from triangles. Mr. Perkins's experiments, and the practice of every sportsman. The recoil, too, takes place, whether the firing be with blank or ball cartridge; if the recoil be greater with a ball, it arises merely from the resistance which this offers to the discharge, allowing time for the more complete ignition of the gunpowder, and the generation of a greater force; hence, also, the effect of a rifled barrel, and the recoil of a foul gun.

The sky-rocket illustrates, also, this theory of recoil. To increase the surface of the composition exposed to combustion, the rocket is bored conically, nearly to its entire depth, the products of this combustion are met by the atmosphere as they rush from the neck of the rocket, and recoil from the resistance; as the cone enlarges, the force increases, and accelerates the ascent of the rocket, poised and directed as it is by the rod. The difference between the effects of the rockets and the shot, is, that in the former, the force increases from the gradual but increasing surface in combustion; in the latter, the force is at once generated, and the aid to the force which separates the shot from the mandrel, is greatest at first, and, though gradually lessening, always adds something to the force of the discharge, until the air within the calibre is equalized with the atmosphere.

The father of the late sir Wm. Congreve, tried some experiments with shot fired from a mandrel; but as he bored the mandrel into which the discharge was put, and did not put the magazine in the chamber of the shot, they failed.

As the expense of trying experiments with Mr. Sieviere's engines, is too great for an individual to incur, the probability of its becoming a most destructive engine in warfare, ought to recommend it to the serious attention of government. The advantages of the lightness of the mandrel, and the unlimited weight of the projectile, are immense. When the experiment was made with the 25 pound shot, an invalid watchman carried the cannon shot and ammunition upon his head to Primrose Hill, before breakfast; and the safety of the engine to those employed in its use, may be shown in the fact, that the shot which burst did no injury to the gunner; and no mischief could happen: for if the shot burst without advancing from the mandrel, the fragments dispersed at right angles, and if with any *projection, in* lines resulting from the united forces, leaving the gunner in safety. The recoil of the mandrel is very small, and arises only at the moment of separation from the pressure of the gases, which, escaping from the calibre, presses upon the end of the mandrel with effect proportioned to its surface. [*Quarterly Journ.*

On the Origin of Air Balloons. By G. Cumberland.

Sir,—It is rather remarkable, that so many books having been published on the subject of balloons, and so much money expended in useless experiments, to discover a method of guiding them with

precision, no one that I know of has as yet pointed out *the origin* of the invention, which will be found, copiously detailed, accompanied by a figure explanatory, in a folio volume, dedicated to Leopold I. by *Francesco Lana*, a Jesuit of Brescia; and published by Rizzardi, of Brescia, MDCLXX. The principal part of this volume is taken up by eight chapters on the subject of telescopes and microscopes, in which he gives directions for grinding lenses, and reflectors of metal, with plans to give the true hyperbolic, elliptic, and parabolic curves, the latter of which is extremely ingenious, and shows how well all this part of the business was understood in Italy, some years before sir Isaac Newton sent in his first papers on the subject, to the Royal Society. There are twenty plates of his own engraving, in outline only, except No. 2, on which he has given a feebly shadowed representation of his favourite invention, the aerial ship, with its four balloons, its mast, and sail; but, as the book must be very scarce, it not having been noticed by either *Fontanini*, or Apostolo *Zeno*, or found in the *Florid* catalogue, I may as well give you the title at length, which is as follows:—

"*Prodromo*—overo saggio di alcune inventioni nuove permesso all' *arte Maestra*—opera chez prepara H. P. Francesco Lana, *Brecian.* Della compagnia di Giesu, per mostrare li più riconditi principij della naturale Filosofia, riconosciuti con accurata Teorica nelle piu segnalate inventioni, ed isperienze sin' hora ritrovatè da gli scrittori di questa materia, et altre nuove dell' autore medesimo.—Dedicato alla sacra Maestra Cesarea del Imperatore Leopoldo I.—In Brescia, MDCLXX."

