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ECONOMY OF FLIGHT.

During a voyage from San Francisco to Portland, my attention was attracted to the remarkable sailing of the sea gulls. In their search for food these birds are obliged to hover near the vessel; and they usually select a place three or four yards above and out from the railing, where they remain on motionless wings. What seemed so remarkable was the length of time they could follow without movement of wing or feather. I know they moved neither, because I could see and count each feather, see the vanes of the feathers, see the shadows of the coverlets of the wing, see each movement of the head and eye. The wings remained absolutely motionless and as nearly level as the eye could distinguish, yet the birds glided on with apparently more ease than a sled on ice. Timing them with my watch, I found that they could easily float for one minute without descending and with a loss of only about 120 feet on their original position with reference to the boat. During this one minute they must have passed over more than one thousand feet of space, for the vessel was moving at no less than fifteen miles per hour. If, then, my observations were correct, we have the singular fact of a bird traveling through the air with an economy of energy rivaling that of the sleigh on ice, the car on a good track, or the fish in water. I should like to learn of similar observations with measurements and circumstances accurately determined.

Of course this performance is remarkable only on the supposition that the birds were sailing but not soaring. By the term soaring I mean ascending on motionless wings without loss of velocity. Soaring in general can be accomplished in either an up current or in a variable horizontal current. With a variable horizontal current soaring can be executed only by continuous cycling and only by the great masters of flight. In an up current any bird can soar, and without cycling. As these birds, then, were not cycling, I knew that they could not be soaring unless there were something of an up current of air beside the boat; but as I had no better means of determining the direction of the breeze than that of throwing out paper wads, my conclusions were unsatisfactory. Judging from the conclusions of the ablest modern writers on aviation, that a good sailor inclines its wings less than two degrees to the horizon, it would seem that a bird should ride steadily forward against and slowly ascend on a breeze blowing upward at an angle of somewhat more than two degrees to the horizon. I have frequently watched birds riding on such sloping currents in the neighborhood of cliffs. At the Shoshone Falls, an eagle has for years built its nest on a rock jutting out of midstream just above the falls; and, when preparing for a long journey, has been observed to fly directly from its nest to a cliff half a mile distant, there soar up to a very great height, then suddenly set sail for a point some miles distant, gliding steadily onward as a boy would coasting from such a height. So it might be proved that the current beside the boat moved slightly upward, thus aiding the bird forward and upward.

Having, however, observed similar feats of sailing near the earth and in calm air, I have thought that this kind of locomotion must be effected with wonderful economy; in other words, that the air passed over must be almost equivalent to a solid frictionless plane. It was pointed out many years ago that a horizontal aeroplane falls, when moving horizontally, more slowly than when not so moving, and the greater the horizontal speed, the less the vertical velocity of fall. This fact has been fully confirmed by recent experiments. The unqualified statement, however, that flight may be effected with less power at high speeds than at low speeds is not true. Neglecting skin friction and the slight resistance of edges, the economy of transportation of an aeroplane depends solely upon the angle of advance. Velocity is a factor of economy only in so far as it permits a favorable diminution of the angle of advance; and when this angle becomes so small that the horizontal component of air pressure equals the combined other resistances to progression, the limit of favorable velocity is reached.

That both the friction and angle of flight are exceedingly small may be argued from the great distance covered by a bird during the period of hovering. If, for example, as in the case cited, a bird with an initial velocity of 22 ft. per second hover for one minute, and cover in this time a distance of 1.200 ft., the average velocity is 20 ft. per second, the final velocity 18, and the kinetic energy lost, $M\frac{(22^2 - 18^2)}{2} = \frac{M\,160}{2}$, M being the mass of the bird. This lost energy, $\frac{M\,160}{2}$, is equivalent to an ascent of the bird's weight through a vertical distance of $\frac{160}{2g}$ ft. = 2·484 ft. nearly. If all this loss were due to the component alone of air pressure against the lower surface of the wing, the angle of advance would be that of a triangle with base equal to 1,200 ft. and perpendicular equal to 2·484 ft., or an angle of about 7′. If we charge one-half the above loss to skin friction and other hurtful resistances, the above angle must be halved very nearly. This calculation assumes that the bird is not helped by a favorable current, but moves in calm air, and I give it for what it is worth, trusting that the observations of some one else may confirm or contradict it. The result, if true, indicates that a bird can sail indefinitely down an incline of eleven feet per mile—economical traveling indeed!

