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U. S. DEPARTMENT OF COMMERCE

BUREAU OF STANDARDS

TESTING EQUIPMENT FOR LARGE-CAPACITY SCALES FOR THE USE OF WEIGHTS AND MEASURES OFFICIALS

MISCELLANEOUS PUBLICATION No. 104

U. S. DEPARTMENT OF COMMERCE
R. P. LAMONT, Secretary

BUREAU OF STANDARDS
GEORGE K. BURGESS, Director

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FOREWORD

The Bureau of Standards receives many requests for information on specialized, mobile equipment for use by weights and measures officials in the testing of large-capacity scales. Being convinced of the necessity for such equipment if commercial scales having capacities of 10, 15, and 20 tons are to be given an adequate test, the bureau desires to further the efforts of officials to procure apparatus of this character, and to that end the present publication has been prepared. There will be found herein some material on the subject formerly published in Reports of the National Conference on Weights and Measures; combined with this is additional material recently assembled.

The effort has been to present in this publication a convincing argument for the procurement of suitable equipment for the testing of large scales, and descriptions of typical outfits already in successful use by weights and measures officials. The official seeking such an equipment will therefore be in a position to supply to the members of a legislative committee, a county board, a city council, or a town board, in addition to his own recommendations, a concise summary of the results of the thought and experience and the recommendations of other officials.

It is hoped that this publication will be the means of stimulating interest in this very important branch of weights and measures activity, and of assisting in raising the standard of efficiency of apparatus for the official testing of large-capacity scales, to the end that greater service may be rendered to the owners of commercial scales and greater protection afforded to those who buy commodities over them.

Weighing a truck load of coal on a 20-ton auto truck scale

The gross weight of this load was 32,550 pounds, the tare weight of the truck was 14,700 pounds, and the net weight of the coal was 17,850 pounds. The inadequacy of a test load of 1,000 or 2,000 pounds to prove the accuracy of a scale used for weighing such loads as this is discussed in this publication.

TESTING EQUIPMENT FOR LARGE-CAPACITY SCALES FOR THE USE OF WEIGHTS AND MEASURES OFFICIALS

I. THE NECESSITY FOR SPECIALIZED EQUIPMENT

The function of a scale is to determine the weights of varying amounts of commodity. The object of the official test of a scale is to determine whether or not the scale is capable of correctly indicating the weights of the commercial loads which will be weighed upon it. If the test of a scale is incomplete, then the inspector of weights and measures can not know all that he should know about the performance of the scale to enable him to decide whether or not to approve it for commercial use; if, proceeding upon insufficient information, he approves the scale, he is making an unwarranted assumption that the scale is correct, and he may thereby become directly responsible for serious financial injury to the public on the one hand and to business concerns on the other, whose dealings involve weights taken over the scale in question.

However competent and careful the weights and measures officer may be, he can not properly perform his duties without suitable equipment. The testing of scales is a specialized activity, and demands specialized equipment of indisputable accuracy; moreover, not only must the inspector's field equipment include accurate test weights, but these weights must be available in sufficient quantity to enable him to prove the accuracy of the scales throughout the weighing range in which they will be used. In the case of scales of large capacity, such as the 10, 15, and 20 ton "auto-truck" scales necessitated by the size and capacity of the present-day automobile truck, the amount of test weights required is greatly in excess of the test-weight loads which have been acceptable in former years for the testing of the relatively low-capacity wagon scales.

There is a popular conception to the effect that a scale which will weigh a small load correctly will weigh any load within its capacity range with equal accuracy. This belief is entirely erroneous. A scale is, after all, nothing but a machine; it may have been improperly designed, made, or installed, or it may get out of condition through use, abuse, accident, or intent on the part of the owner or user. The superficial appearance of a good scale may not differ from that of a poor scale; initial and continued accuracy may only be demonstrated by adequate and regular tests.

Inspectors have been known to test large-capacity scales of the wagon and truck types with only a small quantity of weights and to base approval upon the results under the "light load" only, that is, under the load of test weights alone. Even if the scale is found to weigh correctly up to a ton or so, this information is of little value, because that portion of the weighing range is used up in taking the tare weight of the vehicle and is seldom if ever used in determining the weight of commodity. It is the upper weighing range, the "commodity range" above the weights of empty vehicles, which is of most importance, because it is here that commodity weights are determined. If, in addition to the test under light load, the scale is not put under at least one strain load and the test weights again applied, the inspector knows nothing about what the scale is doing in the commodity range.

What constitutes an ideal test? This question may be answered by saying that an ideal test is a test to the capacity of the scale, using standard weights as the test load. This ideal can be realized in practice on small scales, but on large-capacity scales it is practically unattainable. This phase of the problem then resolves itself into the question of how large a test-weight load the inspector should have available for testing these large scales.

In the days when 4 and 5 ton wagon scales were the largest scales usually encountered by the inspector, 1 ton of 50-pound test weights, representing 25 or 20 per cent of the scale capacity, was considered a reasonable test load. This load could be applied to each corner of the scale platform over the corner bearings; a loaded vehicle used as a strain load could then be "balanced out" on the platform and the test-weight load again applied, thus giving the scale a reasonably good test practically up to its capacity.

But on a 20-ton scale, a ton of test weights represents only 5 per cent of the scale capacity, and is entirely too small a load upon which to rely for a test. If 1 ton of test weights are necessary for the test of a 5-ton scale, at least several tons of test weights should be available for 15 and 20 ton scales.