The book is beautifully printed in small folio, and has a preface of seventeen pages, on the subject of the state of the sciences in his day, and the necessity of adopting the experimental mode in natural philosophy. Of course, like all the writers of that period, he is verbose, but, in many respects, very interesting, and, in general, very rational and ingenious. We will now, however, lay aside all criticism, and relate what he writes on the subject of his *balloon vessel*, which is the most remarkable novelty in his book.

After having, in his fifth chapter *of mechanic inventions, to cause birds to fly through the air*, spoken of *Architus's* dove; Baptista Porta's *flying dragon;* the relation of *Aulus Gellius* in his tenth book of the Aldic Nights; *Regiomontanus's* famous *eagle*, which flew to Charles V. on his entrance into Nuremburg; *Boetius's* narration of certain copper birds, which not only flew, but sang; *Glicas's* relation of other similar birds, which belonged to the emperor Leo; and *Famiano Strada's* account of those which *Tariano* made for Charles V. to amuse him in his retirement,—he goes on to give the rationale of such contrivances, by four different modes, all very plausible; and then, in his sixth chapter, the title of which is, *How to construct ships, which shall be sustained only by the air, and be conducted by means of a mast and sail—the practicability of which is demonstrated*, he thus proceeds—

"The human intellect is not satisfied with the above inventions, but proceeds to improve on them by a method, by which *men*, like birds, should fly in the air; and, probably, the story of *Dædalus* may not be fabulous, since we are told, as a certainty, that a person (whose name I do not remember) in our times, by a similar method, passed across the lake of Perugia, and afterwards, in attempting to alight on the ground, let himself descend with such impetuosity, that it cost him his life. No one, however, has, hitherto, thought it possible to fabricate a ship to pass through the air, as one does that is sustained by the water, since it has been judged to be impossible to construct a machine lighter than the air itself, which would be necessary to produce the desired effect.

"Hence, I, whose genius ever led me to recover difficult inventions, after long study, conceive that I have obtained my object of constructing a machine lighter than air, which, not only by its own levity, can sustain itself in air, but be capable of supporting men, and any given weight; neither do I fear to be deceived, since the whole can be demonstrated by certain experience, and by an *infallible demonstration* from the 11th book of *Euclid*, received as such by every mathematician. Let us, therefore, lay down certain propositions, from whence may be deduced a practical method of fabricating such a vessel, which, if it does not merit, like that of Argus, to be placed among the stars, will, of itself, be able to sail towards them."

He then proceeds to describe in what manner he found the weight of the air, by a method then in use, and which is, afterwards, more fully detailed, when describing the practical part of his machine; and after going through a long series of calculations, founded on the principles laid down by *Euclid*, in his 11th and 12th books, to prove that the superfices of a ball or sphere, increases in the duplicate ratio of its diameter,—as, for example, that a globe whose diameter is double that of another—say, one of one foot, and another of two—the superfices of the globe of two feet, will be four times as large as that of one, and that the solid body of the globe, if two feet increased in a triplicate proportion, will be eight times as large, and, consequently, eight times as heavy as a globe of one foot diameter; so that the superfices of the larger, over the smaller, will be as four to one, and the solidity, as eight to one. All of which may be easily proved by experience, of which he gives numerous examples in his own experiments with glass globes filled with water, or divested of the air; and then proceeds to calculate, to what dimensions *copper globes* may be made, light enough to weigh less than the air they are capable of containing; and comes to the conclusion, by figures, that they may be conveniently made to contain 718 lbs., and that when the air is extracted, they will weigh 410 lbs. $\frac{1}{4}$ oz. less than before, and, consequently, be capable of lifting two or three men. His method of procuring the vacuum, is as follows:—he fills his globes of copper, resting on a stage, with water, by means of a plug at the top, and, by opening a stop-cock, lets it out through a *long* tube, into a vessel of water below, and, unscrewing the tube,

his globe is in a condition to ascend, but is restrained by cords; and four or more of these globes are bound together, according to the weight of the vessel to be elevated from his *balloon;* to which is attached the boat, furnished with a mast and sail, capable of being turned in any direction, which is to be accommodated with an anchor, also, when proposed to be stationary.