ALBERT F. ZAHM.

Improved Car Couplers.

A meeting of railway people took place in the Chamber of Commerce, New York, on November 10, being a hearing before the special committee appointed to promote congressional action with reference to the adoption of safety devices on railways. Quite a number of railway superintendents were present, also commissioners, representatives of locomotive engineers, conductors, trainmen, switchmen, yard masters, car builders, *et al.*

The statement was made that the American Railway Association, which represents about 125,000 out of the 160.000 miles of railroads in this country, had passed a resolution favoring a vertical plane, automatic coupler.

Representatives of the yard switchmen did not mince words in denouncing the present state of affairs. Mr. Frank Sweeny, Grand Master of the Switchmen's Mutual Aid Society, said that the great variety of car couplers, or "draught irons," as he called them, were an imposition on the switchmen. By introducing so many different kinds of couplers the railroad companies have made the duties of the switchmen extra hazardous. If there was only one kind of coupler, the number of fatalities among switchmen would be lessened materially. Mr. Sweeny said that if he had all of the cars in the country absolutely under his control he would equip them all with the old link and pin. A national convention of switchmen held last year adopted a resolution favoring the link and pin. Another member of the switchmen's fraternity said that the new-fashioned couplers were continually getting out of order. He preferred the link and pin.

John A. Hall, of the Supreme Council of the United Order of Railway Employes, explained the duties of a yard switchman, and argued for uniformity in the types of couplers and uniformity in the height of freight cars. He thought the railroad companies should be assisted by legislation in hastening the time when the car couplers will be uniform. He believed in the link and pin himself, but was willing to accept any one of the improved types providing all the roads used that one.

Secretary Moseley, of the committee, has been in active correspondence with railroad officers throughout this country, and as a result of the information received he has prepared the following statement, which, of course, only includes such roads as he has heard from:

The total number of freight cars owned, leased, or controlled, 978,161; the total number equipped with automatic couplers, 129,304; the kind of couplers used and the number of cars equipped with each, about as follows: Of the Master Car Builders' types, Janney, 40,231; Gould, 23,357; Hinson, 42,061; designated simply Master Car Builders', 13,279; total, 118,928. Of the Safford type, 12,207 were reported, and specified couplers, 38.955.

Owing to the imperfect manner in which the replies were made, Secretary Moseley cannot tell whether the difference between the totals above mentioned of cars equipped with specified couplers (170,090) and the total number of freight cars owned, leased, or controlled (978.161) would make the number having the link and pin 888,071. Of the total number of cars reported, 110,127 are equipped with train brakes, as follows: Westinghouse, 97,238; Eames, 30; Boyden, 304; other types, 12,555.

New Planet.

Dr. Palisa, of Vienna, who but the other day discovered a new minor planet, No. 320, now announces another, No. 321. Its right ascension was 2 h. 18 min. 48 sec., with a daily motion of —48 sec., and its north polar distance 76° 47′ 26″, with a daily motion of +3′. It was observed on October 15 at 11 h. 6·8 min., and appeared like a star of the 12th magnitude. The list of these small denizens of the solar system is increasing so rapidly, and the orbits pursued by them are so eccentric, that it is no light task to keep pace with the movements of those already discovered.

The Deadly Alternating Current.

One of the engineers employed at the Lauffen (Swiss) generating station recently met with a fatal accident through touching a wire through which a high tension current was passing. The deceased, whose name was Rau, was discovered lying dead on the floor of the transformer-house by the engineer-in-chief. It appears that Rau, in defiance of the instructions given him, entered the transformer-room to attend to a defective lamp, and coming into contact with a high-tension wire, was killed instantaneously.

Artificial Coffee Beans.

