, and two inches and a half thick. I then hung it upon two half-ſtaples to a joiſt of the cieling of an out-houſe, oppoſite the door, ſo that it might be eaſily taken off and on as I wanted it, and ſwing to and from the door-ſpace ſo freely on its pivots, as to be eaſily put in motion; the pivots being greas'd or oil'd, to prevent any extra-friction of the ſtaples cutting the pivots: I then fixed a ſmall iron-rod from the lower part of the wood or pendulum, to reach within about four inches of the floor, with a loop-hole at its end, to faſten a ribbon or tape to. At a little diſtance before it, was laid looſe on the floor a piece of wood (heavy enough to reſiſt a ſmall force) to which was fixed a piece of ſimple contrivance, through which the tape might be drawn eaſy, but yet ſtiff enough to meaſure the extent of the vibration, after a blow given to the pendulum; one end of the ribbon being faſtened to the loop-hole of the rod. The little inſtrument for drawing the ribbon through was thus made. I took a piece of thin plate-braſs, about the ſize of a card, bent down ſquare about three quarters of an inch of its breadth, through which two holes were made, to faſten it by two ſmall wood-ſcrews to the piece of wood mentioned; the other edge was bent

down ſquare the contrary way for about half an inch of it, and cloſe to the part bent down, near one end of it, was a hole as long as the breadth of the ribbon, and a thin ſpring of braſs rivet-ed to the other end of the part, bent down ſome-thing longer than the whole, in order to preſs it down by the finger, whilſt I put the ribbon thro' which was to draw tight betwixt the ſpring and the upper part. The machine thus compleated, and faſtened to the piece of wood, and laid a-bout twelve inches before the rod of the pendu-lum (to which was faſtened the ribbon) and drawn tight through the machine, and laid looſe on the floor, I put a pin through the ribbon, cloſe to the edge of the braſs next the pendulum; and fix'd a reſt, to lodge the muzzle of the gun upon, at ſeven yards diſtance, in order to make every trial at the ſame diſtance, as well as to level it exactly at the center.

The firſt experiment I made, I found the wood was too hard, as ſome of the ſhot rebounded from it: I therefore cover'd it with a piece of poplar-plank, faſtened to the wood of the pendulum by a nail at each corner: which I found very con-venient, as I could eaſily take it off after ſhoot-ing many times at it, and fix on another piece; becauſe by often ſhooting at it, the pendulum will become heavier; which would cauſe ſome difference in the experiments, unleſs allow'd for.

The

The first of the following experiments I made to try the difference of the force of powder, from a piece of two feet ten inches the barrel, the bore five-eighths: weight of the whole gun five pounds four ounces; with eighty grains of powder, and one ounce and a half of shot.

No. 1.	Yards.	Inches
The best double strong powder drew the ribbon out - - -	18	1-half.
Ditto - - - -	19	1-half.
Powder bought at 16*d.* per pound	12	1-half.
Ditto bought at 20*d.* -	16	1-half.

No. 2. The same charge with a piece three feet three inches the length of the barrel, and six-tenths the bore: weight of the whole gun five pounds twelve ounces.

	Yards.	Inches
The best double strong powder drew the ribbon out - - -	27	1-half.
Ditto - - - -	28	1-half.
Powder at 16*d.* per pound -	18	
Ditto at 20*d.* - -	20	

The trials made with the first gun were weaker, I believe, on account of the touch-hole being wider than usual: but the proportions are much the same, and agree nearly to the proportions in those experiments made in the former part with

my powder-trier: I ſay nearly; for exactneſs is incompatible with experiments of this kind.

No. 3. A gun two feet ſix inches the length of barrel, and ſix-tenths bore; weight of the whole gun five pounds ſix ounces.

	Yards.	In.
With eighty grains weight of powder, and one ounce and a half of ſhot, drew the ribbon out	24	
Ditto	25	
Ditto with two ounces of ſhot	27	
Ditto with ninety-two grains of powder, and two ounces of ſhot	30	

No. 4. Another gun two feet ſix inches the length of barrel, and five-eighths bore; weight of the whole gun five pounds eight ounces.

