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TO
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Mechanico-Therapeutics and Orthopedics

By Means of Apparatus

BY

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PREFACE.

The present monograph is intended to afford to English reading physicians an opportunity to acquaint themselves with Dr. Zander's apparatus.[1]

Since the foundation of the first Zander Institute in this country a year ago, the need of this work in the English language has been especially felt. For, as was pointed out in the preface to the preceding monograph of this series, the whole subject of mechanico-therapeutics is in its infancy in America, and the basis has hitherto been wanting upon which to carry on a fruitful discussion of it.

The correctness of Dr. Zander's assertion in his accompanying preface, that if there is a mechanical method it is his, is the more conspicuous here by reason of the absence of science and the superabundance of "methods" which prevail in this field, where anyone constructs[2] a specific appliance, and members of the profession can be found to recommend the latest rowing machine or a "Star Exerciser," which among other achievements cures

[1] The apparatus are constructed exclusively under Dr. Zander's supervision in Göransson's Mekaniska Werkstad, Stockholm.

[2] "The wish to construct a specific apparatus for exercise for the treatment of an internal malady shows that one knows very little about mechanical treatment "—Zander.

Extract from a very interesting letter to Dr. Heiligenthal, director of the Zander Governmental Institute in Baden Baden, written in reply to a question as to his opinion of Corval's "Mountain Climbing Machine."

Dr. Heiligenthal having consented to its publication, the whole letter will be embraced in a forthcoming monograph on the mechanical treatment of affections of the heart.

consumption! There has been no lack of mechanical appliances. On the contrary, rather an excess of them, to the detriment of mankind. For have we not specific machines for "the cure" of the lungs, the liver, and malaria?

By affording a basis for the scientific medical application and discussion of mechanico-therapeutics, Dr. Zander has placed the subject above the level of a peculiarly Swedish method and has enriched the science of Medicine. Hence, although Dr. Zander is a Swedish physician, his method can no more be called Swedish than pathological anatomy which has been so effectively promoted in Germany is German, or antiseptic surgery English because Joseph Lister was born in England. It is characteristic that the impulse for Dr. Zander's work was derived from the classic soil of mechanico-therapeutics, when the pupils of the gifted, self taught, layman Ling were at the height of their efforts. So far only is his method Swedish.

In every thing essential for us physicians, Dr. Zander formulates concisely the theory of the movements of the human organism from the standpoint of anatomy and physiology which he has embodied in his apparatus. It is from this strictly medical standpoint that these apparatus are admirable. The physician has here forced the mechanical progress of our age into the service of medicine for the solution of problems of an anatomical nature. He enables us to exercise any given group of muscles strictly in accordance with the laws of physiology; to exclude any other group at will; to determine which groups are called into action, *and to what extent*, in every movement made.

By subjecting to localization, measurement and control a therapeutic agent, which for want of these qualifications was not susceptible of rigid scrutiny, Dr. Zander has created the basis for the use of mechanical treatment as an agent capable of fulfilling all the conditions imposed by the most exigent scientific criticism.

The importance of systematically organized muscular exercise is no longer a subject of debate. The question always open for the conscientious physician is: How shall such treatment be administered without risk of harm and with all the benefit which is in many cases obtainable from it?

To this question in its broadest sense, the following monograph contains a reply as convincing as it is compact.

In view of the claims, by no means small, made by Dr. Zander, and, after twenty-seven years of experience and criticism, acceded to by many of the best representatives of the medical world abroad and confirmed by the number of institutes already in action and of new ones founded every year, it becomes the duty of the profession here, candidly and thoroughly to investigate this method, which represents the higher form of mechanico-therapeutics. This done, the inevitable consequence will be the withdrawal of mechanical treatment from the hands of quacks, Swedish or native.

A beginning, decisive for the future, has already been made. For three leading universities having taken steps towards the establishment of Mechanico-Therapeutic and Orthopedic Zander Institutes in connection with their medical schools, the students of these institutions will acquaint themselves with the fundamental principles of mechanico-therapeutics. And the profession in general will perceive the anomaly of leaving to quacks a discipline recognized as academic.

One statement in Dr. Nebel's preface might give rise to a misapprehension on the part of those unacquainted with the subject, namely, his correction of the erroneous impression[1] that the mechanical method according to Dr. Zander is more appropriate to dietetic purposes and less for the treatment of the sick.

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[1] Arising from the confusion, too common here also, of mechanico-therapeutics with common gymnasium work and Turnen, which are wrongly regarded as suitable for dietetic use. Under competent medical supervision they may be useful for *educational* purposes. See first monograph of this series.

When Nebel points out that nine-tenths of the frequenters of Zander's Institute are people seeking treatment, *i. e.*, patients, he merely correctly states a fact. But he by no means detracts from the high dietetic value of the method which he has, on the contrary, especially emphasized in his principal work.

In truth it is the dietetic element, the fact that together with local treatment the organism as a whole is constantly treated, this characteristic integral part of the therapeutic worth of this method, which assures to it a permanent place in the development of the science of Medicine.

L. Wischnewetzky, M. D.,

Director of the New York Mechanico-Therapeutic and Orthopedic Zander Institute.

PREFACE TO THE GERMAN EDITION.[1]

The accompanying monograph contains a detailed description of the apparatus for mechanical treatment which Dr. Zander has constructed and tested by twenty-seven years' experience. It was originally intended to afford to physicians and patients of the Institute information often asked for. For the former it contains the theory of movements so far as the muscular system is concerned, worked out with extraordinary care and not less valuable than the directions for breathing.

After convincing myself by several months[2] of study in Stockholm of the great value of Swedish mechanical treatment, which cannot be applied more rationally or more strictly according to scientific principles than in the Institute under Dr. Zander's direction, I believe that I undertake a grateful task in affording to German physicians, through the accompanying translation, an opportunity to appreciate the labors of a man whom unwearying care for his many patients has hitherto unfortunately deprived of leisure to publish much from the rich treasury of his experience and

[1] From which the present translation was made with additions from the newest edition, Stockholm, 1890, including the very valuable new preface by Dr. Zander. The exclusive right of publication of all his works has been conferred upon the editor by Dr. Zander, who has revised the translations. A compilation of extracts from the description of apparatus very freely translated, was published some years since in England. Being incomplete and inexact, it was never recognized by Dr. Zander as an authorized translation.

[2] Dr. Nebel can now speak of several years' fruitful study of mechanico-therapeutics, as his publications which will follow the present monograph indicate.

studies. This deprivation is especially to be regretted in relation to the mechanical treatment of affections of the heart, which has long been successfully practised here.

In view of the widespread misapprehension that Dr. Zander's mechanical treatment is more for dietetic purposes and less appropriate for the treatment of the sick, it should be stated that about nine-tenths of those who visit the Institute, some three hundred or more persons daily, seek medical aid for some ailment, *i. e.*, mechanical treatment; that all ailments which can rationally be combated by means of exercise are treated by Dr. Zander with the best results, that cardiac disorders (valvular defects and fatty degeneration) find decided relief for the former and cure for the latter and have been from the first among the most grateful patients of the Institute; that scoliosis cannot be treated more effectively than by means of the apparatus which are here available, and, finally, that no physician can work with greater care and conscientiousness for the welfare of his patients than Dr. Zander.

Physicians who examine and test without prejudice the means by which Dr. Zander has enriched medical science cannot fail to render to his genius the tribute of their admiration and to his scientific endeavor the highest recognition.

I shall count myself fortunate if I can contribute at least in some measure to this result.

DR. H. NEBEL,

Director of the Mechanico-Therapeutic and Orthopedic Zander Institute, Frankfort-on-the-Main.

PREFACE.

BY

DR. GUSTAF ZANDER.

Experience having shown that regular muscular exercises gradually made more strenuous not only develop and strengthen the muscles but promote the removal of pathological changes in the tissues, give tone to the nervous system and vitalize the circulation of the blood and lymph and the activity of many organs, it is natural that such exercises should be included among therapeutic agents. For this purpose there was, however, requisite the power to execute these exercises according to physiological laws and to modify their action like that of other therapeutic agents according to the needs of each individual case.

Since 1857, when I began to devote my attention to mechanical treatment, I have endeavored to meet these requirements by means of my mechanical method and have shown in divers publications that they could be complied with only by producing the resistance, which the muscles are to overcome, by means of mechanical apparatus, and indeed with the aid of the lever.

By the use of the lever it is assured:

(1.) That the resistance is arranged in exactest harmony with the physiological and mechanical laws of the action of the muscles, and

(2.) That the graduating of the dose of the therapeutic agent can be accomplished in the most perfect manner.

It is not unknown to me that others have constructed

single apparatus for mechanical treatment,especially of late and possibly also before my time. But no one except myself has ever produced a complete collection of apparatus for the harmonious development of the whole muscular system, nor formulated the principles according to which the lever must be applied in each individual apparatus.

If, then, there exists to-day a *mechanical method* of exercise it is mine. Especial circumstances constrain me to call attention to this fact.

As already stated, the mechanical method applies mechanical apparatus, with an especial apparatus for the exercise of every separate group of muscles. The resistance to be overcome by each group of muscles is obtained by the muscle in its alternate tension and relaxation raising and letting sink a weight attached to a lever. By the intervention of the lever the important requirement is met that *the resistance during the time of the movement increases and diminishes with the natural change in the mechanical effect of the muscular action.* When this effect is greatest, the lever assumes the position in which it reaches its greatest momentum, *i. e.*, the horizontal; when the effect diminishes the lever leaves this position. On the contrary, the effect increasing, the lever approaches the horizontal.

The weight can be moved along the lever and can by means of a screw be fastened at a longer or shorter distance from the axle of the lever so that every grade of weight desired from zero to the maximum appropriate to each apparatus can be readily obtained. The degree of weight is indicated by the scale on the lever.

Equipped with such apparatus the mechanical method offers the following advantages:

1. The resistance during the movement adapts itself exactly to the natural change in effect of the muscular power.

2. The strength of the movement is weighed as if in scales and its exact measure is obtained.

3. The gradual increase in strength of movement requisite

for normal muscular development can be obtained with certainty and in every degree desired.

4. The resistance indicated by a given number is always the same, hence every necessary change in the strength of the movement, whether increase or decrease, can be made readily and with precision.

My mechanical method embraces besides the active movements, which are the essential part of all muscular exercises, *passive* movements of the joints, such as arm and foot rolling, as well as *mechanical operations*, such as vibration, percussion, kneading, etc.

The institutes in which my mechanical treatment is applied are usually called Mechanico-Therapeutic Institutes. The first one was founded by myself in Stockholm in 1865. In the years immediately succeeding the opening of this institute, the institutes for curative exerise in Sweden began to equip themselves with my apparatus and since 1875 many institutes have been founded in other countries. There are at present fully equipped Mechanico-Therapeutic Institutes in [1] Stockholm, Gothenburg, Christiania, Helsingfors, St. Petersburg, Hamburg, Berlin, Breslau, Dresden, Wuerzburg, Frankfurt-am-Main, Mannheim, Baden-Baden, London, Buenos Ayres, New York. In Stockholm there have been, since 1885, two Institutes fully equipped and one with a partial equipment.

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[1] The Woman's College and the Bryn Mawr School in Baltimore have both obtained partial equipments, which are used under the supervision of physicians by the students and pupils.

The Berlin Institute, under the competent direction of Dr. Gustav Schütz, is unable after three years of activity to meet the needs of Berlin and a second institute is now being founded.

A second governmental institute in Baden-Baden is now in process of erection, the first one, founded in 1884 under the direction of Dr. Heiligenthal, having become inadequate to the needs of the increasing numbers of patients who visit Baden-Baden during the Summer season.

There is also a new Institute in process of equipment in Leipsic.

There are also Institutes having an equipment temporarily incomplete in Upsala, Oerebro, Norrköping, Hjulsta, Abo, Moscow, Copenhagen, Carlsruhe, Munich, Pforzheim, Vienna, Budapest, Kissingen.

For America, application for an equipment for an Institute in connection with the University Hospital has been made to Dr. Zander by Dr. William Pepper, Provost of the University of Pennsylvania (Philadelphia).

Preparations are also being made for an Institute in Boston, to be connected with the medical school of Harvard University.

The Johns Hopkins University has obtained from Dr. Zander the right to establish an Institute in Baltimore.

Apparatus for Mechanical Treatment and Their Use.

The apparatus for mechanical treatment are divided into three series, according as they are set in motion or merely exercise (corrective) pressure.

First Series: Apparatus set in motion by the patient's own muscular power.

Second Series: Apparatus set in motion by some motor, such as a gas or steam engine.*

Third Series: Apparatus designed to exercise a corrective pressure upon the skeleton or to stretch the elastic parts of the body by means of the patient's own weight resting upon the apparatus, or by means of mechanical contrivances.

According to the nature of their physiological effects they fall under four divisions:

I. **Apparatus for active movements,** *i. e.*, such as have for their direct object the exercise and development of the muscles. This division is subdivided into four groups:

A. Active arm movements.

B. Active leg movements.

C. Active trunk movements.

D. Balancing exercises.

II. **Apparatus for passive movements,** *i. e.*, such as move the members of the body without the help of the muscles, stretching and mobilizing tendons,

*The New York Institute has introduced a seven horse power electric motor.

ligaments and muscles. This division contains but one group:

E. Passive movements.

III. **Apparatus for mechanical operations.** This division contains four groups:

F. Vibration.

G. Percussion.

H. Kneading.

J. Friction and rolling.

IV. **Orthopedic apparatus,** designed especially for the treatment of curvature of the spine. This division contains two groups:

K. Apparatus for reclining, designed to exercise corrective influence upon abnormal curvatures of the spine by means of pressure appropriately applied.

L. Apparatus for exercise, by means of which certain active movements are executed for the purpose of correcting abnormal curvatures of the spine.

When these eleven groups are distributed in the three series above mentioned,

Series I. contains groups A, B, C and L;

Series II. contains groups D, E, F, G, H and J;

Series III. contains group K.

The individual apparatus belonging to each group are indicated by the letter of the group with a number.

The following table shows at a glance all the apparatus now completed. Some numbers are omitted in certain groups. They belong to apparatus which are not yet completed, but are expected to take their proper places in the system in the near future.

I. Active Movements.

A. ACTIVE ARM MOVEMENTS.

B. ACTIVE LEG MOVEMENTS.

C. ACTIVE TRUNK MOVEMENTS.

D. BALANCING MOVEMENTS.

II. Passive Movements.

E. PASSIVE MOVEMENTS.

III. Mechanical Operations.

F. VIBRATION.

G. PERCUSSION.

H. KNEADING.

J. FRICTION AND ROLLING.

IV. Orthopedic Apparatus.

K. APPARATUS FOR RECLINING.

L. APPARATUS FOR EXERCISE.

Measurement Apparatus.

General Rules for the Use of the Apparatus.

The movements, which are made in the order indicated on the prescription, are divided into groups embracing three each. In general, the first in each group is the most laborious, *i. e.*, an active arm or trunk movement. Then follows an active leg movement and then a passive movement or mechanical operation. For vigorous persons more energetic movements in the same group may be selected, and the third may be a balancing exercise or an active trunk movement. These three movements in a group may be taken, one immediately after the other with about five minutes rest at the end, unless a pause at the end of each movement is prescribed.

At first all the movements must be slight. Even if the exercise should seem to the patient to be too slight, he still must not make it more vigorous during the first few days, for although each individual movement may be slight in comparison with that which he believes himself able to endure, yet, taken together, they make considerable demands not only upon the muscles but also upon the nerves, and the patient is more weary, especially towards evening, than he expected to be. Curative exercises, too, have a much more intense effect than the ordinary, chiefly automatic movements of every day life.

That number in the scale of the apparatus is given upon the prescription, which the physician thinks suitable for the patient. But the instructor who accompanies the patient while making the movements is free to diminish the number

if it seems too high. He should not increase it. During the first day or days the groups are not all tried, at least by feeble patients.

After a few days, when the first weariness has passed away, or if none has been felt, the vigor of the movements may be somewhat increased, one number at a time, until some slight fatigue is observed. Then this grade of effort is maintained until the fatigue is wholly overcome and new increase can take place. In this way the strength of the patient grows slowly but surely.

From what has been said, it is clear that every sign of fatigue is not a thing to be avoided. Work, up to a certain point of weariness, is an indispensable condition of increased strength. But a large number of patients who use curative exercise are compelled to carry on their daily avocations during the cure and thus to incur more or less fatigue, and the strength of such patients must be carefully economized if they are to make progress. Hence the rigid rule that only that degree of energy is to be used which causes a slight and quickly passing weariness.

