

Mount Everest

By Col. H. L. CROSTHWAIT, C.I.E.

MOUNT EVEREST, everyone knows, is the highest mountain in the world. It was discovered, and its height determined, during the operations of the Great Trigonometrical Survey of India in the course of carrying out the geodetic triangulation of that country in the years 1849-50. The figure adopted, namely, 29,002 ft. above mean sea level, was derived from the mean of a large number of vertical angles observed to the peak from six different stations situated in the plains of India south of Nepal. These stations were at distances varying from 108 to 118 miles. It was not until some months afterwards, when the necessary computations had been completed, that the great height of Everest was first realised. The actual discovery was made in the computing office at Dehra Dun.

The determination of height above mean sea level by the method of vertical angles, observed from one station only, involves the assumption of a coefficient of refraction—always a doubtful quantity, especially where great differences of height are concerned as in the present case—and also a knowledge of the amount of separation of the geoid and the spheroid. Suffice it to say, however, that the subsequent extension of observations to the mountain so as to include stations situated within the hills, and the adoption of a more probable coefficient of refraction, made the summit some 29,149 ft., but the estimated separation of the geoid and spheroid, due to deformation caused by local attraction, would reduce this amount, the net result being to assign to the peak a probable height of about 29,050 ft. above mean sea level. There are also certain other corrections which can be estimated theoretically but these are not taken into account in ordinary trigonometrical levelling.

By height above mean sea level is implied the distance of the summit above the geoid immediately beneath it. Accepting this definition, it is not possible to determine accurately the height when access cannot be had to the summit for purposes of observation. Taking into account that there are still doubtful quantities involved, it has been considered best to allow the time honoured figure of 29,002 ft. to stand, anyhow until sufficient data are available to enable a more exact solution of the problem.

It may be asked why so little was known about the highest mountain in the world beyond its position and height, until comparatively recently, considering it was discovered eighty-two years ago. This was, without doubt, due to its great distance from civilisation and above all to the strict political isolation maintained by the two countries, Nepal and Tibet, on the border of which it is situated. The shortest way, some 110 miles, to reach the mountain from India

would be through Nepal, but even if the Nepalese Government were willing to permit the passage of its country, the route would be through trackless leach-infested jungles impossible for pack transport. Added to this, the snow line is about 2,000 ft. lower on the south side than on the north, for it is subject to the full force of the monsoon and is probably more deeply eroded and, in consequence, more inaccessible than from the Tibet side. For these reasons successive expeditions have taken the longer route, about 350 miles from Darjeeling via the Chumbi valley, Kampa Dzong and Sheka Dzong, made possible since the Tibetan objection to traversing its territory has been overcome.

This route possessed the advantage of passing through country where pack transport was available, and could be used up to the base camp. Further, it lies at an average elevation of about 14,500 ft., so the long march has a certain beneficial effect in acclimatising the party before the base of operations is reached.

Though the project to climb Mount Everest had been long in the minds of several mountaineers, the first definite move in the matter appears to have been due to Major Rawling and Captain Noel, about the year 1912-13. Both these officers had had experience of Tibetan travel. Then followed the years of the War in which Rawling was killed. The project was revived in 1920, when permission was obtained from the Tibetan Government to approach the mountain through its country. A Committee, consisting of three members each of the Royal Geographical Society and the Alpine Club, was formed to collect funds, select personnel, purchase instruments and equipment and generally to manage the business of an expedition to Everest. The chairman of this Committee was Sir Francis Young-husband.

There have now been three expeditions including the one in 1921, which was of the nature of a reconnaissance. The other two were serious attempts to reach the summit—they were undertaken in the years 1922 and 1924. As already announced, a fourth expedition will leave England early this year.

The expedition of 1921, led by Col. C. K. Howard-Bury, consisted of Dr. A. M. Kellas, C. Raeburn, G. H. L. Mallory, G. H. Bullock, mountaineers, and A. F. R. Wollaston, doctor and naturalist. Since the local topography of the mountain and its neighbourhood was quite unknown, Majors Morshead and Wheeler, of the Survey of India, with three Indian surveyors, and Dr. Heron, of the Indian Geological Survey, joined the expedition in India. Unfortunately, that veteran mountaineer, Dr. Kellas, died at Kampa Dzong on the way out.