It is recommended that equipments be designed to provide at least a 10,000-pound test load. In addition to the fact that such a test load represents a more reasonable proportion of the scale capacity, another very important reason may be advanced for the recommended test load: The error of scale indication is more surely and definitely determined on a large than on a small test load and the allowable tolerance may be more fairly applied; in fact, an error in excess of the tolerance may not be discovered at all when only a small test load is being used. With a 5-ton test load, however, the observed weight difference caused by a multiplying error of a given amount would be five times as great as with a 1-ton test load; this makes it possible to detect many errors which are of real importance in the use of a scale, but which might readily remain undiscovered if only a small test load is utilized.

Another fact which should not be overlooked in this connection is that when large-capacity scales are tested with known loads of 10,000 pounds or more the owners of the scales will feel much better satisfied with the character of the test applied and will have justifiably greater confidence in the results.

From the standpoint of the conservation of the time and energy of the official inspectional force, as well as for the purpose of rendering prompt and efficient service to the community, provision for transporting the test weights and for handling them by mechanical means is of practically equal importance with provision of a suitable amount of test weights. No argument need be advanced in support of a recommendation for a suitable automobile truck for transporting the test weights from scale to scale; the necessity for this is obvious. As to means for mechanically handling the test weights during the test of a scale, it should only be necessary to mention a few facts in order to convince the most conservative reader of the advantages of such an arrangement.

The cost of 5 tons of 50-pound cast-iron test weights is at least double the cost of an equivalent weight made up of 500-pound or 1,000-pound units. With the same amount of use, the larger weight units will maintain their accuracy better and longer than the 50-pound units. A given test with 500-pound or 1,000-pound weights may be made much more quickly than with 50-pound weights. The physical effort involved and the time consumed in handling 5 tons of 50-pound weights—200 weights—from five to ten times would be a continual incentive to shorten or slight the test. The inspector would require several laborers to handle two hundred 50-pound weights; if he calls upon the scale owner for such assistance he sacrifices a certain amount of independence which, as an official, it is very desirable that he maintain.

FIGURE 1.—*Testing a 15-ton scale with 50-pound test weights*

About 13,500 pounds of test weights are illustrated. The stack of 99 weights piled on the corner of the scale platform constitutes a load of 4,950 pounds, which is being used for a corner test. The other weights illustrated are not on the scale platform. The large amount of time and labor involved in the test of a large-capacity scale with 50-pound weights may be realized from this view.

It should be obvious from the foregoing that weights in large units are greatly to be preferred for at least the bulk of the test load used in testing large-capacity scales; 50-pound weights will be required by the inspector for testing other types of scales, and 1,000 or 2,000 pounds of these may reasonably be included in the large-capacity-scale-testing equipment if desired, although for scales of the wagon and truck types practically the entire test-weight load may consist of large weights.

Granting the desirability, then, of large-unit weights, it follows that mechanical means must be provided for handling them. For loading and unloading, a movable hoisting arrangement is necessary. This may be a hand-operated chain hoist or a power-operated winch, the latter being preferred; after elevation, the weights may be shifted through the medium of a trolley rolling on an overhead track, or of an adjustable boom and mast combination.

For moving the test load to different positions on the scale platform, any one of several methods may be employed: There may be provided a short wheel base dolly, or small truck, of standard weight which constitutes part of the test load and on which the test weights are piled; this dolly is then pulled by hand to different positions on the scale platform. The dolly should preferably be made entirely or almost entirely of metal so that it may be depended upon to remain constant as to weight; it should preferably be standardized at some even weight, as, for instance, 500 pounds, and should be equipped with a shot cup or its equivalent so that ready adjustment may be made to compensate for changes in weight resulting from use; it should have wheels at least 10 or 12 inches in diameter to facilitate movement over uneven scale platforms, and should have a short turning radius to minimize the movement necessary for spotting the load in the several test positions.

Weights of 500 or 1,000 pounds may be shifted individually on the scale platform by means of a simple 2-wheeled device having a gooseneck axle and a long handle with dependent hook; such a device is

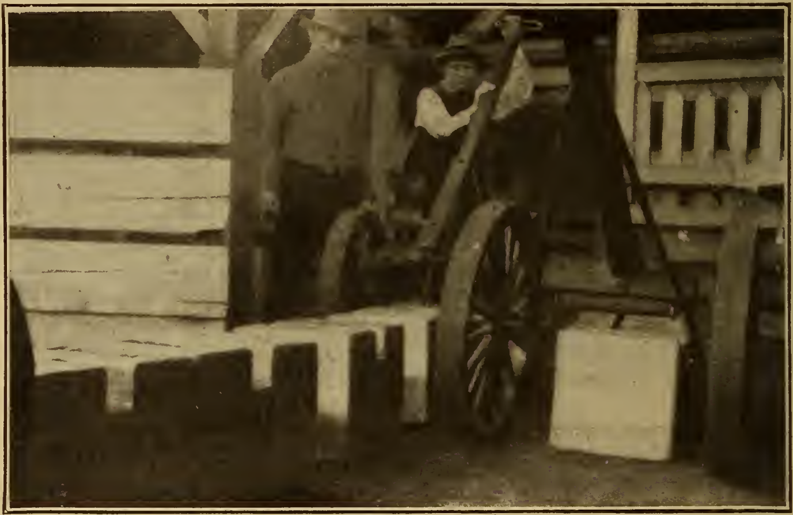

FIGURE 2.—*Two-wheeled carts used for shifting 1,000-pound weights during the testing of scales at the Detroit stockyards*

illustrated in Figure 2. Five-hundred-pound weights of suitable design may also be shifted with an ordinary 2-wheeled "warehouse" truck. Where the large carrying truck is equipped with a mast and boom having a sufficient range of movement, weights may be shifted on the scale platform with this apparatus.