There is no doubt that patients who can devote themselves exclusively to the treatment, so as to undergo it two or three times daily with sufficient rest between, attain more speedy and complete results than are usual in Mechanico-Therapeutic Institutes.

There are patients whose weariness is obstinately persistent, even though they make but a few slight movements. But that is no reason to lose courage. In individual cases the fatigue may last weeks or months and then gradually wear away, giving place to an amazingly rapid increase in strength and general health. This form of weariness is a nervous affection brought about by all sorts of enfeebling influences, particularly by an enervating way of living and a careful avoidance of all physical exertion, except, perhaps, dancing and late hours. Absolute rest, were such a thing attainable, might improve this condition, but health and strength can be

had for such patients only by means of curative exercise. Of course they must devote themselves exclusively to the treatment. Unfortunately such patients are apt to be induced by persistent weariness to abandon the cure too soon.

The prescription is written according to a certain plan, with reference to the condition and needs of the patient. Any change in the sequence of the prescription should therefore be made only after conference with the physician. Those persons who use the exercise without being sick, for the purpose of maintaining health and strength, should keep to the prescribed order of each group, but they may change the order of the groups. They may, to gain time, exchange a movement of one group with a similar one of another group, for instance, arm, leg and trunk movements.

For a patient himself to change the movements indicated upon the prescription would be utterly out of the question and not to be tolerated.

The generally strengthening treatment which exercises and develops all the muscles as far as possible forms the skeleton of the prescription. This is farther modified and increased in such a way that the movements which are calculated to affect a certain ailment or weakness are prevailing or repeated. Insight and experience are required for sketching such a plan and carrying it out, besides careful consideration of such changes as accidental circumstances may render necessary. For many persons this does not seem to be clear. They omit movements which are not agreeable to them, or the utility of which they do not see, and take in their place others not prescribed, which they prefer and which seem to them more attractive, perhaps because they set in motion muscles which are stronger and in better practice. It is natural that such a motion should seem agreeable and beneficial, while work with feeble and unused muscles is wearisome and disagreeable. But the more the strong is exercised at the cost of the weak, the more abnormal and out of proportion the organism becomes, and thus malformed it loses its power of resistance to

unwholesome influences. The object of the treatment is not attained, and the patient afterwards blames the system instead of his own unreasonable selfwill for the failure.

Of especial importance in mechanical treatment is correct breathing. In the following descriptive pages there will be found directions for breathing accompanying each active movement. It is especially necessary to pay attention to this in the arm and trunk movements. Certain muscles which extend from the arms to the thorax, the muscles of the back and the abdomen, affect the breathing in such a way that certain fixed rules can be deduced. Where this is not the case, other circumstances must serve as guides. Every active movement has its more and its less laborious moment. The former corresponds with that part of the movement in which the balance weight is raised, which is done by the tension of the muscles. The latter corresponds to the sinking of the weight back into its usual position, and is brought about by the gradual relaxation of the muscles. As the act of breathing has its own moment of exertion and relaxation, the following rule is the result:

The more laborious moment of the movement is identical with the act of *expiration*, the less laborious moment with the *inspiration*. The only movements excepted from this rule are those in which the chest, during contraction of the muscles, assumes the position of inspiration, namely A2, A4, A6, C2, C4, C5, C10.

In all these inspiration takes place during the more laborious moment of the movement, *i. e.*, the inspiration is at the beginning. In all other active movements except C6 the inspiration precedes the movement.

Of course all the movements are to be carried on quietly and regularly.

The following points should be noted.

Patients should reach the Institute in time to make the prescribed movements quietly and with sufficient time for rest.

They should not fatigue themselves before or after the exercise. This is especially true of patients with affections of the heart and those suffering from debility.

Patients should at once inform the physician if marked or long continued weariness follows the exercise.

The whole attention should be devoted to the exercise, and there should be neither conversation nor reading.

Dancing and late hours are to be avoided during the use of the treatment for general debility.

Loose, comfortable clothing is to be worn, leaving waist and throat free, breathing and use of arms unconstrained, and the abdominal organs without pressure. Corsets, tight neckties, tight garters are to be avoided.

A large meal should never be taken immediately before beginning the exercise. A cup of coffee, tea or milk with a roll is harmless, and in some cases for elderly or feeble patients, necessary. After an ample meal 1 to 2 hours should pass before beginning the exercise.

The Application and Effect of Each Individual Apparatus.

A. Active Arm Movements.

A1.

ARM SINKING (SIDEWISE SINKING).

The arm, which is stretched upward, is to be drawn outward and downward until it hangs straight down. The movement is made first with one arm, then the other.

The patient seats himself sidewise against the shoulder support. The seat is raised or lowered until the top of the upper arm reaches the same height as the shaft of the apparatus. The hand grasps the movable handle while the arm is stretched upward along the vertical lever. To carry out the same movement with the other arm the patient is seated facing in the opposite direction.

A newer construction of this apparatus is so adjusted that the chair can be pushed on tracks right or left along the apparatus, the shoulder support being turned correspondingly. If the right arm is to make the movement, the chair is pushed to the left (as seen from the apparatus), the side support is turned to the right; conversely when the left arm is to make the movement.

First a long breath is taken; during *expiration* the arm is drawn down until it hangs vertically; during *inspiration* the arm slowly yields to the pressure of the lever and is moved back into the upright position, but without leaving the shoulder support.

Effect: Upon the strong back and chest muscles.

Upon the stretched side of the upper arm the muscles contract to hold the arm extended. The lateral flexors of the trunk contract upon the side on which the movement is made and prevent the trunk from being bent in the opposite direction. This movement promotes the development of the chest, and if the shoulder is held steady by means of a strap or the hand of the instructor, is very useful for curing stiffness of the shoulder joint and participating muscles.

ON THE HUMERUS THERE WORK: *pectoralis major, latissimus dorsi, teres major,* dorsal third of *deltoideus* (to 45° below the horizontal) *anconæus longus* (= caput long. of the triceps) and *coraco-brachialis.*

ON THE SHOULDER BLADE THERE WORK: the *rhomboidei,* the *levator anguli scapulae* and the *pectoralis minor.*

A 2.

ARM LIFTING, SHOULDER RAISING.

The arms are to be stretched upwards; the shoulders raised and rotated.

The apparatus consists of ten pairs of dumb bells of 1–10 lbs. weight.

ARM RAISING is practised from two starting positions.

No. 1. The patient takes one dumb bell in each hand, standing erect, heels together, *arms hanging at the side.* During *inspiration* the arms (always held extended at full length) are moved upward and forward; during *expiration* they are moved backward and downward into the starting position. The inspiration begins best when the arms are half way forward and upward, and the expiration should not begin until the arms are somewhat drawn back.

No. 2. The same starting position as before, except that the arms are *held sharply flexed at the elbow* so that the lower arm rests against the upper arm, which hangs down straight. The hands reach the same height as the shoulder. During *inspiration* the arms are stretched up straight. During *expiration* they are moved down into the starting position.

SHOULDER RAISING.—Starting position as above in No. 1.

During *inspiration* the shoulders are drawn upward and forward, then backward and downward into the starting position, while the arms, burdened with weights, hang outstretched. The shoulders are held quiet during *expiration* and the movement begins anew with an inspiration.

Effect.—In part upon the delta muscles which cover the shoulder joint, in part upon the muscles which start from the neck and spinal column and from the sides of the chest to the shoulder blades; in part, too, upon the muscles of the stretched side of the upper arm. Vigorous inspirational movement; promotes the development of the chest.

To the horizontal position, the arms are raised by the *deltoid and supra spinatus*, while the *serratus anticus major and the clavículo-acromial* portion of the *trapezius* contract to hold the shoulder blade. The dorsal third of the *deltoid* raises the arm only the first 45° from below outward.

To the vertical the arms are drawn by the *serratus anticus major* which turns the shoulder blade outwards in the *acromio clavicular* joint. While the arms are directed forwards, the lowest part of the *trapezius* and the long muscles of the back simultaneously contract. The *anconæus internus* and *brevis* hold the arm stretched or stretch it during the raising. In shoulder lifting, the shoulders are drawn up by the *trapezius* (upper half), and moved forward and upward by the *pectoralis major* (uppermost part) and backward by the *latissimus dorsi* (uppermost part).

A 3.

ARM SINKING AND BENDING (FORWARD.)

The upward stretched arms are to be lowered, and flexed at the elbow joint. Reverse of A 2, second starting position. The patient takes his place under the pendant handles.

Before the exercise begins, the cords from which the handles hang must be so adjusted that the patient, in order to hold the handles, has to keep his arms bent at the elbow so that the upper arms are held vertical and the hands at the same height as the shoulders. (Compare A 2, starting position No. 2.) The levers are fixed in a horizontal position by a fastening in the floor, which is undone by push-

ing the bolt with the toe. It is fastened by pushing back the bolt with the heel. After the handles are placed at a suitable height and the patient has grasped them, he draws the cords slightly so that he can loosen the fastening and then lets the levers draw up the arms. This is the starting position of the movement. The patient corrects his position so that the arms are held extended directly upward, not inclined forward. The head must be held high, the chest well forward.

First a long breath is taken. During *expiration* the arms are drawn down until the hands reach the height of the shoulders; the elbows must be well held back. During *inspiration* the arms are again drawn up.

Effect: Upon strong back and chest muscles which draw down the upwards stretched upper arm. The bending of the elbow is more passive and has little influence upon the flexor muscles of this joint. The movement promotes the development of the thorax.

ON THE HUMERUS THERE ARE CALLED INTO ACTION: *Pectoralis major, latissimus dorsi, teres major, dorsal third of the deltoid* (to 45° below the horizontal), *anconæus longus* and *coraco—brachialis.* ON THE SCAPULA: The *rhomboidei,* the *levator anguli scapulæ* and the *pectoralis minor.*

The weight which is drawn downward by the arms works in such a way by means of the rib insertion of the *pectoralis* and *latissimus dorsi* that the breast bone and ribs are drawn upward, whence the chest keeps to a certain degree the inspiratory position even during expiration. The movement, therefore, affects a sunken, inelastic chest by expanding it and diminishing its resistance to the efficiency of the inspiratory muscles.

A 4.

ARM RAISING AND STRETCHING.

The arms sharply flexed, are to be raised so that the lower arm is stretched and the upper arm raised. The movement is the opposite of that made by A 3, and corresponds with the A 2, second starting position. True, in the latter, the patient stands free, using loose weights (dumb bells) as resistance, while

in A 4, the weight works on a lever. The apparatus is provided with two parallel levers, the upper one of which holds the handle and can be raised or lowered, to correspond with the shoulder height of the patient. The patient stands with his toes against a brace that is fastened into the floor, and holds the handle bar with the arms sharply bent up in such a way that the backs of the hands touch the shoulders. The whole body, which is to be held erect with chest well forward, is inclined somewhat forward. This position must be maintained throughout the whole movement.

During *inspiration* the arms are stretched upward; during *expiration* they are drawn down again to the height of the shoulders. The patient must take care to keep the inclined position.

Effect: Upon the delta muscles, which cover the shoulders, upon several large muscles which extend from the chest and the spinal column to the shoulder blades, and upon the extensors of the upper arm. The abdominal muscles, in consequence of the inclined position, are spanned and hold the lower ribs, while the chest muscles during the upward extension of the arms, draw the upper ribs upwards, so expanding the chest. This is, therefore, a vigorous inspiratory movement which promotes the development of the chest.

To the horizontal, the upper arms are raised by the *deltoid* and *supraspinatus* while the *serratus anticus major* also contracts and the *claviculo-acromial portion* of the *trapezius*, to hold the shoulder blade. To the vertical the upper arm is raised by the *serratus anticus major* which turns the shoulder blade outward in its *acromio-clavicular* joint. The *anconæus internus* and *brevis* stretch the arm straight.

A 5.

ADDUCTION OF THE ARMS (HORIZONTAL).

The arms stretched horizontally out from the sides, are to be drawn together in front (Adduction of the arms). The chair is screwed to such a height that the arms of the patient rest comfortably upon the levers of the apparatus, which are

screwed together far enough to touch the sides of the patient without pressing them. The crossbar with the back cushion is pushed back just far enough for the tops of the shoulders at each side to reach above the vertical shafts. The hands, with their backs turned somewhat backward, loosely hold the outer (back) side of the arm supports.

First comes an inspiration. During *expiration*, the arms are drawn together until the supports touch. During a fresh *inspiration* they are slowly drawn back, somewhat behind the connecting line of the shoulders.

Effect: Upon the muscles in the front of the chest (*pectoralis major*) and of the shoulder joint (anterior third of the *deltoid*). The movement strongly promotes the development of the chest.

As the patient's arms rest upon the supports and the *deltoid* is, therefore, not required to act, to hold them in the horizontal position, the whole of the *pectoralis major* can be called into activity because there is no need for its lower third to act as antagonist of the *deltoid*. But it is precisely this lower third of the *pectoralis* which can exercise a decided influence upon the chest by drawing up the sternum and median ribs and, with them, all the others, the more so when, as in the case of this movement the insertion of the muscles is at the same height as the shoulders. Throughout the movement, both during the less active moment (the drawing backward), and the more active moment (the drawing forward), there is, therefore, brought to bear upon the front of the chest a drawing upward, backward and outward, *i. e.*, a more or less markedly inspiratory position is maintained. Although the movement does not work so strongly as the drawing movements A 1 and A 3, it is very effective, and this must be emphasized the more because the charge has been made that it justifies an apprehension of compression of the chest.

A 6.

ABDUCTION OF THE ARMS (HORIZONTALLY).

The arms are horizontal and are to be drawn backward (abduction of the arms).

The chair should be screwed up so high that the patient's arms rest comfortably upon the lever arms. The supports

are screwed together so far that they touch, but do not press upon, the patient's sides. The back cushion must be just far enough pushed back to hold the tops of the shoulders directly above the vertical axes. The hands, with the backs inward, loosely hold the inner side of the supports. The patient sits only far enough in the chair to lean his back slightly against the chair back.

During *inspiration* the arms are drawn outward and backward somewhat behind the connecting line of the shoulders; during *expiration* they are moved slowly forward.

Effect: Upon the muscles of the back and posterior side of the shoulder joint. The back muscles hold the back against the chair back.

MUSCLES CALLED INTO ACTION: *Deltoid* (posterior third), *latissimus dorsi.* The shoulder blade is held and somewhat drawn back by the *trapezius, rhomboid* and *latissimus dorsi.*

A 7.

CIRCUMDUCTION OF THE ARM.

The arm describes a circle about an axis imagined horizontally outward through the shoulder joint. Every point in the arm describes a curve which is larger in proportion as the point is nearer the peripheral end of the limb.

Such a movement can be made with the swinging arm of the apparatus when the patient merely lays his arm upon the apparatus and sets it in motion. The patient sits sidewise against the crutch meant to receive the shoulder and stretches his arm along the swinging arm of the apparatus, holding it loosely with the hand. The chair is screwed high enough to place the armpit firmly in the shoulder crutch.

The number upon the prescription refers to the position of the adjustable weight upon the graduated lever. The balance weight upon the other end of the lever must also be moved to the corresponding number on the scale so as to form a perfect balance. The throwing movement of the arm is

brought about and maintained by a slight muscular effort of the patient, who moves the rotary arm in a circle first towards one side, then towards the other about one half minute in each direction. The movement is made in the same way with each arm unless there is some other arrangement specified in the prescription.

The breathing must be deep and slow, so that two turns go to each INSPIRATION *and two to each* EXPIRATION.

The shoulder caps and several arm, chest and back muscles are alternately stretched and relaxed.

The movement is carried on by the *pectoralis major, latissimus dorsi, teres major* and the *rhomboidei.*

A 8 a.

ARM ROTATION.

By means of this apparatus the turning of the arm forward and backward, is practised (pro and supination).

The chair is raised so that the patient seated upon it holds his arm horizontal when he clasps the handle. The arm is stretched at full length.

In turning forward, the handle is placed horizontally, by means of a spring bolt; in turning backward, it is placed vertically. The movement is made alternately with both arms, the patient reversing his position when the second arm's turn comes. The hand can describe $\frac{3}{4}$ of the circle. In turning forward (pronation), the movement begins with the back of the hand turned downward and the thumb backward. In turning backward (supination), the back of the hand is turned forward and the thumb points downward.