The party started from Darjeeling on May 18 and after the long detour through Tibet, already mentioned, reached Tingri, a place about 45 miles north-north-west of Everest, a month later. On June 23, Mallory and Bullock began the exploration of the western and northern sections of Everest. Approach was soon found to be, if not impossible at least very difficult, from the west and north-west. They then turned their attention to the great Rongbuk Glacier which drains the northern slopes of the mountain. It was seen to consist of at least two important branches—one trending away to the west, and the main glacier coming down from the northern face of Everest itself.

As the result of these explorations the following facts were established, that the key of the mountain appeared to be an important saddle, the Chang La (North Col), 22,990 ft., situated at the head of the main Rongbuk Glacier, about $1\frac{3}{4}$ miles from the summit of Everest, and that it could only be reached with the greatest difficulty from the main glacier. It then became necessary to seek another way of approach to the Chang La. They decided to try what could be done from an easterly direction. They therefore marched round to a new base which, in the meantime, Howard-Bury had established in the Kharta Valley, at the head of which lies the Hlakpa La (22,200 ft.). This point they eventually reached in the face of very adverse weather. It was found to lead to a hitherto unsuspected eastern branch of the Rongbuk glacier, draining into the main valley through a narrow gorge, which had been missed during the first reconnaissance. Mallory, Bullock and Wheeler crossed the East Rongbuk glacier and succeeded in reaching the summit of the Chang La itself on September 24. In doing this they had the most difficult climb, especially for laden men, that had so far been encountered. "Beyond the Col (Chang La) an easy succession of rock and snow slopes could be seen leading to the north-east shoulder (27,390) of Everest."

The weather and the exhaustion of the party prevented any further advance. This closed the season of 1921. The results may be briefly stated. A practical route had been discovered, via the Chang La, which had been reached from the

Kharta valley, but there was an easier way by the East Rongbuk glacier which avoided the ascent of the Hlakpa La and consequent descent of about 1,200 ft. in order to reach the foot of the Chang La. The best time for high climbing appeared to be the months of May and early June.



FIG. 1.—Everest and the surrounding country. By courtesy of the Royal Geographical Society

In the course of this reconnaissance, 600 square miles in the immediate neighbourhood of Mt. Everest were mapped photographically on the 1-inch scale, which proved of great use in subsequent expeditions.

A way had now been found to make a real attempt to reach the summit. The expedition of 1922 comprised Brig. Gen. the Hon. C. G. Bruce, as leader, Col. E. L. Strutt, as second-in-command,

Mallory, T. H. Somervell, Dr. T. H. Wakefield, Prof. G. I. Finch, Major (now Brigadier) E. F. Norton, mountaineers, Dr. T. G. Longstaff, doctor and naturalist, J. B. L. Noel, photographic and cinema expert. In India the party was joined by the late Lieut.-Col. H. T. Morshead, C. G. Crawford, Capt. Morris and G. Bruce.

One of the questions which the Mount Everest Committee had to consider was the use of oxygen for climbing the last stages of the mountain, which appeared to offer no great difficulty apart from lack of oxygen inseparable from great altitude. It is a matter on which climbers and physiologists are not agreed. Some are in favour of relying on the acclimatisation of those men selected for the final assault. This means remaining for some time at high altitudes under what, at best, must be very trying conditions, where deterioration may set in from the lack of well cooked food and exposure to great cold. The disadvantages of oxygen were the considerable weight of the apparatus, about 30 lb., which the climber himself would have to carry, and the number of porters required to take up the supply of spare cylinders in which the gas is compressed to 120 atmospheres. Then there was the danger of the apparatus going wrong at the critical moment. After taking into consideration all the arguments for and against, "the Committee finally unanimously agreed" to its use.

Profiting by the experience of the previous year, the expedition left Darjeeling on March 26, 1922, following the same route as the year before to Sheka Dzong where they turned south, reaching the spot selected for the Base Camp at the snout of the Rongbuk glacier, 16,560 ft., at the end of April. By May 20 camps were established up to Camp IV as shown on the accompanying sketch map. Camp III at a height of 21,000 ft. at the foot of Chang La on rock, Camp IV on the Chang La, on snow, just under 23,000 ft. What they had now "to aim at was getting two tiny tents carried up the North Face to some niche near the North-East Ridge at a height of 27,000 ft.", that is somewhere above the position of Camp VI on the map, and 2,000 ft. from the top. From such a point it was hoped the final assault on the summit could be successfully made. "So the crux of the situation was the capacity of porters to carry two tents and sleeping bags, provisions and light cooking apparatus for this 27,000 ft. camp" sufficient for four climbers. This arduous work was to be carried out by a specially selected corps of forty Nepalese porters.

