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A NEW DYNAMOMETER FOR USE IN ANTHROPOMETRY.

By J. H. Kellogg, M. D.

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A NEW DYNAMOMETER FOR USE IN ANTHROPOMETRY.

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SOME twenty years ago I began the employment of calisthenics and Swedish movements, manual and mechanical, in the treatment of chronic invalids. Some years later I visited Stockholm, Sweden, and spent a little time under the tutelage of Prof. Hartelius, to enable myself to become better acquainted with the Ling system. For the last twelve or fifteen years I have made gymnastics a very prominent feature in the treatment of invalids of all classes coming under my care at the Battle Creek Sanitarium, and in this time have subjected to various forms of exercise, as curative means, more than 10,000 cases.

Early in my experience I became convinced that we have in voluntary muscular exercise one of the most powerful means of modifying nutrition. A more mature experience has fully established me in the belief that muscular exercise is one of the most valuable of all therapeutic agents. From the outset of my use of exercise as a means of cure, I appreciated a difficulty, which I have no doubt has been experienced by every person who has undertaken to make a definite prescription for exercise, which should be closely adapted to the needs of the individual for whom the prescription was made. This difficulty is found to be much greater in the employment of exercise for invalids than in that class of persons who usually come under the care of the physical director, owing to the very great degree of muscular asymmetry which is frequently encountered in invalid adults. In fact, it is a very rare exception to find among adults a person whose habits of life have not been such as to allow important muscular groups to fall into a state of idleness, and what might be termed, to borrow a political phrase, innocuous desuetude. This is well attested by the fact that such deformities as hollow chest, round shoulders, promi-

nent abdomen, curvature of the spine, forward carriage of the head, and similar deformities, are so prevalent that the majority of men and women who have reached the age of forty years or over, furnish illustrations of one or more of these defects. Among chronic invalids, especially, it is exceptional to find a person who does not present defects of this sort, as I have shown in a series of outline studies of the human figure, which is presented elsewhere.[1]

In dealing with this class of persons, I experienced very great difficulty in adapting my prescriptions for exercise to individual cases. In fact, I found myself constantly at a loss to know exactly what my patient needed, and was frequently embarrassed by the fact that notwithstanding the exercise of the greatest possible care in making a prescription which I thought to be suited to my patient's needs, I had done harm rather than good, owing to the failure to recognize weaknesses which were quite as serious, though less manifest, than those which my prescription was intended to relieve, and which required a very different sort of prescription. I made use of the usual methods of anthropometry, exercising the greatest care in taking my measurements, but only to be disconcerted by the fact that patients not infrequently decreased in measurement while gaining in strength, or were discouraged by making little or no change in their dimensions, notwithstanding hard and persevering efforts in the gymnasium.

I soon discovered that measurements were of very little value indeed in dealing with adult invalids, however useful they may be in the management of the physical training of growing boys and girls and undeveloped youths. I learned that quality rather than quantity was the thing important in dealing with adults — at least invalid adults. Through the assistance of Prof. Sargent I possessed myself of all the various forms of dynamometers which had been constructed for use in testing the strength of the muscles of the human body. I found, however, that these dynamometers had so little range of adaptability that only a few muscular groups could be studied

1 "Outline Studies of the Human Figure, comprising 118 Figures, which Embody the Results of Several Thousand Observations, Embracing Studies of a Number of Different Civilized and Uncivilized Races."

by their aid, and finding myself daily embarrassed in consequence of my inability to meet the requirements of my patients, and being unable to avoid most unhappy blunders in my exercise prescriptions, in sheer despair I sought to attempt to devise some accurate means of testing muscular strength which could be adapted to the principal muscular groups of the body.

Having become accustomed, in the physiological laboratory, to the use of the mercurial column as a pressure indicator, I adopted this as a source of resistance, and arranged a simple apparatus consisting of a cistern containing about half an inch of mercury, which received the lower end of a long piece of barometer tubing. The space above the mercury in the cistern was completely filled with water, and with the cistern was connected, by means of three or four feet of rubber tubing, a strong rubber bulb about the size of an ordinary atomizer bulb. These were also completely filled with water. By compression of the bulb, the water contained in it was forced through the tube into the cistern, displacing an equal quantity of mercury, which was forced up into the glass tube. I found that a tube nine feet in height was sufficient to provide for as much resistance as was needed to balance all the force that could be brought to bear by a strong man in pressing the bulb. By means of various accessories, I arranged to apply to this bulb the force of all the principal muscular groups of the body, — extensors as well as flexors, — including the muscles of the trunk.

