Tricycling as an aid in treatment by movement, and as a means of carrying out resistance-exercise / by Martin Siegfried ; translated by Louis Elkind.

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Tricycling

as an aid in treatment by movement, and as a means of carrying out resistance-exercise.

By

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Georg Thieme.

I am indebted to the kindness of Professors Goldscheider and Renvers, of the »Moabit Municipal Hospital«, for having had placed at my disposal, during the winter of 1898/99, a number of cases of affections of the spinal chord, the nerves, and the heart, in order that I might be able to submit them to the influence of a course of gymnastics by means of the tricycle which I had devised for that purpose.

I made a short communication bearing on the subject at the Twentieth Balneological Congress [1]) and I now give a more extensive account of the observations which I have made.

The cases selected and submitted to a trial were for the most part of such a nature that the patient's power of walking was entirely, or to a very large extent, suspended.

That by the methodical use of the tricycle in such cases notable results may be obtained, and under what circumstances these benefits take place, I have previously [2]) shown in cases of inability to walk which were of peripheral origin, in which rigid ankyloses with subsequent muscular atrophi impeded the use of the lower extremities.

It is interesting to observe the results of the influence of wheel-gymnastics upon the affections of central origin, for it is universally admitted that cycling exercises the central impulses and effects the nerve current in a beneficial manner.

It must also be accepted a priori that the resuscitating power, to the influence of which it is due that frequent repetitions of similar movements take place in spite of ill-conduction on the part of the nerves, would become the more marked, inasmuch as the movements on the wheel can be continued without producing any fatigue for a much longer time than is possible when a stationary apparatus is used.

Much depends upon the peculiarity of the locomotion of the cycle, which glides along almost without friction and in which the law of continuity is so pronounced that once the machine is in motion only a very small amount of exertion on the part of the person who rides it is necessary to keep it going.

There are other important hygienic advantages which invite us to give cycling further therapeutical trials, namely the fact that the movements of the extremities take place in a strong, rhythmical and at the same time easy manner and that cycling is enjoyed together with open air respiration and the influence of continuous contact between air which is in motion [3]) and the skin surface.

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1) Veröffentlichungen der Hufeland'schen Gesellschaft 1899. pp. 50—52.

2) »Curative Results of Wheel-Riding Gymnastics«. Deutsche medicinische Wochenschrift 1897. No. 27.

3) The influence of air in constant movement is entirely different from the influence of tranquil air, as Sir H. Weber excellently emphasises in describing the therapeutical value of Sea-Voyages. Zeitschrift für diätetische und physikalische Therapie Vol. 2. part. 1.

Of course, if a tricycle which originally was intended for athletic purposes, is to be used by people who are unable to walk, helpless, and dependent upon the care and attendance of others, it must undergo a great alteration in the construction of the seat and the pedals.

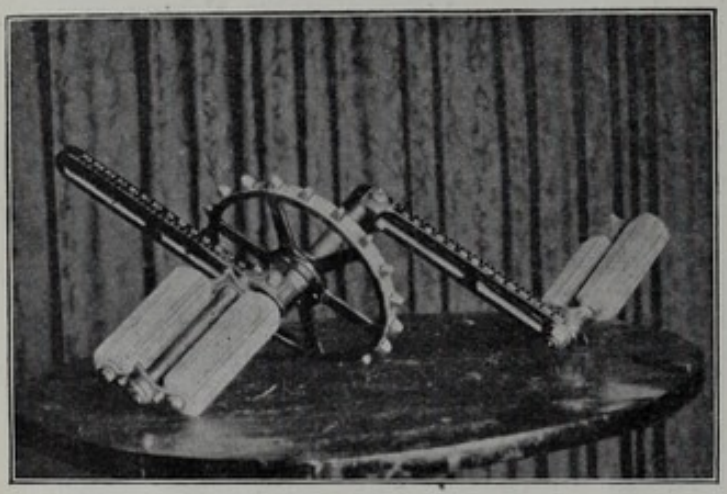
In order not to exceed the limits of this paper I must defer till another occasion a more complete description and explanation of these alterations, which, briefly, are as follow:

1. A comfortable, padded, springy seat, which at the same time retains the usual shape of the riding saddle.

2. A padded back-support nearly fifty centimetres high, the anterior surface of which is shaped concavely and can be placed at different angles of inclination.