As to breathing, the general rule applies that *inspiration* takes place during the less laborious part of the movement (while the lever sinks), and *expiration* takes place during the more laborious part, where the lever is rising.

If the arm is not held straight, this proves that the resistance is too strong and should be diminished by one or two numbers.

This movement affects chiefly the muscles on the inside of the lower arm (pronatoren) and the outer side (supinatoren), but also some muscles of the upper arm and shoulder joint; it accomplishes a diversion of blood towards the arms.

PRONATORS: *Pronator teres and quadratus, radialis internus, brachio-radialis* (to the median position) *subscapularis, teres major and latissimus dorsi.*

SUPINATORS: *Supinator brevis, radialis extermus longus and brevis, brachio radialis* (to the median position), *biceps brachii, infraspinatus and teres minor.*

A 8 b.

ARM PRONATION AND SUPINATION.

Turning the arm forward and backward with alternate slight resistance from both sides.

By means of this apparatus the intention is not so much to exercise the rotating muscles of the arm as to stretch them and the ligaments and joint capsules of the arm, and so produce both flexibility and increased flow of blood to them, and thus to accomplish a diversion of blood from head and chest without muscular exertion.

The chair is screwed so high that the patient seated upon it holds his arm, which is to be kept outstretched, horizontally after grasping the handle. By turning the handle a wheel is set in motion more or less rapidly. The speed of the wheel rotates the arm more than the muscles alone could do. The rotation finds its check in the resistance of the ligaments and tendons. The wheel should not move too rapidly, but so that a moderate stretching of the tendons can bring it to a standstill. Only when this is accomplished does the counteracting rotator begin to contract for the purpose of turning the wheel in the reverse direction. If the tension is felt to be too strong, it is only necessary to let the handle go.

Inspiration takes place during the supination and *respiration* during pronation.

MUSCLES CALLED INTO ACTION: The same as in A 8 a.

A 9.

FORE ARM FLEXION.

The lower arms are to be flexed at the elbow.

The patient places himself upon the seat, which is so adjusted that the lower edge of the arm support comes just above the elbow. He must sit only far enough in the chair to let his upper arms hang vertically.

The handles are to be clasped loosely with the hollow of the hand forward, leaving them some play.

First comes an *inspiration*. During *expiration* the arms are bent upward as far as is possible without removing the upper arms from the arm cushions. During inspiration the arms are drawn back into the vertical position.

Effect: Upon muscles in the forward (inner) side of the arms. The flexors of the wrist hold the hand and the back muscles check the inclination of the trunk to bend forward.

MUSCLES CALLED INTO ACTIVITY: *Biceps brachii, brachialis internus, brachio-radialis and pronator teres.* The wrist is held by the *radialis internus, palmaris longus* and *ulnaris internus.*

A 10.

FORE ARM EXTENSION.

The flexed arms are to be extended at the elbow. The patient takes his place upon the chair which is so adjusted that the lower side of the arm cushion comes just above the elbow joint and moves back only far enough to let the supported upper arms fall vertically. With the arm bent (in acute angle position) the palm of the hand is held forward and clasps the handle loosely, leaving some play.

First, there is an inspiration. During *expiration* the arms are stretched straight and the patient again *inspiring*, they are drawn back into the acute angle position.

Effect: Upon muscles in the stretching side of the upper arm. The flexor muscles of the wrist hold the hand, the

broad back muscles hold the upper arm against the arm cushion.

MUSCLES CALLED INTO ACTIVITY : *Triceps extensor, anconaeus quartus.* The hand is held by the *radialis internus, palmaris longus* and *ulnaris internus.*

A 11.

FLEXION AND EXTENSION OF HAND.

HAND FLEXION : The handles are placed diagonally upward. The lower arms are supported upon the table so that the wrist is parallel with the axis of the apparatus. The backs of the hands are turned upward and the fingers closed around the handles ; the lower arms are to to be fastened to the table with leather covered iron clasps which are movable.

First, a long breath is taken, during *expiration* the handles are pressed downward ; during *inspiration* they are drawn upward again by the patient yielding slowly to their pressure.

HAND EXTENSION : The handles are placed directly downward. The lower arms are placed and the handles held as indicated above.

First, there is an inspiration ; during *expiration* the handles are drawn upward and during *inspiration* they are permitted slowly to sink. Hand flexion affects muscles on the inner side of the lower arm ; hand extension acts upon muscles in the outer side of the lower arm.

FLEXORS : *Radialis internus, palmaris longus, ulnaris internus.*
EXTENSORS : *Radialis externus longus and brevis, ulnaris externus.*

A 12.

FINGER FLEXION AND EXTENSION.

The movement is made by means of an iron bow, in the middle of which a fork-shaped iron piece is attached. Between the tines of the fork a small piece of leather is stretched, against which is pressed the lower joint of the finger. The lever for finger flexion is at the right, that for finger exten-

sion is at the left. By reason of the unequal strength of the flexor and extensor muscles the levers are very unequally weighted. The lever which is to be used is attached to the iron bow by means of a spring bolt. In finger flexion the iron bow then rests in a horizontal position; in finger extension it is vertical. To prevent the corresponding spring bolt on the other side of the iron bow from hindering the free play of the latter, the bolt is drawn back and turned 90°.

The fore arm and hand are so placed upon the small table plate that the joint which is to be exercised rests on the line which would join the two axles of the apparatus. This is the case when the finger is bent downwards at a right angle in the joint in question and the hand drawn so far back that the bent finger touches the edge of the table plate. The forked iron is adjusted to the length of the finger so that the lowest section rests in the stretched leather.

An inspiration precedes each of these movements. The returning part of the movement is made during inspiration.

MUSCLES CALLED INTO ACTIVITY.

FLEXORS: 1st Phalange: *Interossei and lumbricales;* 2d Phalange: *Flexor sublimis digitorum;* 3d Phalange: *Flexor profundus digitorum.*

EXTENSORS: 1st Phalange: *Extensor communis digitorum, Extensor indicis proprius, Extensor digiti quinti proprius*; 2d and 3d Phalanges: *Interossei and lumbricales.*

B. Active Leg Movements.

B 1.

HIP FLEXION.

The thigh is to be bent upward and forward. The patient sits with one thigh in the seat and lets the other leg hang down. The hip joint of the hanging leg must fall in the same line as the axis of the apparatus. The movable knee support is to be fastened in such a way that it rests upon the front of the thigh directly above the knee cap. The arms are sup-

ported upon a handle at each side and help to give the body a firm, erect position.

First, there is an inspiration. During *expiration* the patient bends the thigh in a sharp angle upward against the trunk, bending the knee at the same time. During *inspiration* the thigh is slowly lowered and the leg stretched until it hangs straight down again.

Effect: Upon the muscles within the pelvis and along the anterior portion of the spinal column, as well as along the hip and front of the thigh.

MUSCLES CALLED INTO ACTIVITY: *Ilio-psoas, tensor fasciae latae, rectus femoris* and *Sartorius.*

B 2.

HIP EXTENSION.

The outstretched leg is to be drawn downward and backward. The patient reclines upon an inclined plane in such a way that one leg can move freely in the opening in the middle; the foot is put into a foot strap so that the whole leg is hung up in it. The other leg rests upon the inclined plane with the sole pressed against the footboard.

First, there is an inspiration. During *expiration* the leg is drawn down as far as possible without bending the knee. During *inspiration* it is moved upward. Even towards the close of the movement the knee must upon no account be bent.

Effect: Upon the glutæal muscles and the muscles at the back of the leg. The muscles of the lumbar region hold the pelvis.

The movement is executed chiefly by the *glutæus maximus* (the posterior part of the *glutæus medius* and *minimus* do, of course, help the movement especially at the beginning) the flexors of the knee which start from the tubera ischia, namely the *biceps, semimembranosus* and *semitendinosus;* the fibres of the *gastrocnemius* also contract. The extension of the hip joint is ultimately restricted by the *ligamentum ilio-femorale.* The patient is tempted to continue the movement by bending the knee, but that is not permissible, as it does not enter into the plan of this movement.

B 3.

a. HIP-KNEE FLEXION. *b.* HIP RAISING.

a. This flexes simultaneously hip and knee joints. *b.* Repeated raising and lowering of one hip.

a. The patient places himself upon the foot boards and with the right hand presses the handle down to raise the stirrup. Then the leg which is to carry out the movement is placed in the stirrup so that the cushioned parts of the latter surround the instep and rest upon it. The handle is now let go and the patient supports himself upon the poles at each side, stretches his leg and lets the foot fall between the foot boards.

First there is an inspiration; during *expiration* the upper and lower leg are simultaneously bent until the former forms a right angle with the pelvis. During *inspiration* the leg is slowly straightened.

b. Hip raising. The same starting position as in hip-knee flexion. The leg is kept straight during the whole movement. *First there is an inspiration.* During *expiration*, the lower hip is raised as far as possible without bending over in the other direction. During the *inspiration* the leg is lowered again.

Effect: Upon muscles within the pelvis and along the anterior portion of the spinal column, the hip and posterior portion of the thigh.

UPON THE FLEXION OF THE THIGH THERE ACT: *Ilio-psoas, tensor fasciæ latæ and Sartorius.* UPON THE FLEXION OF THE LOWER LEG THERE ACT: *Biceps femoris, semimembranosus, semitendinosus, Sartorius and gracilis. The tibialis anticus, extensor longus digitorum, extensor longus hallucis* and *peronæus tertius* hold the foot bent upward so that the stirrup does not slip. A large number of muscles are contracted in the leg upon which the weight of the body rests during the movement, especially the *glutæus medius* and *minimus.* These two latter muscles are especially exercised in the *hip raising* since they are constrained to contract throughout their entire contractile length. In the hip-and-knee-flexion this is not the case, as they only contract rigidly to hold the pelvis.

B 4.

HIP-KNEE EXTENSION.

Simultaneous extension of hip and knee joints.

The patient places himself upon the foot board and supports himself upon the poles at his sides; one foot is then placed upon the iron step which, for the sake of convenience, is held by a hook near the floor; as the patient steps upon it, the hook gives way. Slowly yielding to the upward pressure of the step, the knee is permitted to rise until the thigh forms an acute angle with the pelvis, or so far that, at the highest point reached by the knee, the pressure of the step is still felt. If the step should not rise high enough for this, the spring bolt could be adjusted in a lower hole in the chain wheel. At the close of the movement the hook is moved forward over the lever of the step, and the foot is not taken away until the patient feels that the hook has caught. This must be done carefully because the lever of the apparatus is heavily weighted; if the step should be allowed to knock against the hook, the apparatus might be damaged.

After the foot has been placed upon the step and the leg stretched so that the step touches the floor, the patient *takes breath*, the leg is bent upward as far as possible, the patient yielding very gradually to the upward pressure. During *expiration* the patient stretches his leg straight again.

Effect: Upon all the gluteal muscles, as well as upon the muscles along the anterior portion of the thigh and the back of the lower leg.

ON THE HIP JOINT THERE WORK: *Glutæus maximus, Glutæus medius and minimus (posterior third).* ON THE KNEE JOINT THERE WORKS: *quadriceps extensor.* The ankle is held by the *soleus, peronæus longus* and *brevis, tibialis posticus.*

B 5a.

LEG ADDUCTION (SEATED).

The outstretched legs, which are apart, are to be brought together (Adduction). After the patient has seated himself

and laid the lower part of the legs in the foot clamps, he clasps the strap with the right hand and draws the legs a little nearer together, so that the strap can be loosened. During *inspiration* he lets the legs move outward and during *expiration* he draws them together.

MUSCLES CALLED INTO ACTIVITY. *Pectineus, adductor brevis* and *longus, magnus* and *minimus, gracilis.*

B 5b.

LEG ADDUCTION (HALF RECLINING).

The *flexed* knee joints which are apart are to be brought together.

The patient seats himself in the chair, his back against the cushioned chair back, the roll in his neck, his feet on the foot board, which is of the same height as the chair seat. In the middle of the foot board there is a space inclined backward and slanting sharply at both sides. The feet are to be placed on the edge between this middle space and the slanting sides. They can be thus flexed outward, while the knees are drawn apart (abduction). This avoids a too strong tension of the ankles.

The foot board can be removed while the patient is taking his place. It is so adjusted that the legs are flexed to a right angle. The knees are drawn apart, the cushioned knee clamps laid over them, and the brass caps fastened on the lever so that the shaft of the knee clamp forms a right angle with the plane in which the leg is bent.

An inspiration precedes the movement. During the expiration the knees are slowly drawn together and again separated during inspiration. B 5b works upon the same muscles as B 5a. As the pressure upon the abdomen is diminished by the reclined and supported position of the trunk, this movement (but not the preceding one) can be used in cases of rupture and other pelvic disorders.

Professor von Preuschen has made the observation that the musculus levator ani contracts synergically with the

adductors of the leg, especially when coincident with the raising of the pelvis from a sitting position, *i. e.*, with contraction of the extensors of the back and hips. This would thus afford a means of strengthening the floor of the pelvis. This can be especially well accomplished by B5b, because the abdominal muscles are in repose in consequence of the reclining posture of the trunk; and they therefore do not counteract the raising of the floor of the pelvis.

B 6.

LEG ABDUCTION.

The legs, which are side by side, are to be drawn apart. After the patient has taken his place and laid the lower part of the legs in the foot clamp, he *takes breath.* During *expiration* the legs are moved apart; during *inspiration* they are drawn together.

MUSCLES CALLED INTO ACTIVITY: Approximately the posterior third of the *glutæus medius and minimus,* the *pyriformis, obturator internus* and the *gemelli.*

B 7.

VELOCIPEDE MOTION.

As in A 7, A 8b, and B 11, so in B 7, there is no mechanism belonging to this apparatus, having for its object a particular resistance. A wheel is set in motion by a treadle movement while the patient is seated.

The chair is screwed to a height such, that when both treadles reach the same level, and the patient's feet rest upon them, the thighs are horizontal, while the lower legs are vertical upon the treadles. If the seat is raised, the extension is increased. If it is lowered, the joints are flexed more sharply.

After the checking bar has been pushed forward, the wheel is set in motion with the right hand, and kept going with the

treadles. This is to be continued until the legs are slightly tired. Quick tempo calls forth greater effort of the muscles and is apt to lead to breathlessness.

Effect.—The mobilization of the hip and ankle joints, alternate extension and relaxation of many muscles, hence a diversion of blood to the legs.

The muscles called into play to sustain the motions are the large seat muscles, and the muscles at the back of the thigh.

MUSCLES CALLED INTO ACTIVITY : *Glutæus maximus, biceps femoris, semimembranosus and semitendinosus.*

B 8.

LEG TURNING (OUTWARD).

The rolling chair is pushed back far enough for the legs to be stretched when the feet rest upon the iron soles.

First there is an inspiration. While the feet are moved outward as far as practicable, *expiration* takes place. While they are drawn together, the patient *again makes an inspiration.* The legs are to be kept stretched.

The widespread habit of turning the feet inward while walking, would apparently render it superfluous to exercise the muscles which turn the feet inward, particularly as these muscles are exercised by B 1 and B 3. If, however, it should seem desirable to have this practiced, the movement could be made with one foot at a time, the left foot being placed in the right iron, and the right foot in the left iron.

Effect.—Chiefly upon the hip joint and the muscles behind and below it, of which two originate in the pelvis. The effect upon the ankle is insignificant; a number of muscles are, however, called into activity on the front and outer side of the lower leg to hold the foot. The movement diverts blood from the organs of the pelvis.

MUSCLES WHICH TURN THE FEET OUTWARD : *Pyriformis, obturator internus* and *gemelli, quadratus-femoris* and *obturator externus.* While the patient is seated, the *pyriformis* may be but little called into activity as rotator, because it works almost parallel with the thigh. To hold

the foot several muscles contract; *tibialis anticus, extensor digitorum longus, peroneus tertius, longus* and *brevis* and *abductor digiti quinti.*

MUSCLES WHICH TURN THE FEET INWARD: *Glutæus medius* and *minimus,* about the forward two-thirds of these two muscles with *tensor fasciæ latæ.* The foot is held inward by the *tibialis posticus, flexor digitorum longus, flexor hallucis* and *abductor hallucis.*

B 9.

KNEE FLEXION.

The patient seats himself in the chair so far that the knees are at the same height as the axis of the apparatus; the legs are stretched at full length upon the cushioned iron bows of the footrest in such a way that its cushions are directly above the heels. The knee support is mounted so that the thighs are held against the seat; the hands rest upon it.