	Yards.	In.
With eighty grains weight of powder, and one ounce and a half of ſhot, drew the ribbon out	25	1-half.
Ditto with two ounces of ſhot	28	
Ditto with ninety-two grains of powder, and two ounces of ſhot	30	1-half.
The gun, No. 2. with eighty grains of powder, and one ounce and a half of ſhot, drew out	25	1-half.
Ditto with two ounces of ſhot	29	
Ditto with ninety-two grains of powder, and two ounces of ſhot	31	

Her

e

Here it ſhould be remarked, that though the ribbon was drawn out farther with two ounces of ſhot than with one ounce and a half, and 80 grains weight of powder; yet as there was a fourth part more weight in the two ounces, ſo one fourth part of the inches meaſured on the ribbon ſhould firſt be taken off, and then by comparing, it will be found; that each ſingle ſhot of the ounce and a half charge had the greateſt velocity: the quantity of powder muſt therefore be increaſed in proportion to the addition of ſhot, to give each ſhot in the different charges the ſame velocity.

The number of inches drawn out and meaſured on the ribbon, will, I apprehend, be thought ſufficient, by the greater part of my readers, for diſcovering the velocities that ſhot are thrown with from different guns, by comparing them with each other, or the force of different powders by the ſame compariſons. But if we be further curious to know the actual velocity given by the exploſion of powder, that is, how many feet in a ſecond the ſhot would move with at firſt coming from the barrel; this requires a farther inveſtigation, which I ſhall endeavor to explain in the moſt eaſy method.

'The principle on which the machine here 'deſcribed is founded, is this ſimple axiom of 'mecha-

'mechanics; that if a body in motion ſtrikes 'another at reſt, and they are not ſeparated after 'the ſtroke, but move with one common motion; 'then the common motion is equal to the motion 'with which the firſt body moved before the 'ſtroke: whence, if that common motion, and 'the maſſes of the two bodies are known, the 'motion of the firſt body before the ſtroke is 'thence determined. Hence then, if the weight 'of the pendulum be known, and likewiſe the 'reſpective diſtances of its center of gravity, and 'center of oſcillation, from its axis of ſuſpenſion; 'it will thence be known what motion will be 'communicated to this pendulum by the percuſ-'ſion of a body of a known weight moving 'with a known degree of celerity, and ſtriking 'it at a given point. Hence then, if a bullet or 'charge of ſhot of a known weight ſtrikes the 'pendulum, and the vibration which the pendu-'lum makes in conſequence of the ſtroke be 'aſcertained, the velocity with which the ball or 'ſhot moved is thence to be known.

'But in order to compute the velocity from 'the vibration of the pendulum after the ſtroke, 'it is firſt neceſſary to know the dimenſions of the 'pendulum.

The weight of this whole pendulum was 32 pounds 1-half: its center of gravity was 42 inches diſtant

diſtant from its axis of ſuſpenſion: and 55 of its ſmall ſwings were performed in a minute: whence its center of oſcillation (determined from hence) is 46 inches and near 3-4ths diſtant from that axis. The center of the piece of wood is diſtant from the ſame axis 49 inches: and to the loop where the ribbon is faſtned is 96 inches from the ſame axis.

To find the center of oſcillation, ſay, as the ſquare of the vibrations is to the ſquare of 60 (the vibrations in a minute) ſo is the length of a pendulum which beats ſeconds (viz. 39.2 inches) to the diſtance of the center of oſcillation from the axis of ſuſpenſion. Thus as 3025 is to 3600 ſo is 39,2 to 46 3-4ths, the diſtance required.

'In a compound ratio of 49 to 46 3-4ths, and '49 to 42, take the quantity of matter of the 'pendulum, 32 1-half, and the fourth Number 'will be 26 pounds nine ounces.' Thus 49 multiplied by 49 is to 46,75 multiplied by 42 as 32,5 to 26 pounds 9 ounces, the anſwer required.