3. A strap to support the body on the seat.

fig. 1.



Slotted cranks, divided into centimetres.
Shortest and longest position of the pedals.

4. A lever for the automatic working of the dorsal and plantar flexion in the joint of the foot.

5. Arrangements shaped like skates for the securing of the feet to the pedals.

6. The slotting of the tread cranks from the tread axis to the free end, thus allowing for the pedals to be fixed at from two to eigtheen centimetres along the crank (fig. 1).

7. The division into centimetres of all the moveable parts of the wheel (saddle-support, pedal-cranks, back-support).

By these alterations of the seat and arrangements for supporting the body and feet, the patient — who is accustomed to being in bed or lying in a half recumbent position in a bathchair, and to whom comfortableness has become a necessity — is given a feeling of being secure from falling.

The presence of these protective arrangements is necessary for patients who suffer from affections which are associated with complete anaesthesia.

The moveability of the pedals has the following advantages:

1. The movement of the joints may be graduated according to circumstances, for by altering the position of the pedals in the slotted tread-cranks, smaller and larger circles — of from four to thirty-six centimetres in diameter — are described.

2. The lever power of the tread-crank, which acts as a one-armed lever, can, by the elongation or shortening of the lever, be increased or diminished, and, hence, the expenditure of force is a matter of choice.

3. The pedal of the right tread crank moves independently of the left one, and, therefore, the extent of the movements of the joints of the right leg as well as that of its function are independent of those of the left limb.

In addition to the means afforded by the lengthening and shortening of the position of the pedals, the raising or lowering of the seat allows of a different degree both of extension and flexion of the limbs, which can be varied at choice, so that by the combination of the two alterations a greater number of variations

of the position of the different joints is possible than could be obtained by means of any other apparatus.

The patient who is at all able to occupy a sitting position is, by the arrangement of the seat and pedals, which can be altered according to circumstances, so placed on the tricycle that the initial movements are painless and cause no irritation whatever.

This is made still more evident by the description of individual cases to which I now proceed.

A commencement may be made with the account of a course of treatment by cycling in a case of myelitis.

From the clinical history of a female patient who was in the hospital for two and a half years I take the following facts:

E. B., 28 years of age, a tailoress, was admitted to the hospital on May 26, 1896, suffering from paraplegia and paralysis of the bladder and rectum. The case was diagnosed as one of compression myelitis with its seat in the region of the 9th dorsal vertebra, and consequently an extension dressing and a permanent catheter were applied. In the course of the year 1897 several inunctions were made in consequence of a suspicion of syphilis, after which a considerable decrease of all the symptoms took place, so that at the end of a year and a half the extension bandage could be removed. A great abscess on the sternum, a bedsore in the region of the os sacrum as large as the palm of the hand — which, the result of a trophical disturbance of the skin, appeared in spite of the employment of all protective measures — a venous thrombosis of the left leg and an attack of rheumatism — propably of gonorrhoeal origin — of the left elbow, were each cured by the end of 1897.

In September 1897 the patient was placed in a walking-chair for the first time, remained out of bed for a few hours, and, with the help of two nurses, made attempts to walk. Iron plates were affixed to the soles of the shoes near the toe, as the feet, which were in a moderate degree of pes equinus, could not be raised in walking, but, by treading, on the thenar eminence, were shuffled along one against the other. The function of the bladder was so far restored that the urine could be retained in it and the patient made water voluntarily about every hour or every hour and a half. The paralysis of the rectum disappeared. When attempts at walking were made, violent pains were complained of and located by the patient just beneath the sole, particularly of the right foot.

The patient was in the following condition, which had not shown any particular alteration during October and November, when, on the lst of December 1898, the treatment by means of the tricycle was begun.