For a discussion of two types of testing equipment designed to utilize 2,500-pound weights, reference should be made to pages 13 to 17, inclusive, of this publication, where there are given extracts from a paper prepared by H. M. Roeser, of the staff of the Bureau of Standards. So far as is known no equipments of the types described have yet been built, but the ideas presented in the paper merit serious consideration. The statements and recommendations contained in the present discussion are based upon information of existing equipments, and are to be construed as having been made without prejudice to the advantages, yet to be proved by actual trial, of such equipments as are discussed by Mr. Roeser.

In the following pages will be illustrated and described a few of the special equipments in use in different weights and measures jurisdictions. While only one of these equipments provides a test-weight load of 10,000 pounds or more, nevertheless the equipments illustrated represent a big improvement over the apparatus in general use a few years ago, and it is not unreasonable to anticipate further improvements in the future. The weights and measures jurisdiction without special equipment for testing large-capacity scales should make every reasonable effort to secure such equipment without delay. The ideas herein presented may be utilized directly by the official who desires to duplicate a unit already in successful use; or the official may select what is believed to be best from each of the several outfits described, and reassemble these parts to form a new combination; or, if he wishes to pioneer and develop something entirely different in the way of a testing equipment, a knowledge of the accomplishments of others along the same line will be found very helpful, to say the least. In any event, decisive action of some kind should promptly be taken, so that large-capacity scales may be given tests commensurate in effectiveness with the importance of the weighings which they are daily called upon to make.

II. SOME EXAMPLES OF TESTING EQUIPMENTS FOR LARGE-CAPACITY SCALES, NOW IN USE BY WEIGHTS AND MEASURES OFFICIALS

SUFFOLK COUNTY, N. Y.[1]

The equipment illustrated in Figures 3, 4, and 5 is the most recent addition to this class of apparatus which has come to the attention of the Bureau of Standards. It is also the most elaborate of the equipments in use, and provides the largest test-weight load. It was designed by C. P. Smith, sealer of weights and measures of Suffolk County, N. Y., and was put into service in May, 1929. With this unit, tests are regularly made up to 15,000 pounds with standard test weights, the weights are removed and a strain load consisting of the carrying truck, weighing approximately 13,000 pounds, is applied, and the test is then carried up to 28,000 pounds with standard test weights. An additional 2,000 pounds of test weights are available for use whenever this may be considered necessary.

The unit consists of a 6-cylinder, 5-ton truck, having five forward speeds, 36 by 8 pneumatic tires in the front, and 40 by 14 solid tires in the rear. The truck is guaranteed for the 50 per cent overload which it carries. The truck is electrically equipped throughout. The cab is inclosed; the body is open, a tarpaulin being provided to cover the weights in bad weather. The wheelbase is 162 inches; the body is approximately 7 feet wide by 12 feet long; a 12-foot overhead clearance is safe.

Behind the cab and directly over the transmission is mounted a winch-and-crane assembly. The power take-off for the winch is bolted rigidly to the transmission case; it is now believed that a flexible mounting with a universal joint at this point would be an improvement. The winch is controlled as follows: By means of a

[1] The information presented was gathered at the time of a personal examination of this equipment.

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lever in the cab, connection is made with the power plant of the truck. Two levers are mounted on the left side of the winch; one of these is the gear shift lever, which may be set for elevating or lowering the

FIGURE 3.—*Equipment of Suffolk County, N. Y.*

A test-weight load consisting of fourteen 1,000-pound weights and twenty 50-pound weights is carried. The large weights are handled by a power-operated winch and a hand-operated trolley and swinging boom. The levers for controlling the hoisting mechanism, the chain by which the trolley is moved in and out on the boom, and the rope by which the boom is pulled around or snubbed in position, may all be seen in the illustration. In bad weather the weights are covered with a tarpaulin.

FIGURE 4.—*Loading 1,000-pound weights from the side of the Suffolk County, N. Y., equipment*

The boom may be swung through a complete circle, thus facilitating the spotting and recovery of the weights. In the illustration one operator is shown handling the winch controls, while the other guides into position the weight being loaded.

weight tackle; the other is the clutch lever which must be held in the engaged position. When released, the clutch lever disengages itself, and the load being handled is automatically locked in position in so far as up or down movement is concerned; in other words, power must be used to lower a load just as it must be used to raise a load. The weight tackle is moved in and out on the crane or boom by means of a hand-operated chain control, also on the left side of the assembly. The capacity of the crane is 5,000 pounds up to 5 feet from the mast, and 3,000 pounds 12 feet from the mast. The crane will rotate through 360°, being turned by means of ropes attached to the outer end of the crane; these ropes also serve to snub the crane. The chains shown on the weight tackle are to be replaced by hooks, to simplify engagement and disengagement with the weights.