The manufacture of artificial coffee beans has, it appears, assumed some importance in this country, and specimens of the spurious beans have been sent to Kew, by Dr. Brown Goode, the secretary of the Smithsonian Institution. The idea of preparing artificial coffee beans for the purpose of mixing with the genuine beans is, however, not entirely new. As long ago as 1860 coffee beans, made from finely powdered chiccory, were sent to the Kew Museums. The American beans are supposed to be composed of rye flour, glucose, and water, they are made to resemble, in size and color, a moderately good sample of roasted coffee beans, and, by the introduction of a few genuine beans, are made to possess the aroma of coffee. In the specimens we have seen the modeling is sufficiently good to deceive the ordinary public, but if the product is at all critically examined it is noticed that the groove on the flat surface is broad and shallow, and that it does not extend into the heart of the bean by a long narrow slit as in the real article, and, also, that there is no trace of the silvery skin at the mouth of the slit.

The introduction of spurious coffee beans as an article of commerce in the United States is described in the following article from the New York *World*, reproduced in the Kew *Bulletin:*

"The average bulk of the genuine coffee imported into the United States is 8,000,000 bags, or 180,000,000 pounds, per annum. Experts estimate that fully twenty per cent of the coffee sold to consumers is bogus, which raises the consumption to 216,000,000 pounds. Taking thirty cents per pound as the average retail price, the people of America pay $65,000,000 every year for this one article of food, of which $13,000,000 is paid for roasted and ground beans, pease, rye, or a manufactured article in no way resembling the Brazilian berry. To this must be added the production and sale of what are called 'coffee substitutes.' So extensive is this business that it is quite safe to say that consumers pay $12,000,000 for what they believe to be cheap coffee. This raises the total expenditure to $77,000,000, and it represents a sale of 276,000,000 pounds, for the 'substitute coffee' usually sells at twenty cents per pound. It will thus be seen that 96,000,000 pounds of bogus coffee are sold in the United States every year, and some estimates place it at 120,000,000 pounds. Taking the lowest figures, $25,000,000 are received for substances which can be profitably placed on the market at six cents a pound. The manufacturers, therefore, receive $6,000,000 for their goods, while retailers gain a profit of $18,000,000. There are two kinds of bogus coffee, an imitation bean and the ground article. The bean is the most difficult to produce, and it is only recently that actual success in this direction has been attained. The bogus bean must not only look like the genuine berry when raw, but it should be capable of taking a proper color when roasted. A very good specimen is now manufactured in Philadelphia and Trenton, being composed of rye flour, glucose and water. The soft paste is then moulded and carefully dried. To the eye of an expert the presence of this imitation is easy of detection and it cannot be used to any great extent among wholesalers. But when coffee goes to the retailer, adulteration begins. Sometimes the retailer is deceived, but nine times out of ten he is the one who introduces adulteration. The ground article is very easily produced in the proper color, and an aroma is infused by using strong decoctions of coffee essence.

"When mixed with real coffee even the expert eye and tongue may be deceived, while to the ordinary consumer it seems to be the genuine product. Bogus coffee beans have only a slight resemblance to the natural berry, for though they possess proper form, the cicatrice on the inner face is too smooth. Then again the gray color of the raw bean is not quite up to the mark, but when these manufactured beans are roasted with five per cent of genuine coffee they find a ready sale. These bogus beans can be made at a cost of $30 per 1,000 pounds, and when mixed with fifty pounds of pure coffee the whole 1,050 pounds cost $37.50, or 3¾ cents per pound, so that a profit of nearly 100 per cent is the result. There are any number of 'coffee substitutes,' the Hillis variety being the most successful. This company is already manufacturing 10,000 pounds per week, it being sold by the barrel to retailers in nearly all of the New England, Middle and Western States. The profits of this concern are supposed to be $300 per day, and its operations have reached such a scale that the stockholders were recently offered nearly $1,000,000 for their secret and business, but it was declined. No one accustomed to coffee drinking would imagine that a decoction of this stuff was like either Mocha or Rio, but when mixed with four times its bulk of genuine coffee only an expert could detect the imposition. The manufacturers of these 'coffee substitutes' claim that they are not violating the law of adulteration of food products, because they do not sell their goods as coffee, but simply as a substitute. While this may be true, it does not apply to the retailer, who mixes the bogus stuff with good coffee, and sells the whole as the genuine article. Though manufactories may be beyond the penalties of the adulteration law, they should be suppressed, for without them coffee adulteration by retailers would be impossible. When it is remembered the American people are compelled to pay $25,000,000 for ingredients that can be manufactured for one-fifth the sum received by coffee growers, the necessity for the suppression of this nefarious trade is apparent. Oleomargarine cannot be sold as butter, neither should 'coffee substitutes' be made to masquerade under the name of Java, Mocha or Rio."