The first assault was made on the morning of May 20 from Camp IV, where four climbers—Mallory, Somervell, Norton and Morshead—had slept the night before, but they were only able to reach Camp V, 25,000 ft., and had to spend the night there. The next day was fine and they succeeded in reaching a height of 26,985 ft. just below the north-east shoulder of Everest (marked 27,390 ft. on the map). They were "within one mile of the summit and there appeared

to be no serious obstacle in this last remaining lap—only it was more than could be accomplished in one day from a camp at 25,000 ft." They were compelled to turn back on account of the slow progress made and the lateness of the hour. It was between 10 and 11 P.M. before the party reached the shelter of Camp IV on the Chang La. All four were more or less frost bitten during the descent. The worst case was Morshead, who afterwards had to have the top joint of three of his fingers amputated.

Finch, G. Bruce, and the Gurkha Lance-Corporal Tejbir, then made another attempt, this time using oxygen. They were accompanied from Camp IV by twelve porters carrying spare oxygen cylinders and camp gear. The climbers themselves carried the oxygen apparatus weighing about 30 lb. They hoped to pitch a camp at 26,000 ft., but they only succeeded in reaching 25,500 ft. when they were forced by the weather to camp and send the porters back to Chang La. For thirty-six hours the storm lasted, and there was great danger of the whole camp being blown away. On the third day, still using the remaining oxygen, they reached a height of 27,235 ft., about half a mile from the top, when they were compelled to return.

One more attempt was made early in June by Mallory, Somervell and Crawford, but an avalanche, on the steep ascent to the Chang La, carried away seven of the porters, who were killed instantaneously. The monsoon had now arrived and all further attempts for the season were abandoned.

The results of the 1922 expedition were—heights of 27,235 ft. and 26,985 ft. were reached with and without oxygen; it was ascertained that there are no serious physical obstacles between the highest point attained and the summit. Camps were made at 25,000 ft. and 25,500 ft., but it was found that it was not possible from there to reach the top and return in one day. Oxygen was used for the first time, though its efficacy does not appear to have been definitely proved or disproved.

We now come to the third expedition, which was undertaken in 1924. This year Gen. Bruce was again the leader, but owing to illness he was obliged, shortly after the start, to hand over to Col. Norton who had been appointed second-in-command. The other members were Mallory, Somervell, G. Bruce, Odell, Beetham, Hazard, Irvine, Shebbear, Major R. W. G. Hingston, and Noel who was in charge of the photographic equipment which was to contribute so much to the finances of the expedition.

Darjeeling was left on March 25, the old Base Camp at the foot of the Rongbuk glacier being reached on April 29. The three camps in the glacier valley had then to be established and stocked, and the route to Camp IV on the Chang La made practicable for laden porters. This done, Camp V, 25,500 ft., would have to be similarly established and stocked and finally

Camp VI, at 26,500 ft., and possibly another camp (not marked on the map) at about 27,200 ft. "All this had to be done before the actual attempt could be made."

Camps I and II were established and stocked with Tibetan labour, while all above this were worked by the specially enlisted Nepalese porter corps, fifty-two strong. Early in these operations the occurrence of violent winds and snow impeded the work, obliterating the way which had been prepared a short time before. On the night of May 6-7, the thermometer fell to $21\frac{1}{2}^{\circ}$ F. below zero. There were many sick porters at Camp III who had to be sent down to Camp II. In these circumstances it was not easy to keep up the morale of the porter corps. This first attempt got no further than Camp III. It was beaten by the weather and in the end the whole expedition had to retreat to the Base Camp; even this was only carried out with considerable difficulty. "So ended Round One with the mountain."