Of the muscles of the lower extremities, the quadriceps cruris showed a moderate degree of atrophy on both sides, the left ileopsoas was greatly atrophied and very weak functionally and the right ileopsoas hardly reacted at all to the electric current.

The muscles of the sole of the foot were so greatly atrophied that the tendon of the muscle peron. long. which extends in a diagonal line from the margin of the foot to the capit. oss. metat. I. was visible to the eye under the thin skin, and, in passive dorsal flexion of the foot, appeared as a sharp-edged border; and, in addition, the extending of the shortened tendon of the peroneus muscle caused violent pain at the place of its insertion, namely, on the capit. oss. metat. I. This pain, which occurred at the moment the foot was raised from the ground, impeded the walking exercise. At the same time there appeared, when walking was attempted, a considerable ankle-clonus.

After carefully observing the relation between the size of the seat and the pedals, which were placed at half the length of the crank, the patient was put on the saddle and secured there, and the feet were so fixed to the skate-shaped

arrangements that at each rotation of the crank a slight stretching of the shortened Achilles-tendon took place, this being directly brought about by the action of the levers which are seen on the plate (fig. 2) and which extend from the pedal to the posterior axis and are fixed below the latter by a moveable joint.

fig. 2.

Myelitis.
Body and feet secured. Extension of the Achilles tendon by the mechanism of the lever.
Temperature —2° R.

The working of the tricycle was at first passive, but in a few days it was made active.

On the 9th of December the patient worked the machine herself for half an hour, and on the 20th of December and afterwards for a full hour every day.

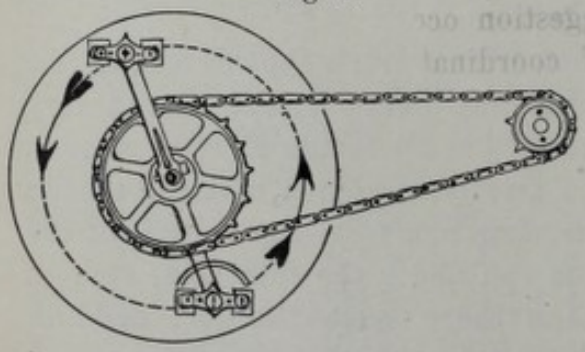
On the 10th of January 1899 the pes equinus was so far improved that the patient was able to tread with the whole sole.

The therapeutic action upon the paralysed ileopsoas, which, as I showed on a former occasion [1]), does not come into action in cycling, was obtained in the following way, namely, that by the fixation of the feet to the pedals it was possible to continue the movement of the wheel (fig. 3) not by pushing down the high standing pedal in the anterior part of the circle *(a)* but by raising the lower standing *(b)* pedal in the posterior part of the circle.

In carrying out the former movement *(a)* the extensors of the limb come into action; the latter movement is performed by the flexors — ileopsoas — of the thigh acting against the pelvis.

An indication of the taking into action of the previously inactive ileopsoas was the naive astonishment of the patient, who in moving the limbs felt, not in the limbs, but in the abdomen, a twitching sensation which she quite correctly located at the point of insertion and along the course of the strong muscle.

fig. 3.



The strengthening of the ileopsoas muscle obtained by this method of exercise became noticeable when the patient walked, for the knees were raised higher and more energetically and the ascent of hills and the stairs was done more easily.

The ankle-clonus which at first was present, disappeared in the fourth week of treatment. The mental condition of the patient underwent a considerable change. During the course of this tedious affection she was greatly depressed and made two attempts at suicide, but under the influence of the exercise on the tricycle which,

[1]) Deutsche medicinische Wochenschrift 1899. No. 33. pp. 5 and 6.

lasting from an hour to an hour and a half, was made every day in the open air, — no matter whether the weather was mild or slightly frosty and when it was obvious that her functional capacity was improving, there appeared a more hopeful mood, a firm belief in the possibility of a complete restoration to health, and a state of mind which, by way of suggestion, exercised an unmistakably favourable effect upon the bodily condition.