The production of artificial coffee has also received some attention in Germany, where an imperial decree has been issued forbidding the manufacture and sale of the machines for producing the artificial beans, which certain German newspapers have recently advertised. These artificial German beans are not intended in themselves as a beverage, but are to be used in trade for mixing with the genuine article.

High Railway Speeds.

Within the last few weeks a good deal has been heard in this country of exceptionally fast runs made on American railroads. So long as the evidence that these runs were really made and the stated speeds actually attained was confined to daily newspaper paragraphs we paid little attention to them, preferring to wait for the utterances of the American technical press on the subject. The railway journals appear to accept without much question what has been said on the subject, and we are therefore justified in bringing the matter before our readers. Three notable runs have, it seems, been made. The first of these took place in connection with a special effort, to which we have already referred, to accelerate the transport of mails from Yokohama to Queenstown. The steamer Empress of Japan left Yokohama on the 19th of August at 8:45 A. M., and arrived at Vancouver about noon on August 29. A special train on the Canadian Pacific Railway, consisting of one mail and baggage car and one sleeping car, started at 1 P. M. with thirty-three bags of mails, and ran to Brockville, a distance of 2,792 miles, in 76 hours 31 minutes actual time, the average speed being thus 36·22 miles an hour. At Brockville the train crossed the ferry to Morristown, where it entered the Rome, Watertown, and Ogdensburg line, and ran to Utica. There it got on the New York Central and Hudson River systems, and reached New York on September 2. From Morristown to New York the distance is 361 miles, which was traversed in 6·58 hours, the rate being 51·81 miles an hour. The mails were put on board the City of New York, which sailed at 6:30 A. M. on September 2, and were delivered in London at 10 A. M. September 9, the whole time being thus under twenty-one days. It will be seen that there was no exceptionally fast railway traveling done, but the performance, taken as a whole, is very remarkable and without precedent.

The second run took place on August 27. It was made by a special train on the Philadelphia and Reading Railroad. This train was run for the purpose of ascertaining how fast it was possible to go, and the quick running was made on the section between Jenkintown and Langhorne, a distance of 12 miles. The road is undulating, the maximum gradient being 1 in 143. The total weight of the engine and a train of three cars was 150 English tons, and the average speed over the 12 miles is given as 82·7 miles an hour, while one mile is said to have been traversed in 39¾ seconds, or very nearly 90·5 miles an hour. This was at the end of an incline of 143 in favor of the train. The engine was a Wooten locomotive, with 18·5 inch cylinders, 22 inch stroke, and four driving wheels 5 feet 8 inches in diameter. We regard this report with considerable suspicion; not because we believe there was any intention to deceive, but because the arrangements for taking the time were untrustworthy. The time of passing each mile post was recorded by observers working with chronographs marking fifths of seconds. We do not hesitate to say that no man living could be certain of his time, under the conditions, to one-fifth of a second. However, we do not doubt that a very high speed indeed was attained. At 90 miles an hour the wheels must have made 445 revolutions per minute. What this means our readers will not be slow to perceive. As the velocity per minute would be 7,920 feet, for each 4·16 pounds pull on the draw bar, 1 indicated horse power would be required. If we assume the whole resistance of engine, tender, and train to have been but 20 pounds a ton, the indicated horse power must have reached $\frac{150 \times 20}{4 \cdot 16} = 721$. But at very high speeds the internal resistance of locomotives, especially the back pressure, becomes enormous, and even if we credit the train with the full advantage of the down grade, it still remains certain that the power exerted must have been very great, or that, as there is reason to think, the resistance of a train augments very slowly indeed with the speed.