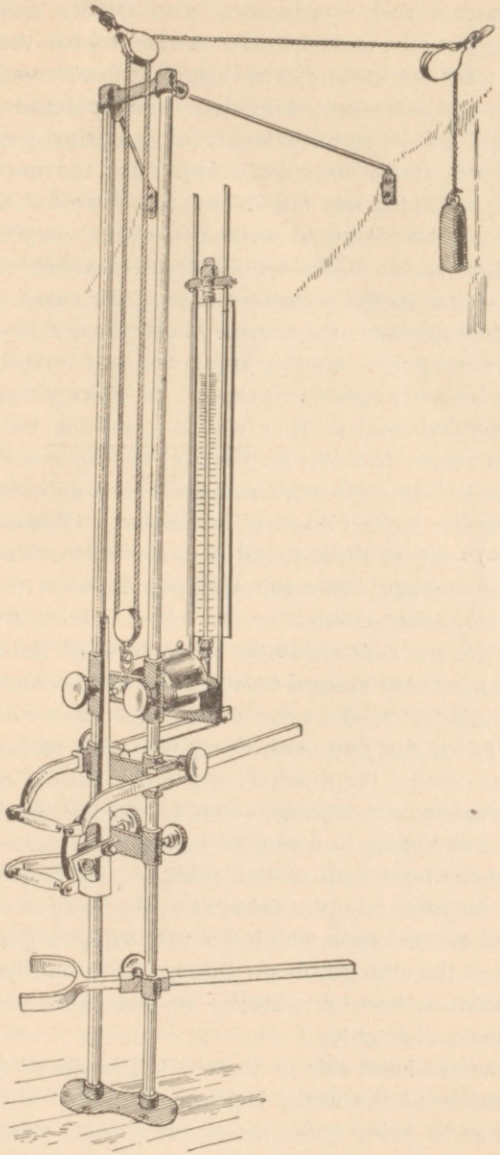
I encountered various difficulties, however, the chief of which were the gradual deterioration of the rubber bulb in use, and the frequent admission of air to the cistern by a change in level of the rubber bulb, causing the mercury column to disappear from the glass tube. Closure of the upper end of the glass tube enabled me to shorten the tube and diminish some difficulties, but it increased others. After several years' experimenting with the various forms of apparatus, I finally substituted a steel cylinder and piston for the rubber bulb, and connected this with the cistern by a metal tube, placing the apparatus upon a carriage which was made to slide up and down a vertical rod, so that there should be at no time any change in the relative positions of the cylinder and the cistern.

In this arrangement I substituted oil for water, as in using water my steel cylinder and piston would soon become useless from rust. To my dismay, however, I soon discovered that the oil entered into combination with the mercury, and deposited a gummy precipitate upon the sides of the cylinder, seriously interfering with the movements of the piston, which must necessarily be as sensitive and delicate as possible. I tried various sorts of liquids without any advantage. Finally the thought occurred to me that the oil and mercury might be separated by means of water, the relative specific gravity of which would keep the oil above and the mercury below. This simple device enabled me to overcome the last serious difficulty in the construction of the machine, and some three years ago I had constructed the apparatus, a cut of which is herewith shown. This apparatus has since been in constant use in the Anthropometric Department of the Sanitarium at Battle Creek, Mich. It is also on exhibition in the Anthropological Department of the World's Columbian Exposition, and during the last year the dynamometer has been employed in connection with the Physical Culture Department of the Battle Creek College.

The dynamometer shown by Prof. Seaver in his work on Anthropometry, and which he has the kindness to commend, is my first instrument which I discarded several years ago for the improved form which I have very briefly described.

