Weighing Apparatus in Industrial Plants*

Suggestions for the Selection and Maintenance

By Fritz Reichmann, Ex-State Superintendent of Weights and Measures of New York

THE ultimate object of every industrial plant is to secure profits on every one of its manufacturing operations. It is therefore necessary to keep the cost of production down to the lowest possible limit consistent with proper manufacture and to raise the selling price to the highest point that the market will stand. This bare statement of fact may be, and is glossed over or veneered in many ways, generally for popular consumption. The selling prices are often fixed by competition or by agreement. Some may cite anti-trust laws as preventing this, yet it takes very little reasoning to see that such laws are economically unsound. They serve only to help a few lawyers and individuals and furnish a medium for official favoritism and possibly temporary notoriety, but in the end they result only in bringing about a most deplorable contempt for statute law.

In this paper I shall not attempt to discuss selling, but only a certain phase of the problems of production. The individual plant must be concerned with economical production. This means that among the many factors to be considered is the quantity factor, the careful, quick, reliable determination of quantity at various stages of production, from the reception of the raw material to the point of selling. This is a phase of weights and measures with which the public official is not concerned, at least not under any law now existing. Effectively he never will be concerned therewith. The simple reason is that official regulatory inspection is and will remain, under our system of government, in the sphere of politics to a considerable extent. Governmental efficiency supervision of private industrial plants is ethically and economically wrong and is doomed to failure. It is attempted now and then for the sake of notoriety—witness the costly and ineffective so-called efficiency bureaus being experimented with by the city of New York, which interfere with business. Ultimate failure results because political activities should be for the general public and the ultimate consumer and should not be for and by the business man primarily. Make the results of the business meet the consumer's welfare and do not have the official officially fit the consumer to the dictates, carefully and insidiously given to be sure, of the business man.

Through the courtesy of Harvey Miller, of the Fairbanks Co., I have recently had an opportunity to examine in detail various kinds of weighing and measuring instruments used in industrial plants and to assist the manufacturer in solving some of the problems causing money losses due to improper weighing and checking. I would like to interject right here that this work which I am doing and which I call scale, or weights and measures insurance, is absolutely divorced from sales and is independent of the type, make, or size of the apparatus. I am only concerned with its proper use and its continuing accuracy for the benefit of the manufacturer and the business man, that he may thereby furnish to the consumer a better and more nearly correct product. In this wise it is helping the weights and measures official and also the food official.

The average manufacturer and business man is so much concerned with other problems that he neglects the details of his scales and balances, his weights and measures. He wants them right, to be sure, but he knows nothing of them and assumes (oh, woeful assumption!) that a scale is a scale and a pound a pound and that they are always right. He generally leaves to an underling the purchasing of his scales, though they meter the dollars into his till or determine the uniformity of his product. To be sure, he sometimes employs efficiency experts or efficiency engineers (often a most expensive luxury), but they are mostly accountants and know about as much about scales and weighing as a barber knows about the construction or adjustment of a chronometer or other astronomical instrument.

The business concern must consider:

- (1) Devices for checking the receipt of materials.
- (2) Devices for checking the manufacture or inter-departmental records.
- (3) Devices for putting up and selling.

In most instances these devices are scales, and the

particular type, size, and accuracy required depend on the nature of the product and the process of its manufacture. Certainly, for an expensive commodity a more accurate device should be used than for an inexpensive one; for a heavy, concentrated commodity a different type than for a bulky one. A note of warning must be raised against many of the automatic and dial scales. They are not a "cure all," and their complication involves sources of error and loss absolutely prohibitive in some instances. Whatever device is used and wherever it is used it needs careful consideration and constant attention and supervision, not only as to the instrument itself but as to its use; for weighing instruments, it should not be forgotten, are very precise and responsive, far more so than almost any other machine.

In my very first report as superintendent of weights and measures of the State of New York, I emphasized that the majority of business men were honest but often careless. Where errors occur due to weighing, the business man generally is the loser, and, mind you, the loss is a percentage loss of gross receipts, not a percentage of the profits only. If, for instance, on a \$100,000 volume of business, with a nominal profit of \$10,000, the scales were 2 per cent inaccurate the loss would be \$2,000 and not simply \$200. In short, with correct scales the profits on this business would have been \$12,000 instead of \$10,000, or 20 per cent higher.

It may be stated as a positive fact that every concern that uses scales or any kind of measuring instrument, subject to wear, needs an expert supervision by a disinterested party with specific and particular technical knowledge. It must be evident that for very good psychological reasons an employee of the concern itself will not suffice. In order to illustrate and make myself clear, I shall cite a few instances.