The invigorating influence upon the mental condition, which, in healthy persons, is the inevitable outcome of cycling, was in this case the more obvious inasmuch as the awkwardness of the attempts at walking, which quickly led to fatigue and necessitated the assistance of others, formed a remarkable contrast to the independence and perseverance of the patient on the wheel and the ease with which the machine was worked. A simple calculation shows that at a moderate average of twenty-five pedal rotations a minute, each rotation moving the tricycle a distance of four metres, there are $4 \times 25 = 100$ metres a minute traversed, and therefore in the course of sixty minutes, during which time six kilometres of ground are covered, fifteen hundred extensions and flexions of both legs, or a total of three thousand muscular contractions and joint movements, take place.

The possibility of making such a great number of movements without feeling fatigue is partly explained by the fact that, owing to the firm connection of the two tread-cranks, in pushing down one pedal an automatic raising of the other pedal takes place, so that a foot which stands on it is raised not actively but passively. The leg therefore receives a mechanical impulse analogous to that produced by the water of the kinetic baths[1]) introduced by Leyden and Goldscheider, which by relieving the patient of his bodily gravity facilitates or indeed renders possible the carrying out of exercise in the baths.

When, after having been employed for three months, the treatment by means of the tricycle was for various reasons discontinued, the patient was, by using two sticks, able to stand and walk, and also to walk up and down the exercise-stairs, in which latter case it was only necessary for her to support herself with one hand on the bannister.[2])

As the employment of wheel gymnastics in this case restored the injured tracts which had been placed out of function to their normal condition, and thus served as a way-opening exercise treatment,[3]) the suggestion occurred that an experiment be made to see what effect on disturbances of coordination would be obtained by a compensatory exercise treatment, in which, as is well known, the appearance of compensatory new tracts in place of unconducting ones is aimed at.

To place on a tricycle a tabetic patient in an advanced state of ataxy and loss of sensibility is a difficult and dangerous undertaking. If accidents caused by falling from the machine, or fractures of the feet — which are continually thrown off the pedals — or of the legs are to be avoided with certainty, then it is necessary that the patient should be firmly secured to the saddle by means of waist-straps and the feet fixed to the pedals. The securing of the body is necessary not only because there is danger of the patient slipping off the saddle without perceiving what is

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1) Zeitschrift für diätetische und physikalische Therapie Vol. 1. part 1.

2) An unexpected incident occurred when the patient heard that it was necessary to interrupt the treatment, for, fearing that she would return to her former condition, she made another attempt at suicide.

3) Funke, l. c. Vol. 2, part 3. Jacob, l. c. Vol. 2, part 1.

taking place, but also because, when there is no particularly heavy body weight, the violent atactic movements of the feet — which latter, being fixed to the pedals, are, so to say, firm points — may dislodge the body from the seat.

The securing of the feet is only necessary during the first weeks of the treatment, for, though the possibility of locomotion, even in a case of the highest degree of ataxy, impresses the patient very strongly, the far-seeing physician cannot overlook the fact that the real aim of treatment, which is to exercise the will, to improve the conducting power, and to open up the nerve paths, will fail if the patient is not taught to work the pedals without being secured to them. After a few days, therefore, the iron shoes are replaced by a single transverse strap, shaped like a stirrup. The patience of the instructor and the perseverance of the pupil are thus put to a hard trial, for it may happen that for weeks each attempt to work the pedals has to be corrected. But only in this way can the patient gradually obtain independence in the locomotion of the cycle, for the continued use of the iron shoes has the same disadvantage which in many cases attends the employment of sheathed splints: the patient is more helpless after he is obliged for some reason or other to discontinue the use of the splints than he was before employing them.

By the continual repetition of the attempt to follow the circle of the pedals, which run along a horizontal level, without allowing a receding of the feet, the tabetic patient gradually loses some of the signs of the ataxy, the impulses of the will which control this particular movement being especially influenced in a favourable manner.