In order to dispense with the long tube, Prof. Seaver suggested using a shorter tube and closing the upper end. I have adopted this suggestion, and now use a tube one meter in length. At the upper end of the tube is placed a metallic stop-cock, which is closed after the machine is adjusted, so that the amount of air in the tube always remains the same. The scale of the instrument is made by the application of weights of known value to the lever connected with it, and has a range of one pound to 1000 or more pounds as the air contained within the tube is capable of affording an infinite amount of resistance.

With this dynamometer, which I have very imperfectly described, but which I think will be clearly understood by reference to the cut, I have made, and had made by my assistants, careful tests of the strength of the principal groups of muscles in several thousand adults — men and women. The muscular



A New Form of Dynamometer Designed by the Author for Testing the Muscular Capacity of the Human Body.

groups tested are as follows: Hand flexors and extensors, forearm pronators and supernators, arm flexors and extensors, deltoids, pectorals, and shoulder retractors, for the upper extremities; for the lower extremities, foot flexors and extensors, leg flexors and extensors, thigh flexors and extensors, thigh abductors and adductors; for the trunk, anterior, posterior, and right and left lateral muscular groups; for the neck, anterior, posterior, and right and left lateral muscles; for the chest,— inspiration,— the force of waist expansion; expiration being measured by means of Waldenburg's pneumatometer.

After obtaining the necessary data in the cases of 100 men and an equal number of women, I constructed a physical chart on a percental plan somewhat similar to that followed by Prof. Seaver in his anthropometric chart. In making this chart, the tedious mathematical work of which was done by one of my medical students, Mr. W. A. George, the figures obtained for each group of muscles were arranged in a column in regular order from the highest down to the lowest. Obtaining the sum of fifty per cent, of those found in the middle column, and obtaining the average, the result was put down in the center of the corresponding column on my chart. Forty-five per cent reaching five per cent above the upper level of the middle fifty per cent, were next massed together and the average found, and the result placed in the same column just above the previous result. Thirty-five per cent, thirty per cent, and so on down to one per cent of the numbers above the middle were cut out in like manner, the averages found, and the results properly placed. Proceeding in a similar manner, the figures were obtained for the lower half of the column. By treating the data obtained for each group of muscles in the body in this manner, I obtained a chart upon which I could make a graphic representation of the strength of the body, just as bodily dimensions have heretofore been graphically represented upon anthropometric charts and tables.

At the right-hand side of the chart, I arranged five columns for the totals of the arms, legs, trunk, chest, and the entire body, so as to bring under the eye at a single glance both the relative and the actual strength of the principal divisions of the body.

I have since prepared two other sets of tables, one based upon the data obtained from testing 600 adult men and an equal number of adult women of various ages between eighteen and sixty years, and another based upon the data obtained from 200 young men twenty to thirty years of age and an equal number of young women of the same ages. I was surprised to find, as, however, Prof. Seaver had predicted would be the case, that the figures obtained from the examination of 600 persons differed very little from those obtained in the examination of 100 persons of the same class. The chart based upon the examination of 200 healthy persons between twenty and thirty years of age, differs from the other chiefly in that the figures start at a higher level. In transferring the graphic representation of a person's muscular strength from one to another of these tables, I find that the characteristics, although slightly modified, always remain the same.

As a further test of the value of the chart, I have platted the figures obtained for the various groups of muscles, and find that excellent curves are made. In the case of the left foot flexors, for example, an almost absolutely perfect binomial curve is obtained, as will be observed by the diagram presented with this paper in connection with other illustrations.

The best test, however, for the value of this method of obtaining a basis for a prescription for exercise, is the fact that it meets in a most admirable manner the purposes for which it is designed.

The data afforded furnish exact information concerning the capacity of each of the principal groups of muscles in the body. Knowing the capacity of each muscle, it is easy to proportion the work in such a manner as to secure symmetry of development. My plan of accomplishing this, is as follows :—

Taking 300,000 foot-pounds, one sixth of a full day's work, as the proper daily dose of exercise for a man whose total strength capacity is 10,000 pounds, corresponding very nearly to the greatest capacity shown upon my table prepared from 200 young men in vigorous health, I undertake to establish the definite relation between the strength capacity and the total amount of work to be performed. This is easily accomplished by dividing the total amount of work done by the total capacity

of the muscles; that is, 300,000 is divided by 10,000, giving 30 as the result. This indicates that in a symmetrically developed man with a total strength capacity of 10,000 pounds, each muscle, in order to do its proportion of the 300,000 foot-pounds' work prescribed, must do work to the amount of thirty times its lifting capacity represented in foot-pounds. It is only necessary, then, in order to ascertain the exact amount of work to be done by each group of muscles, to multiply by 30 the figures in each column of the horizontal line at the top of the table, multiplying each successive total by 30, and for each individual group of muscles by the same means.

