gear, so that the car runs very quietly. The advantages of this peculiar type of motor are in the large and well ventilated armature, giving a powerful torque, and permitting the use of very heavy currents without excessive heating, and, second, in the simple form of the field magnets enabling magnetism to be obtained with comparatively small expenditure of energy. The actual maximum efficiency of the motor is satisfactory without being phenomenal. The machine was designed, however, to give its maximum efficiency at something like its average output. Fig. 2 shows its efficiency curve at various loads. The motor being nominally of 20 h. p., its point of maximum efficiency is at about 15 h. p., and even at 15 h. p., its normal load, the efficiency will be seen to be 80 per cent. This is not a remarkable figure, but it gives a good all-around commercial efficiency even under widely varying loads. The use of a single motor once geared is in itself a decided advantage, as it both increases the commercial efficiency by avoiding multiplicity of gears and also reduces the working weight of the equipment. The motor and the regulating devices together weigh less than 1,500 pounds, with the result that the total weight of batteries, motor, and regulating appliances in this Waddell-Entz car is less than that of the motor equipment of the standard cars used on the trolley system. This means a very decided saving in power, for one of the besetting sins of the storage battery system has been the excessive weight of equipment, every extra pound of which meant extra coal burned at the power station. Of course the same or similar motors could be used for the trolley system if desired, although such has not been the usual practice. The total weight of the copper in the motor is 130 pounds, a very satisfactory result for a motor intended for such exceedingly heavy currents. The regulating appliances of the car are interesting. The platform switch has six steps. Of these the first throws on the batteries, four in multiple to start the car, the second changes this arrangement to two in multiple, the third throws all the cells in series, while the fourth and fifth cut out sections of the field, and the sixth reverses the motor on its lowest speed. The motors when the car is running down hill can

FIG. 5.—CAR EQUIPPED WITH THE WADDELL-ENTZ MOTOR.

operate as dynamos and restore energy to the batteries. This feature of the system is of practical use of course only on roads with perceptible grades, but under such circumstances it is undoubtedly somewhat effective, possibly saving as much as 10 per cent. of energy. The road over which the trial trip was made is almost exactly three miles in length, giving a six mile round trip for the car, and the power required to charge the batteries for the work is very nearly six horse power hours, practically one horse power hour per car mile. The total capacity of the batteries is of course much greater than this, sufficient for perhaps half a day of ordinary service. This result of one horse power hour per car mile at the power station is immensely satisfactory; it is unquestionably better than has been usually obtained by storage battery cars, and compares very favorably with the output shown to be necessary on trolley roads, which, however, it should be said, have heavier grades and a heavier car equipment than the one we are considering. The trial trip was a thorough and complete success. The car ran smoothly and regularly, and its motion down grades was reported to be exceedingly easy, owing to the reversal of the motors and the braking action of their use as dynamos. In the same way stopping is accomplished within the length of a car, and very smoothly, owing to the device just mentioned. Fig. 5 shows a view of the complete car with which the experiments were made, and Fig. 4 a diagram of the output required at each point of the test run over the road. The readings were taken with Weston ammeters and voltmeters each ten seconds and the result shows clearly the ability of the batteries to stand a very heavy output without serious drop in their power. The portions of the curve below the axis represent, of course, periods during which energy was being restored to the battery. It will be seen that the running speed in this test was 10 miles per hour, the three miles being covered in 18 minutes. Altogether this alkaline storage battery motor system seems to be a very useful addition to the methods of electric traction, certainly the most promising that has appeared for some time in the way of proper equipment for city service. Of course time alone will tell its success when operated by unskilled labor under adverse conditions, but the results obtained are certainly such as to warrant a considerable degree of encouragement to the advocates of storage battery traction.—*Electrical World*.

THE ANALYSIS OF DEGRAS.

By F. SIMAND.

GENUINE degreas contains a substance described by Jean as resembling a resin, which the present author terms *degras producer* or *substance*, upon the quantity of which the quality of the degreas depends; the greater the proportion of it in any sample, the higher is the quality of the article. This substance in the impure state is of a brownish black color, but after purification forms a light brown mass, which contains nitrogen, dissolves very readily in alkalies and ammonia and is precipitated from these solutions by acids in the form of a light colored flocculent mass. Hot water, especially when it contains a little acid, dissolves the substance to a certain extent; it is also soluble in alcohol, glacial acetic acid, and aniline, almost insoluble in ether, and quite insoluble in light petroleum and benzene. It does not melt on heating, and is chiefly found in genuine degreas from chamois leather, in the process of preparing which it appears to be formed. It occurs, however, in greater or smaller amounts in almost all train oils, and is of great value for tanning purposes.