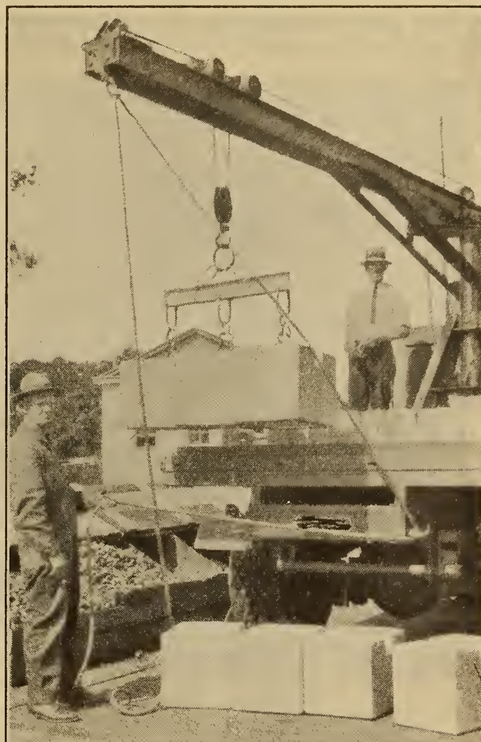

Figure 5.—*Unloading three 1,000-pound weights from Suffolk County, N. Y., equipment*

One, two, or three weights may be handled at one time. When the winch clutch lever is released the hoisting mechanism is automatically locked in position. In the illustration a 15-ton scale is being loaded with 8,000 pounds of weights for an end test.

To prevent undue strain on the truck frame when large loads are lifted from the side of the truck, two large jacks are provided as part of the hoist unit, these to be placed in position on either side of the truck, engaging special castings made to receive them. In handling a single 1,000-pound weight from the side under all ordinary conditions, however, no unsafe stresses are developed in the truck frame, and it is unnecessary to make use of the jacks.

The test-weight load consists of fourteen 1,000-pound weights and twenty 50-pound weights. For use when occasion demands there are two additional 1,000-pound weights, but these are not regularly carried because to do so the New York State highway load limitation of 28,000 pounds would be exceeded. The size of the 1,000-pound weights is approximately 15 by 19 inches by 15 inches high; sealing plugs are provided for adjustment. When the carrying truck is fully loaded approximately 80 per cent of the load is carried by the rear axle.

To facilitate and speed up the shifting of the 1,000-pound weights on the scale platform, Mr. Smith expects to add to his equipment a 2-wheeled cart similar to those illustrated in Figure 2, appearing on page 4.

The entire equipment as described was furnished on a single contract by the truck manufacturer at a cost of $7,500. As a matter of interest to other officials, it may be said that the list price of the winch-and-crane assembly is $1,400, and that the price of the 1,000-pound weights was $60 each.

CITY OF DETROIT, MICH.[2]

The equipment illustrated in Figure 6 was designed by Inspector George F. Austin, city sealer of weights and measures of Detroit, Mich., and has been in service about a year.

The unit consists of a 3½ to 5 ton special truck, having seven speeds forward and two reverse, 30-inch cushion wheels, 36 by 5 tires in the front and 36 by 12 tires in the rear. The truck is electrically equipped throughout. The cab is semiclosed; the body is fully inclosed. The wheel-base is 134 inches; the over-all length is 18 feet 5½ inches; the body is 10 feet long, 55 inches wide (inside), and 62 inches high (inside).

FIGURE 6.—*Equipment of the city of Detroit, Mich.*

A test-weight load consisting of seven 1,000-pound weights and forty 50-pound weights is carried. The large weights and dolly are handled by a hand-operated chain hoist and overhead trolley. The dolly has roller bearings, and is standardized at 540 pounds; it is carried immediately to the rear of the large weights. Small weights, tools, etc., are carried ahead of the large weights, access being had through the side doors.

The truck is equipped with a hand-operated high-speed trolley hoist, traveling on an overhead track, for handling the large weights. A dolly is provided for moving a test load to different positions on a scale platform. This dolly has roller bearings, a wheel base of 38 inches, and its weight is standardized at 540 pounds.

The test-weight load consists of seven 1,000-pound weights and forty 50-pound weights; a complement of small weights is also carried. Each 1,000-pound weight has two dowels on the upper side and corre-

[2] The information presented was furnished by letter by George F. Austin, jr., assistant supervisor, department of weights and measures, Detroit, Mich.

sponding recesses on the under side so that the weights will be held securely in position when stacked. The light weight of the truck is about 11,000 pounds; fully loaded its weight is about 20,600 pounds.

The truck, hoist, and dolly were furnished on a single contract by the truck manufacturer at a cost of $3,970. The seven 1,000-pound weights were secured at a cost of $336 ($48 each). Other items included in the complete equipment represent an investment of between $400 and $500.

ALAMEDA COUNTY, CALIF.[3]

The equipment illustrated in Figure 7 was designed by Edward K. Strobridge, sealer of weights and measures of Alameda County, Calif.,