I have made a careful approximate calculation of the amount of work to be done in each exercise, or set of exercises, with each apparatus in my gymnasium. It is necessary to know the strength of the medicine as well as the needs of the patient. Knowing the amount of work required for each individual and for each set of muscles, and also the result obtained from each exercise, it is very easy to construct tables of exercises exactly adapted to any capacity.

To make a prescription for exercise, I first note the total capacity of the individual, and write down a number which indicates the day's order which would secure for an individual of the given capacity the proper amount of work. Then glancing over the chart, I note the low points, and check or underscore each of these, which indicates to the assistant who superintends the exercise in the gymnasium, that the work is to be doubled on all such points, so as to secure to the weak muscle such rapid development and growth as will enable it to overtake the rest of the body, and thus secure muscular symmetry.

In practice, I find that this method never results in giving to a muscle more than a full day's work, and consequently there is no danger of injury resulting from this doubling of the amount of work required of weak muscles. In case of complete paralysis of the muscle, it is necessary, at the beginning, to administer the exercise by electrical or mechanical means. As a rule, I find it sufficient, for practical purposes, to divide the series of total capacities represented upon my table into five groups, instead of making a distinct schedule of work at each of the levels indicated by the several quantities representing total muscular capacity.

The ratio which I have established between the muscular capacity and the day's work is probably too small for persons in vigorous health ; but I find it well suited to the class of persons who come under my observation, who are for the most part invalids or semi-invalids. The man who is in training and desires to develop his whole body to its highest capacity, should of course be required to execute a full day's work, or 1,800,000 foot-pounds, and even more. In arranging a day's order of exercise, due account is of course taken for the work done in walking, running, and similar exercises, which may be made a part of the program.

The patient does not undertake to do all the exercises prescribed in the series the first day, but gradually takes them up from day to day as he learns them and becomes able to do them, and by the end of two or three weeks is expected to have thoroughly mastered all the exercises given him, and to have become able to take each day all the exercises given him in his prescription.

At the end of a month, another chart is made and the changes noted, and a new prescription made according to the requirements. It is a matter of frequent observation that the points which at the first examination are lowest on the chart, are so improved by the specific exercise directed to these particularly weak muscles that the lowest points become the highest ones upon the second chart.

By means of this method, it is possible to obtain exact knowledge respecting the requirements of each individual case. Possessed of this exact knowledge, it is possible to make a prescription which will be exactly adapted to the wants of the individual. It is possible to make in less than a minute's time, a prescription which is more exactly adapted to the wants of the individual examined than could be made by the most elaborate study and the consumption of any amount of time, without the aid of the accurate data obtained by this method.

One of the charts herewith presented, that of Mr. A., shows the value of this mode of investigation in the diagnosis of morbid conditions affecting the motor system. This patient was suffering from paresis of the left arm. This would be apparent from the chart alone, without other evidence, as will be readily seen. The dynamometer picks out the particular groups of

muscles which are affected by paresis or paralysis, and thus gives important indications respecting the location of the central lesion, of which the paralysis is merely a symptom. This chart also shows in a most interesting manner, the value of the dynamometer as a means of indicating the progress made by a paretic patient under treatment.