As regards the improvement of the ability to walk, which, in the majority of cases, is the matter which tabetic patients are most deeply concerned about, the perpendicular circular movement has a beneficial effect, inasmuch as it contains several elements of walking. This is particularly so when the foot, being in the posterior part of the circle, is raised passively by the rising crank to the highest point of the circle, and only tries to follow the pedal forward and downward. As in walking, the leg of the patient suffering from ataxy is thrown forward from the pedal in the same manner, the foot in the wheel exercise recedes by jerk-like movements and then swings forward and externally, while the pedal continues quietly to describe its circle.

If the tabetic patient succeeds in correcting the faulty movements, he has gained an advantage which will assist him in the walking exercises. I therefore regard cycling as a preparatory exercise, as far as the movements of the legs are concerned, for the subsequent instruction in walking, which should be conducted with the aid of the apparatus designed by Leyden and Jacob. The exercise on the wheel is advantageous inasmuch as in following it the legs are relieved of the weight of the body, and, therefore, the desired movements can be continued for a long time without any danger of fatigue. Moreover, there is the already mentioned benefit gained by the rhythmical motion, while at the same time the rotating pedals, moving with the regularity of clockwork, render impossible, or annul the effect of, each jet-like muscular contraction. Since the rhythm of the movements is independent of the patient's will, inasmuch as one pedal rises irresistibly as the other falls, the patient will be thus prepared for the more difficult feat of keeping time while pedalling the machine, that is to say, to give his attention to his sense of hearing rather than to that of sight. The most important point for this is that he should bear in mind during practice some rhythmically repeated sound, count

the divisions of the bar, set down his foot on the principal beat and perform the other movements which complete his step on the accentuated beats into which, at least in music, the bar is divided.

On a verbal suggestion made to me by Professor Goldscheider I experimented and found that the most beneficial timing for the patients was a $^3/_4$ bar at 69-Larghetto; the division of the pace into $^4/_4$ was unsatisfactory. Gräupner was the first to suggest the use of acoustic stimulants, but this method is different; in his, the tone-sensation does not act till the pace-movement is completed, inasmuch as the electric circuit which discharges the acoustic signal is not closed by the downward pressure of the side of the foot. The regulation of the pace-movement, a uniform division of the several phases (of the movement) upon a constantly similar interval of time, cannot be attained in that way.

One difficulty in the use of the metronome lies in the fact that none of the clicks of its pendulum bear any special accent, but all are equally loud, so that the time is given, but not the rhythm. The patient, however, while counting the acoustically identical sounds in threes or fours, is compelled to accentuate one of them in order to bring the time into rhythm, and the more forcible accent placed by him in speaking on the number »One« is involuntarily transferred to that phase of his movement which is carried out at that instant. That phase therefore more easily falls out of time than the phases upon the numbers enunciated without accent »Two« and »Three«.

It is therefore better to practise the movements to the notes of a song, and in the choice of the latter to take into consideration a certain physiological effect of the sense of hearing which I have more fully discussed in dealing with the inefficiency of ordinary kinds of alarm signals employed by cyclists. As I then explained, the peculiar tone of a signal and the way in which it is produced acts on the nervous system of the hearer, and transposes him into a corresponding mood. Harsh and sudden signals or orders lead to retreating and sudden movements, while prolonged drawn out sounds cause similar deliberation in the action of the hearer. The movements of tabetic patients will be less coordinate to the sounds of an incisive military march than to any other music, while a smooth Volkslied will round off the hasty movements and make easier to them the acquisition of compensatory control of the excursions of their joints.

A second effect which exercise on the tricycle has upon the tabetic patient is alleviation of pain. Goldscheider, in a lecture on »Treatment by Physical Exercise«,[1]) called attention to the pain-alleviating effect of movements, and mentioned a case in which a tabetic patient warded off the attacks of lancinating pain by opportunely mounting a tricycle whenever he suspected that an attack was about to make its appearance. I have made the same observation myself in many cases, and especially in those in which the patient was subject to attacks of pain in the regions of the intestines or the extremities. In cases of the latter character, a tricycle supplied with a mechanical handle[2]) has done good service in attacks of pain situated in the course of the plexus brachialis.