'Now geometers well know, that if the blow 'be ſtruck in the center of the piece of wood, 'the pendulum will reſiſt to the ſtroke in the 'ſame manner as if this laſt quantity of matter, '26 lb. 9 oz. was concentrated in that point, and 'the reſt of the pendulum taken away. Whence

'ſup-

'ſuppoſing the charge of ſhot impinging round 'that point to be two ounces, or 1-212th part 'of this quantity of matter (nearly) the velocity 'of the point of oſcillation after the ſtroke will, 'by the laws obſerved in the congreſs of ſuch 'bodies as rebound not from each other, be 1-'212th of the velocity the body of the ſhot moved 'with before the ſtroke.'

'The velocity of the point of oſcillation after 'the ſtroke is eaſily deduced from the chord of 'the arch, through which it aſcends by the blow: 'for it is a well known propoſition, that all pen-'dulous bodies aſcend to the ſame height by their 'vibratory motion, as they would do, if they 'were projected directly upwards from their low-'eſt point, with the ſame velocity they have in 'that point. Wherefore, if the verſed ſine of 'the aſcending arch be found (which is eaſily 'determined from the chord and radius being 'given) this verſed ſine is the perpendicular height, 'to which a body projected upwards with the 'velocity of the point of oſcillation would ariſe: 'and conſequently, what that velocity is, can be 'eaſily computed by the common theory of fal-'ling bodies. For inſtance; the chord of the 'arch deſcribed by the aſcent of the pendulum 'after the ſtroke, meaſured on the ribbon, has 'been ſometimes 28 inches; the diſtance of the 'ribbon from the axis of ſuſpenſion is 96 inches.'

Then

Then proceed from 28 in the ratio of 96 to 49. Thus, as 96 is to 49 ſo is 28 to 14 1-3d, the chord of the arch through which the center of the board aſcended after the ſtroke. Now to find the verſed ſine of an arch, whoſe chord is 14 1-3d, and radius 49, ſay, as 98 (the duplicate of the radius) is to 14 1-3d ſo is 14 1-3d to 2,2.

Now the velocities acquired by falling bodies are as the ſquare roots of the heighths fallen from: and as a body falls by its gravity 16 feet 1-12th in one ſecond, and acquires a velocity to carry it uniformly through 32 feet 1-6th, or double the former ſpace in a ſecond; we have, as the ſquare root of 16 1-12th, or the ſquare root of 193 inches, is to 32 1-6th; that is, as 13,9 is to 32 1-6th, ſo is 1,49 to near 3 feet in a ſecond, the velocity which would carry a body to this height; or, which is the ſame thing, the velocity which a body would acquire by deſcending thro' this ſpace.

'To determine then the velocity, no more is 'neceſſary than to multiply 3 by 212, and the 'reſulting number, 636, will be the feet the 'charge of ſhot would deſcribe in a ſecond, if it 'moved with the velocity it had at the moment 'of its percuſſion. But this velocity is to be in-'creaſed in the duplicate ratio of the diſtances of 'the points of oſcillation and percuſſion from the

'axis of ſuſpenſion. That is to ſay, as the ſquare 'of the oſcillating-diſtance is to the ſquare of the 'percuſſion-diſtance, ſo is the velocity here found 'to the true velocity.' Thus, as 2186 is to 2401 ſo is 636 to 695 feet in a ſecond, the actual velocity.

'And ſince the length of the ribbon drawn is 'always nearly the chord of the arch deſcribed 'by the aſcent, and theſe chords are known to 'be in the proportion of the velocities of the pendulum acquired from the ſtroke; it follows, that 'the proportion between the lengths of ribbon 'drawn out at different times, will be the ſame 'with that of the velocities of the impinging ſhot; 'and conſequently, by the proportion of theſe 'lengths of ribbon to 28, the proportion of the 'velocity with which the ſhot impinge, to the 'known velocity of 695 feet in a ſecond, 'will be determined.' Suppoſe it be requir'd to find how many feet in a ſecond the ſhot impinged with to draw the ribbon out 20 inches: ſay, as 28 is to 695 ſo is 20 to 460 feet, the anſwer.