Case 1. A factory making hardware specialties: In one department small bolts were put up and a count of the boxes revealed the fact that there was an average of 3.25 per cent overcount. As the production was 12,000,000 of these bolts a month, at a selling price of 22 cents per hundred, it can readily be seen that the concern was giving away over \$800 a month on this item alone. In this case, though the scales were correct, the weighing was carelessly done by cheap labor. Even the manufacturer did not realize that a few extra bolts meant so large a loss. This is now corrected, and the weighing matters are regularly attended to.

Case 2. A wholesale drug house: This concern was of the highest reputation and was using scales of entirely too large a capacity and old weights with the openings filled with various accumulations. These were used for putting up 1-ounce packages of drugs. In the case of an order for 600 1-ounce bottles of ipecac, too large a bottle was used, and the amount put in each bottle was more than 30 per cent overweight. Ipecac was worth \$1 an ounce. It was not hard to convince the officials of this company that it would be a paying investment to have all their weighing instruments under a periodic supervision. No wonder the business concern had never had a complaint. Almost anyone ought to be satisfied with 25 to 30 per cent overweight.

A similar case was that of a jewelry house, whose troy weights were heavy, and consequently gold was being given with each shipment or sale.

Case 3. A fertilizer plant: The bagging scales had recently been repaired by one of these so-called itinerant scale mechanics who infest some sections and know no more about a scale than a lawyer does. A test showed that there was an error of $1\frac{1}{2}$ per cent on the scales, and in their use there was an overweight of an additional 1 per cent given, which meant a loss to the concern on its production of thousands of tons of an expensive fertilizer, of a very considerable sum. This is now remedied, and a regular inspection assures its nonrecurrence.

Case 4. Several coal yards: In the coal business the scale gages the returns directly in terms of dollars and cents. These need attention regularly. Many equipments are all but ruinous to the dealer on account of irregularities in weighing. A number of these show an error of 50 pounds per ton, and this coupled with "up weighing" cause considerable loss on the tonnage. A number of coal dealers in New York city and vicinity now have their scales gone over carefully and

systematically every month by a scale mechanic to protect themselves and their customers. There still persists the unfortunate and vicious system of "official public scales," probably without any legal foundation. (The losses due to lack of proper supervision and weighing in coal yards was discussed at length in the *Coal Trade Journal* (New York) of Mar. 1, 1916.)

Case 5. A large coal dealer: One of the largest coal dealers has no periodic test or adjustment. The weighmaster of the individual yards is instructed by the owner to put a 50-pound weight on the scale every morning. This is about as effective as spitting on the platform would be. I made an investigation on some dozen or more of the weighings, and if all were like these, then the officers of this particular company were losing for the company about \$20,000 per year. This is simply lack of appreciation of the very essentials of their business and is causing considerable loss.

Case 6. A factory making underwear: In this case the weights were worn and the jack spinners were receiving too little pay for their work. They are paid by the weight of the yarn they spin; the finer the yarn the more the payment per unit. As the weights were light the apparent unit weight was more and the spinner's pay was less. This was a case of a loss of thousands of dollars for the employees and the loss of thousands on the part of the employers on account of the dissatisfaction created. This condition has been remedied.

Case 7. A chemical plant: The work done was of such a nature as to be very hard on the weighing devices and there was a continual scourge of error and disagreement. The firm had installed expensive dial scales and were thereby really throwing money away in the first instance and getting poor results. What they needed to do and did do, was to buy less expensive but more accurate beam scales and then replace them frequently as they became corroded.

Case 8. A specialty manufacturing concern: This firm makes celluloid specialties. They use scales to check interdepartment operations. The commodities handled are worth over a dollar a pound. The scales were found to be out of agreement by as much as 7 pounds. It can be readily seen that the records of the department needed considerable doctoring before they could be made to agree. The system of records created expense and chaos where it should have occasioned savings and order. This has been nicely straightened out.

Case 9. A metal manufacturer: A plant in New Jersey making an expensive and much advertised alloy metal had a small scale on which rods were sold at 80 cents per pound. The scale was barely sensitive to 2 pounds. A large dormant scale for weighing large castings was insensitive to 50 pounds. The castings sold for 40 cents per pound. This concern, after having their attention called to the case and being shown that there were considerable losses to them had some temporary repairs made, I believe. They will go along now losing money for the stockholders until the scales become too bad, and then again temporary repairs. The equipment needs decided changes, but at present they are too prosperous to realize their "slipshod" methods.