The patient must not rest his arms upon the arms of the chair.

First there is an inspiration. During *expiration* the knees are bent until the lower leg is at an acute angle to the thigh; during *inspiration* the legs are drawn back into a horizontal position, gradually yielding to the pressure of the footrest.

N. B. The footrest is bolted fast only when one leg alone is to execute the movement, or when the legs are so unequal in strength that they cannot hold the footrest balanced.

Effect: Upon the muscles at the back of the leg: *biceps femoris, semimembranosus, semitendinosus, gracilis, sartorius and gastrocnemius.*

B 10.

KNEE EXTENSION.

The patient is seated in the chair so far that the knees reach the same height as the axis of the apparatus. The legs are placed behind the footpiece so that the front of the lower leg just above the ankle rests against the cushioned bows.

First there is an inspiration. During *expiration* the knees

are stretched until the lower legs are horizontal. During *inspiration* they are drawn back into the vertical.

N. B. The footpiece is not bolted fast, except when one leg alone is to execute the movement or when the legs differ very greatly in strength.

Effect: Upon muscles in the front of the thigh.

EXTENSORS; *quadriceps extensor cruris;* synergically with this muscle, contracts the *tensor fasciæ latæ.* Since this muscle and the *rectus femoris* tend to bend the pelvis forward, the former by taking its rise in the *spina ant. sup. ossis ilium,* the latter, by means of its origin in the *spina anter. inf. ossis ilium,* this is prevented by contraction of the *glutæus maximus.* Weak persons and those unaccustomed to bodily exercise, especially women, contract, especially during the second half of the movement, the muscles of the abdomen. The pressure upon the abdominal cavity thus caused, produces pain in the pelvic organs if they are swollen or sensitive: hence persons suffering in such ways should not endeavor to bring the lower leg into the horizontal position.

B 11.

FOOT FLEXION AND EXTENSION.

This apparatus, like A 7, A 8 b and B 7, has no especial mechanism for creating resistance during the movement. The bending or stretching of the foot sets a wheel in motion and the muscular labor is measured by the number of revolutions. These are recorded by a pointer, which moves along a scale whose figures represent the number of revolutions By putting the connecting rod in the different holes in the wrist wheel, an unequal movement may be obtained for the ankle in stretching and bending, as the different numbers correspond to certain angles. By lengthening or shortening the connecting rod, the whole angle can be distributed unequally, as required for bending or stretching. The apparatus is adjusted for ordinary circumstances and the position of the socket along the connecting rod is indicated by a line. If the foot bending is to be made stronger and the foot stretching less, the connecting rod is shortened;

if the stretching is to be made more and the bending less, the connecting rod is lengthened.

The rolling chair is placed back far enough to stretch the knees when the lower legs rest just above the heels in the cushioned braces; these are placed higher or lower as the case may be, so that the axis of the apparatus and the ankle joints are in line. The feet rest against the treadle iron, the straps are drawn over them.

The wheel is started by the hand and kept in motion at first by drawing the treadle iron towards the patient (foot bending), then by pressing the sole against it (foot stretching), each movement 25-100 times, or until there is slight fatigue. When the pointer has run through the scale the wheel is set in motion in the opposite direction and the pointer moves back.

EXTENSORS: *Gastrocnemius, soleus* (work both as adductors and supinators), *peronæus longus* (works both as *abductor and pronator*).

The *tibialis posticus* places the foot at right angles and adducts it. The *peronæus brevis* also places the foot at right angles but abducts it.

FLEXORS: *Tibialis anticus* (both *supinator* and *adductor*) *extensor hallucis longus, extensor digitorum longus* and *peroneus tertius* (the two latter both as *pronators* and *abductors*).

B 12.

FOOT ROTATION.

The toe is so rotated as to describe a circle. Like A 7, A 8 b, B 9 and B 11, this apparatus has no mechanism for creating resistance during the movement. A wheel is set in motion by the stretching or bending muscles of the foot precisely as in the case of B 11, but the foot is made to rotate, in B 12.

The rolling chair is moved back so far that the leg can be held outstretched, resting in the cushioned heel-braces. The iron soles, to which the foot is screwed fast, can be pushed forward or backward, and the heel-braces can be so raised or lowered that the ankles are in line with the horizontal axis of

the apparatus. The diameter of the circle which the toes describe during the movement depends upon the position of the graduated transversal bar, which is held by the axis of the wheel.

The wheel is started by the hand and kept in motion by active bending or stretching of the foot. The best way is to make 20 to 50 revolutions in one direction, sustaining the movement by foot-stretching, then an equal number of revolutions in the opposite direction by drawing the toes towards the patient, *i. e.*, by foot-bending.

Effect: Upon the muscles of the lower leg; those extending along the back stretch the foot; those along the front bend it. The rotary motion mobilizes the capsules and tendons of the ankle. If the thigh is fastened so that the rotation is not continued as high as the hip joint, the effect upon the foot is much more marked.

MUSCLES CALLED INTO ACTIVITY the same as by B 11.

C. Active Trunk Movements.

C 1.

TRUNK BENDING FORWARD, SEATED.

The trunk is to be bent forward out of a sitting posture somewhat reclined.

The patient takes his place upon the chair and places his feet behind and below (or between) the staves attached to the foot of the apparatus, the leather straps are brought over the shoulders and under the arms, crossed at the back so that the left hand holds the right strap, and the right hand the left strap (at the side but towards the front). Then the patient leans against the back rest and by a slight pull holds the straps tight. *First there is an inspiration.* During *expiration* the patient bends forward, so that the back from having been

erect, is bent as far as possible. While straightening up again, the patient *takes breath* and expiration follows while he slowly leans back against the back rest.

The bending forward is thus accomplished during *one* deep expiration; during the subsequent phase of the movement, the return to an erect position, inspiration is possible only at the beginning of the movement, because later the abdominal muscles are so contracted as to compel expiration. The next inspiration follows while the patient sits reclining.

Effect: In part upon the abdominal muscles, in part upon those which lie within the pelvis and at the front of the spinal column and thigh; vigorous expiratory movement.

The movement is executed in part by the abdominal muscles, *rectus abdominis, obliquus externus* and *internus,* and *transversus,* in part by the muscles which effect the bending of the pelvis forward, *ilio-psoas, tensor fasciæ latæ and rectus femoris.*

C 2.

RAISING TRUNK ERECT, SEATED.

The patient seated bending forward upon a chair, is to straighten up the trunk and bend it backward, overcoming the resistance of the apparatus.

The patient seats himself so that the feet rest upon the movable, slanting treadle, and the lower legs against the cushioned crossbar. Thereupon he bends forward as far as possible and lays the harness across his back in such a way that the horizontal strap passes over the middle of the shoulder blade. He then grasps a strap with each hand at his sides, somewhat towards the front, and holds them tight across the back throughout the movement.

During *inspiration* the trunk is stretched and inclined backward until the back touches the chair back; during *expiration* the patient raises himself erect and bends forward as far as possible, holding the straps tight.

Effect: Upon a large number of muscles at the back of the trunk from the neck to the calves.

MUSCLES CALLED INTO ACTIVITY : *Erector spinæ, rhomboidei, levator anguli scapulæ, latissimus dorsi, glutæus maximus, biceps femoris, semimembranosus and semitendinosus.* The knee joint is held by the *quadriceps extensor* (except the *rectus femoris*) and the ankle by the *triceps suræ, tibialis posticus, peronæus longus and brevis.*

C 3.

TRUNK BENDING FORWARD, RECLINING.

The upper part of the body is to be raised from the reclining to the sitting posture.

The upper movable plane has been placed in the prescribed angle. The patient places himself so that his back rests against the slanting and his legs upon the horizontal plane. The legs are held by a strap just above the knee. The hands are pressed against the sides.

The patient takes breath while reclining; during *expiration* he raises himself into a sitting posture, and bends forward as far as possible, with the head pushed forward. While returning to the erect position the patient *inspires*, and *expiration* follows as he sinks backward slowly upon the plane. Inspiration is to be repeated while reclining, and the movement is begun anew during the ensuing expiration.

Effect : In part upon the abdominal muscles, in part upon the muscles which lie within the pelvis and along the front of the spinal column. The muscles of the neck hold or move the head. As the movement tasks the expiratory muscles heavily, inspiration takes place during the pauses in which they are relaxed.

The abdominal muscles, *rectus abdominis, obliquus externus* and *internus* and *transversus* work almost exclusively to hold the parts until the upright position is reached. The raising, on the contrary, is accomplished by the *ilio psoas, tensor fasciæ latæ, rectus femoris,* and, in the beginning of the movement, by the *pectineus* and *adductor longus.* The *vastus internus* and *externus* are contracted if the knees are not held fast enough against the plane. When the patient bends forward, the abdominal muscles mentioned contract somewhat, but without much energy, because the force of gravitation helps to bend the trunk forward. This diminished activity of the flexors at the end of the movement does not arise in the use of C 1.

C 4.

TRUNK STRETCHING; LONG SITTING.

The patient is seated upon the plane, with legs outstretched, bending forward. He is to raise his body erect and stretch it backwards.

He places himself upon the bench, with legs outstretched, opens the catch with his left hand, and sets the wheel in motion with his right, to push the foot board against his feet. The straps are put in place, the hands pressed against the sides, and the thumbs hold the lower strap coming from the back.

During *inspiration* the patient reclines at an angle of 45° to 60°; during *expiration* he raises himself again into a sitting posture, and bends the upper part of the body forward as far as is possible without bending the knees.

Effect: Upon a large number of muscles at the back of the body, from the neck to the calves. The resistance afforded by the apparatus suffices to call upon all these muscles effectively when the upright position is nearly reached; but in proportion as the patient bends backward, the weight of the body helps, until it finally overbalances the resistance of the apparatus, and, in the case of heavy patients particularly, the weight of the body so far gains the upper hand that the abdominal muscles must contract to keep it up. As soon as this is the case, the movement backward should be checked. This difficulty is less noticeable in C 2, but C 4 has an incidental effect which C 2 does not afford; the apparatus achieves, by reason of the long sitting starting position, a more vigorous stretching of the large gluteal muscle and those in the back of the thigh, as well as of the *nervus sciaticus*. Besides, the farther back the patient lays himself, the more powerful the pressure of the straps upon muscles which support the shoulders.

MUSCLES CALLED INTO ACTIVITY: *Erector spinae, trapezius, rhomboidei, levator anguli scapulae, latissimus dorsi, glutæus maximus, biceps femoris, semimembranosus* and *semitendinosus*. The knee joints are kept stretched by the *quadriceps extensor* (except the *rectus femoris*) and the ankles by the *triceps suræ, tibialis posticus, peronæus longus* and *brevis*.

C 5.

TRUNK STRETCHING, STANDING.

The patient stands bent forward; he is to stretch the trunk backwards.

The patient places himself upon the foot of the apparatus in such a way that the legs touch the cushioned support, which is adjusted to touch the upper third of the thighs. After the straps are adjusted, the hands rest at the side on the crest of the hips; the thumbs hold the back straps so that they cannot slide upward. To facilitate the adjustment of the straps the lever of the apparatus is fastened in a horizontal position.

During *inspiration* the upper part of the body is bent backward 45° without removing the legs from the support. During *expiration* the patient bends forward as far as possible.

Effect: Upon a number of muscles in the back, from the neck down to the calves.

The stretching of the back is accomplished by the *erector spinae*; the weighted shoulders are carried and held by the *trapezius, levator anguli scapulae,* the *rhomboidei* and *latissimus dorsi;* the pelvis is inclined by the *glutæus maximus, biceps femoris, semimembranosus* and *semitendinosus,* which latter muscles, together with the *gastrocnemius,* flex the knee joint.

C 6.

LATERAL FLEXION OF THE TRUNK.

The patient seats himself with his back to the cushioned lever, and bends his arms around its ends. As the lumbar region of the back possesses the greatest flexibility, the movement causes the most marked flexion in that part of the back; hence the seat must generally be so placed that the axis of the apparatus reaches about the same height as the middle of the lumbar portion of the spinal column. Correspondingly the cushioned crossbar must be pushed up from the axis far enough to be readily held by the sharply flexed arms.

For persons of medium size it usually answers to fasten the lever in the fourth hole from below, for smaller ones in the third or second. If the rotary effect is meant to reach a higher portion of the spine, the chair may be screwed down until the axis falls in the same line as the curvature, and the crossbar is placed at a corresponding height. In view of the smaller flexibility in the upper portion of the back, the scope of the movement will be less and the resistance more. The instructor must often help by pressing his hand against the convexity of the curvature. When, as in such cases, the movement is to be made for one side, the crossbar should be placed towards the left for a movement to the right, and conversely for the reverse movement.

If it seems desirable to diminish the angle of the lateral flexion, it is only necessary to place a bolt upon the iron bow which projects upward from the footpiece and holds the weighted lever, thus preventing it from sinking too low.

In this motion it is desirable to make the inspiration during the laborious portion, in order that the side of the chest which is not working may be expanded as much as possible. Therefore, *during inspiration*, the patient bends upwards from his slanting position and downwards towards the other side, and *during expiration* he returns to his starting position.

Effect: Upon back and abdominal muscles at that side which makes the movement, and upon the raising muscles of one shoulder and the depressing muscles of the other. The flexors of the arm hold the lever.

LATERAL FLEXORS: *Qadratus lumborum, serratus posticus inferior, intertransversarii.* MUSCLES WHICH HAVE ALSO A COMPONENT FOR BENDING BACKWARDS, *iliocostales lumborum et dorsi, longissimus dorsi* (lateral insertions). The *levatores costarum* must work as active ligaments, *i. e.*, they strengthen the connection between ribs and vertebræ. Besides this, some power is required in order to bring the ribs nearer together; this may be brought about by the contractions of the *intercostales* and the accessory group of the *iliocostalis dorsi.* Of the abdominal muscles, the posterior portion of the *obliquus externus* and *internus* which

draw down the lowest ribs towards the crest of the hips seem really able to contribute in a higher degree to the lateral flexion of the trunk.

The apparatus works, by means of its transverse lever, first upon the arms and through them, upon the shoulder blades, by pressing one up (contrary to the working of the *latissimus dorsi, teres major* and *minor, rhomboideus*, lower part of *trapezius, pectoralis major* and *minor*) and the other down contrary to the working of the upper part of the *trapezius* and *serratus anticus major* and *levator anguli scapulæ*.

C 7.

TRUNK ROTATION.

The patient turns the upper part of the body while the pelvis is held fast.

The patient seats himself, places his feet upon the foot-rest and, after the knees have been fastened with a strap, he lays his arms into the forked ends of the cushioned bar. This must be screwed as high as is possible without inconvenience. If the movement is to be made in one direction so, for instance, that the turning is to be only towards the right, the patient must seat himself facing towards the left, so that the axis which carries the bar is to be turned to the right, and *vice versa*, when the turning is to be made to the left. By means of a spring bolt the axis can be fastened to correspond with the different starting positions.

First there is an inspiration in the starting position. During *expiration* the upper part of the body is turned as far as possible towards the other side; during the *next inspiration* the patient returns to the starting position, slowly yielding to the pressure of the bar. When the movement has thus been made repeatedly in one direction, the transverse bar can be turned after removing a spring bolt and adjusted for the other side, when a similar number of movements in that direction should be made.

Effect: Upon the abdominal and back muscles. In turning to the right, the right arm is held by the muscles of the back and the left by the muscles of the chest; in turning to the left, the right arm is held by the chest muscles and the left by the muscles of the back.

When the upper end of an elastic staff, such as the spinal column, is turned while the lower end is held, the angle is, of course, greatest at the upper end, and each part of the staff is less turned the nearer it approaches to the fixed end. Hence, in C 7 the upper part of the spinal column is most strongly turned, in C 8, on the contrary, where the upper part of the back bone is held, the lower undergoes the stronger rotation. This takes place moreover chiefly in the dorsal vertebræ, as the rotary power of the lumbar vertebræ is extremely slight.

This immobility of the lumbar vertebræ (so far as rotation is concerned), is necessary since their *processus spinosi* with the *crista pelvis* form the starting point for the long sequence of muscles which extend from one side of the loins and pelvis, around the abdomen and the thorax until, reaching the shoulder blade and upper arm of the same side, they accomplish the rotation of the trunk. When the rotation is towards the right, this sequence of muscles is formed by the following from below upwards: *Obliquus abdominis internus, transversus* and *serratus posticus inferior* upon the right side, *obliquus externus, serratus anticus major, rhomboidei, multifidus spinæ, semispinalis dorsi* upon the left side. *trapezius, rhombodei* and *latissimus dorsi* (upper portion) on the right side.