Whilſt I was making the experiments at the pendulum, it came into my mind, that the proportionate velocities with which ſhot are thrown from guns of different lengths and bores, might be diſcovered by ſhooting at a maſs of ſtiff-tempered clay, at ſuch a diſtance, that a ſufficient number

number of the ſhot might be thrown into the maſs, to take the medium of the depths they were ſunk into the clay. I therefore formed a cube of clay, cleared from ſtones, and well beaten, as ſtiff as poſſible to be found: this having ſix ſides, I had opportunity of making ſix ſhoots, either from different guns, or with different charges: from which I made the following experiments.

Some experiments made to try the velocity or force of ſhot, by firing at a maſs of ſtiff-tempered clay at thirty-five yards diſtance.

No. 3. A gun two feet ſix inches the barrel; the weight of the whole gun five pounds ſix ounces; the bore ſix-tenths diameter.

Powder.	*Shot.*	*Sunk deep.*
Grains.	Oz. qrs.	Inch. eighths.
80	1 1	1 3
——	1 2	1 2
——	2 0	1 0
——	2 2	0 7
——	2 0	1 1

No. 5. A Spaniſh barrel three feet five inches; weight of the whole gun was ſix pounds; and ſix-tenths of an inch bore.

Powder.	*Shot.*		*Sunk deep,*		
Grains.	Oz.	qrs.	Inch.	eighths.	
80	1	1	1	2	
——	1	2	1	2	
——	2	0	1	2	
——	2	2	1	1	
——	2	0	1	1	1-half.

The depth of the ſhot-holes made in the clay in the above experiments was taken as nearly as I could at a medium: for they were not all of a depth at each ſhoot: which I attributed partly to the inequalities of the ſhot, though of the ſame number, and partly to ſome ſmall ſtones that might be left in the clay, though it had been well picked and tempered. I therefore cut the clay into thin ſlices, dried it, beat it in a mortar, and ſifted it, then wrought it again into a maſs which was well beaten, and formed a cube of about ſix inches diameter. This maſs was not ſo ſtiff as the laſt; which I ordered purpoſely that the ſhot might ſink farther into it. The experiments made with it were as follow. The wad uſed in theſe experiments was ſtamped out of liſt.

No. 4. The gun two feet ſix inches the barrel, ſix-tenths bore, and weight of the whole gun five pounds eight ounces, being opened a little towards the breech.

Powder.

Powder.	*Shot.*		*Sunk deep.*	
Grains.	Oz.	qrs.	Inch.	eighths.
80	1	1	2	3
——	1	2	2	2
——	2	0	2	0
——	2	2	1	6
——	2	0 paper wad	2	0

No. 6. A gun three feet five inches the barrel; 5-8ths bore; weight ſeven pounds and one quarter.

Powder.	*Shot.*		*Sunk deep.*	
Grains.	Oz.	qrs.	Inch.	eighths.
80	1	1	1	7
——	1	2	1	7
——	2	0	1	6
——	2	2	1	6
——	2	0 paper wad	1	2

Though in theſe experiments the ſhot were ſunk deeper into the clay than in the former; the depth was not more regular: ſo that I prefer clay that is temper'd as ſtiff as is compatible with making a ſound maſs of it.

I order'd another maſs of clay to be temper'd very ſtiff, to try two guns at of a larger bore: but firſt made one ſhoot with the gun, No. 3. by way of ſtandard to refer to.

