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SOARING OVER THE CRATER OF MOUNT LASSEN, CALIFORNIA

A Pack Train of Eagles*

Suggested Use of Aircraft in Mining Operations Where Roads and Trails Are Absent

By Eugene Shade Bisbee

A CERTAIN mining company had received several reports from different engineers about a property in a remote part of Idaho. Practically all of the reports were in favor of the property, which the company seriously considered buying. As a final precaution the president sent a young mining engineer to report. After a month or more, this telegram was received: "Vein all right; sample correct; ore is there. To get the stuff out would take a pack train of eagles." This story was told a long time ago, and the acumen of the young engineer was admired, his reference to a "pack train of eagles" exciting a hearty laugh wherever the story was told. Times have changed. What then appeared an absurdity has now passed beyond the air-castle stage. A "pack train of eagles" may not elicit much surprise in the mining industry in the course of a few years. In this day of keen competition the man who says "It can't be done" wakens some morning to discover that somebody has done it.

I have shown before the value of the airplane in preliminary mining operations, the saving of time and money and the greater accuracy of the work. Since that article appeared several American airplanes have been put to work in Peru; and down in Mexico an American mining operator has petitioned the Carranza government for permission to use an airplane in his work. Therefore, it has been demonstrated that aircraft possess a unique usefulness in this field. They not only can be used to survey and map the significant area, but also to carry men in and out and to transport supplies, material, and high-grade ore. They are destined to play a part in mining development, but they will co-ordinate with the prosaic mule in transportation and never wholly replace him

in certain fields that are all his own. In fact, if a mine needs the services of an extra mule it will be the airplane that will carry the mule in, transporting the animal fifty times as fast as his own sure feet would take him there and taking his feed along to boot. For the airplanes that are going to be used in mining will be built to carry not less than 1,200 lb. of useful load.

For this new work both the airplane and the dirigible will be used, as the lighter-than-air craft needs less landing space than the plane, and will, generally, be called upon to transport the more bulky freight, leaving the lighter packages, the high-grade ores and bullion for the speedier plane. In carrying vanadium, uranium and radium ores at present from Paradox Valley to Placerville, in Colorado, four-horse teams are used, and from two to four days are required for the trip of about seventy miles. An airplane would take 1,000 lb. of the ore, winter or summer alike, over the mountains, in less than an hour, making not less than half a dozen trips a day and keeping it up, regardless of ground conditions of snow, ice, land-slides, or anything else, as continuously as may be necessary. Returning to the mine from the railroad shipping point, the airplane can take in men and emergency supplies; it will take the superintendent or other officials back and forth on business; it will keep the operators in continuous touch with both ends, thus making for higher efficiency and greater production and rapid delivery of the product to the base of final disposition.

Very rich ores may be transported in small compass, but an airplane will carry in four days—the time required by a horse or mule team to go one way—not less than twelve times the weight of ore brought out by the animals during

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a like period of time. And it must not be overlooked that it will make twelve return trips, taking in all kinds of necessary supplies or men.

Although it has been said that the airplane will never entirely supersede the mule or the horse in the field where those animals have been pioneers, certain comparisons between draught and pack animals and the airplane throw an interesting light by contrast. After the location has been made by airplane exploration, and the mosaic maps have been prepared and the ore uncovered, tools, men, and supplies must be sent in. The lighter of these tools and supplies can be transported by plane, the heavier by team. Consider the saving of time by the assurance that every bit of smaller machinery, every tool, all supplies, and every man, will be on the ground and ready for action by the time the heavy material has arrived by mules, because they have been taken in by plane, at a speed more than twenty times that of the animals that plod over the rough ground, while the plane darts to and fro above them; the whole circumambient blue being its magnificent roadway. Dwell for a moment upon the toiling string of llamas that pursue their course down the slopes of the Andes, their backs laden with precious ore. All day long they trudge onward, urged by their drivers, who, by the way, are ever careful not to get within "spit-shot" of an irate llama. For there are at least two things that start a fight in South America; one is a llama that believes itself to have been abused, the other is a man whom the llama believes has abused him and into whose eye, from a distance of fifteen or twenty feet, the llama has violently spit. The insult is eradicable only by the near-death of the llama, which can only be saved by the interposition of someone in authority.

While the llamas are covering the distance from the mine to the railroad or seaport the airplane is ever speeding above, back and forth, with mineral and supplies, and even men, doing every day the combined work of not less than thirty llamas, and neither complaining of treatment nor spitting in one's eye!

Statistical details may be made less uninteresting by showing that a pack train of sixty mules can carry approximately, 24,000 lb. some twenty-odd miles over mountain roads in a day of eight hours. Six men will be required to drive sixty mules, and six men will draw, again approximately, \$36 per day in wages. Add to this the cost of the rations for the men and the animals. For the last named the cost will be, based upon the present price of oats and hay at Atlantic tidewater, \$1.06 per day, as a healthy, hard-working mule will need sixteen quarts of oats and twenty pounds of hay daily, if you expect the animal to work. The men will eat up more money, if not an equivalent weight in food.