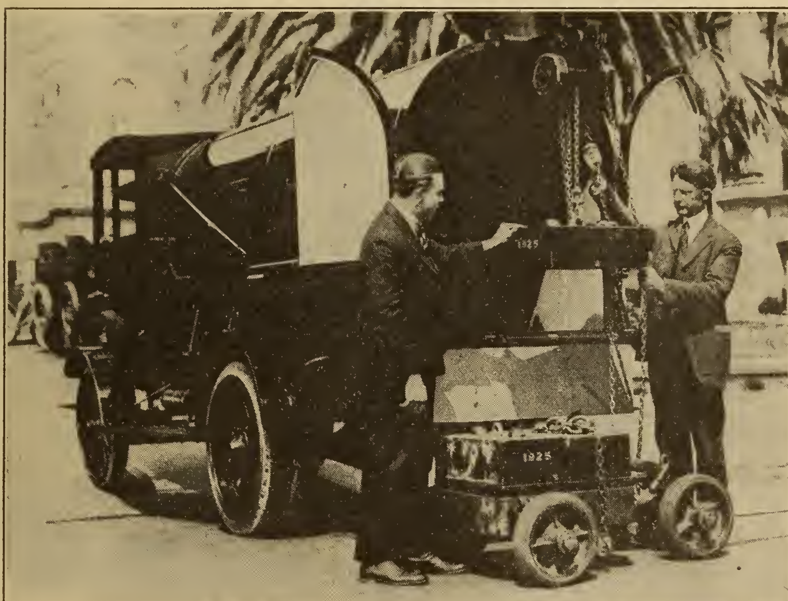

FIGURE 7.—*Equipment of Alameda County, Calif.*

A test-weight load consisting of five 500-pound weights and one hundred and twenty 50-pound weights is carried. The large weights and dolly are handled by a hand-operated chain hoist and overhead trolley. The dolly has roller bearings and is standardized at 500 pounds; it is carried just to the rear of the large weights. The 50-pound weights, a small 350-pound dolly for use with 50-pound weights on indoor scales, small weights, tools, etc., are carried ahead of the large weights, access being had through the side doors. This equipment was the model from which the New Jersey State equipment was designed.

and was the model from which the New Jersey State equipment, which is described in detail further on, was patterned. The general characteristics of the two equipments are the same.

This equipment consists of a truck having a completely inclosed metal body; this is equipped with a hand-operated trolley hoist, traveling on an overhead track, for the handling of the large weights. A dolly is provided, equipped with roller bearings and standardized at 500 pounds; this is used in combination with 500-pound weights for

[3] The information presented has been taken from the paper prepared by Edward K. Strobridge, sealer of weights and measures of Alameda County, Calif., for presentation to the National Conference on Weights and Measures in 1925. (Report of the Eighteenth National Conference on Weights and Measures, Bureau of Standards Miscellaneous Publication No. 70, pp. 59 and 60.)

the testing of large outdoor platform scales. A smaller dolly, standardized at 350 pounds is used in combination with 50-pound weights for the testing of inside scales.

The test-weight load consists of five 500-pound weights and one hundred and twenty 50-pound weights, a total of 8,500 pounds; including the two dollies, there is a standardized load of 9,350 pounds. The weight of the entire unit, fully loaded, is 16,000 pounds.

STATE OF NEW JERSEY[4]

The equipment illustrated in Figures 8 and 9 was designed by the New Jersey State department of weights and measures, being pat-

FIGURE 8.—*Equipment of the State of New Jersey*

A test-weight load consisting of nine 500-pound weights and forty 50-pound weights is carried. The large weights and dolly are handled by a hand-operated chain hoist and overhead trolley. The dolly has roller bearings and is standardized at 500 pounds; it is carried just to the rear of the large weights. The 50-pound weights, small weights, tools, etc., are carried ahead of the large weights, access being had through the side doors.

terned after a very similar equipment which had been in service for several years in Alameda County, Calif.

The unit consists of a 4-cylinder, 2½-ton truck, having 34 by 5 solid tires in the front and 36 by 5 dual solid tires in the rear. The cab is semiclosed; the body is fully inclosed, the covering being of steel. The wheel base is 114 inches; the over-all length is 18 feet 3 inches, the over-all width is 6 feet 2 inches, and the over-all height is 9 feet 1 inch; the body is 11 feet long, 44 inches wide, and 53¼ inches from bed to bottom of bows.

[4] The information presented was largely gathered at the time of a personal examination of this equipment; some data have been taken from the paper presented to the National Conference on Weights and Measures in 1928 by Joseph G. Rogers, assistant superintendent of weights and measures, State of New Jersey. (Report of the Twenty-first National Conference, Bureau of Standards Miscellaneous Publication No. 87, pp. 48 to 53, inclusive.)

The truck is equipped with a hand-operated trolley hoist, traveling on an overhead track, for handling the large weights. One 500-pound dolly is provided; this is of all-metal construction and has roller bearings and a gooseneck connection between body and front axle to provide a short turning radius.

The test-weight load consists of nine 500-pound weights and forty 50-pound weights. The size of the 500-pound weights is 11½ by 24 by 8 inches high; each weight has two dowels on the upper side and corresponding recesses on the lower side, so that the weights will be held securely in position when stacked. The light weight of the truck is about 9,000 pounds; its weight when loaded is about 16,000 pounds.

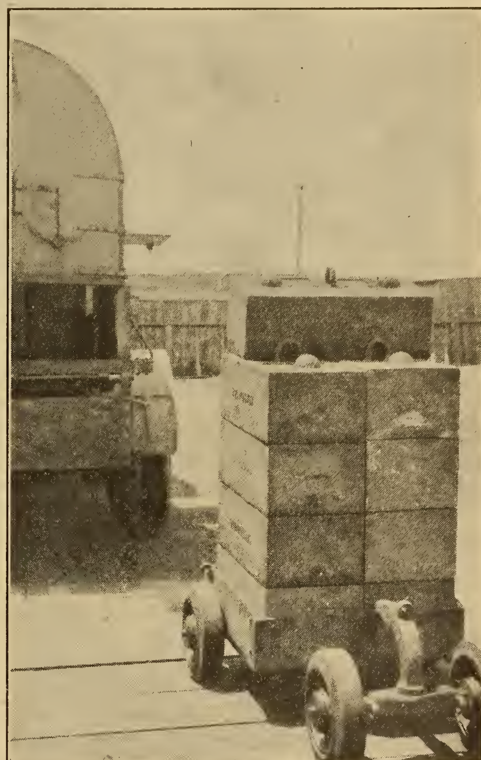

FIGURE 9.—*Loaded dolly of New Jersey State equipment*

Test weights and dolly constitute a 5,000-pound test load, shown in position for a corner test on a 15-ton scale. The front axle of the dolly is connected to the body by a gooseneck to provide a short turning radius. The detachable handle by which the dolly is moved and guided is not shown in the illustration.