The

	Inch.
The gun, No. 3. with 80 grains of powder, and two ounces of ſhot, at 35 yards, ſunk into the clay	1 1-4th.
One, No. 7. the barrel two feet ſeven inches, and 6-8ths bore, with the ſame load; weight of the gun ſix pounds	1
Ditto with 92 grains of powder, and two ounces and a half of ſhot	1
A gun, No. 8. the barrel three feet ſix inches, and 6-8ths bore; weight of the whole gun ſix pounds twelve ounces; with 80 grains of powder, and two ounces of ſhot	1 1-4th.
Ditto with 92 grains of powder, and two ounces and a half of ſhot	1 1-8th.

In the experiments made with the guns two feet ſix and three feet five inches at the firſt maſs of clay, there appears to be no difference in their velocities, tho' the barrels were of the ſame bores. I therefore conclude the ſmall barrel to be the beſt.

In the experiments made at the ſecond maſs of clay, the barrel three feet five inches being the largeſt bore to try it fairly, it ought to have had

had a greater load: for the ſhoots from that of two feet ſix inches are greatly ſuperior.

From the experiments made at the third maſs of clay, that the barrel two feet ſeven, ſix-eighths bore, did not throw the ſhot with ſo much force by one fifth part with the ſame load; and that when half an ounce of ſhot was added to the charge, it required twelve grains weight of powder, to give the ſame velocity the ſhot had from the former charge.

That the barrel three feet ſix inches, and ſix-eighths bore, threw the ſhot with only the ſame velocity as the barrel two feet ſix inches, and ſix-tenths bore. So that there appears to be no other advantage in ſhooting with theſe larger bored barrels, than their carrying a larger load. Whereas, 92 grains weight of powder and two ounces and a half of ſhot, ſeems to be as much as any man will care to ſtand againſt.

I could with pleaſure have made more experiments, both at the pendulum and clay: but my health at this time could not permit it. However, as the method for both are here fully given, every one may ſatisfy himſelf with as great a variety of experiments as he pleaſes: and I doubt not but it will afford more pleaſure to thoſe who have leiſure, than many other trifling diverſions, in which men often waſte their time.

As

As the conſideration of the reſiſtance of the air is a ſubject of the greateſt importance to the perfection of gunnery: I think it would be a culpable omiſſion not to ſay any thing on that head, tho' of no great conſequence in ſhooting flying: becauſe few perſons will uſe ſo large a quantity of powder in proportion to the charge of ſhot, as to have it retard inſtead of increaſing their velocities.

Mr. Robins, from computations confirmed by ſucceeding experiments, makes it appear, 'that 'a leaden ball of 3-4ths of an inch diameter, and 'weighing nearly 1-3d oz. averdupoize, if it be 'fired from a barrel of 45 inches in length, with 'half its weight of powder, will iſſue from 'that piece with a velocity, which if it were 'uniformly continued, would carry it near 1690 'feet in one ſecond: and that the reſiſtance of 'the air on a bullet firſt moving with that veloci-'ty amounted to 10 pounds, which is 27 times its 'own weight. That an iron bullet weighing 24 'pounds, if fired with 16 pounds of powder '(which is uſually eſteemed its battering charge) 'acquires a velocity of about 1650 feet in a ſe-'cond, ſcarcely differing from the other. Whence, 'as the ſurface of this laſt bullet is more than 'fifty-four times greater than the ſurface of a 'bullet of 3-4ths of an inch in diameter, and 'their velocities are nearly the ſame; it follows,

'that

'that the reſiſtance on the larger bullet will amount 'to more than 540 pounds; which is near twenty 'three times its own weight. And if the charge 'of powder be increaſed, the reſiſtance of the 'air will be increaſed: conſequently, though in-'creaſing the charge of powder will increaſe the 'velocity of the ſhot, till the powder arrives at 'a certain quantity; yet after this if the powder 'be increaſed, the velocity of the ſhot will de-'creaſe.'