Case 10. A paint and color factory: Here there was a considerable loss due to gummed pivots and bearings as well as to woefully improper scales. The products are valuable and the management intelligent and they want the scales in their factory gone over regularly.

Case 11. A special chemical product plant: In this plant commodities worth \$40 a pound were weighed on scales that were correct to the smallest graduation, but the finest graduation was only a pound. There was a possible error of \$40 on each weighing.

I could go on enumerating all sorts of business concerns—feed dealers, cheese dealers, grocers, hair dealers, manufacturers of all sorts of metal goods and chemicals, drugs, varnishes, and paints. The above few cases illustrate the point that I want to emphasize. Every concern in its business needs some sort of weighing or measuring device, and above all needs to know that it is correct and correctly used; needs disinterested technical advice as to the proper kind to use and advice based and backed by practical knowledge. I also wish to emphasize that such work of proper supervision does help the consumer or purchaser, and

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that is the one that the official is concerned with and the only one he should be concerned with. If he is not, he is a poor public official and will not accomplish much. I am speaking now of the officials carrying out regulative laws, not scientific or technical bureaus, which serve an entirely different function. There are no such bureaus in any of the States as far as weights and measures are concerned.

Also to the business man I would say that the weights and measures official is doing a lot of good in apprehending the crook; doing good not only for the ultimate purchaser, but also for the honest business man. But the public official can not protect the business man in the matter of weights and measures in the organization of his business nor in the conduct thereof. The business man must do that himself, and if he does not do it properly or wisely he loses, and loses more by the giving of overweight than in any one thing.

In conclusion I wish to summarize by stating that the State or city or county weights and measures official can not test the scales and weights and other metering devices of a business concern often enough for the business man's protection. He can only hope to do something in apprehending the thief who mulcts the consumer. Every business man who has any use at all for scales or other metering devices can certainly save, and thus make a very considerable amount of money by having these devices periodically tested and adjusted by experts in that line, and stopping the leaks as soon as possible, for it is the daily and the hourly visible and invisible leaks that cause the greatest losses.

Linking up Electric Supply Lines

Active steps are now being taken in various directions with a view to bringing about as much interconnection as possible between electric power stations. The need for linking up the stations in different districts has often been considered, but it is only recently that the full advantages have been generally appreciated, and that the problem has been attacked on broad lines. In this way lies not only economy in fuel, but safety to many vital national industries. Though there are so many differing voltages and alternations at which electricity is supplied, it is fortunate that the great majority of stations in this country generate three-phase current at 50 periods, so that the problem of interconnecting is relatively simple. But there is a number of large systems which generate at 25 and 40 periods, several generate at 60 periods, two large stations generate at 33 periods, while a considerable number generate at other frequencies. These last are principally single-phase systems. The problem of linking up systems of different frequencies is much more complicated than that of linking up systems of the same frequency, and each particular case requires careful consideration in order to determine the best method to adopt.

At the last meeting of the Institution of Electrical Engineers Mr. John S. Peck dealt very ably with many of these cases. He pointed out that when two alternating-current generators having the same number of poles and the same rating are operated in parallel, they must, of course, run at exactly the same speed, and, if they are to divide the load equally, it is essential that the two engines for turbines driving them should have the same speed regulation, i. e., the same drop in speed from no load to full load. If one engine should have a regulation of 2 per cent and the other of 4 per cent then (assuming the regulation curve to be a straight line) with full load on one generator there would be only half-load on the other. In other words, the load carried by the generator is determined by the amount of steam admitted to the engine, and not, by the adjustment of the field strength of either machine, i. e., the load depends on the governor and not on the position of the field rheostat. Any two machines may be made to divide the load in any desired proportion by proper adjustment of the steam supply, while adjustments of the field rheostats simply cause wattless currents to flow between the generators. The effect of this current is to strengthen the field of the overexcited generator; thus the voltage across the two remains equal.

When the stations to be linked up have the same frequency, voltage, and phase, the only interconnecting link required is a cable with the necessary switches, etc., for connecting together the busbars of the two stations. It often happens, however, that the voltages of the two stations are not exactly equal, and it may be required to vary the voltage of either station independently of that of the other. For this reason it is desirable to have some form of voltage regulator in at least one of the stations; otherwise, when voltage adjustments are attempted, heavy wattless currents will flow between the stations and the voltages on the two systems will remain equal, except for the difference due to the drop of pressure

in the cable. The regulator may be either of the step-by-step or of the induction type.

It is common practice to operate electro-hydraulic systems of the same frequency in parallel, and on the Continent and in America many large transmission networks are supplied from stations located long distances apart. In Great Britain an increasing number of systems of the same frequency are being operated in parallel, but there has been very little done towards linking up systems of different frequencies.