After a complete reorganisation of the porter corps a fresh start was made on May 17. By May 19 the expedition was in full occupation up to Camp III. The next operation was to tackle the route to Camp IV, which has already been mentioned as the most difficult obstacle. It was here that the seven porters lost their lives in 1922, so the greatest care had to be taken to guard against a similar accident, by finding a way clear of avalanches. This was found by Norton, Mallory and Odell. It proved to be a most exhausting operation, accompanied by several narrow escapes, especially for Mallory, who nearly lost his life by a fall into a crevasse. The establishment of Camp IV was undertaken by Somervell, Hazard and Irvine, using the way marked out by Norton and Mallory. Ropes were fixed at the worst places and a rope ladder was used for negotiating the chimney. Then came the rescue by Norton, Mallory and Somervell of four porters stranded at Camp IV. Incidents like this are most trying and exhausting for members of the climbing party just before they have to make the supreme effort to reach the summit, yet such occurrences cannot be avoided.

The next effort was made by Norton and Somervell with the help of three gallant porters. They pitched a tent at Camp VI, 26,800 ft., and sent the porters back to the Chang La. The night was spent at this height and they slept fairly well. The next morning, June 4, they started at 6.45 for the summit which was about a mile off and 2,200 ft. above them. The going was good, the day perfect. At 27,500 ft. they both began to feel symptoms of distress. Norton felt very cold and had trouble with his eyes; Somervell also was in trouble with his throat and had to stop often and cough. "Now seven, eight or ten complete respirations were necessary for each single step forward." They struggled on, however, to about 28,000 ft., when Somervell could go no further. Norton went on to 28,126 ft., when his progress became very slow. It was then 1 P.M.

when he, too, was forced to give up. The cause of their failure was most likely due to want of fitness following the strenuous time they, with other climbers, went through in rescuing the marooned porters, and other exertions which should be avoided if the final climb is to be successful.

The last and final attempt was now to be made. Two climbers without oxygen had failed. It was the turn of others to try with oxygen: Mallory, the experienced mountaineer whose third expedition it was to Everest, and Irvine, the young undergraduate and Oxford blue. On June 7 they set out for Camp VI while Odell was in support at Camp V. On arrival Mallory returned his four porters to Odell and he and Irvine spent the night at Camp VI. In a note which he sent back with the porters to Odell he said, "the weather was perfect but the oxygen apparatus was a nasty load for climbing."

Nothing is known of what happened after this except that Odell saw them at 12.50 P.M. the next day much nearer their camp than he had expected they would be had they started early in the morning. Shortly afterwards the mist shut out the view and Odell saw them no more. That evening Odell returned to Camp IV, where Hazard was. The following day, as the climbers did not return, Odell, with two porters, reascended the mountain intending to visit Camp V and VI, but did not get further than Camp V, where he spent the night. The following morning the weather had changed, a strong and bitter wind was blowing. As he could not persuade the porters to go any higher he sent them back to Camp IV, going on himself alone to Camp VI. This time he took oxygen, though he does not seem to have derived much benefit from it. He eventually reached Camp VI but found no sign of Mallory and Irvine. After searching in vain further up the mountain for a couple of hours, he too was obliged to return. In a storm of gale force he reached Camp IV; it was evidently a forerunner of the approaching monsoon. Here Hazard was awaiting him. Next day they evacuated the Chang La camp. Thus ended the last assault on Mount Everest.

A great adventure deserves a great narrative. The story of Mount Everest has been told in three large volumes splendidly illustrated by the leaders and members of the three expeditions, in which every aspect of the subject has been dealt with in great detail. But this is not all, for these narratives have been admirably summarised and woven into a single story entitled "The Epic of Mount Everest", by Sir Francis Younghusband.

What are the chances of success in 1933? A great deal, in fact almost everything, depends on the weather, and in weather we include wind. The very best laid plans may be wrecked at the last moment by one of those sudden changes which occur in the high Himalaya without warning. Wireless might be used to receive weather reports from the Indian Meteorological Department, but whether they could give indications of the local changes is more than doubtful.

The climbers must be absolutely fit and have had an opportunity of acclimatisation, undisturbed by any incident calling for great exertion on their part, such as having to rescue porters from dangerous positions. Yet such incidents are liable to occur.

The margin between success and failure must always be small—that is what makes it such a great adventure. Many favourable conditions must conspire to take the climbers to the summit; without these, success is doubtful.