In order to determine the amount of this *degras substance* present, 20–25 gms. of degreas, according to the amount of water contained in it, are saponified on the water bath with 5–6 gms. of caustic soda dissolved in about 10 c.c. of water and 50–60 c.c. of alcohol, loss of alcohol being hindered as much as possible by a small funnel placed in the neck of the flask. As soon as the whole is dissolved, the alcohol is driven off and the soap dissolved in water, the fatty acids, together with the *degras substance*, being then separated by hydrochloric acid. The liquid is then heated until the fatty acids form a clear layer at the top, the whole allowed to cool, and the aqueous solution poured away from the cake of fatty acids. This aqueous solution contains a little of the *degras substance* in solution, and is, therefore, neutralized with ammonia and evaporated. The fatty acids, which contain the *degras substance*, are extracted several times with boiling water to remove hydrochloric acid and the wash water neutralized with ammonia and added to the first filtrate. These combined washings are evaporated to dryness,

If, through careless work, any sodium or ammonium salts be left adhering to the *degras substance*, their presence being shown by the formation of crystals, the whole is dissolved in a little ammonia, water added, and then a slight excess of hydrochloric or sulphuric acid. The precipitate is washed on a weighed filter paper with cold water and weighed.

The author has investigated the properties of this *degras substance* and concludes that it occurs in degreas as a substance resembling the fats, which, like the latter, is readily soluble in petroleum and with difficulty in alcohol; on saponification and decomposition with acid, a substance resembling the fatty acids, and, like them, soluble in alcohol, is formed.

The emulsifying power of degreas depends upon the amount of *degras substance* contained in it. Further researches have led the author to conclude that the compound of this *degras substance* which occurs in degreas is either decomposed by the leather fiber, which then combines with the liberated *degras substance*, or is taken up unaltered by the fiber. In chamois leather the fiber is more intimately and firmly combined with the *degras substance* than in tanned leathers, in which the fiber is saturated with tannin, and therefore shows less tendency to combine with another substance. The action of the *degras substance* in genuine degreas, therefore, is most thoroughly exercised with leathers which are tanned soft and contain fiber, which are to a certain extent crude and in a position to combine with it; the prepared leather will then be very soft and resemble chamois leather.

In connection with his examination of genuine degreas, the author also communicates the method adopted by him in investigating artificial makes of degreas. In the course of such an examination he determines (1) The *degras substance*, arising from genuine degreas, present in the sample or from train oil; (2) Suint; (3) Vaseline oil; (4) Resin, colophonium. Water and ash are determined as in the genuine products.

ESTIMATION OF THE DEGRAS SUBSTANCE.

5–10 gms. or more of the sample are saponified in a flask, the fatty acids precipitated by hydrochloric acid, washed and treated with ether. The *degras substance* which remains insoluble in them is dissolved in alcohol and estimated as already described.

ESTIMATION OF WOOL FAT.

The ethereal solution is placed in a weighed flask, the ether evaporated and the residue boiled with 1 to 1½ parts of acetic anhydride for 1–2 hours, the flask being connected with an inverted condenser. Water is then added and the precipitate repeatedly extracted with water to remove acetic acid, after which it is dried, and the mixture of acetic ethers of the fatty acids and of cholesterol, etc., thus obtained dissolved in 15 parts of boiling alcohol (75–150 c.c.), cooled, filtered from the cholesteryl acetate which separates out, and twice again dissolved in 15 parts of boiling alcohol, to remove vaseline oil as completely as possible. The cholesteryl acetate is then dissolved in ether, the ether evaporated from the clear solution, and the residue weighed and calculated to wool fat.