The truck, hoist, dolly, and five 500-pound weights were originally furnished on a single contract by the truck manufacturer at a net cost of approximately $5,400; four additional 500-pound weights have recently been added at a cost of $40 each.

The New Jersey department now believes that this equipment would be improved by equipping the truck throughout with pneumatic tires. They also recommend power operation for the hoist if this can be worked out in a practical manner. The low headroom inside the body and the sloping top of the body combine to cramp the operator when working inside; a modification of body design which would eliminate this objectionable feature is also recommended.

SOMERSET COUNTY, N. J.[5]

The equipment illustrated in Figure 10 was designed by Melvin H. Cleaves, superintendent of weights and measures of Somerset County, N. J. The unit consists of a 1½-ton truck, having 32 by 6 tires all around. The truck is equipped with a hand-operated trolley hoist, traveling on an overhead track, for handling the large weights.

[5] The information presented was furnished by letter by Melvin H. Cleaves, county superintendent of weights and measures, Somerville, N. J.

The test-weight load consists of five 500-pound weights and thirty 50-pound weights. The weight of the truck fully loaded is 8,900 pounds. The total cost of the equipment was $2,300; the 500-pound weights were furnished at a cost of $35 each.

FIGURE 10.—*Equipment of Somerset County, N. J.*

A test-weight load consisting of five 500-pound weights and thirty 50-pound weights is carried. The large weights are handled by a hand-operated chain hoist and overhead trolley.

Mr. Cleaves is now of the opinion that it would have been better had the capacity of the truck been 2½ tons, and he would recommend this size to anyone planning an equipment of this character.

OTHER JURISDICTIONS

Numerous jurisdictions in addition to those whose equipments have been described above have developed special automotive units for testing large-capacity scales. So far as the Bureau of Standards is advised, the majority of these utilize 50-pound weights for their test-weight loads; these weights may or may not be used in combination with a dolly, standardized at a fixed weight, which forms a part of the test load. Wherever these special units are in use they represent an improvement over the methods followed in large-capacity-scale testing prior to their adoption, and the officials responsible for putting them into use are to be commended for their successful efforts to improve their testing methods.

The principal objection to be found with these units, from the standpoint of the efficiency of the tests which can be made with them, is that the test-weight loads are too small. The officials are not to be blamed for this condition in many cases, for it may be the result of conditions beyond their control.

III. NOTES ON APPARATUS FOR TESTING LARGE-CAPACITY SCALES [6]

Presented to the Twentieth National Conference on Weights and Measures by H. M. Roeser, *Bureau of Standards*

The requirements for an outfit for testing motor-truck scales are most exacting. Such an outfit must be capable of carrying a maximum of standard weights, must have minimum initial operating and maintenance costs, must have a maximum cruising range, and maximum flexibility of movement.

Test requirements, road conditions, and handling equipment limit the amount of standard weights that can be handled effectively and economically to 5 tons or 10,000 pounds. To gain low initial cost it is necessary that stock mechanical equipment be used for transporting and handling, since it is axiomatic that specially designed equipment is extraordinarily expensive. This will, in turn, be reflected in minimum maintenance costs and probably tend to minimum operating costs. Equipment which requires skill or training to operate must, of course, be avoided.

To my mind, the most important factor in operating cost, or, in fact, in the reduction of the cost per test to the ultimate minimum, is the size of the test-weight units. It is unnecessary to tell you that the cost of testing 20-ton motor truck scales with 50-pound test weights is prohibitive on account of the exceedingly great amount of time and labor involved. I have noticed in the descriptions of equipment previously designed for this and similar purposes that 500-pound units are extensively used. This is a long step toward cost reduction, but it is neither far enough nor as far as can be gone without sensibly increasing handling inconvenience. On the assumption that little more time or inconvenience is required to handle a big weight than a little one if the proper equipment is used, handling time and costs are reduced almost in the inverse ratio of the size of test units. My intention or desire, then, is to use as large test weights as possible, and after study of the problem I have concluded that 2,500-pound units may be feasible.

Further study of the problem leads to the certain conclusion that at least two types of equipment should be recommended—one for a city of considerable size where weighing locations are concentrated, space is cramped, and the necessary cruising range of the outfit is not extraordinarily large; the other for a county, State, or other civil subdivision where weighing locations are distributed, where great cruising speed and range are important considerations, and yard space generally free. Diagrammatic illustrations of these have been prepared which show their general nature and the methods of handling and manipulating the test loads.

[6] See Report of the Twentieth National Conference on Weights and Measures, Bureau of Standards Miscellaneous Publication No. 80, pp. 84 to 89, inclusive.

The first mentioned of these types employs the ubiquitous tractor as a source of motive power. The test weights are carried in the