We have no information as to the plans of the new expedition but we fancy the same camps will be occupied up to, and including, Camp IV on the Chang La (22,990 ft.) with, perhaps, some form of portable hut at Camp III as has been suggested. Higher up an attempt may probably be made to establish three camps in order to climb the remaining 6,000 ft.

As regards oxygen, since 1924 a much lighter form of apparatus has been constructed, weighing only about 12 lb.* While a high degree of acclimatisation will be aimed at by the climbers selected for the final assault, no doubt the latest

* See NATURE, 128, 1037, Dec. 19, 1931.

form of light oxygen equipment will be provided, so that it can be used if required for the last portions of the ascent. Aptitude for acclimatisation appears to vary with the individual. With some persons, deterioration, due to remaining at high altitudes, may set in before acclimatisation has been fully attained; this has always to be reckoned with. We think, given reasonable luck, Everest will be climbed. If fortune smiles the summit will be reached.

The new expedition will be led by Mr. Hugh Ruttledge, formerly of the Indian Civil Service, who has had a great deal of Himalayan experience. The other members of the expedition are Mr. F. S. Smythe, leader of the successful Kamet expedition, with three of his companions—Capt. Burney, Dr. Raymond Green, and Mr. E. E. Shipton; Mr. Noel Odell, Mr. C. G. Crawford, Mr. Shebbear, members of former Everest expeditions; Messrs. Wyn Harris, J. Longland, G. Wood-Johnson, and Capt. Hugh Boustead, and possibly Dr. W. McLean as second doctor; Mr. L. R. Wager, of the Arctic Air Route Expedition, 1930-31, and Mr. T. Brocklebank.

Scientific Centenaries in 1933

By ENG.-CAPT. EDGAR C. SMITH, O.B.E., R.N.

THE year which has just closed saw the commemoration of the centenaries of many famous men, among whom were Scott, Goethe, Leeuwenhoek, Locke and Warren Hastings. Of especial interest to men of science was the commemoration of the tercentenary of Wren, while the celebration at Cologne of the centenary of Otto attracted considerable attention in the engineering world.

The closing month of the year also saw the commemoration of four other men distinguished as engineers or inventors. On December 7, the American Society of Mechanical Engineers at its annual dinner paid tribute to the memory of John Edson Sweet (1832-1916), a founder of the Society and once professor of engineering at Cornell, and to the memory of Alexander Lyman Holley (1832-1882), a singularly gifted man, whose monument in Washington Square, New York, describes him as "Foremost among those whose genius and energy established in America and improved throughout the world the manufacture of Bessemer steel". Eight days later, on December 15, a ceremony took place at the base of the Eiffel Tower to commemorate the centenary of the birth of its constructor, Gustave Eiffel (1832-1923), while on December 23 various tributes were paid to the memory of Sir Richard Arkwright (1732-1792) who reduced to practice the principle of roller drawing in spinning machines, and was the founder of the factory system of cotton manufacture as we know it to-day. Lecky, the historian, speaking of the wealth which accrued to Great Britain through the cotton mill and the

steam engine, and the power this wealth gave the country for carrying on the great French wars, declared that Arkwright and Watt deserved statues beside those of Wellington and Nelson, but so far no monument has ever been erected by his countrymen to Arkwright.

Earlier in the year, at Camborne, Prince George unveiled a statue of the Cornish engineer, Richard Trevithick, the centenary of whose death, falling on April 22 this year, will be commemorated by the engineering world on a scale in keeping with Trevithick's place as a pioneer. Trevithick died at Dartford, Kent, a poor man and for half a century was almost forgotten. The publication of his life by his son in 1872 did much to rescue his achievements from oblivion, and in 1888 a memorial window was erected to him in Westminster Abbey.

The forthcoming celebration is being supported by the leading engineering societies of Great Britain, and the arrangements are in the hands of a committee of which Sir Murdoch Macdonald is chairman. There will be memorial services in Dartford Parish Church and Westminster Abbey, an eminent engineer will deliver an address on Trevithick's work as an inventor, and the committee hopes to be able to erect tablets to Trevithick at his birthplace, Illogan, Cornwall, and also at Pen-y-daren, South Wales, and near Euston Road, London, to record his early attempts to introduce steam locomotion on roads and railways. Trevithick's reputation has never stood higher than it does to-day. He may indeed be proclaimed the father of the high-pressure steam engine.