(20) The contractor will have the right to employ his ships in whaling or sealing, and in loading guano or other cargo.

(21) Should the masters be unable to get right or sperm whales to enable them to compete for the bonus offered under the 12th proviso, they will nevertheless be entitled to the bonus should they return with a cargo of any merchantable commodity obtained within the Antarctic Circle, and having a value equivalent to that of 100 tons of whale oil.

(22) Both ships must be in Port Phillip Bay and ready to start on October 15.

(23) That in case of any difficulty arising in England between the Agent-General and the contractor, it shall be referred to the British Antarctic Committee for decision.

THE CAPTIVE KITE-BALLOON.

IT has always been an objection to the extensive use of captive balloons for scientific or military purposes, that a wind of moderate strength suffices not merely to depress them considerably from the vertical, but to cause them to jerk, rotate, and oscillate vertically and horizontally in such a manner as to render them either partially ineffective or totally useless.

During the recent military manœuvres at Dover, it was stated that the captive balloon under the charge of Major Templer was not allowed to ascend beyond the shelter of the surrounding downs, owing to the strong wind then prevailing. It was thus *hors de combat* as far as the enemy was concerned, and this seems to be a common experience of military balloonists.

The jerking, as a balloon after a freshening of the wind suddenly reaches the end of its tether, is, I am told by an experienced member of the Balloon Corps, very trying to the nerves, while the rotation on its axis is a serious obstacle to steady observation.

The depression of a captive balloon in a wind of any sensible strength is also more than most persons would imagine, and as the velocity of the wind generally increases with the height (very rapidly for the first few hundred feet), while the buoyancy of the balloon, owing to several causes, diminishes, this condition becomes more pronounced at the higher levels.

The depression is obviously due to the fact that a captive balloon, as at present employed, can only be secured at its *base*, and thus the normal component of the wind is resolved in a downward direction, pressing the balloon towards the earth. If the fastening could be made two-thirds of the way up its side, this normal component could be resolved in an upward direction, and utilised so as to add to the elevating power of the balloon. The fragile nature of the balloon fabric, however, renders it impossible to do this except by interposing a kite-surface between it and the wind.

All the preceding defects are remedied and several positive advantages are gained by attaching a balloon to a kite in the manner indicated in the accompanying diagram.

(1) The addition of the kite with the fastening at the side instead of the base counteracts the depression produced by the wind, and not only raises its own weight, but even in a light anticyclonic breeze elevates the whole apparatus to a higher level than that which could be attained by the balloon alone.

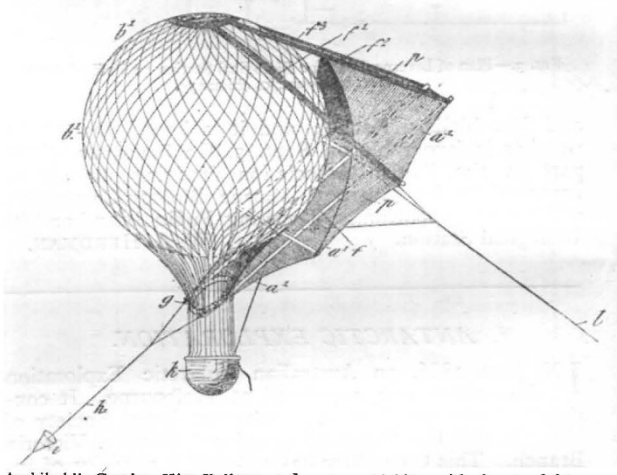
Thus, in an experiment here on Friday, June 10, in the presence of Mr. Eric S. Bruce and others, with a very light wind,[1] the balloon of 113 cubic feet capacity and with 1200 feet of wire out attained *alone* a mean vertical height of 693 feet, while when attached to a kite of 9 feet by 7 feet and the same length of wire it kept steadily at 789 feet. The lifting power in the second case was also greatly increased, as shown by the following comparison of the angles of the kite and wire in the two cases[1]:—

	Angle of Balloon.	Angle of Wire near the ground.
Balloon alone	38°	18°
Balloon with kite	41½°	35°

The addition of the kite raised 1¼ lbs. more than the balloon could have done alone, with a good deal to spare. It increased the height by 96 feet and diminished the sag by 13½°.

(2) With the tail (made of self-regulating cones) it completely counteracts the jerky, rotatory, and oscillatory movement of the balloon, by keeping the wire taut and exerting a constant pull on the balloon at its lower extremity.

(3) With the addition of the *top hood*, an essential feature of the combination, the kite shields the balloon fabric from the destructive action of the wind.



Archibald's Captive Kite-Balloon. a^1, octagonal kite, with frame of four pieces of bamboo; b^1, spherical balloon; f, covering of kite (preferably silk); p, extra or top hood; $f^1 f^2$, &c., bands connecting kite and hood with top of balloon; g, ring connecting lower end of kite with the converging net cords of balloon; h, tail of cones (i); l^1, earth-line connected with kite, one branch passing through a pulley to the car (k).

(4) The combination can be flown on a much larger percentage of days than the balloon alone.

(5) In a large balloon with car attached the occupant can alter his altitude and azimuth by pulling the lower or side attachments of the kite, and thus extend his area of observation.

(6) With the kite, and except in the rare case of a dead calm, a much smaller balloon is needed to raise a given weight.[2]

(7) The use of wire (a suggestion which I owe to Sir William Thomson) greatly increases the strength, and lessens the weight, of the earth-line.

I arrived at the idea of uniting the two apparatuses while conducting my kite anemometrical observations in 1884, owing to my desire to prevent my kites from coming down suddenly when the wind dropped. I found the balloonists equally desirous of some means for shielding their balloons from damage and keeping them *up* in a *wind*. The kite-balloon satisfies both requirements, and will, I trust, be of use both to scientific as well as military observation.

E. DOUGLAS ARCHIBALD.

Tunbridge Wells, June 25.

[1] I have since ascertained that during the trial the mean velocity at Greenwich [211 feet above the sea with a good exposure for the wind (N.E.)] was 12 miles per hour. The present locality was in a valley 260 feet above sea-level, surrounded by hills rising to 500 feet above the sea.

[1] The lifting power of the balloon with hydrogen was about 5 lbs., the wire weighed about 4 lbs. and the kite 2½ lbs.

[2] The kite portion is portable and easily detachable in the event of a calm.