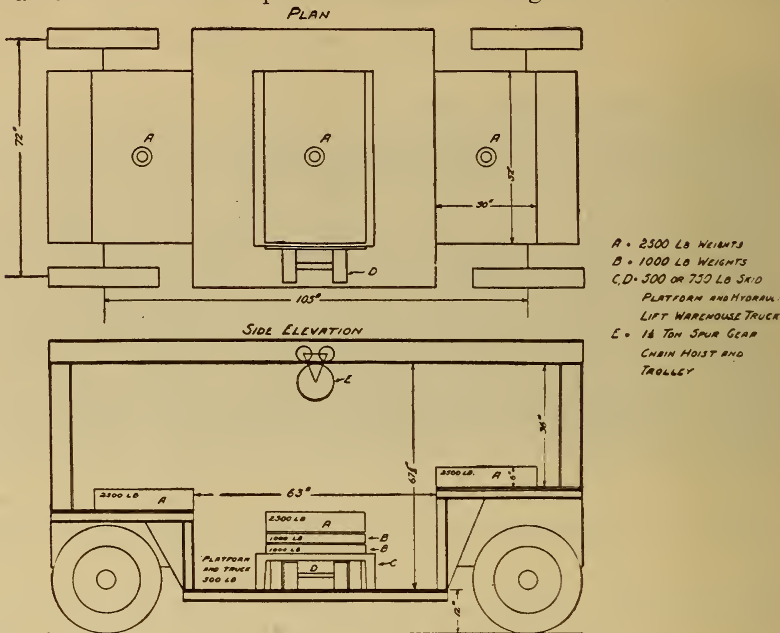

DIAGRAM LAYOUT
MOTOR TRUCK SCALE TESTING OUTFIT
CARRIER AND HANDLING UNITS
10,000 POUNDS TEST LOAD

FIGURE 11

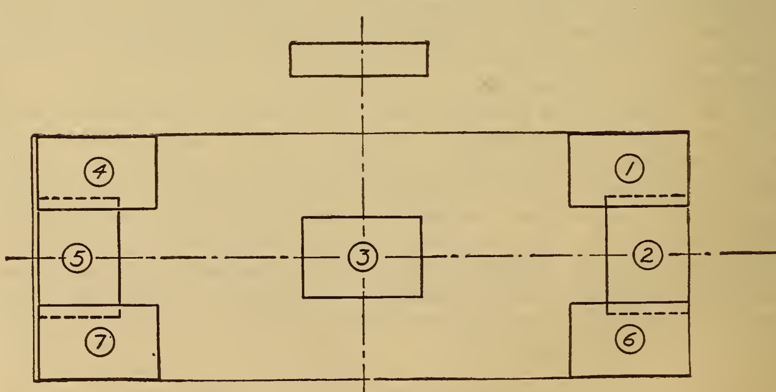

DIAGRAM OF TEST LOAD SPOTTING
24'x9' MOTOR TRUCK SCALE DECK

FIGURE 12

trailer (shown in fig. 11) having a low central portion and inclosed by sides which when let down from the top form a gangplank. While being transported one 2,500-pound weight is carried over each axle, and 5,000 pounds, consisting of a 2,500-pound weight, two 1,000-pound weights, and a 500-pound hydraulic lift warehouse truck and skid platform, is carried in the central portion. A 1½-ton spur-gear chain hoist, running on an overhead I-beam trolley, is used for handling the 2,500-pound weights on and off the portable truck. When making a test, the outfit can be set at any convenient place in the immediate vicinity, the sides let down, the weights loaded on the truck, lowered down the gangplank, and taken to the scale by the tractor.

Test-load manipulation on the scale is shown in Figure 12. The loads are moved to the different spots in successive numerical order by means of the tractor and a drag line. The movement from position 1 to 2 and from position 4 to 5 is manual and consists simply of taking hold of the tongue and swinging the truck around at right angles.

How the trailer may be used in applying a strain load to the scale if clearances permit is shown in Figure 13. The trailer may be

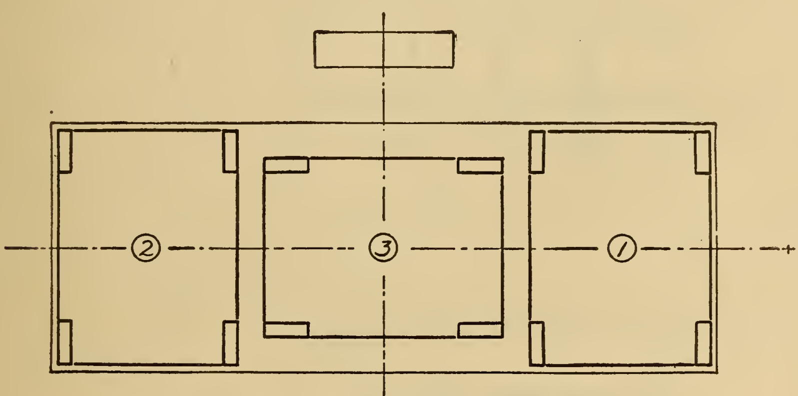

DIAGRAM OF STRAIN LOAD SPOTTING
24 x 9 MOTOR TRUCK SCALE DECK

FIGURE 13

set on the scale in position No. 1 and weighed or balanced off. The test load can then be pulled into it with the tractor and the known increment in load weighed. It may then be shifted to positions Nos. 2 and 3 with the tractor.

This type of outfit has the features of low first cost and low operating and maintenance costs. All parts are stock mechanical equipment and may be operated with ordinary labor. It has the greatest possible degree of mobility in cramped quarters, and yet its cruising possibilities are sufficient for city service. The weights are of a standard form, and the lifting accessories of common design. Labor of handling weights is reduced to a minimum, since in making a test only two weights must be shifted on and off the truck and neither of these need be lifted more than an inch. This is practically all the manual labor that would be involved in making a test. For routine service I am convinced that this type of outfit would yield the lowest possible cost per test.