Another advantage in this mode of studying the motor apparatus is the fact that the dynamometer tests not only the muscles, but the nerves and nerve centers as well, so that it is a precise measure of the condition of the individual's motor apparatus. It is a true measure of the dynamic energy of the body, and shows the actual ability of the individual to manifest energy through his muscular system as a whole and through each particular part of it. The tape-line merely gives the dimensions of a man, — it tells nothing as to whether he is alive or dead. A dynamometer gives us an accurate picture of the living, active man. The chart obtained by means of the dynamometer enables the physical director to make a precise prescription for exercise without even seeing the subject, whereas the data furnished by the measurements of the tape-line may relate to a man who is dead, or so completely paralyzed that all forms and degrees of exercise are alike impossible ; so that without the aid of the dynamometer, anthropometry is a most unreliable guide and almost altogether useless, unless the subject is before the director, who, even then, is obliged to depend upon his intuitions and his experience in arranging a program for gymnastic work, rather than upon the indications of the tape-line.

After several years' use of my dynamometer and the charts which it has enabled me to prepare, I am so thoroughly dependent upon these means of directing the gymnastic work of my patients that I should be utterly at a loss to know how to prescribe for them without this or some equally good means of exact diagnosis.

I ought, perhaps, to have said another word respecting the method of using the dynamometer. I have worked out an exact mode of testing each group of muscles. This method is followed with precision in each test made. The general principle which I have followed is that the resistance of the

dynamometer should be applied at the distal end of the bone which is operated upon by the group of muscles under examination, and in such a manner as to give the muscle an opportunity to act to the best advantage, at the same time isolating its action from that of other groups which might vitiate the results obtained.

I have found very interesting, a study of the relative strength of the different groups of muscles in men and women, and also the comparative study of the tables obtained for the two sexes. But this subject is too large to be entered into in this brief paper, which is intended to be simply a description of the dynamometer and its use. I hope to present at some future time a paper which will embody the results of a critical study of the data presented by these tables, and others which I am now preparing upon a somewhat different plan, which combine the average and the percental methods, and will give for each group of muscles an almost absolutely perfect bi-nomial curve.

—PHYSICAL CHART—

Arranged from the results obtained in testing the strength of the individual groups of muscles in 600 WOMEN, by means of a Universal Mercurial Dynamometer, made and compiled under the direction of J. H. KELLOGG, M. D., Superintendent of the Sanitarium and Hospital, Battle Creek, Michigan.

Except when Otherwise Indicated, Quantities are Expressed in Pounds Avoirdupois.

PER CENT.	HEIGHT (inches).	WEIGHT.	ARMS. R. Hand Flexors.	L. Hand Flexors.	R. Hand Extensors.	L. Hand Extensors.	R. Forearm Pronators.	L. Forearm Pronators.	R. Forearm Supinators.	L. Forearm Supinators.	R. Arm Flexors.	L. Arm Flexors.	R. Arm Extensors.	L. Arm Extensors.	R. Deltoid.	L. Deltoid.	R. Pectoral.	L. Pectoral.	R. Shoulder Retractor.	L. Shoulder Retractor.
1	68.4	202	118	107	[illegible]	30	60	59	62	62	53	52	57	57	80	75	93	86	101	99
2	67.4	177	97	89	27	25	48	49	48	46	43	42	47	47	59	59	78	76	82	81
3	66.9	170	92	84	25	24	45	46	46	44	41	40	45	40	[illegible]	56	75	72	78	75
5	66.3	161	83	82	23	22	42	41	42	40	35	38	41	40	51	52	71	68	71	71
10	65.3	[illegible]	75	74	20	[illegible]	36	38	38	35	33	29	38	30	49	46	62	64	66	61
15	64.8	[illegible]	70	69	18	16	[illegible]	[illegible]	34	31	30	27	35	[illegible]	44	42	[illegible]	59	60	57
20	64.4	133	68	65	17	15	31	32	32	29	27	25	31	30	41	[illegible]	55	55	55	[illegible]
25	64.1	129	65	63	16	14	29	[illegible]	[illegible]	27	25	24	29	28	37	36	52	52	51	[illegible]
30	[illegible]	126	62	59	15	13	28	27	28	26	23	23	26	26	35	34	49	[illegible]	48	46
35	63.4	123	59	57	14	12	27	26	26	24	21	21	24	24	33	33	46	46	45	43
40	63.1	120	56	54	13	11	25	24	24	23	20	20	23	22	31	30	44	44	42	40
45	62.9	118	54	52	12	11	24	23	23	21	19	19	22	21	[illegible]	[illegible]	45	41	39	38
50	62.6	115	51	49	11	10	23	22	21	20	18	18	20	19	[illegible]	[illegible]	40	[illegible]	37	36
45	62.3	112	49	47	10	9	21	20	20	19	17	17	19	18	25	25	37	35	35	33
40	62.0	110	47	45	9	8	20	19	19	17	16	16	18	17	[illegible]	[illegible]	36	35	33	31
35	61.8	108	44	43	9	7	19	17	18	16	15	14	17	16	22	21	33	34	[illegible]	29
30	61.5	105	42	40	7	6	18	16	17	16	14	13	15	15	20	20	31	31	29	27
25	61.2	103	40	38	6	6	16	15	15	14	13	12	14	14	18	18	29	29	26	24
20	60.8	100	37	36	5	5	14	13	14	13	11	11	13	13	16	16	27	27	23	21
15	60.4	97	34	33	4	5	13	12	13	11	9	9	12	11	14	15	24	25	20	18
10	59.8	93	30	29	3	4	10	9	11	10	7	7	11	10	11	13	21	23	17	15
5	58.7	88	25	22	3	3	8	6	7	6	5	5	7	7	9	9	17	16	15	15
3	58.4	85	22	19	2	2	6	[illegible]	5	5	4	4	6	5	7	7	15	13	13	13
2	58.0	81	20	15	2	2	5	3	4	4	4	3	5	5	6	6	14	11	11	10
1	56.5	77	10	12	1	1	2	2	2	2	2	2	2	2	5	4	11	9	8	7

