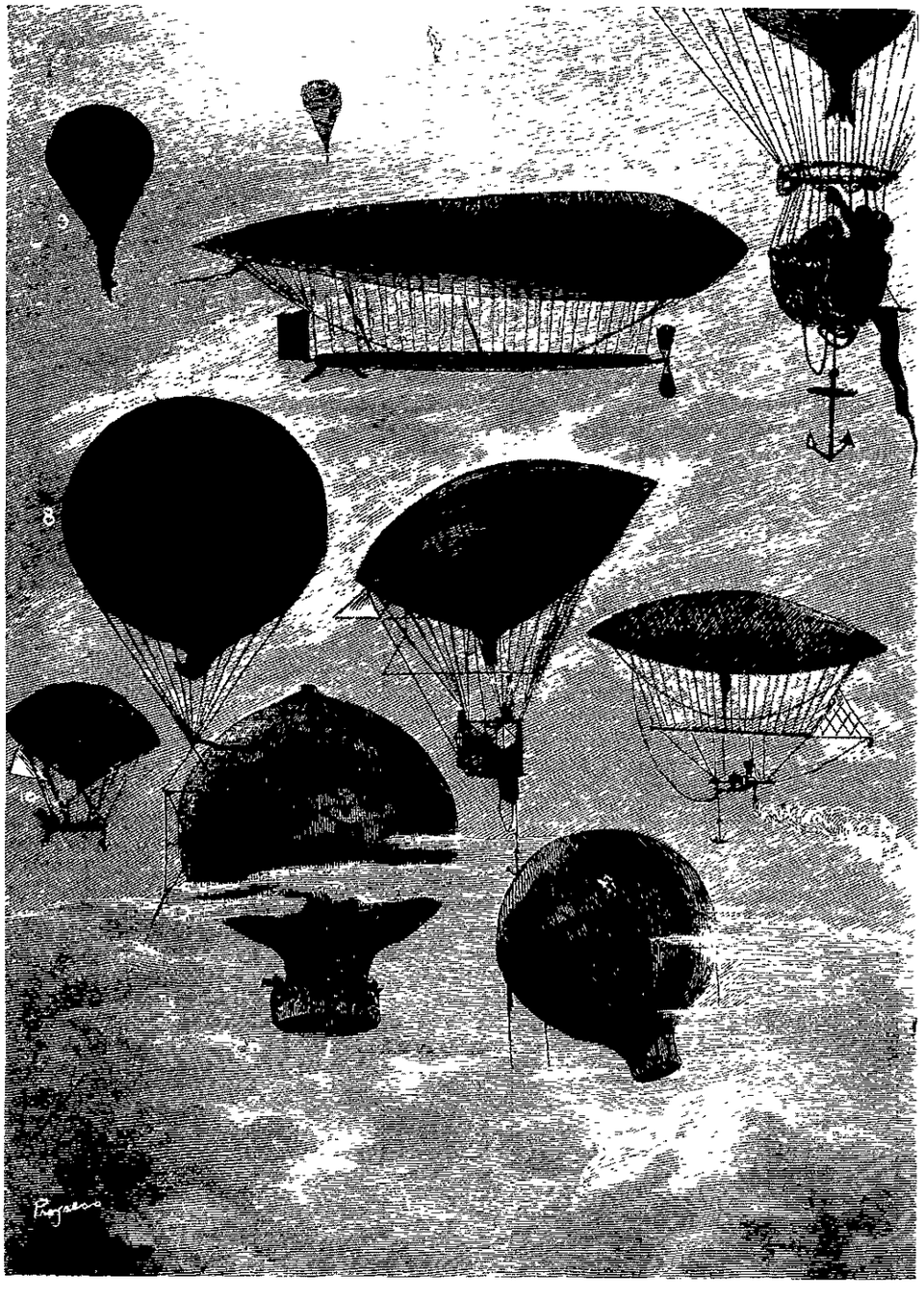

1 MONTGOLFIER 2 TISSANDIER 3 RENARD 4 THAYER 5 CHARLES 6 POWELL, M P 7 WISE
8 CAPTAIN LORRAINE (LOST AT SEA NEAR LYTTELTON, N Z) 9 GREEN 10 GIFFARD

to the seekers of the secret of aerial navigation In 1766 Cavendish discovered the properties of hydrogen, *inter alia* the superior lightness of that gas, and soon after him Black of Edinburgh suggested the plan of making an envelope to enclose any gas lighter than the atmospheric air This suggestion reminds one of the idea put forward by Lana in 1670 Whether it was taken from him or originally hit upon is a question which probably will never be settled Its settlement however at this period of the navigation of the air is immaterial It is enough for all purposes that the brothers Montgolfier flew the first balloon That balloon carried a sheep, a duck, and a cock These were the first aeronauts, and they came safely back to Mother Earth

Two months after the first ascent, the chemist Charles conceived the notion of substituting hydrogen gas for the heated air of the Montgolfier process The obvious advantage was that hydrogen did not like hot air, depend upon a fire to keep it up to the mark as a lifter Charles had some trouble in getting the gas into his balloon but after a little difficulty he succeeded and the first balloon supported by hydrogen went up near Paris remaining in the air for three quarters of an hour On reaching the earth the fabric was torn to pieces by the affrighted peasantry This if it does not confirm the story (now considerably doubted) of Andree's fate in 1898, namely that he was murdered with his companions on alighting by some superstitious natives—Esquimaux, Laplanders, Yakoots inhabitants of some part of the rim of the frozen world—at all events gives it an air of probability The balloon of the chemist Charles was made by the brothers Robert