While the mule train is making its twenty-odd miles per day, with 24,000 lb. of useful load, the airplane is hurrying to and fro at eighty miles an hour, as against the three miles of the mules, and taking with it on each trip about 1,200 lb., or at the rate of a round trip from the mine to the railroad and back, the distance being assumed to be twenty miles, in half an hour, not allowing for time to load and unload. During a day, therefore, the plane could carry back and forth over such a line sixteen loads of 1,200 lb. each, or something better than half of what sixty mules could transport. At the end of the second day the plane would have equaled the work of the sixty mules for the first day, and from then on there would be no contest—just a runaway for the plane.

Considering the cost of the two factors in this work, the mules and their drivers would consume more than one hundred dollars per day in food and wages; the plane would eat up 160 gallons of gasoline and the pilot would cost \$10 each day. Depreciation of both airplane and mules is not considered, but both depreciate proportionately in value as carriers.

The Andes in South America offer a suitable field for the use of aircraft. There are not many roads and there are few trails. Both prospecting and development could be served in almost inaccessible situations. Tools and food supplies

could be brought in at a saving in time and with a sureness that could not be equaled by any other means. Bolivia, Peru and Brazil embrace considerable areas of promising mineral ground, it may be conjectured, but much of it is inaccessible on account of absence of roads and trails. The Chilean nitrate fields could have been reached by exploring parties in no better way than by airplane.

The west coast of Mexico, the Sierra Madre country, and other parts of Mexico, indifferently served by roads, present an inviting field to the prospector-aviator.

The Arctic regions, Canada and northwestern Canada, Siberia, China, and Africa are countries in which ordinary means of transportation and travel are indifferent or almost wholly inadequate. The desert regions of Australia form a vast area presenting possibilities for exploration by flying machines.

As an example of the excessive time consumed in certain features of mine-examination work, mention may be made of a copper region east of the Mackenzie River, in northwestern Canada. It possesses many of the characteristics of the Michigan copper country. To visit this region and complete an examination would require two years, one year to go in and another to come out. With an airplane it is probable that the trip could be made from Dawson in a day's time.

There are certain inherent limitations on the use of airplanes and dirigibles. Both are dependent upon a gasoline supply. In the case of using such appliances in prospecting, the conditions are much the same as would apply to an ocean steamer with but a single base for its fuel supply. The maximum outward trip mileage is equal to but 40 per cent of the fuel supply. This leaves only a 10 per cent margin on both the outward and return voyages. Further, it would indicate that, if the gasoline supply in the case of an airplane would be sufficient for 500 miles at economical speed, and with a normal load of freight and passengers, the extreme safe radius of action would be 200 miles. Thus, from a given center of gasoline supply, the area included within a circle of 400 miles diameter could be served. With a mileage supply of gasoline equal to 1,000 miles, the radius would be 400 miles, and the area, a circle of 800 miles' diameter.

By establishing a supplementary supply point and dividing the trips into pairs, one for extra gasoline transport to the supply point and the other for freight service, the trip in any one direction could be doubled. This computation is based on the assumption that the weight of gasoline carried as freight would be equivalent to the 500 or 1,000 miles assumed respectively for such case. These figures assure to a considerable extent that territory within a practicable distance could be served, although special arrangements would be necessitated for trips from 500 to 1,000 miles in length. These would, of course, require gasoline-supply points at suitable landing places en route. The handicap would be the necessity of bringing gasoline to the supply points. By employing two machines, one could be used for supply stations with gasoline and the other for freight and passenger service.

With the use of airplanes, the practical difficulty would be to find suitable landing places. Necessarily, the first trip would be the most hazardous, but after marking and mapping the landing points, the continuation of service would not be supremely difficult. It is worthy of note that in regions containing a number of lakes, as is the case in many parts of Canada, the hydroplane would be especially adapted for utilizing the lakes for landing places.

In the case of the "blimp" or dirigible, the radius of action would be greater and would admit of reasonably close calculation. There would be a nice division between fuel weight and freight weight. Once a definite route had been established, the proportions of freight and gasoline would be constant. As in the case of airplanes, longer voyages could be attempted by establishing supply stations. As the dirigible could land in a limited area, the pioneering trip of the dirigible would be less hazardous than that of the airplane.

The weak point of the dirigible is the difficulty of adequately protecting it at terminals. Some kind of a structure would be required, at least at the starting terminal, and, where established.

Unlike the airplane, the dirigible could travel at night. The expense of a terminal shed would be almost prohibitive.

Probably the most vital question would be the one of safety, and, after that, the cost. The construction of both airplanes and dirigibles has advanced to the point where both types are safe structurally and mechanically for normal conditions. The danger lies in operation and abnormal weather conditions. Experienced operators could undoubtedly be obtained, and by confining actual flying to periods when weather conditions are suitable the risk could be minimized. Transportation through the air would probably never be as safe as ordinary travel. Hidden defects in mechanical equipment might easily force landing in unsuitable and dangerous places; particularly so where it is proposed to use such devices over mountainous country, as would most certainly be required in prospecting. A highly specialized class of skilled labor would have to be employed, and, for service over a long period, an organization with headquarters and repair shops would be necessary.