Moreover the *pectoralis major sinister* contributes its share by drawing the left upper arm forward, and the *latissimus dorsi dexter* by drawing the right upper arm backward. The same sequence of muscles, but reversed, rotates the trunk to the left.

C 8.

PELVIS ROTATION.

The patient is to rotate the lower part of the trunk while the upper part is held. He takes his place upon the chair and rests his feet upon the footboard. After the straps are fastened across the knees, the cushioned bar, which is to be placed as high as possible, is fastened between the back and the arms (which hold the bar).

If the movement is to be made in but one direction for instance, towards the right, the seat in the starting position must be turned towards the left, and *vice versa*, if the patient is to turn towards the left. The seat is fastened in the proper starting position by means of a springbolt.

First there is an *inspiration* in the starting position. Dur-

ing *expiration* the seat and the pelvis attached to it are turned as far as possible towards the other side; during *inspiration* the return to the starting position is made, slowly yielding to the pressure of the transverse bar. When the movement has been made in this way several times, the seat is reversed after removing the spring bolt, and so fastened that the movement can be made in the opposite direction.

Effect: Upon the abdominal and the back muscles. The muscles of the chest by holding the upper arms hold the bar between the upper arms and the back.

MUSCLES CALLED INTO ACTIVITY: See statements appended to C 7 The *rotation of the pelvis to the right* is accomplished by the same muscles which accomplish the *rotation of the trunk to the left,* and *vice versa.*

C 10.

NECK EXTENSION.

The head is to be bent backwards.

The apparatus can be used for exercising the muscles which bend the head from side to side or forwards, but it is the extensor muscles of the neck which most frequently need strengthening.

The head plate is held with both hands, by its side handles, and is placed with its cushioned side upon the head, about the height of the crown, the patient standing so far from the apparatus that *the cord by which the head plate is fastened is still drawn taut when the head is bent far forward.* During the movement the patient should put each foot forward in turn.

If the *flexor* muscles of the head are to be exercised, the patient turns and places the cushion against his forehead. The starting position would then be with the head strongly bent backward. Lateral flexion is practiced by turning one side towards the apparatus and holding the cushion over the other ear with the other hand. The starting position would then be with the head bent sidewise towards the apparatus.

From the starting position the head is thrown back as far as possible (or forwards, sidewise, *away* from the apparatus) once *during nspiration*, and back into the starting position *during expiration.* Only a gentle movement of the back is permitted during this procedure. The movement is to be made by the head almost exclusively.

In bending the head *forward* and *sidewise*, *inspiration* goes on while getting into position and the movement itself is made during *expiration.*

THE EXTENSORS OF THE NECK: The clavicular portion of the *trapezius*, the *splenii capitis et cervicis, ilio costales cervicis, longissimi capitis et cervicis, semi-spinales capitis et cervicis, spinales cervicis, recti capitis posteriores majores et minores.*

THE LATERAL FLEXORS OF THE HEAD: The above mentioned muscles if they are contracted on one side only, and also *intertransversarii* and *rectus capitis lateralis.*

FORWARD FLEXORS OF THE HEAD: *Sternocleidomastoidei, scaleni, longi colli, atlantis* and *capitis, rectus capitis anterior.*

D. Balancing Movements.

D I.

TRUNK BALANCING.

The seat of the apparatus is made to swing either equally in both directions=D 1 S sidewise balancing, or only in one direction; D 1 B backwards balancing.

The movement D 1 S is accomplished by placing the movable arms of the connecting rod side by side in such a way that the socket S covers the brass plate S.

The movement D 1 B is executed by fixing the inner edge of the socket R or B at the number on the scale of the outer arm, which corresponds to the number given in the prescription. This number also indicates the place to be given the movable wrist pin on the graduated crank at the back of the apparatus, by which the inclination of the seat is determined.

Since the seat is capable of two different motions, and the patient can place himself in three different ways, a series of movements is obtained which produce very diverse effects, and must, therefore, be carefully distinguished.

In writing the prescription :

D 1 S means uniform swing of seat to both sides, the patient being so placed as to present his side to the apparatus or to the handle at the back.

D 1 S forward means that the seat is to be swung in both directions, with the patient facing forward (his back to the handle).

D 1 b right means swing seat backward only, placing patient with his right side towards the apparatus.

D 1 b left means swing the seat backward only, placing patient with left side toward apparatus or handle.

D 1 b forward means swing seat backward only, placing patient so that he faces forward (his back to the handle).

The weight of the body holds the pelvis and thighs upon the seat while the swinging movement constrains the patient to balance the trunk, so calling different groups of muscles into activity, according to the position assumed and the kind of movement.

There are called into activity :

In *D 1 S*, the lateral flexor muscles of the trunk, contraction of the muscles of one side and extension of those of the other side, taking place alternately.

Active muscles. See C 6.

In *D 1 S forward*, the flexor and extensor muscles of the trunk with alternate extension and contraction of both sets of muscles.

Active muscles. See C 1 and C 2.

In *D 1 b Right*, the left lateral flexor muscles of the trunk, with corresponding extension of the muscles and ligaments of the right side, whereby a lateral flexion of the lumbar spine takes place with the convexity to the *right*.

In *D 1 b Left*, the right lateral flexor muscles of the trunk,

with corresponding extension of the muscles and ligaments of the left side, the lateral flexion of the lumbar spine taking place with the convexity to the *left.*

The two last named movements are used only in cases of lateral curvature of the spine, in which they are remarkably effective.

In *D 1 b forward,* the muscles of the abdomen and the flexors of the thigh with corresponding extension of the muscles of the lumbar spine and the hip extensors.

ACTIVE MUSCLES: See C 1. FOR MUSCLES WHICH ARE EXTENDED, see B 2 and C 2.

The flexor muscles of the knees contract whenever the seat swings backward, holding the thighs fast upon the seat.

During all these movements the contents of the abdomen are compressed and the circulation as well as the activity of the intestinal muscles increased.

The patient must sit with the knees apart, the hands supported upon the hips as quietly as possible, and with the trunk and head erect. The movement may last one to three minutes.

D 2.

TRUNK ROTATION, SEATED SIDEWISE.

The seat of the apparatus is gradually moved by steam power to incline in all directions. The number upon the prescription refers to the figure upon the graduated horizontal crank at the foot of the apparatus which conveys the motion to the seat. The extent of the motion depends upon the position of this bar. The seat slants more as the end of the bar which supports the connecting rod is removed from the vertical shaft of the apparatus.

The apparatus stands still when the belt shifter rests in the middle notch. If it is moved to the right, the slanting

motion of the seat is progressive from the right to the left, and *vice versa*, if it is moved to the left. The patient must sit with his right side towards the straps so that he can manipulate the handle with his right hand. During the movement, the upper part of the trunk should be held as quiet and erect as possible, because this accomplishes the desired muscular effect, more completely and uniformly than if the head and trunk sway in all directions, a proceeding which renders many patients dizzy. The movement should be made one minute towards each side.

To maintain a proper balance, the patient must gradually call into use all the muscles which balance the upper part of the body upon the pelvis, *i. e.*, the whole trunk upon the swinging seat; and he must do this the more vigorously the more the seat slants. When it slants straight forward or straight backward, the balance is maintained in part by bending the small of the back with the convexity in the same direction as the slant, in part by the movement (flexion and extension) in the hip joints. If the seat slants directly to the right or to the left, the balance is maintained only by bending the lumbar spine laterally with the convexity towards the same side. All the inclinations which come between main directions enumerated above give rise to a bending of the back and movement of the hip joints, more in the one or the other direction, as the momentary slant is more or less in this or that main direction.

MOVEMENTS IN THE HIP JOINTS are accomplished by the hip flexor and extensor muscles, see B 1 and B 2.

MOVEMENTS OF THE BACK by the flexor and extensor muscles of the back, see C 1 and C 2.

D 3.

TRUNK ROTATION, SEATED ASTRIDE.

The saddle shaped seat of the apparatus is inclined in all directions successively by motor power. The number upon

the prescription refers to the movable graduated horizontal lever at the foot of the apparatus. The peripheral end of this lever, connected by a rod with the saddle, conveys the motion to the latter.

The more the horizontal lever is prolonged by moving its peripheral end from the vertical shaft, the sharper the inclination of the saddle. The apparatus stands still when the strap rests in the middle notch; if it is moved to the right, the inclination of the saddle changes from right to left, and *vice versa*, when it is moved to the left.

The patient takes his place astride facing the strap holder and sand glass.

The trunk is to be held as quiet and erect as possible during the movement. This accomplishes the desired muscular effect much more completely and uniformly than when the trunk and head are permitted to sway about, a proceeding which makes many persons dizzy.

The movement usually lasts one minute in each direction.

To maintain equilibrium the patient must call into use successively all those muscles which balance the upper part of the body upon the pelvis or the whole trunk upon the saddle; and he must use them the more vigorously the more the saddle slants. When it inclines directly forward or backward, the balance is maintained in part by bending the small of the back, in part by bending and stretching the hip joints. If the saddle slants directly right or left, the balancing is accomplished by bending the back with the convexity towards the same side. All inclinations which come between the above named ones call for more bending of the back or more movement of the hip joints, according as the direction of the slant is more or less in one or the other of these principal directions.

THE MOVEMENT OF THE HIP JOINTS *is accomplished by the flexors and extensors of the hip.* (See B 1 and B 2.)

THE MOVEMENT IN THE BACK *by the flexors and extensors of the back.* (See C 1 C 2.)

E. Passive Movements.

E 2.

PASSIVE HAND FLEXION AND EXTENSION.

A rod which is parallel with the table plane of the apparatus and has two movable handles, is set going up and down by motor power. The number upon the prescription refers to the position of the movable wrist pin on the graduated crank. The farther the former is removed from the horizontal shaft the greater is the up and down motion of the handles.

The patient seats himself upon an ordinary chair, rests his arms upon the table and takes hold of the handles, turning the backs of his hands up. When the apparatus is set in motion the handles move up and down, bending and stretching the hands alternately while the patient remains perfectly passive, merely contracting the flexors of the fingers enough to hold the handles. The movement lasts two minutes. It causes alternate stretching of the flexor and extensor muscles, the tendons and ligaments of the hand. It mobilizes the wrists and increases the warmth and flow in blood in the hands and lower arms.

AS TO THE MUSCLES WHICH ARE EXTENDED : See A 11.

E 3.

PASSIVE HAND ADDUCTION (RADIAL FLEXION) AND HAND ABDUCTION (ULNAR FLEXION).

Two wooden plates with movable handles are set swinging in a horizontal plane.

The number upon the prescription indicates the position of the movable wrist pin upon the graduated crank. The farther the former is removed from the vertical shaft, the greater the swing of the handles. The patient sits upon an ordinary chair, lays his arms upon the table and grasps the

handles which are to be pushed so far in or out that the middle of the wrist comes directly above the turning point of the wooden plates.

When the apparatus is set in motion, the wooden plates with the handles swing and convey to the hands an alternate adduction and abduction movement while the patient remains perfectly passive, merely contracting the flexors of the fingers enough to hold the handles.

The movement is continued one to two minutes. It causes alternate stretching of the muscles which adduce the hands (flex them inward), and abduce (flex them outward), when the latter lie with the flexed side downward; it also stretches divers ligaments and certain parts of the joint capsules, mobilizes the wrists, increases warmth and circulation in the hands and lower arms.

ADDUCTORS : (radial flexors) *radialis internus* and *radialis externus longus.*

ABDUCTORS (ulnar flexors) : *ulnaris internus* and *ulnaris externus.*

E 6.

CHEST EXPANSION.

This apparatus accomplishes passive extension of the trunk and expands the chest, by drawing the shoulders upward and backward by means of a pair of levers while a cushion is pressed against the back. The levers are horizontal and at one end of each there is a shoulder crutch. At the other end they are both attached to the same sabre shaped lever, which raises a balance weight at its free end.

This lever with its weight is in its turn attached by a movable socket and a connecting rod to another vertical bar, which is set going up and down by means of an eccentric wheel. This movement is thus conveyed to the horizontal levers with their shoulder crutches.

When the socket is fastened at the free end of the sabre shaped lever (No. 1 on the scale), the upward movement of the crutches is least. The higher the number on the scale the greater the movement of the crutches.

The forward pressure of the back cushion increases the extension of the trunk and the expansion of the chest which results from raising the shoulders. This forward pressure is proportional to the raising of the crutches, increasing from the insertion (No. 1 upon the sabre shaped lever to No. 20), but is, to a certain extent, limited when the back offers resistance, by inserting a spiral spring the elasticity of which moderates the pressure upon the back. This pressure can, on the other hand, be increased either by pushing the cushion forward upon its own notched bar (so tightening the spring), or by inserting a coarser spiral spring, for which purpose three of assorted sizes accompany this apparatus. The coarsest spring is used chiefly for gentlemen, the finer for ladies and children.

When the movement is to begin, the eccentric pulley is placed with its longest radius vertical so that the crutches are in their lowest position. The patient places himself upon the seat and rests the armpits in the supports, which are pushed against the chest but without compressing it. The seat is raised or lowered until the crutches rest firmly against the armpit without pressing. The cushion is so placed that it touches points of the shoulder blades with its upper part and the horizontal bar is placed in notch No. 1. When the socket of the sabre shaped lever is also placed upon No. 1 the apparatus is set in motion and the attendant changes the position of the cushion and the raising movement of the crutches until the patient finds their pressure agreeable and suitably strong. The adjustment found suitable is noted on the prescription by means of four numbers.

The first indicates the height of the seat; *the second*, the height of the cushion; *the third*, the position of the cushion and *the fourth*, the elevation of the shoulder crutches. If the movement should be found too strong, in spite of the fact that the latter numbers are both at No. 1, a farther diminution of the effect of the apparatus can be obtained by raising the seat and lowering the back cushion. The first of

these changes makes the crutches touch the body only after they have finished a part of their upward motion, while the lowered position of the back cushion conveys the pressure to a softer and more yielding portion of the back. In the case of sensitive patients it is better to take these precautionary measures in the first place. Conversely by lowering the seat and raising the cushion the movement can be intensified.

The patient remains perfectly passive and need only inspire when the chest begins to expand.

The movement is repeated five to ten times.

This is one of the most important apparatus in mechanical treatment. It stretches the trunk in the same way as hanging by the arms, so diminishing the natural and abnormal curves.

All the muscles, the membranes and tendons along the walls of the chest are extended, and the chest itself assumes a position of vigorous inspiration by reason of the elevation of the ribs. All these effects are farther intensified by the pressure of the back cushion. To give the chest a position of equally vigorous inspiration in any other way it would be necessary to exert a large number of muscles which do not come into use in the ordinary quiet breathing.

In consequence of a sedentary occupation, particularly if the trunk is bent forward and the chest contracted as in writing and similar occupations, these muscles are weakened, and as the thorax becomes stiff they are less able to accomplish vigorous breathing, whence it is that persons of such habits readily suffer from want of breath when exercising. The agreeable feeling which this expansion of the chest engenders is doubtless explained by the fact that the chest is so considerably *expanded* without exertion of the muscles.

The inspiration takes place involuntarily at the beginning of the movement, and is strengthened by the effort of the patient. But it cannot be continued throughout the whole expanding action, for the abdominal muscles are also stretched

(passively), and prevent the farther contraction of the diaphragm.

The main point is this, that the stiff chest is so expanded and mobilized that the muscles which draw up the ribs are more readily called into activity, and can be better developed; and that in breathing the upper part of the chest is more expanded, which is necessary if the weakest parts of the lungs, the tops, are to have an opportunity to work and so be strengthened.

E 7.

PASSIVE TRUNK ROTATION.

The seat of the apparatus is set by motor power in a sidewise swinging motion on its axis. The angle described in relation to the median line of the apparatus is determined by the position of the movable wrist pin upon the graduated scale of the crank.

The angle of rotation to the right and left increases in proportion to the numbers.

The seat can be arranged, if desired, to swing towards one side only; for this purpose it must be raised about an inch, turned 30° right or left, and again lowered when a key on the axis of the apparatus catches a corresponding notch in the under side of the seat. The patient places himself upon the seat, puts his feet upon the iron footrest, fastens the straps over the thighs and lays his arms around the upholstered bar, which is to be placed as high as possible. The bar is thus held firmly between the upper arms and the back.