The author has examined 7 samples of commercial wool fat, in order to ascertain how much cholesteryl acetate these yield. He found a minimum of 7.59, and a maximum of 19.43, the average being 14.05 per cent. According to this the factor for calculating the amount of wool fat would be 10.42, 5.15, or 7.11. Thus, for example, 0.4 gm. cholesteryl acetate obtained from 10 gms. of degreas would correspond to either 20.60 or 41.68 per cent. of wool fat, or taking the average number, 28.44 per cent. Chemists intrusted with such analysis will be able to tell from the appearance of the fat separated from the degreas and dried, and from its melting point, whether 20 or 40 per cent. are present. In any case the presence of wool fat can be detected with certainty and estimated with sufficient accuracy. A further indication of wool fat in a mixture of fats is the lustrous surface of the solidified fat, or, if this does not solidify, the lustrous and non-crystalline surface of the solid fatty acids obtained on saponification; the smell of wool fat, especially when the fat is rubbed on the hands, can also be easily recognized. It must be borne in mind that small quantities of cholesterol also occur in genuine degreas and in fish oils; the fatty acids of these, however, solidify to a crystalline state, or, from some of the fish oils, not at all, so that any mistake is impossible.

The *vaseline oil* is estimated by evaporating off the alcoholic solution, which contains the acetylated fatty acids, the vaseline oil, and the resin. The residue is saponified with caustic soda, glycerine added (Nitrate, Benedikt, Analyse der Fette und Wacharten, p. 119), and the vaseline oil extracted by shaking with light petroleum. The substance thus obtained always contains soap, which is removed by agitating it with water, after the removal of the petroleum, adding a little magnesium sulphate, which forms an insoluble soap, and again extracting with light petroleum.

ESTIMATION OF COLOPHONIUM.

The residual soap solution is decomposed with hydrochloric acid, the precipitate washed, the fatty acids and resin dissolved in alcohol, the alcohol evaporated off in a weighed vessel, and the residue weighed. The resin acid is then determined in an aliquot part by the method of V. Hubel and Stadler. The silver salts are extracted with ether, in which the salt of the resin acid is soluble, and the latter is then decomposed in ethereal solution with hydrochloric acid. The weight of the resin can then be determined by evaporating the ether.

The author examined one sample from a well-known German works, which from its price should have been genuine chamois degreas, but really consisted of water 15.8 per cent., wool fat not less than 20 per cent., vaseline oil 9.71 per cent., resin 10 per cent., fish oil 44.46 per cent., in which about 1 per cent. of *degras substance* is contained. The article was, therefore, an artificial product, and had never been near chamois leather.

A French article contained water 17.69 per cent., wool fat 35 per cent. (about), vaseline oil 10 per cent., genuine anhydrous degreas about 25 per cent., fish oil, palm oil, etc., 12.31 per cent.—*Chemiker Zeitung*.

the residue dissolved in a little water, and a slight excess of hydrochloric acid added. The precipitated substance is filtered off, washed until free from hydrochloric acid, dried on the filter, and added to the fatty acids, etc., which have in the meantime been dried at 105° (this drying is not absolutely necessary). The united mass is placed in an Erlenmeyer flask and covered with 100–120 c.c. of light petroleum, boiling below 70°. The fatty acids dissolve, whereas the *degras substance* and a small amount of albumenoid matter remain undissolved. The liquid is filtered, the residue washed with light petroleum, the filtrate being evaporated and the fatty acids weighed. The residual mass, which was insoluble in the petroleum, is treated with hot alcohol, in which the albumenoid matter is insoluble, the liquid filtered and the *degras substance* finally weighed after the evaporation of the alcohol.

A sample of degreas can only be considered genuine and pure when it contains at least 12 per cent. of this *degras substance*, the amount of water present being 20 per cent. In some cases as much as 16–17 per cent. is present.

To determine the amount of water, 25 gms. of degreas are weighed into a tared porcelain basin, provided with a short thermometer to be used as a stirring rod, 50–100 gms. of train oil added to render the mass more fluid, and to prevent spurting, and the whole heated on a wire gauze to 105° C. until no more gas bubbles are given off; the loss of weight is due to water. A certain amount of other volatile matter is lost with the water, but this error does not exceed 0.5 per cent.

The train oil or other oil (vaseline oil is not well adapted for the purpose) which is used must have been previously heated to 105°, if necessary, with the addition of water until all volatile matter has been removed. The amount of water varies from 15–20 per cent. in products obtained by the French process, and from 20–40 per cent. in leather dressers' degreas.

The ash is determined by heating 25 gms. of degreas until all the water has been driven off, the mass being continually stirred with a glass rod, cleaning the rod from adhering fat by a piece of filter paper, lighting the degreas by means of this paper, and heating the residue to redness.

It varies from a few hundredths per cent. in the French product to about three per cent. in leather dressers' degreas.