The cost of operation, as previously indicated, would be high, but in the aggregate it is doubtful if it would exceed the cost of trails or roads. A 100-mile trail at \$500 per mile would equal \$50,000; a wagon road of the same length at \$2,000 per mile would be \$200,000. Road and trail cost would of necessity be comparatively figured in any actual case. Considering the saving in time, as pointed out before, the number of cases where flying machines could be used for prospecting and development would not be negligibly small.

Already the airplane is a common sight the West, and the skies of California are never clear of its gauzy wings. It has conquered the Atlantic and is about to venture the Pacific for a \$50,000 prize. Airplanes are no dream; they are one of the hardest of hard facts; they are the carriers, the fleet messengers, the fighting wasps and the unconquerable servants of man, who has created and harnessed them. Soon they will swarm in every sky, and the mining man who has not adopted them for his purpose will compare with the farmer who, on his way to market with his horse-drawn produce, is passed by the other chap in the motor truck, on his way home with the cash in his pocket.

RECENT PROGRESS IN THE INVESTIGATION OF THE UPPER LAYERS OF THE ATMOSPHERE.*

By DR. K. SCHOLICH.

EVEN at the very beginning of systematic observations of meteorological phenomena, early in the previous century, the significance of the occurrences in the upper layers of the atmosphere was recognized. However, meteorologists were long obliged to confine their observation merely to the trend followed by the clouds. It was not until the turn of the century at the beginning of our modern conquest of the air, when the necessity for information concerning the atmosphere became indispensable, that methodical investigation of the upper atmosphere was instituted.

Pilot balloons have been of especial service in this respect, whether sent up empty for the purpose of the rapid measurement of high winds or whether provided with registering apparatus so as to furnish data with regard to air pressure, temperature, and humidity of the upper regions of the atmosphere. These rubber pilot balloons possess the great advantage of making their entire upward journey with a constant vertical velocity, as was proved by Hergesell. The information obtained from pilot balloons with regard to atmospheric phenomena has been enlarged particularly in Germany by means of kite ascensions.

During the late war both sides experienced the necessity

of placing the military weather service upon as broad a basis as possible. It was particularly necessary to provide the air service with exact data concerning the air currents in the middle layers of the atmosphere. Because of the embargo, also at the Germany found herself short of rubber for the making of pilot balloons and, therefore, employed as a substitute paper made air tight to a certain degree by means of suitable impregnation. These balloons naturally did not possess the unlimited ascensional power of the rubber ones, but since they were able to attain an altitude of about 6,000 meters they were sufficiently servicable for the needs of the air service, and because of their greater cheapness they will doubtless be employed for practical weather service even during times of peace.

The rapidity of ascent of the paper balloons is, however, not the same at all heights as it is in the case of the rubber balloons; consequently their course must first be determined by empirical methods. Afterwards it is sufficient to observe the ascent of the balloons from a given point.

A very great disadvantage was experienced in the determination of wind conditions under a cloudy or rainy sky, and this was a serious matter, particularly for the artillery. The French were the first to obviate this difficulty by the ingenious method of sending up a pilot balloon provided with a number of melinite cartridges arranged in a row along a fuse in such a manner as to explode at given intervals during the ascent. The resulting detonations were received in sound meters and these acoustic signals were evaluated by means of simple graphic methods similar to those employed for optical signals during fine weather. In this manner it was usually possible to make measurements of the velocity of air currents up to an altitude of 7,000 meters. The kite measurements previously made as a usual thing attained only very moderate heights.

Because of the discontinuation of meteorological information over the domain of the Atlantic Ocean, the prediction of storms was made considerably more difficult for the Central Powers. On this account it was more necessary than it was previously to obtain and make use of information concerning the distribution of temperatures, humidities, or air pressures in the upper layers of the atmosphere. Since, however, kite stations require not only an extensive provision of apparatus but even more a skilled staff, and the latter cannot be quickly trained, difficulty was experienced in rapidly increasing such stations. On this account recourse was had to flying apparatus as a substitute for kites. These were furnished like the kites with registering apparatus and succeeded in securing the desired data. Furthermore, the art of photogrammetry, which made excellent progress during the war, was impressed into service of the weather bureau. It is quite possible by taking records of two points at a certain distance from each other, to determine the height and also (an especially important point) the angle of inclination of cloud strata. This method is especially valuable for the investigation of the otherwise almost inaccessible stratum of the lofty cirrus clouds, and it is precisely in this stratum that the processes of circulation are of supreme significance as regards the origin of storms upon the surface of the earth.

NEW USE FOR ABANDONED MINES.

EVEN old abandoned mines are going to be put to some possible use according to the latest suggestion: A mine superintendent in the Joplin-Miami, Mo., district has visions of making a fortune out of mushroom raising in the abandoned mine drifts in that section. They are continually warm, just about moist enough, and in those where mules have been utilized for ore hauling there is plenty of good soil. The superintendent has rigged up an ingenious electric lighting scheme, with tinted globes, some one having told him mushrooms must have a little light, even if it is not sunshine, and he has planted his first bed and is awaiting results. If it works he estimates there is enough acreage in the abandoned mines in the district to produce mushrooms for the whole world.

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