While the upper part of the body is thus held, the lower part with the legs is swung from side to side and the rotary muscles of the trunk and the ligaments of the spinal column are stretched alternately right and left. This increases the circulation in these muscles, and promotes the flexibility of the thorax and its development. The *contents* of thorax and abdomen, too, are more or less influenced by the move-

ments of the trunk, which affect their circulation and functions. As the movement is wholly passive, it is excellent as a general stimulus, especially for feeble patients.

E 8.

PELVIS LIFTING.

The apparatus has a cushioned plane of which the forward half is fast; the rear half moves upon an axle attached to its rear edge, by means of which it can be raised at divers angles to the horizontal plane. The forward free edge is thus raised to different heights above the fastened plane, and moves up and down alternately when the apparatus is set in motion by motor power.

Two numbers are stated upon the prescription. *The first regulates the position of the movable wrist pin on the graduated crank*, and indicates the grade of elevation of the slanting plane. *The other number determines the length of the connecting rod*, upon which it depends whether the movable plane shall sink to the same height as the fixed one or shall pause at a certain distance above it. In the first case, both numbers are equal; in the latter the second number (that of the connecting rod) *is two or three figures higher*. It must never be lower than the first (for the crank) because that would check the action of the apparatus.

The patient lies with chest upon the forward plane of the apparatus, so that the free (movable) edge of the lifting plane reaches a line dividing the upper from the middle third of the thigh. The upper part of the body is supported upon the elbows; the lower arms resting and the upper arms vertical.

If the adjustable plane is now raised the points of support for the trunk are the shoulder joints and the hip joints. The patient must be perfectly passive, so that the trunk hangs relaxed from the four points of support. *Inspiration* takes place during the lifting (of the rear plane); *expiration* while it is lowered.

The movement is made ten times in the beginning, then gradually oftener to fifty, one hundred and over.

In this movement, pelvis lifting, the *second* figure upon the prescription (that of the connecting rod) must be two or three numbers higher than the *first* (that of the movable wrist pin), or else the abdomen of the patient would be pressed against the fixed plane at the lowest position of the moving plane, and this would produce an unpleasant sensation and diminish the effectiveness of the movement.

Raising the pelvis diminishes the pressure in the abdominal cavity, which actually becomes negative at the highest point reached by the pelvis. The first consequence of this is to facilitate the access of blood to the organs in the abdominal cavity, but, as the pressure in the chest cavity also sinks, the outflow is also facilitated, so that no considerable general hyperæmia of the pelvic organs can arise, at least so long as there is no active digestive process taking place. The hydrostatic conditions, on the other hand, are changed by the position of the body. The pelvic organs, which ordinarily have to endure the greatest pressure of blood, are now brought into the highest position. Their extended, loosely-woven net of blood vessels can more readily empty itself, and any existing plethora of blood can diminish. The floor of the pelvis and the organs directly above it are freed from the usual pressure from above. Their own weight and the diminished pressure in the abdominal cavity enable them to rise in the abdominal cavity as far as their own attachments permit. This counteracts both the causes which produce sinking, abnormal positions, and abnormal forms, and these affections, themselves, which can, in some cases, be directly removed. It is only by persistent and gradually increased use of this apparatus with generally strengthening treatment that a lasting result in pelvic difficulties can be obtained by this treatment.

This apparatus can also be used to exercise the abdominal muscles when it is desirable to avoid strong pressure within

the abdominal cavity. The balance weight of the movable plane is then pushed so much farther that the patient's own weight does not press it down, and the lifting plane is elevated so that, when the patient is placed as above indicated, his abdomen suspended free does not touch the fixed plane. The apparatus is not set in motion, but the patient tries to curve the lnmbar portion of his back upward by contracting the abdominal muscles. This movement is repeated twice to twenty times.

The apparatus is used further to stretch and mobilize lateral curvatures of the spine. The prescription then bears the direction:

Position, on the right or the left side. The patient reclines upon the side indicated and the apparatus is placed with both planes horizontal. The hips are near the movable edge of the rear plane, the shoulder and side rest upon the fixed plane. Before the apparatus is set in motion, both numbers (those of the connecting rod and movable wrist pin) are to be made similar, usually No. 1–1.

F. Vibration.

F 1.

VIBRATION OF DIFFERENT PARTS OF THE BODY.

The parts of this apparatus, which are kept vibrating by mechanical power, for the purpose of conveying the vibratory motion to the different parts of the body, are an upholstered beam and a vertical pole with a movable horizontal bar on which the different appliances (plates, balls and handles of divers forms and sizes) are fastened. The beam vibrates most strongly at the end where the belting is attached and least strongly at the opposite end (the zero point). The vibrations conveyed by the vertical iron pole are stronger according as the small, graded horizontal bar with the

appliances is pushed forward, *i. e.*, the latter are removed from the vertical axis.

The vibratory movements most frequently used are:

BY MEANS OF THE BEAM.

Foot vibration: The patient sits upon an ordinary chair and lays the lower legs upon the cushioned crossbeam in such a way that the heels reach beyond it. It is not permissible to place the feet upon the cushioned beam and bend the knee, because this would injure the mechanism of the apparatus. The muscles of the leg should be relaxed during the motion.

Vibration of the pelvis: The patient is seated astride of the beam near the zero with his back to it. The vibration of the beam is communicated to the whole body, most strongly to the pelvis and its organs.

BY MEANS OF THE VERTICAL POLE AND THE APPLIANCES BELONGING TO IT.

1. A ROUND CUSHION.
2. A SMALLER ROUND CUSHION.

Shoulder joint vibration: Standing. The cushion is placed against the front, side and back of the shoulder joint, *i. e.*, the whole surface of the delta muscle.

Shoulder blade vibration: Seated. The cushion touches one shoulder blade at a time.

Back vibration: The movement is made standing or seated, the cushion being placed so high that it comes between the shoulder blades.

Vibration of the loins: Seated or standing. The cushion must be placed at the height of the upper lumbar vertebræ.

Vibration of the sacrum: Seated or standing. The cushion must be adjusted to the height of the sacrum.

Hip vibration: Standing. The point of attack for the cushion is between the top of the crista ilii and the trochanter, and back of the latter to the large gluteal muscles.

Chest vibration: Standing. The cushion comes upon the middle of the breast bone and between this and the shoulder.

Vibration of the pit of the stomach: Standing. The cushion is placed directly upon the spot indicated.

Colon transversum: Standing. The cushion is placed below the pit of the stomach, or on a line which would connect the front of the tenth ribs, and above the navel. The movement must proceed from right to left, *i. e.*, from the liver to the spleen. The patient turns, at first, towards the left to set the cushion at the right side and lets it move towards the left as he slowly turns towards the right. He draws back from the cushion when it has reached the left side and repeats the movement several times in a minute.

Small intestine: Standing. The cushion comes directly against the navel.

Vibration of the hypogastrium, right or left: Standing. The cushion is placed directly over the right hypogastrium (coecum) or the left (S. romanum of the colon descendens).

Sidewise knee vibration: Standing. The cushion is placed against the inner and outer sides of the knee joints.

Vibration of back of knee joint: Standing. The cushion is placed in the popliteal region.

N. B.: The larger or smaller cushion is used according as the surface to be affected is larger or smaller.

3. AN IRON WITH A SMALL OVAL VERTICAL PLATE.

This is used when it is desirable to affect the depths of a muscle or a deeply imbedded nerve.

Hip nerve vibration: Standing. The small felt or leather covered plate is pressed against the bed of muscles between the large trochanter and the os coccyx.

4. AN INCH WIDE, CUSHIONED IRON BENT LIKE A CRUTCH WITH THE CONVEXITY OUTWARD.

This iron is so bent that when the horizontal bar is placed in hole No. 5 on the vertical pole it forms an arc, the radius of which corresponds to the distance from the median line of the vertical axis. The movement is, therefore, always of uniform strength wherever the arc may be touched.

Vibration of the neck: The iron is placed in the neck, higher, lower, or at one side, wherever a sensitive spot is found (muscle infiltration).

Vibration of forehead: The iron is placed against the forehead above the eyebrows.

5. A RUBBER BALL.

Vibration of the temples, ears, nose, throat: This ball is used when a small sensitive spot is to be treated, especially about the head. In vibration of the *ears*, the ball is placed against the outer ear. In vibration of the *nose*, it is placed against one side first, then the other. In vibration of the *throat*, it should be placed against each side of the throat near the angle of the jaw.

6. A SMALL FORK SHAPED IRON, CUSHIONED.

Vibration of the larynx: The iron embraces the larynx.

7. A CURVED IRON AN INCH AND A HALF WIDE WITH THE CONCAVITY OUTWARD.

Running vibration of the upper arm: The iron is placed against the middle of the upper arm. The shoulder is raised and lowered, and the upper arm moves up and down in the curve.

Running vibration of the thigh: The iron is placed about the middle of the thigh and the different sides of the latter are pressed against it, and moved up and down by bending the knee joint.

Knee vibration: The iron is placed directly above or below the knee cap.

Vibration of the calf of the leg: The iron surrounds the thickest part of the calf. The leg must be somewhat raised and lowered.

8. A CURVED IRON AN INCH AND A HALF BROAD WITH THE CONCAVITY UPWARD OR DOWNWARD.

Shoulder top vibration: The iron rests on top of the shoulder.

Vibration of the supported arm: The patient seats himself in front of the apparatus a little at one side, with the arm stretched to one side resting upon a rod. The curved iron works upon the upper or lower side of the arm, for instance, in places where there is muscular infiltration.

9. AN IRON WITH A BUTTON-SHAPED KNOB TURNED DOWNWARD.

This is used to penetrate farther into the muscles, for instance, in vibration of the top of the shoulder; or when a certain spot is to be treated upon the lower arms or hands.

10. AN IRON WITH TWO HORIZONTAL HANDLES.

This serves to vibrate the whole arm. But it depends upon the manner and direction in which the arms are held, whether the vibration extends to the whole arm or is limited to a certain part of it. The only muscles contracted are those which hold the hands closed about the handles; the rest are relaxed.

Vibration of the right or left raised arm: The patient sits so that he turns the side in question towards the apparatus and clasps a handle (adjusted to suit his height) with the arm extended sidewise and raised at an angle of 45°. The movement has a powerful effect upon the whole arm, as well as upon the shoulder blade and shoulder joint.

Arm vibration: The patient stands facing the apparatus and holds the handles with both hands so that the arms are horizontal. Effect upon whole arm.

Lower arm vibration: The patient stands as before, the horizontal handle is placed lower, so that the lower arms alone are horizontal. Effect chiefly upon lower arm.

Hand vibration: Position as before; the handles are placed so low that the lower arms also slant downward when the hands loosely grasp the handles. Effect chiefly upon the hands.

A solid object vibrating in contact with the soft tissues of the body has a quickly alternating, stretching and compressing effect. This promotes circulation in the capillaries and

lymph vessels. It increases resorption and aids the dispersion of infiltrations of the muscles and tendonous tissues.

The mechanical stimulus of vibration causes, directly or reflexly, a contraction of the smooth muscular fibres which manifests itself in several different ways. A vibration of the *os sacrum* causes such vigorous contractions in the full rectum or bladder, that the sphincters of these organs contract vigorously to prevent evacuation. The expectoration of mucous is facilitated by *back or throat vibration*, which causes a contraction of the air channels. Sensitive persons find their feet cold during *vibration of the feet*, but this sensation is quickly succeeded by increased warmth corresponding to the subsequent relaxation of the muscles of the blood vessels.

The mechanical stimulus of vibration has a farther effect, namely, the allaying of pain, which is probably explained by the direct influence upon the disposition and mutual action of the nerve molecules.

A vibration lasting two minutes, applied to a painful spot is often sufficient to alleviate the pain for a short time at first, and for a longer time if sufficiently repeated.

There is no doubt that the vitalizing influence of vibration upon tired muscles is connected with the promotion of circulation and allaying of pain. A *vibration of the feet* after a long walk, *of the back* after wearisome sitting, *of the throat* after protracted speaking or singing, always produces an agreeable and beneficial effect.

F 2.

VIBRATION IN THE SADDLE.

This apparatus is designed to produce a vibration of the whole body as in riding.

A wooden frame, shaped like the body of a horse, carries a ladies' or gentlemen's saddle, and is made to vibrate. It is desirable to have two ladies' saddles, a right and left, so that this exhilarating exercise can be used in cases of curva-

ture of the spine. A saddle adjustable for the right and left side could not be used for this purpose. The apparatus makes about 180 vibrations per minute. The intensity of the vibrations is regulated by a screw on the wheel. The movement lasts two to three minutes.

Vibration in the saddle produces a stimulating effect upon the nervous system. In the case of persons not accustomed to riding there is more or less contraction of the arterial system. This can be readily demonstrated by registering the pulse curve immediately before and after the vibration. This reaction is wanting in persons accustomed to riding.

In the case of persons with feeble action of the heart and unaccustomed to riding, this movement must be made with caution, because through the contraction of the arterial channels of circulation the work of the heart is intensified. If palpitation or dizziness occur the movement should be omitted wholly.

Experience has repeatedly shown that vibration in the saddle stimulates a torpid intestinal canal.

In cases of rupture, catarrh of the bladder, or hæmorrhoids, this movement should be avoided or used very gently (No. 2, 3 or at most 4).

G. Percussion.

The following apparatus have two to four elastic hammers made of steel and rubber and set in rapid oscillating motion by motor power. Two sets of hammers with different thickness of rubber belong to each apparatus. The thinner and softer are used for more sensitive parts, such as the back between the shoulders, the pit of the stomach, the chest and the abdomen, where rude percussion is never taken However, the vigor of percussion depends not only upon the hardness or softness of the hammer, but upon the manner in which the patient presses the affected part against the hammers.

Percussion has approximately the same effect as vibration, but more superficially and locally, with greater irritation to the softer parts, especially when a thin coating covers a bone. Hence no percussion should be undertaken for fresh infiltrations, but rather gentle vibrations.

G 1.

PERCUSSION.

This apparatus can be used for a certain limited surface, or it can be made to move up and down over a larger surface. The raising and lowering of the little hammers are effected by the turning of a wheel managed by an attendant.

BACK PERCUSSION. The patient sits with his back to the hammers and the apparatus is made to move up and down two or three times. At the beginning of the movement the patient should not immediately press strongly against the hammers. He should approach gradually and ascertain the proper and comfortable measure of strength of the hammering.

PERCUSSION BETWEEN THE SHOULDER BLADES. The apparatus must move up and down four to six inches so that the percussion affects the space between the shoulder blades.

LOIN PERCUSSION (RUNNING). The apparatus moves up and down along the small of the back.

LOIN PERCUSSION, CROSSWISE. As before, but the patient moves to the right and left so that the percussion also affects the sides.

SACRUM, HIP AND SHOULDER PERCUSSION affect the parts named.

ABDOMINAL PERCUSSION (RUNNING). The patient stands with the stomach turned toward the hammers and turns now to the right, now to the left, so that the percussion is distributed over the whole abdomen.

RIGHT RUNNING ABDOMEN PERCUSSION is applied to the right side only of the abdomen, between the right groin and the edge of the ribs (colon ascendens).

LEFT RUNNING ABDOMEN PERCUSSION is applied to the left side of the abdomen, between the left groin and the edge of the ribs (colon desendens).

STOMACH PERCUSSION. The hammers work upon the stomach, *i. e.*, upon the triangle between the lower end of the breast bone and the connecting line of the free edges of the tenth rib at each side.

COLON TRANSVERSUM PERCUSSION. The hammers are so placed that they work upon the space between the front end of the tenth rib and the navel. The patient turns so that the percussion moves from right to left, from the liver to the spleen (colon transversum).

G 3.

LEG PERCUSSION.

The patient can move the hammers of this apparatus up and down, or let them work especially upon affected surfaces. The apparatus is used for

RUNNING THIGH PERCUSSION for all the muscles of the thigh both back and front, unless "front" or" back" is especially written upon the prescription.

RUNNING LEG PERCUSSION for all the muscles of the back and outer sides of the lower leg.

There must be no percussion of the front with its hard bone surface directly beneath the skin.

CALF PERCUSSION is used directly upon the calves of the legs. Percussion must never be used upon places in which there are varicose veins.

G 4.

TRUNK PERCUSSION.