PER CENT.	LEGS. R. Foot Flexors.	L. Foot Flexors.	R. Foot Extensors.	L. Foot Extensors.	R. Leg Flexors.	L. Leg Flexors.	R. Leg Extensors.	L. Leg Extensors.	R. Thigh Flexors.	L. Thigh Flexors.	R. Thigh Extensors.	L. Thigh Extensors.	R. Thigh Abductors.	L. Thigh Abductors.	R. Thigh Adductors.	L. Thigh Adductors.
1	88	86	316	318	103	104	130	124	153	150	157	151	123	128	118	119
2	72	71	276	268	93	92	96	96	125	125	123	124	104	104	105	99
3	68	67	264	257	87	86	92	92	121	120	118	122	100	100	101	94
5	62	60	248	244	81	81	87	86	116	114	110	115	93	94	93	90
10	54	53	221	219	72	71	77	77	107	104	100	103	84	86	81	82
15	[illegible]	49	205	205	[illegible]	66	70	71	100	97	93	96	77	78	74	74
20	47	46	193	192	62	61	65	67	93	92	87	90	73	73	70	70
25	44	44	182	182	57	57	60	62	[illegible]	85	81	85	69	[illegible]	66	66
30	[illegible]	[illegible]	173	172	54	54	57	58	82	80	77	80	66	65	63	63
35	41	40	164	163	51	50	54	55	77	76	72	76	63	62	60	60
40	39	38	157	155	48	48	51	52	73	72	68	72	60	59	57	56
45	37	36	149	148	46	45	[illegible]	[illegible]	69	69	65	69	57	57	53	53
50	35	33	142	141	43	42	46	46	66	65	61	65	55	54	51	51
45	34	33	135	134	40	40	43	43	63	62	58	61	52	51	48	48
40	32	31	128	127	37	37	41	41	59	58	55	58	49	49	45	45
35	30	30	121	121	35	34	38	38	55	55	52	55	47	46	42	42
30	28	28	115	114	32	32	35	36	52	52	49	52	44	44	39	40
25	26	26	106	107	30	30	33	33	49	49	46	48	41	41	37	37
20	24	24	101	100	28	27	30	31	45	45	43	45	38	38	34	34
15	22	21	93	93	25	25	28	28	42	42	39	41	35	35	31	30
10	20	18	86	86	22	22	25	24	37	36	34	36	30	30	26	27
5	18	14	73	73	18	17	20	19	30	30	27	29	25	25	22	22
3	13	11	63	63	16	14	17	16	27	25	23	25	22	22	19	19
2	12	10	56	54	14	12	14	13	25	24	21	22	20	20	17	17
1	8	6	31	29	9	7	8	8	20	17	17	13	15	15	11	12