In South Wales a 40-cycle system is operating in parallel with a 50-cycle system through two 500-kilowatt induction motor-generators. One set has a 40-cycle induction motor and a 50-cycle synchronous generator. The other has a 50-cycle induction motor and a 40-cycle synchronous generator. These sets have worked very well in service, except that the heavy wattless currents taken by the induction motors limit the output of the stations and cables. A synchronous condenser is being installed which may work on either system.

In France and Italy there are some large systems of different frequencies connected through motor-generators. Mr. Peck gave some most useful particulars of a very interesting installation at Savona, Italy, where a synchronous set is used for linking up two very large systems—one of 16 2-3 periods and the other of 50 periods. The synchronous set consists of two 10,000 k. v. a. generators, one having two poles and giving a frequency of 16 2-3 cycles, and the other six poles with a frequency of 50 cycles. Synchronizing is usually done by first synchronizing the turbine with the 50-period part of the plant, and afterwards with the 16.6-period part, the latter operation being very easy. Only from time to time is it necessary to telephone to other stations to adjust the speed.

In this case the two machines are coupled to a steam turbine. The original plan was to use the set for feeding either or both systems, but as coal is now at an almost prohibitive price in Italy, the set does excellent service as a frequency changer.—*The London Daily Telegraph.*

Physical Geography of the Southern Algerian-Moroccan Frontier

A CLASSIFICATION of this borderland into natural regions has been obtained by Francis Rey, a French army officer, by combining geological and geographical observations made in the course of explorations undertaken between the years 1910 and 1912 (*Recherches géologiques et géographiques sur les territoires du Sud Oranais et du Maroc sud-oriental, Revue de Géog.* Vol. 8, 1914-1915, 175 pp.). The area investigated embraces nearly forty thousand square miles and is included between the parallels of 30 degrees and 33 degrees N. and the meridians of 0 degrees and 5° W. Three main regions are distinguished. The steppes and the Shott Tigri form the most northerly. The mountainous intermediate region of the Saharan Atlas follows, while a southern region comprises the zone of *hammadas*, or Saharan plateaus.

The steppe region has an altitude varying between 3,600 and 4,600 feet. Originally a folded area similar to the Saharan Atlas, it has been transformed into a number of desertic peneplains. These forms are shown to be the result of five successive cycles of erosion, characterized by a persistent conflict between eolian and alluvial agencies. The transition from this natural region to that of the Saharan Atlas occurs without a break. Mountain features merge insensibly into those of the desertic peneplain type.

The distinctiveness of the Saharan Atlas is due to structure. In the west the mountain region shades off into that of the Moroccan Atlas. The area investigated by Rey is subdivided into three sub-regions, namely, the Tamlelt elevated plain, the Ksur and Figuig ranges, and the Moroccan Ksur ranges. The Tamlelt plain lies at an average altitude of about 3,900 feet. Its greatest length strikes east-west. In places upon its sandy surface, saucer-like depressions with a clayey bottom form the sites of oases with sparse verdure. Life in the region is centered around these patches of green. Beyond lies the bare plain with its Saharan flora. The Ksur mountainous region presents the appearance of an elevated plateau supporting a system of roughly parallel ranges. The altitude of the intervening plains decreases from north to south. Thus the descent into the *hammada* zone follows in steplike sequence. The Figuig ranges differ from the preceding in geological character. Jurassic limestones almost exclusively compose the rock strata. The folding is of a distinct Alpine type with upturned anticlinals, whereas in the Ksur region it is Jurassic in character. The limestone foundation combines with the desertic climate to convert the region into a land of desolation.

South of the Atlas the *hammadas* form a region which has been subjected to powerful erosive agencies. Beginning at the end of the Tertiary successive layers of this

desertic formation have been deposited. Their surface is devoid of life and conveys an excellent impression of the Saharan desert. As a rule they are slightly tilted toward the south.

Special mention of the influence of eolian action is made in the course of this study. It is shown that, while the wind has exercised a destructive action in the northern zones of steppes and mountains, its effects have been constructive in the southern *hammadas*, where thick layers of sand have been deposited over landforms modeled by river erosion. The sand dunes, or ergs, carved by the wind thus provide a system of forms due to eolian action which overlie a morphological series due to river erosion.

From an economic standpoint the region is one of meager resources. Sheep raising constitutes the most profitable occupation on the plateaus, and hopes are entertained of the possibility of creating a dry-farming industry. Mining may become an important source of revenue in the Atlas country.—*Geographical Review.*

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