With this apparatus all the movements mentioned under G 1 can be given, though not to so great an extent; here, also,

the patient can help himself by moving the hammers up and down, and placing them at the level of such parts as are especially in need of treatment (for instance, muscle infiltrations).

G 5.

HEAD PERCUSSION.

The patient seats himself before the apparatus and the chair is screwed so high that the hammers can work upon his head. He bends his head forward, backward and sidewise to let the hammers reach the largest possible surface. The height of the chair must be so adjusted that the tapping is most strongly felt when the back is held straight, and somewhat less strongly when it is bent. The beginning should be made with gentle tapping, experimentally, and the movement should be instantly abandoned if dizziness ensues.

Head percussion promotes the circulation of blood and lymph in the soft envelopes of the skull, and is therefore used with advantage in rheumatic infiltrations. The skull, with its contents, is made to vibrate slightly, which undoubtedly produces a slight contraction of the blood vessels of the brain, with ensuing expansion and consequent flow of blood thereto, after which the original condition is restored. These variations in the circulation, and the direct effect of the percussion upon the brain molecules are probably the cause of the frequently observed effect of this movement in relieving headache and sleeplessness.

H. Kneading.

H. I.

ABDOMEN KNEADING.

The apparatus has a movable plane for reclining, which is moved forward and back by motor power while six small

wheels in an opening in the middle of the plane move up and down in turn. By turning a wheel a mechanism is called into action, which increases or decreases the rising and falling motion of the rollers, as is shown by an indicator connected with it pointing a higher or lower figure upon a scale. The figure to be used is indicated upon the prescription. The motions of the plane forward and backward can also be modified.

The patient lies with the abdomen resting upon the cushioned couch, so that the stomach is directly above the opening through which the kneading rollers work. The elbows rest upon the cushion in front of the elevation in the surface. The abdominal muscles must be left relaxed.

The movement lasts two minutes.

Circulation is promoted in the abdominal muscles and intestine, and contraction of the latter is stimulated.

J. Friction and Rolling.

J. I.

ARM FRICTION.

Arm friction is accomplished by two pairs of straps which move up and down, and are held taut by means of a lever with a weight attached. The figure upon the prescription refers to the weight upon the graduated lever. The chair is so adjusted that the patient's outstretched arm is held horizontal when the hand grasps the movable handle. To relax the straps and facilitate the insertion and withdrawal of the arm a handle attached to the front of the chair is pressed down with the hand not in use.

The arm is turned and pressed forward and backward while the straps work upon it.

The movement continues one minute for each arm.

Arm friction while rotating the muscles promotes circulation and warmth.

This movement aids the dispersion of muscle infiltrations.

J 2 b.

FINGER FRICTON.

J 2 b is an apparatus for massage which applies friction with exactly the vigor and over precisely the surface prescribed, stroking forwards under pressure and returning with cessation of pressure.

The friction is executed by means of a pair of steel springs which are cushioned at the free ends. When the apparatus is at work the cushions surround the finger and stroke it from the tip upwards.

The cushion is covered with a fresh piece of chamois skin for each patient. This is fastened with a rubber ring and greased with vaseline. To make this change the more readily the springs can be detached from the mechanism by means of a key.

By turning five brass knobs the following results are obtained :

1. *The two side knobs*, at each side of the case which encloses the mechanism by which the springs are held at a suitable distance apart. If the patient turns the knob away from him the springs approach each other, and *vice versa* if he turns the knob towards him.

2. *The knob on the front, at the right, above.* This sets the apparatus in motion according to the direction of the engraved brass plate or brings it to a standstill.

3. *The knob on the front at the left, below* determines the extent of the friction. The brass plate gives the appropriate direction.

4. *The knob on the front of the table below the springs* regulates the pressure, *i. e.*, how close together the springs shall come while moving forward. This also according to the direction on the engraved brass plate.

All these knobs can be manipulated and the results obtained while the apparatus is in motion.

For each brass circle deposited the apparatus executes 120

movements lasting two minutes. By depositing five circles the massage can be continued ten minutes.

The circle is deposited in a slit at the top of the apparatus. Until this is done the apparatus cannot be set in motion. After 120 movements it stops and can be started again only after another circle has been deposited. While the 120 movements are in process of execution the apparatus can be stopped or started at will.

Directly beneath the springs there is an iron rest attached by a screw, and on this rest the finger lies during the stroking. It can be removed whenever it is in the way, as in the stroking of the metacarpal bone of the thumb.

There is also an iron support with an adjustable cushion for the support of the lower arm while using this apparatus.

When the apparatus is to be used the patient seats himself in such a way that the hand which is to be treated can be comfortably held before the springs, and rests the lower arm upon the cushion of the iron support. When the finger and the chamois skin have been greased with vaseline, and the finger inserted between the springs, the latter are adjusted so that the chamois skin rests against the finger. The finger is then removed and the apparatus is allowed to execute several strokings to show whether the length of the movement is appropriate. If the cushions come too close together, so as to render the friction too intense and painful, the knob on the front of the table is screwed to the left until the springs are somewhat farther apart. Then the finger is again inserted between the springs and the changes required are made during the stroking.

Finger friction is used when the fingers, their joints or tendons are swollen, either from rheumatic or traumatic causes. In case of frost, too, it is serviceable.

In consequence of the unavoidable vigor of the friction, pain cannot be wholly avoided; but it can be very much mitigated by beginning gently and increasing the pressure gradually.

J 3.

LEG FRICTION.

Leg friction is accomplished by two arms, which move forward and backward and are covered with smooth or ribbed friction cushions. By means of a wheel these are so placed that they work upon an especial spot in the leg, or they are made to move up and down in such a way as to rub the leg throughout its whole length.

By means of a lever supplied with weights the friction cushions are moved nearer together to give the desired pressure during the friction

The patient stands before the apparatus, places the leg which is to be treated between the cushions and raises them to the height of the spot to which friction is to be applied, or lets them move up and down.

The movement lasts one to three minutes for each leg.

The most common movements executed with this apparatus are:

LEG FRICTION: The kneading cushions are placed at the lowest point, the leg is inserted between them and the wheel slowly turned so that the cushions *rise* the whole length of the leg.

The leg is constantly turned. When the kneading cushions are descending the leg is withdrawn.

THIGH FRICTION: Friction of the thigh from the knee upwards.

KNEE FRICTION: In friction of the outer and inner side of the knee the kneading cushion is raised and lowered several inches. For the front and back of the knee, the cushion is placed first above and then below the knee cap.

LOWER LEG FRICTION from the ankles to the knees.

HEEL FRICTION: The patient stands with one foot upon a stool and pushes the heel of the other foot between the

kneading cushions by bending the front part of the foot upward. (The shoes must be removed.)

Effect of friction: Friction of the skin and pressure upon the muscles. It urges the blood towards the leg and warms it. It promotes dispersion of existing infiltrations in the muscles and in the neighborhood of the knee joint. If these are recent, a smooth cushion should be used. If there are varicose veins, this movement is contra indicated.

J 4.

FOOT FRICTION.

The patient sits upon a chair with rollers, takes off his shoes, lays the lower leg or heel upon a cushion and rests the sole against the wheel. When this is set in motion, friction is applied to the soles as long as is necessary, some one, two or three minutes.

The tickling which troubles some persons at first, disappears ordinarily with firmer pressure, or a thin cushion may be inserted between the foot and the wheel.

The friction draws the blood to the feet and warms them. In very sensitive patients the excitation of the nerves of the skin causes such contraction of the blood vessels that the feet are cold to the touch during the movement. If this chilliness does not disappear immediately upon the cessation of the movement, giving place to an agreeable warmth, it is well to substitute for this movement some active exercise such as B 11 or B 12.

Hand friction can be had by means of this apparatus, the hand being laid upon the ribbed wheel. The same shaft which carries the large wheel carries a smaller one also, in which the sides of the knee joint and the popliteal region of the knee can be warmed. *Heel friction*, too, can be accomplished by the same wheel. The shoes are removed and the heels and sides of the ankle are rubbed upon the floor and sides of the wheel track. In rheumatic swellings near the Achilles tendon along

the heel bone, this movement has a good effect. The back of the foot also can be rubbed upon this wheel.

J 5.

BACKSTROKING.

Two cushioned wheels, which roll up and down at each side of the spinal column, exercise a certain pressure progressively upon the soft parts of the back.

The prescription indicates two numbers. *The first* relates to the position of the movable weights on the graded levers, which press the wheels against the back; *the second* determines the length of motion of the roller chair, which moves forward and back, and upon which it depends whether the friction shall extend the whole length of the back or only along a part of it. Corresponding to this latter number is the position of the movable wrist pin on the graduated crank which unites the wheel and connecting rod. If the rollers are only to work upon the lower part of the back the connecting rod is shortened. If the upper part of the back alone is to be treated, the connecting rod is lengthened. Such a localizing of the effect is possible only when the forward movement is limited to about half the distance, *i. e.*, when the second number does not exceed 5.

The patient places himself as high as possible upon the roller chair, and his head and back rest upon the strongly reclined chair back.

When the apparatus is set in motion the cushioned wheels which are pressed down by a catch, are released, as soon as they reach the small of the back, along which they roll.

When the movement is to be stopped, and before the patient rises, he must fasten down the catch with his left hand, to prevent the heavily weighted levers from falling and injuring the mechanism, besides making a disturbing noise.

The movement promotes circulation in the softer parts of the back and soothes the sensory nerves of the skin.

J 6.

CIRCULAR ABDOMEN ROLLING.

This apparatus consists of two poles with adjustable screws, one of which holds a support for the back and the other a mechanism for the two rollers, designed to work upon the stomach. The patient takes his place between the two, leans against the inclined back support in such way that his position is half sitting, the feet resting against the floor piece of that pole which is in front of the patient. The mechanism is so adjusted that its axis is directly in front of the navel. The holder supporting the rollers is placed vertically and the lower roller so low that it touches just above the symphysis while the upper roller is placed at the same number or one higher.

When the wheel to the right is turned, the body is pushed forward by the back rest until the stomach is pressed against the rollers. The apparatus is then set in motion. With the help of the same wheel and the catch upon the left side, the pressure of the rollers upon the abdomen can be so adjusted as to give exactly the effect required, yet avoid inflicting pain. The mechanism for raising and lowering the rollers can be set in motion for changing their height.

If the pressure of the rollers upon the stomach is to be suspended quickly, the catch at the left side is lifted and the back support is pushed back by turning the wheel at the right.

The movement accelerates circulation in the abdominal walls and intestines and causes contraction of the intestinal muscles.

The apparatus affects the colon especially, as the the rollers follow approximately the direction of the large intestine. As they work in the same direction as the contents of the intestines proceed, evacuation is strongly promoted.

K. Orthopedic Apparatus for Reclining.

The orthopedic apparatus is designed to exercise a corrective influence upon abnormal curvatures of the spine by means of suitable pressure, stretching such retracted muscles and ligaments as hold the vertebræ in a perverse or rotated position, and relieving that portion of the intervertebral cartilage which is within the concavity of the curvature, while bringing stronger pressure to bear upon that which is within the convexity.

This effect is facilitated or intensified according as the patient reclines, or is suspended, whereby the pressure upon the spinal column is diminished, or the spinal column actually stretched by a part of the weight of the body.

K I.

LATERAL SUSPENSION APPARATUS.

This apparatus has a movable plane which can be placed at different angles to the horizontal. At the fixed end of the plane there is a cushioned crossbeam, and beyond it a movable ladder to be taken hold of with the hands. A second ladder is attached non-adjustably below the crossbeam. Between the crossbeam and the movable ladder, a saddle girth is stretched to support the patient's head. The rotary plane bears a centimetre scale whose zero coincides with the rear edge of the cushioned crossbeam.

The plane is placed horizontally. The patient lies down upon it in such a position that the convexity of the curvature of the spine rests upon the crossbeam and the head upon the saddle girth. Whichever arm is uppermost grasps the movable ladder, which is placed at a distance sufficient to stretch the arm well. The other hand grasps the stationary ladder below the crossbeam. The trunk must, however, not rest directly upon one side, but is turned some-

what upward, so that the pressure of the crossbeam works towards the left or right diagonal of the thorax, according as the patient rests upon the right or left side. Accordingly the patient does *not* grasp the middle of the ladder rung, but the upper hand reaches somewhat backward and the lower hand forward.

If the upper curvature is a high one (dorso-cervical), it is important to fix the shoulder girth as much as may be. For this purpose the movable ladder is held with both hands by the highest and lowest rungs and the lower arm is held stretched. The shoulder which is habitually drawn up, is thus lowered, while the shoulder which is habitually lower is raised. The corrective effect of the lateral pressure upon the curvature is thus intensified.

If the Zander trunk measure apparatus has been used and a lateral section diagram in the frontal plane obtained, the distance from the soles of the feet (in centimetres), at which the lateral pressure must be applied, can be ascertained at once from it, and this is mentioned in the prescription. It remains for the patient to lie upon the plane in such a way as to bring the soles of the feet to the same height with the prescribed centimetre number on the scale, and it is certain that the pressure takes place at the point desired.

When the patient has thus assumed the prescribed position the handle at the free end of the plane is grasped, lifted slightly, an assistant removes the pin from the socket and places it in the hole indicated by the number written upon the prescription and the plane is then slowly lowered until the pin touches the rest.

The patient retains his position three to five minutes or more ; when he removes his hands from the ladders he slides down and stands upon the floor. It is better to have the patient use the apparatus twice during the hour, five minutes each time, rather than ten minutes at once.

The manner of using the apparatus is indicated upon the prescription as follows :

K1, right, 105, 30°. *Right* indicates the side upon which the patient is to lie, 105 the position of the soles of the feet upon the plane and 30° the inclination to which the plane is to be adjusted.

This apparatus is used for a corrective pressure upon lateral curvature in complete C shaped, or upon the dorsal curvature in S shaped, scoliosis.

K 2.

LATERAL PRESSURE APPARATUS.

The apparatus consists of a bench one-half of which supports an upholstered plane that can be adjusted to an inclination of 10°, 15° or 20° from the horizontal. The other half is occupied by two adjustable upholstered supports, which can be inserted at various distances from the fixed end of the adjustable plane and at different heights above it, according to centimetre scales attached to the apparatus. The support nearest to the plane, the side pressure cushion, is intended for corrective pressure upon the curvature of the spine; the other, the head cushion, supports the head. The latter support can be fixed in a horizontal position or varied to an angle of 30°.

The patient reclines upon the upholstered plane upon the side toward which the convexity of the lumbar curvature inclines, and in such a way that the top of the hip corresponds to the edge of the plane.

The side pressure cushion (Spc) is removed from this edge far enough to press upon the greatest projection of the lumbar curvature. The head rest (hr) is fixed at a suitable distance, its height and inclination determined by the form of the upper curvature or curvatures and the carriage of the head. The trunk is turned with the abdomen somewhat upwards, so that the side pressure cushion presses in a diagonal direction; the legs are kept somewhat bent, so that the patient reclines more securely upon the plane. The patient being thus in position, the free end of the cushioned plane

is raised and fixed at an angle of 10°, 15° or usually 20° by means of the mechanism to be found under it. The side pressure cushion is usually pushed during this process somewhat farther from the edge of the plane; this is because the whole trunk is shoved somewhat forward by the slanting position of the pelvis, and the side pressure cushion follows this movement because its adjustment is smooth, but its plush covering prevents its sliding against the clothing. The press ure is thus kept at its proper place. If, however, the cushion should remain stationary and the body move, the position of the cushion must be corrected, unless it is desirable that it should press upon the lumbar region.

The patient retains this position five minutes. On the prescription the manner of using the apparatus is indicated as follows:

$$\text{K 2, left, spc} \begin{matrix} \text{distance : 7} \\ \text{height : 6} \end{matrix} \text{———or——or merely} \begin{matrix} \text{d : 7} \\ \text{h : 6} \end{matrix}$$

$$\text{7—6 (farther) hc———or merely 58—12} \begin{matrix} \text{d : 58} \\ \text{h : 12} \end{matrix}$$

In writing the prescriptions a trunk measure diagram is of the utmost value.