PER CENT.	TRUNK. Trunk Anterior.	Trunk Posterior.	Trunk R. Lateral.	Trunk L. Lateral.	Neck Anterior.	Neck Posterior.	Neck R. Lateral.	Neck L. Lateral.	RESPIRATION. Inspiration — Waist.	Inspiration — Chest.	Inspiration — Waist Expans'n (in.)	Inspiration — Chest Expans'n (in.)	Expiration — (Pneumometer)	Expiration — Spirometer (cubic in.)	TOTAL STRENGTH. Arms.	Legs.	Trunk.	Chest.	Entire Body.	PER CENT.
1	134	430	149	142	39	64	63	61	166	181	5.6	5.5	176	240	1281	2368	1103	350	5102	1
2	121	341	119	119	33	60	49	49	129	145	4.7	4.7	136	224	1043	1973	891	277	4184	2
3	116	324	112	114	32	56	46	46	128	136	4.4	4.5	134	217	983	1889	846	267	3985	3
5	109	291	107	108	30	[illegible]	42	42	112	126	4.1	4.2	118	211	913	1774	780	240	3707	5
10	93	244	98	99	28	45	41	38	[illegible]	109	3.7	3.9	[illegible]	201	818	1590	686	208	3302	10
15	[illegible]	216	91	92	[illegible]	42	37	34	90	98	[illegible]	3.6	84	193	750	1470	622	[illegible]	3031	15
20	78	184	85	86	[illegible]	40	34	32	84	91	3.1	3.3	78	185	699	1379	559	176	2813	20
25	72	175	79	79	[illegible]	37	31	29	78	[illegible]	3.0	3.2	72	180	656	1296	521	168	2636	25
30	68	162	73	73	18	35	29	27	73	79	2.8	3.0	68	173	616	1229	485	152	2483	30
35	65	150	69	68	17	34	27	25	69	74	2.6	2.9	64	167	581	[illegible]	[illegible]	144	2342	35
40	59	140	64	64	16	32	25	24	65	70	2.5	2.7	58	162	546	1105	[illegible]	136	2211	40
45	56	131	60	60	15	30	23	23	62	66	2.4	2.6	54	157	519	1050	397	129	2095	45
50	51	123	56	56	13	29	22	21	[illegible]	63	2.3	2.5	52	153	487	997	371	122	1977	50
45	48	115	53	52	12	27	20	20	[illegible]	59	2.1	2.3	48	148	458	[illegible]	347	115	1864	45
40	44	108	49	[illegible]	11	25	19	18	51	56	2.0	2.2	46	143	431	893	324	108	1756	40
35	41	101	[illegible]	47	10	[illegible]	18	17	[illegible]	54	1.9	2.1	42	128	[illegible]	841	302	104	1652	35
30	38	93	42	42	9	22	17	16	46	50	1.8	1.9	38	133	375	792	[illegible]	97	1543	30
25	34	86	38	38	8	[illegible]	15	14	43	47	1.7	1.8	36	129	347	741	254	91	1433	25
20	30	78	35	34	7	19	14	13	40	43	1.6	1.7	34	123	316	687	230	84	1317	20
15	27	69	31	30	6	17	13	11	36	39	1.4	1.6	30	116	282	630	204	76	1192	15
10	22	58	26	26	5	15	12	9	32	35	1.2	1.4	26	107	241	559	174	68	1042	10
5	19	48	21	21	2	12	7	7	28	29	1.0	1.2	20	95	185	462	137	57	841	5
3	16	40	18	18	1	11	5	5	24	26	.9	1.	20	83	152	395	114	50	713	3
2	15	26	16	17	1	9	4	4	22	24	[illegible]	1.	20	72	128	351	92	46	617	2
1	10	22	12	12	1	5	2	2	13	18	.5	.8	12	58	84	221	66	31	402	1

Sept 1, 1892.

May 2, 1892.

Apr 6 1892.

Strength Measurements of Miss D. H. Taken Apr. 6, 1892, May 25, 1892, Sept 1, 1892, ——189—, by M. M. C., J. M. P., A. E. T.

Chart No 1.