The second type of outfit (see fig. 14) is on the order of the conventional motor-truck outfit. The test weights and secondary methods of transportation are the same as in the tractor-and-trailer type. An I-beam trolley carrying a spur-gear hoist is used for handling the weights. In order to keep the outfit from being top-heavy, the trolley is not overhead, but is about level with the breast of a man standing on the floor of the body. This arrangement will also give greater convenience in pushing the weights in and out of the car while suspended from the hoist. The movement of weights in and out of the car will be attended with some difficulty if the truck is standing on ground inclined along its longitudinal axis. It is not improbable that a geared trolley block or other means of racking the hoist will have to be provided. Also, in order to keep down

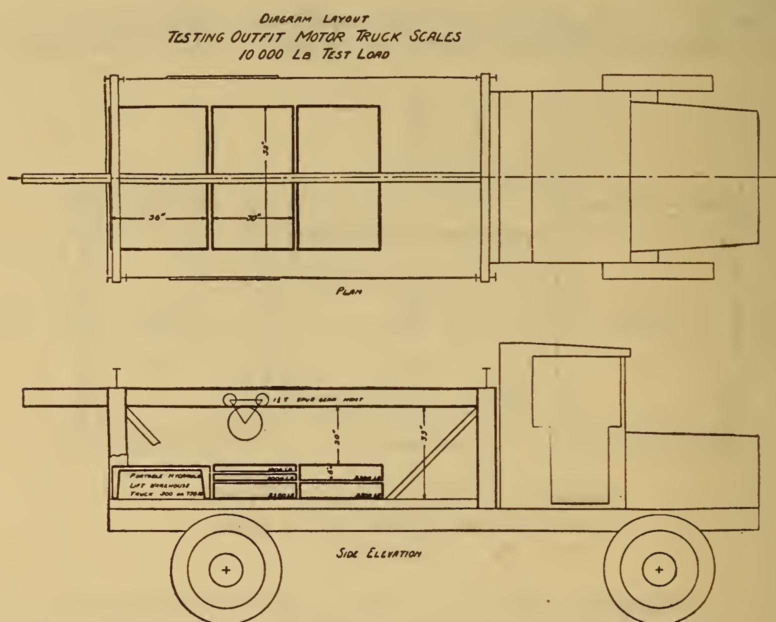

Figure 14

weight, the I beam may be fixed in position so that it projects over the end of the body instead of being movable in and out, as in some designs in use.

The effective use of such an outfit as this will require more time per test, more freedom of space about the scale, and better conditions generally than the tractor-and-trailer type. More manual labor will also be required. It has, however, greater cruising range, in fact as much as may be required, greater speed, and independence of movement, and should be recommended where these last-named requirements are dominating.

Upon beginning a test, the truck may be backed up to the scale platform and the portable weight deposited directly upon the deck in one of the regular positions shown in one of the illustrations. The test load may be shifted about on the scale platform, using the truck and a drag line, some suitable form of winching apparatus, or a gear arrangement on the test load itself. Strain loads may be applied by use of the test weights and the truck in appropriate combination or by depositing the test weights along the scale deck and straddling them with a truck load of coal. The weights are not so thick as to interfere with a differential housing.

As stated previously, these plans are submitted as ideas for a verdict of common opinion as to correctness of principle. Detailed design will require much time and expense, and I think it well to spend considerable time in circumspection before setting out upon it. These things are too costly for experimentation. It is an economic necessity that we guess right the first time.

DISCUSSION ON PROPOSED APPARATUS FOR TESTING LARGE-CAPACITY SCALES [7]

C. A. Briggs (livestock weight supervisor, United States Department of Agriculture). We have had experience in testing livestock scales with 2,500-pound weights and with 1,000-pound weights, and our experience has been favorable to the 1,000-pound weights. The 2,500-pound weights are a little heavy to handle, and in attempting to move them about it requires elaborate machinery, so that, as a matter of fact in the cases I have in mind, it was found easier to handle three 1,000-pound weights than it was to handle one 2,500-pound weight.

Mr. Roeser. The general idea that I was working on is that it takes two and one-half times as long to load up the same amount of load in 1,000-pound units as it does to handle 2,500-pound units, and time is a deciding factor in making these tests.

Mr. Briggs. I might make it clear by stating that the 2,500-pound weights were handled by a device having a metal carrier and hoist, requiring from three to five men to handle it, whereas to handle the 1,000-pound weights is a simple proposition. They are handled by means of light two-wheeled carts,[8] which are felt to be an improvement over the device for handling the heavier weight. At first they had very heavily built carts, but the lighter carts, when built to meet an emergency, were found to be very satisfactory and one man can handle a 1,000-pound weight with ease when the heavy elaborate carts have been disposed of. With these light two-wheeled carts they carry the weights from scale to scale; they haul them sometimes a quarter of a mile.

J. A. Sweeney (city sealer of weights and measures, Boston, Mass.). Do I understand, Mr. Roeser, from your testing of scales, that you ignore the test of scales with loads of less than 1,000 or 2,500 pounds?

Mr. Roeser. No; not necessarily. My talk was centered about the kind of outfit necessary to get a 10,000-pound load on the scale and move it around. The main weight units would naturally be 2,500 or 1,000 pounds each.

Mr. Sweeney. Do you think that is more practical than having a specially built 2 or 3 ton capacity truck and carrying 3,000 pounds of 50-pound weights? Wouldn't you get the same results that way?

Mr. Roeser. No; you would run up the cost of your test too high. You would have practically the same investment tied up in handling facilities in either case, but the test per scale would cost considerably less with the outfit I have proposed, and you would have a considerably better test. I think you should have an outfit that takes the least time to make the test; otherwise you are wasting somebody's time.

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[7] See Report of the Twentieth National Conference on Weights and Measurers, Bureau of Standards Miscellaneous Publication No. 80, pp. 89 to 92, inclusive.

[8] See Figure 2, p. 4.

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