And now, says the author, "I can hardly help smiling to myself, to think that it seems to be a fable not less incredible than that which issued from the voluntary and wild fancies of the head of Lucian; while, on the other hand, I know that I have not erred in any of my proofs, having conferred on the subject with numerous well-informed men, who could not discover any errors in my calculations, and who only desired to behold the experiment, and see the vessel ascend; which I would willingly have gratified them with, previously to publishing my invention, *if the religious poverty I profess, had permitted me to expend one hundred ducats, which would be more than enough to satisfy a curiosity so agreeable.* Hence, I must request any of my readers who may be induced to try this experiment, to favour me with an account of their success; since, should any errors be committed in the operation, I may be able to correct them; and, in order to incite others to the trial, I will here resolve such difficulties as may be opposed to the practical operation of this discovery."

He then proceeds to state a safe mode of exhausting the air; and remarks, that some persons may suppose that, from the violence of the rarefaction, the balloon may either be broken, or so bent, as to destroy its rotundity; but, in answer to this objection, he replies, that the globes, being perfectly spherical, the air will compress every side alike; so that it is more likely to strengthen, than collapse them, as his experience taught him with glass globes, which, when not round, were easily destroyed by the egress of air; but when perfectly so, then they resisted all pressure. Next, he proposes, in order to be secure of this form, that they shall be constructed, first, as two half globes, and then soldered up as one balloon. Again, with respect to the question as to what height this vessel may ascend, since, if they could be raised to the surface of our atmosphere, it naturally follows that the men in it would not be able to respire?—to this he replies, that it could only be supported at a certain height, where the atmosphere was sufficiently dense to sustain it, and that she may be loaded according to the altitude intended to sail in; and would have the power to decline, by merely opening the key of the valve, so as to introduce a certain quantity of common air, and thus they could, at any time, descend.

Again, it might be objected, that she could never sail in any fixed direction, as ships do, who have a resistance from the water; but, says the author, "although air does not resist like water, it still makes some resistance, and if it has less than water, there is less to overcome in sailing; and, as there is always some wind, however weak, there will, probably, be always enough to propel the vessel; and with respect to its being contrary to the course they mean to

keep, he has a contrivance to allow the mast to rotate with its sail in all directions."

Lastly, it may be objected, says he, that it will be difficult to overcome the violence of the wind, which may drive them against the mountains—those formidable rocks in this ocean of air, which might overset them; but here, like all sanguine inventors, he finds an easy answer, which is, that the four globes being above the navigators, they must always be a counterbalance, and until atmospherical air is let in, they need never fear to touch the earth.

"And now," says he, "I can see no other difficulty to putting in practice this invention, except one, which is greater than all the rest; and that is, that God would never permit such a machine to succeed in practice, as it would disturb the civil and political government of the world! For who does not see that no city would be secure from surprise, as these vessels would have the power to place themselves directly over their public places, and thus enter them?" And here he gets heated with horror of the fatal consequences of his new invention, and talks of their cutting ships' cables, throwing down darts, and burning navies, by artificial fires and balls, bombs, &c. killing men, and destroying cities and castles, since, by their height, they might contrive to precipitate mischief on others, whilst they remained secure themselves." In a word, the good friar, like Uncle Toby, seems really alarmed, at last, with his own discovery; and I should not wonder if the scarceness of his folio was occasioned by his withdrawing it from general view, at last, lest he should be the author of so much mischief to mankind. [*Ib.*

Abstract of a Memoir read before the Wernerian Society, giving an account of Experiments directed to ascertain the Principles of Attraction and Repulsion in the Lunar Rays, &c.; a Description of several Varieties of the instruments constructed for that purpose; and some Applications of the Observations made, as illustrative of other Subjects. By MARK WATT, ESQ. Member of the Wernerian Society, &c.

THIS paper commenced by some remarks on the unsuccessful attempts that had been made, to determine whether the lunar beam had any calorific properties or not. And, laying this subject altogether aside, the author considered it more probable, that he might succeed in exhibiting, with sufficient certainty, the attractive influence of the moon; a principle which it was generally acknowledged to possess, from the coincidence of its monthly revolutions, with the flux and reflux of the sea. The received calculation also being, that the attractive power of the moon upon our globe, when contrasted with that of the sun, was as 10 to 3, from her greater approximation to the earth.