The apparatus is used for general corrective effect upon lumbar curvatures. It is more suitable to these curvatures than K 1 for the following reasons: in part because K 1 is not always effective in cases of low curvatures, in part because it is often difficult to correct the false relation of the lower lumbar vertebræ to the pelvis by means of mere lateral pressure. For this purpose it is needful to be able to rotate the pelvis upon its sagittal axis while the spinal column is prevented from following this movement. The first is accomplished by means of the rotary plane, upon which rest the pelvis and the lower extremities that hold it in place, while the spinal column is pressed in the direction opposite to that in which the pelvis is turned. In cases of lumbar curvature of long

standing, although the lateral deviation may not be considerable, the inclined relation of the spinal column to the pelvis can become so firmly fixed by partial resorption of the intervertebral cartilage and retraction of muscles and ligaments that movements which are ordinarily very effective for the treatment of lumbar curvatures remain perfectly ineffectual while, by the use of K 2 or some corresponding appliance, the lumbar vertebræ are mobilized.

In cases of low dorsal curvature with compensating lumbosacral reverse curvature, this apparatus must not be used because it would aggravate the latter.

K 3.

THORAX ROTATION (RECLINING).

This apparatus consists of an inclined plane with adjustable footrest, a mechanism which works through an opening in the upper part of the plane, and a pair of straps attached to its upper end, which pass under the patient's arms and prevent his slipping down the plane when the footrest is removed.

The mechanism referred to rotates the thorax by means of two cushions, one of which, the *back cushion* (bc.) is applied at that point in the back at which the projection of the ribs is located, and the other, the *chest cushion* (cc.) is applied at the corresponding projection at the opposite (front) side of the thorax.

There is attached to the back cushion, by means of a double joint, a flat piece of iron, the *cushion holder*, with numbered holes one centimetre apart. This cushion holder is always kept *vertical* by means of two parallel forked shaped levers, which turn upon two axles placed in the vertical median plane of the apparatus. These levers grasp the flat cushion holder between their forks and it is inserted by means of a pin both at the requisite distance from the median line of the plane and at the necessary height above its level. The holes in the lever are marked with letters. A means 6, B 8,

C 10, D 12, E 14, F 16, G 18 centimetres distance fron the axle.

If, for instance, the *back cushion* (*i. e.*, its central point) is to be brought to bear 8 centimetres from the median line, the pins are inserted in the holes marked *B*. If, farther-the height of the cushion above the plane is to be 2 centi, metres, the pin, which passes through the hole *B* in the upper lever must pass also through the hole *3* in the cushion holder. As the axles are 10 centimetres apart, the pins which pass through the cushion holder must, if the levers are to remain parallel, also be 10 centimetres apart. In the assumed case, therefore, the lower pin must be inserted in the hole *B* in the lower lever, and the hole *12* in the *cushion holder*. The height of the cushion above the plane is thus indicated by the number of the hole in the cushion holder in which the upper pin rests. This is true, of course, only when the lever is in a horizontal position.

The application of the *chest cushion* requires a somewhat more detailed prescription. The *vertical holder* of the chest cushion is held like that of the back cushion by parallel levers which are on the same line but the opposite side of the axle. Since the holder must rise at the side of the patient, so that the cushion can be brought to bear upon the front of the thorax, it cannot be pushed in and out between the levers but *must be placed in the farthest hole G where it can be either raised or lowered, so regulating the height of the chest cushion above the plane.* The *distance from the median line* is farther regulated by the fact that the cushion is attached by means of a double joint to *another holder* which passes *horizontally* through a slit at the upper end of the vertical holder, and bears a scale which indicates, in centimetres, the distance of the cushion from the median line, provided that the vertical holder is fastened in the hole G. The vertical holder of the chest cushion is much longer than that of the back cushion since the height of the former above the plane is always much greater than that of the

latter, viz.: the height of the back cushion, *plus* the sagittal diameter of half the chest. Usually, however, the height must be made somewhat greater still, because the pressure of the back cushion must be much stronger than that of the chest cushion. If, therefore, the height of the back cushion is 2 centimetres, the sagittal diameter of the chest 18 centimetres and 3 centimetres are added to lighten the pressure upon the chest, the height of the chest cushion will be 23 centimetres. The hole bearing this number in the vertical holder must accordingly be occupied by the pin placed in the G hole of the upper lever. The lower pin comes 10 centimetres lower or in the 33d hole.

The *axles* repeatedly referred to are of diverse forms. The upper one is round and its levers can turn freely upon it, the lower one is four sided and its levers are fast upon the axle in the same plane but upon opposite sides, while the axle itself turns in an iron bed.

This arrangement is necessary in order to render it possible to use a special lever for modifying the whole axle and the system of levers which it bears. This lever which modifies the whole system, turns upon a round deviation upon the four sided axle and thus hangs vertically below the apparatus. If it is raised it strikes on either side at an angle of 15° from the horizontal against a wrist pin which rests in a round socket attached to the axle, and it then turns the axle from right to left if the lever is turned to the right, and from left to right when it is turned to the left.

The pressure which the cushions exert upon the thorax of the patient is thus accomplished by means of this lever, and is brought about in the following manner: at each side, at the lower outer edge of the plane, there is attached a pulley with a cord running over it that carries a hook at each end. One hook is attached to the free end of the lever, the other is weighted 10–15 lbs. The lever must always be raised and weighted upon the side on which the back cushion is placed.

The pair of levers of the back cushion always rest upon the

same points on the axles and are prevented from sliding by means of pins in the axles. The levers of the chest cushion, on the contrary, can be pushed farther away and must rest lower, partly in order to protect the mammillary glands and partly because the front ends of the ribs lie deeper than the corresponding back ones. For most cases three centimetres difference would probably be sufficient. If the dorsal curvature is high, the difference is increased; if it is low the difference must be somewhat less.

Since the back cushion must always rest higher upon the axles than the chest cushion, it must always be placed upon the upper pair of levers; since it must, furthermore, be applied to the left as well as the right of the spinal column (according to the character of the given case of scoliosis), all the pairs of levers are necessarily arranged to turn to the left as well as to the right.

After the vertical cushion holder is removed it is easy to turn the levers upon the round axle, but those adjusted to the four-sided axle must first be shoved to the rounded spot upon the axle, there turned towards the opposite side and again replaced on the four-sided part of the axle.

The application of this apparatus is greatly facilitated when the physician has a transverse diagram of the thorax at the point of the greatest deformity of the back. For it is then easy to determine, in advance, the manner of using the apparatus. To determine the *position of the foot rest* the height of the greatest deformity above the floor must be known. This distance, expressed in centimetres, is subtracted from 135 and the remainder indicates that one of the holes at the lower end of the plane into which the pins of the foot rest should be inserted. Its *lowest* position is 135 centimetres from the upper stationary pair of levers and the centre point of the back cushion.

The distance of the back cushion from the median line of the apparatus is so calculated as to bring the pressure of the cushion to bear upon the middle of the rib projection. The

cushion holder is placed in the hole A, B, C, or D, according to the breadth of the patient's chest. The outside holes (C or D) are used when it is desirable to have the effect of the apparatus not only rotary, but also compressive in a diagonal direction. In the latter case, however, it is difficult to determine the proper position of the cushion without a transverse section diagram of the thorax.

The height of the back cushion must in most cases be so measured that it rises a few centimetres above the plane when the levers are horizontal. The pressure upon the rib-projection elevates the thorax while rotating it. True, the pressure of the *chest cushion* tends to counteract the raising process, but only partially, because the chest cushion cannot be allowed to press with the same energy as the back cushion. If, therefore, the patient's trunk is light and flexible, and yields readily to the pressure of the back cushion, the levers might assume a position so sharply slanting as to render them ineffectual, a case which arises when they rest at an angle of 30° from the horizontal. To prevent this the back cushion is fixed a few centimetres above the plane, so that the levers are given a longer range than exactly 30°.

The height of the chest cushion above the plane is calculated as stated above. The number of centimetres obtained indicates the hole in the vertical cushion holder in which the upper pin must be inserted. As the vertical holder must always rest in the G hole of the lever, the distance of the *chest cushion from the median line* is regulated by moving the horizontal holder in or out within its socket. The number on the line which coincides with the outer edge of the socket indicates in centimetres the distance of the central point of the chest cushion from the median line, and this distance is so adjusted that the cushion presses against the highest rib-projection or somewhat farther out when it is desired to compress the thorax.

In the prescription the arrangement is indicated as follows: K 3, Footrest 24—R: Bc. B 3—L: Cc 3, G 17 (12)—15

lbs. That is to say: The *footrest* is set at hole 24.—*Right:* The back cushion is placed with the upper pin in the B hole of the lever and the third hole of the cushion holder. *Left:* The chest cushion three centimetres lower on the axles, the upper pin in the G hole and in the 17th hole of the vertical cushion holder, the horizontal holder at line 12 in the outer edge of the socket. *Weight* 15 lbs.

After the apparatus is adjusted in this way, the patient lies down upon the plane with his feet upon the footrest, pushes his arms through the straps which are buckled tightly enough to hold him in position when the footrest is removed. Care must be taken that the cushions are in the proper position, that the weight is not too heavy, and that the pressure is felt chiefly upon the back. The footrest is then removed and the patient retains his position five, ten, fifteen or twenty minutes, according as he grows accustomed to the apparatus.

He must draw a long breath frequently while in this position, so that the untrammeled side of the chest can be duly expanded. A strong inhalation is promoted by a forced expiration divided into two, (Oertel).

The object of this apparatus is to counteract, diminish or remove the most dangerous and most difficult to reach of all the symptoms of scoliosis, *the rotation of the vertebræ of the back and perversion of the thorax.* It is used most frequently in cases of dorsal curvature, but can be applied to advantage in lumbar curvature also, when an incipient rotation can be detected. In these latter cases the chest cushion plays no part as the pressure upon the ribs is omitted and it is therefore placed very high and used merely for a side rest. In dorsal curvatures, on the other hand, it is of great use, not only because the ribs which have been pushed forward by the vertebral rotation are pushed back and so contribute to turn the vertebræ into a normal position, but also because the respiratory movements of the protruded half of the chest are

restricted and the sunken half, therefore, the more strongly expanded during the inspiration.

The observer readily convinces himself of the powerful and appropriate action of the apparatus by watching the change of shape of the thorax under its influence. This apparatus alone can, however, accomplish no actual improvement in the shape of the thorax without simultaneous use of active movements (trunk rotation, pelvis rotation and arm movements, which expand the chest). That patience and persistent treatment are also needed in proportion to the age and the development of the scoliosis, follows from the undeniable fact that no one can make a crooked person straight, but that he can be constrained *to grow* straight.

Of late in the treatment of dorsal and cervico-dorsal scoliosis, I have used instead of the arm straps mentioned in the foregoing, the head straps belonging to the Charcot suspension apparatus, the so-called head holder.

K 4.

STRAIGHTENING CHAIR.

The apparatus consists of a chair with a high back and an adjustable seat, inclined backward (20°). The back carries, at about the height of the armpit, an adjustable, upholstered board, the *side support*, besides numerous rungs at different heights above and below it.

The apparatus is primarily intended to reverse lumbar and total curvatures so as to curve them whenever possible in an opposite direction; and with the spinal column thus straightened the patient remains seated a certain length of time. It is used either immediately before or after a group of active movements.

If, for example, the patient has a left lumbar or total curvature, he is seated with his right side against the chair back. The "side support" is so placed that it presses against the patient's right side directly below the armpit;

the right arm is drawn over and behind the side support, and the hand grasps one of the lower rungs. The physician or assistant now endeavors, aided by the effect of the slanting seat, to straighten the convexity as far as possible by pressing upon it with the left hand; or, when the curvature is mobile enough, to bend it in the opposite direction. The patient's back must be laid bare, at least the first time. It can then be seen whether the seat must be moved nearer to the chair back or farther from it. After the curvature has been transformed as far as possible in this manner, the patient is left sitting in the position described, five to ten minutes.

In a right dorsal or left lumbar curvature the treatment is the same, except that the seat must be nearer to the chair back than in the simple curvatures, so that the side support presses more vigorously against the dorsal curvature and the pressure is still further intensified by the patient's grasping one of the upper rungs above his head with his left hand and pressing himself from time to time against the side support.

It is advantageous to use the straightening chair several times daily.

In the treatment of curvatures of the spine in the direction opposite to the one assumed above, the patient is seated with his left side against the chair back.

L.—Orthopedic Exercise Apparatus.

The apparatus for orthopedic exercises exert a corrective influence upon abnormal curvatures of the spine in part actively, by exercising such muscles as influence the carriage and curvature of the spine, and in part by means of contrivances which passively correct an abnormal position and curvature.

L 1.

COMBINATION OF A 3 AND D 1.

The apparatus is so constructed that, by means of it, the movement A 3 can be executed sitting, but while in A 3 the resistance is accomplished by means of iron weights, in this case the patient lifts a greater or less portion of his own weight. The seat is borne by a lever upon which the cords work. The farther the seat is removed from the axle of the lever the greater the portion of the weight of the body which rests upon the cords. If the arms pull both handles at once the work is twice as great as when one arm only pulls and the other is kept stretched. In this latter case the outstretched arm does not work; it is passively stretched by the same force (a part of the weight of the body), which the working arm has to overcome. In the same way the exertion is diminished one-half when both arms pull at once upon one handle. For this purpose a staff can be inserted in the brass socket of one of the handles and both hands can hold the staff. In both these last methods of using the apparatus, the inclination of the seat is but half as great as when both arms pull the handles simultaneously; for when the lever is raised by the tension of the cords, the seat assumes a slanting position, corresponding to the right or left "trunk balancing" (D 1 backward seated right or left) according as the patient sits with the right or left side towards the post which supports the axle of the lever.

The position of the seat is determined by the holes in the lever, which are numbered 35, 40, 45, 50, centimetres from the axle. The pulleys upon which the cords move are adjustable, their axles are inserted in notches which bear the same numbers as the hole into which the bolt that holds the seat is inserted.

The length of the cords is regulated by means of a buckle in such a way that the starting position of the lever, when both arms are outstretched is horizontal.

The movement is of use, both in simple lumbar and total scoliosis or in double lateral curvature of the spine, in the latter especially when the upper curvature is a high one (cervico-dorsal).

In right dorsal and left lumbar curvature the prescription is written, for instance:

R. seat, L. stretch, R. draw No. 40

For left side, total scoliosis, for instance,

R. seat, R. stretch, L. draw No. 40.

For left side, lumbar scoliosis, for instance,

R. seat, both arms draw No. 40, etc. When the arms draw upon the staff referred to and the pulley is so placed that it hangs directly in the middle of the seat.

L 2.

HORIZONTAL POSITION.

This apparatus consists of a bench, the upholstered top of which is divided into two parts, a higher one for the legs, and a lower one for the trunk. At one end of the bench there is an adjustable arrangement for holding the feet during the movement, the *foot catch*, which can be pushed forward or back according to the length of the patient's legs. Instead of one long bench of two different heights, two shorter benches of different heights can be used.

The movements executed by means of this apparatus are:

Lying face forward. The patient lies face forward upon the bench so that the legs rest upon the higher plane and the body upon the lower one, the position being so adjusted that the upper edges of the iliac bones rest at a uniform height with the forward edge of the upper plane. The foot catch is pushed forward far enough for the patient's lower legs to be caught just above the ankle in its side curves. The patient now contracts the muscles of the back, lifts the trunk so far that it forms a straight line with

the legs and *holds* it so for several moments. Inspiration takes place while raising the trunk, and during expiration the trunk sinks slowly into the starting position.

Trunk raising, while lying down. The arrangement is the same as the preceding. The patient bends the trunk upward in a curve, holds it so a moment and then lets it sink slowly into the starting position. Breathing as before. (See plate.)

Muscles called into action. See C 5.

Lying upon one side. The patient lies upon the side prescribed, with the upper edges of the iliac bones upon the forward edge of the higher plane. The under leg is placed in the forward notch of the foot catch and the free leg in the rear curve. The patient then raises the trunk from the lower plane, holds it several seconds in a straight line with the legs, and then slowly sinks into the starting position. Breathing as before.

Lateral flexion in lateral position. The starting position is the same as before. The patient bends his body in an upward curve, holds it so a moment, and then slowly sinks into the starting position. Breathing as before.

Muscles called into action. See C 6.

All the foregoing movements are used in the treatment of lumbar and total curvatures of the spine. They must be preceded by the use of the K apparatus, K 2, K 3 or K 4 in lumbar and K 1 and K 3 in total curvatures.

Where there is a tendency to lordosis it is better to use the position lying face forward, than trunk raising while reclining. In total curvatures, lateral flexion lying on the side is best; in lumbar curvatures, lateral reclining.