In November, a month later, Zambeccari discovered the advantages of oiled silk as an envelope for the lighter gas, and since then all balloons have been constructed of that material Soon after the new departure Zambeccari sent up a balloon which crossed the English Channel from Sandwich to the neighbourhood of Ostend, but there was nobody on board Hydrogen eventually took the place of heated air The latter was of course relied on for some little time The first human aeronaut, J Tytler ascended in a balloon inflated by heated air carrying the means of keeping the same hot The unfortunate Pilatre des Rosiers did the same thing, flying over Paris on December 1st, 1784, after ascending from Versailles Limardi followed quickly with a hydrogen balloon The rival aeronaut compromised in the struggle of the elements, and ascended with two balloons, one above the other one filled with hydrogen the other with heated air Unfortunately something going wrong with the upper balloon the gas escaped, and the fire not being alight for expanding the air of the lower balloon the whole fabric came to the ground with a sickening thud from a height of 700 feet Hydrogen after this disaster displaced its rival Before his untimely death Rosiers had flown thirty leagues in his balloon establishing a record which the aeronauts of the day made it the object of their lives to beat In 1787 Blanchard crossed the Channel in a balloon, and the art of managing balloons had begun to be fairly well understood A valve at the top of the balloon worked from the car sundry bags of ballast, and an open throat were the indispensables—the first for lowering by letting out gas, the second for raising by throwing weight overboard, the third for preventing the expansion of the gas at the higher altitudes from bursting the balloon The last precaution was suggested by the fate of several aeronauts whose balloons had collapsed over them after bursting from this cause In 1821 the celebrated English aeronaut, Mr Green, substituted coal gas for hydrogen, and many used it after his example. But the other gas has never gone out of use in consequence In 1836 Green travelled from London to Weilburg in Nassau in his balloon, a distance of 500 miles, and was considered very lucky to have got safely to that place. For it was well understood that the big round balloon was unwieldy, unsteerable, entirely at the mercy of the wind and not too safe in rough weather The type of that balloon is seen in figure 9 in the illustration

The balloon was however, used for many purposes and no car was ever considered complete without a set of observing-instruments The atmosphere was tested and studied at every possible altitude, and under every manageable condition Humboldt was an indefatigable observer, and the names of the most famous aeronauts were Glaisher, Coxwell Croce-Spinelli, Nadar, Godwin and the American Wise, Tissandier, Giffard, and Dupuy de Lome Of these the American Wise flew from St Louis to Jefferson, a distance of 1159 miles He conceived a project for crossing the Atlantic but fortunately for himself it came to nothing It was early in the history that the aeronauts discovered the difficulties of the upper air. Mention has been made of the expansion of the gas at those heights The knowledge of the effect of the atmosphere on the human constitution followed speedily. Balloons ascended to heights up to 31,500 feet Breathing proved difficult, the faces of the aeronauts grew purple, insensibility often occurred, and on one occasion of three men who went up to a height of over 25,000 feet, all became unconscious and two died This type of balloon is in use to the present day Every war office has numbers of them for purposes of observation, many aeronauts keep them for show purposes, descending from them in parachutes,* giving displays on various public occasions, putting them to a variety of uses The only conspicuously serious purpose to which one of the type was put in later years was the purpose of making Andree's attempt on the North Pole This famous aeronaut had invented a system of steering the balloon by a system of drag ropes which he had experimented with in several journeys over the Baltic, all with much success He believed implicitly in the system But his fate contributed greatly to the encouragement of the reaction that had set in so far back as the early fifties against the round type of balloon, whose demerits the aeronauts had found such abundant reason for being displeased with, reasons chiefly of unwieldiness and unsafety.

One of the earliest proposals for getting over the steering difficulty was that of the Greek Stagapoulos who suggested harnessing birds to the sides of balloons to drag them through the air He did not go into any details to show how these novel teams could be driven as well as those which drew the renowned chariots of Venus and Queen Mab, but in the drawing which he made they seem to be doing their work fairly well Giffard—of Injector fame—was the first to devote serious attention to the much desired improvement In 1852 he elongated the shape of the balloon, making it elliptical instead of spherical constructed an example 144 feet long by 39 feet in diameter, fitted it with a rudder, installed a propeller and a motor, (steam) of three horse power, the weight of the motor apparatus being 462 lbs In this he ascended from Paris and, the weather being calm managed to work up to a speed of between six and seven miles an hour having his balloon under some sort of command

He was followed in 1872 by Dupuy de Lome Chief Constructor of the French Navy—a service which has always been in the van of enterprise—with a machine worked by man power taking up on the occasion of his ascent from Paris twelve men for operating the motor. The machine was 118 feet long by 49 feet in diameter, and he had a *success d'estime* He preferred man power, having a wholesome dread of a fiery motor working in close proximity to the hydrogen in the balloon The man power not proving economical others turned to steam, amongst them Wolfert and De Bradski who thought they could take sufficient precautions against the danger feared by their predecessor But they failed, and they lost their lives in full view of Paris

Tissandier came next, in 1883 with a "Dirigible" (see figure 2) which accomplished the best

* Baldwin in 1887 descended a mile in 3½ minutes with a parachute