The third run was by far the most noteworthy of the three. It took place on Monday, September 14, on the New York Central and Hudson River Railroad, from New York to East Buffalo, a distance of 436⅛ miles. The train consisted of an engine and three cars; the total weight being 230 American tons. The distance was traversed in 439½ minutes. The engines were changed three times, and there was a short delay caused by the heating of an axle box. The actual running time was 425 minutes 12 seconds, and, excluding stops, the average speed was 61·56 miles an hour. This performance has never been equaled. The speed was very uniform, the quickest mile being done at the rate of 76·5 miles an hour. The locomotives used were very powerful, weighing 60 American tons, or say 53·6 English tons. The tenders weighed 40 tons of 2,000 pounds, or nearly 36 English tons; and the cars 130 American, or 116 English tons; the total load moved being thus, in round numbers, 206 tons. The engines were all alike, save that two of them had 5 feet 9 inches drivers and the third 6 feet 6 inches. The cylinders are 19 inches by 24 inches stroke. The boilers are of great size, having no less than 1,821 square feet of heating surface and 27·3 square feet of grate. They are thus nearly twice as powerful as the Lady of the Lake class, which ran the fast Scotch express to Crewe during "the race to the North," hauling a train weighing about 80 tons, at an average speed of 57·1 miles an hour. The Waverley has 16 inch cylinders; stroke, 24 inches. The grate area is 15 square feet, and the total heating surface 1,098 square feet. The weight of the engine is 27 tons, and of the tender 17½ tons, or together 44½ tons, or nearly 10 tons less than the weight of the American engine alone. The weight of the engine and tender was about 55 per cent that of the train, whereas the weight of the American engine and tender was very nearly 77 per cent of that of the train. The speed attained was only four and a half miles an hour better than that of the Waverley.

Taking the American run as a whole, it constitutes a distinct departure in railway work. Not the least remarkable feature about it is that it shows that it is possible to attain very high speeds with comparatively small coupled wheels. It by no means follows, however, that it is advisable to retain them for very fast trains. On the other hand, we believe that very high wheels are equally out of place if very long runs are to be made, because on such runs it is certain that more or less steep inclines will have to be surmounted. If the average speed of a train is to be about fifty to fifty-five miles an hour, then banks may be ascended at forty miles an hour, or even less, and descended at sixty to sixty-five miles an hour. But when an average speed of over sixty miles an hour must be made, we cannot rely on descents to compensate for ascents, because enormous velocities would be required, and the cost and wear and tear would be out of all proportion to the advantage gained. The engine must, therefore, be competent to maintain a high speed when running up hill, and this is almost impossible if very high wheels are used, unless the cylinders are too large for the rest of the road. As these high-speed long-distance trains cannot be heavy, it appears to us that the best type of engine would be one with 18 inches cylinders, 26 inches stroke, 1,400 square feet of heating surface, 20 square feet of grate, and single drivers, carrying about 18 tons, and 6 feet 8 inches in diameter, provided with the sand blast. Such an engine would be an admirable hill climber, and would run about as fast as any locomotive made. When the runs are over comparatively level roads, then a big wheel, such as Mr. Stirling proposes, is no doubt good, because its use reduces wear and tear.

Whether any extremely fast running will be done in this country remains to be seen. Any speed that can be attained in the United States can, of course, be got here on our better roads. But it is more than questionable that these excessive speeds pay. Whether they do or not is really the whole question. The problem is not one for the locomotive superintendent, but for the general manager.—*The Engineer.*

To Clean a Dirty Engine.

Dissolve a pound of concentrated lye in about two gallons of water, and with a mop saturate the engine with the liquid—being careful that it does not get into the oil holes of the journals and bearings. After the lye has eaten all the grease and gum from surfaces, clean perfectly by scraping and brushing, and apply after the iron is dry and free from grease a thin coat of lead paint. And after this is thoroughly "set," paint the iron a deep black, and varnish heavily—coloring, striping or decorating according to taste can be done afterward. Then the greater part of the works can be easily and quickly cleaned with a dusting brush or cloth, and escaped oil can be mopped off thoroughly with but little trouble.

OWING to the improvements made in the manufacture of wood or smokeless powder during the past twelve months, by the American Wood Powder Company, of this city, their output has more than doubled. It is a matter of congratulation to American sportsmen that they can now use an article of American manufacture equal to the best foreign nitro compounds, which are so popular with the sportsmen of England and France, at a much less cost than the imported article.