The ſhot generally made uſe of by ſportſmen for ſhooting flying, are No. 3. No. 4. and No. 5. and are in the proportion of 300, 400, 500, and 600, in every two ounces of ſhot of each number; which is a very proper load for a bird-ing-gun of a middle-ſized bore. Now the ſmall-eſt of theſe numbers are made uſe of by ſome, on account of their flying thicker, and thereby having the greater chance of diſabling the wing. But as birds are ſo frequently loſt when only winged; and if only three ſhot take place in the body of the bird, it will be more certain of killing the bird than ſix of the ſmaller ones; I believe the advantage will be in thoſe of the larger ſize: but No. 4. will do very well 'till Michaelmas, for partridge-ſhooting; after which time No. 3. I ſhould think the beſt: becauſe birds will then fly ſtronger, and are not ſo eaſily brought down with thoſe of No. 4.

The proportions of the ſurface of a ſingle ſhot of each of theſe numbers are nearly

As	7,3681	6,0822	5,2415 and	4,6415
Which multiply'd by	300	400	500	600
Give	22,1043	24,3288	26,2075	27,8490

The proportions of the reſiſtance upon the charge of two ounces: for theſe laſt numbers expreſs not the abſolute quantities of the ſurfaces, but the proportionate quantities of ſurface of 3, 4 5, and 6 hundred ſhot to each other. By comparing which it appears, that there is ſo great a difference as 1-4th of ſurface more on the charge of No. 6. than there is on the ſame charge of No. 3. conſequently the reſiſtance of the air is ſo much greater on No. 6. and as there is but half the quantity of matter in each ſhot, their velocity is not half ſo great as thoſe of No. 3. which muſt, I think, be ſufficiently clear to thoſe who conſider it.

It is well worth while for any perſon to ſatisfy himſelf by making ſeveral ſhoots from the ſame gun, at a cube of clay at different diſtances, as 20, 30, or 40 yards, with a proper load of powder and ſhot of No. 3. and then repeat the ſame trials at the other three ſides of the clay, with the ſame gun and load at the ſame diſtances, but with ſhot of No. 6. taking the medium

dium of the depth of the ſhot-holes from each ſhoot; or he may make the like experiments with ſhot of any other ſizes, and at any diſtances he likes, by comparing of which he will be able to determine what ſort of ſhot will beſt ſuit his purpoſe.

The reſiſtance of water is 850 times greater than that of air: and by increaſing the velocity, it will ſometimes reſiſt as much as a ſolid. I ſhall give you the following remarkable experiment, mentioned by Dr. Deſaguliers, to confirm this aſſertion. A ſail was ſpread horizontally in a pond, about two feet and a half under the ſurface of the water; and a muſket with a ſmall charge being fir'd obliquely to the ſurface of the water, but perpendicularly to an half-inch deal-board fixed under the water over the ſail; the bullet went through the board under the water, and after that through the ſail-cloth. The experiment was made again with a greater charge; and the bullet ſtruck againſt the board, without going through it, making but a ſmall impreſſion in the board; yet its roundneſs was alter'd more than the reſiſtance of the board ſeem'd likely to have cauſed; and therefore the bruiſe in the ball was thought owing to the reſiſtance of the water. Upon increaſing the charge a third time, the ball fell upon the ſail, without reaching the board, and was much beaten out of ſhape. At laſt, putting in a charge nearly equal to the

proof, (that is, the weight of powder equal to the weight of the bullet) the bullet was beaten to pieces upon the ſurface of the water.

This great reſiſtance of water was farther confirmed by an accident which happened in firing off ſome water-rockets (upon the Thames) whoſe property is to go under water ſeveral times, and riſe again, and at laſt burſt above the water. One of them in its laſt riſe ſtopping under the middle of a barge, broke there, and made ſo great a hole in the barge's bottom, that there was only time for the company to ſhift into another barge which was near, and the waterman to row to ſhore from the middle of the Thames (at Mortlake, where it is but narrow) before the barge was half full of water. Here the water reſiſted like a ſolid; and conſequently the powder made its way through the wood, which was leſs denſe, and not very thick.

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