Thirdly, we have to take into consideration the effect which tricycling has on the general state of health of the patient, who, through having passed his time indoors or in a bath chair, is frequently in a low bodily and mental condition.

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[1]) Delivered at a meeting of the »Verein für innere Medicin« of Berlin, December 18, 1899.

[2]) See p. 18, fig. 16 and 17.

Then, also, there is the beneficial influence upon the mind, the amelioration of the metabolic process, in short, the increase of the power of resistance of the individual cell against the affection, which is characterised by a tendency to progress and resists a treatment by drugs.

A fourth point to be considered is the fact that tricycling necessitates a series of preliminary movements, which the patient has to go through each time he ascends and descends the machine, and for the carrying out of which a series of coordination movements, especially difficult of accomplishment by tabetic patients, is requisite.

The first of these movements is the act of ascending a woodenstep. The step is from fifteen to twenty centimetres high and is designed to place the body at nearly the same height as the crank axis.

How difficult it is for an atactic patient to accomplish this in a nearly normal manner is made obvious by the fact that Goldscheider specially included a wooden-step among the apparatuses for compensatory treatment by exercise.

Inasmuch as when the front wheel stands straight the handles of the guiding-bar, which is constructed far behind, prevent an approach to the saddle being made by way of the space between the back wheels, it is necessary to turn the front wheel to an external right-angled position.

The patient is thus placed in a position which enables him to use both handles of the guiding-bar for support, and if he at the same time employs the brake the wheel is prevented from moving.

If the patient, after a series of unsuccessful attempts, succeeds in overcoming these difficulties, he is then obliged, as he approached the machine from the front in order not to fall over the projecting back wheel, to turn almost completely round on the wooden-step so that he may face the direction in which he is about to travel. This turning round must be done at once and with the feet together — one of the most difficult of exercises for the atactic patient, for he is accustomed to walk and stand in a straddling manner.

Before he can sit down the patient is obliged to pass one leg over the frame, taking care the while not to strike it against the frame; a movement which reminds him of the similar one carried out in connection with the exercises with the Jacob's »Rahmen« and Goldscheider's conductor.

In this way the patient, before he sits on the saddle, goes through a series of movements like those in the compensatory treatment by exercise, though with the following difference:

While in using an apparatus the individual movements are always repeated in the same manner until, after an interval of rest, a new apparatus is employed, in mounting to the seat of a tricycle the patient accomplishes, from the time he approaches the wheel in the prescribed way till he is seated on the saddle, in continuous succession a series of exercises like those on the »Laufrahmen«, the wooden-step, the spiral, and the conductor.

In addition to this, the accomplishment of such exercises is to him not the principal aim, as it is when using the apparatus, but merely a means to attain the end in view.

This fact must not be underestimated, for the patient cannot leave out this series of coordinate exercises if he wishes to carry out the wheel gymnastics. Moreover, in getting down from the saddle the same exercises are repeated in a reverse manner, and, finally, the energy of purpose and the strength of intention

and of concentration of the will must obviously become intensified if the patient has a distinct object before him, which in this case is to get on the saddle, the accomplishment of which gives him a gratifying feeling of having achieved an unaccustomed and difficult act and at the same time enables him to rest after his unusual exertion.

When the back support is absent, the patient may get on the machine from the rear, that is, over the axis of the posterior wheel. In doing this a great many groups of muscles are put into action one after another.

Figure 4 shows how the female patient who, as has been described above, suffered from myelitis, was able to perform this exercise after ten weeks practice.

After she had risen from the chair and got on the wooden-step, in doing which the extensors of the whole leg and of the pelvis and particularly of the glutaeus maxim, were brought into action, she was able to contract the greatly weakened ileopsoas muscle so much that the left foot could be raised to the axis of the posterior wheel.

Figure 4 shows the position of the patient at the moment when, by the aid of the whole of the muscles of the arm and by extending the left knee, the weight of the body has been raised to the axis of the posterior wheel. The weight must now be supported by both arms and the left leg until the right leg also is drawn up to the axis and from there carefully moved to the right pedal. When this position has been gained the patient is at once able to sit down in the saddle, for all that remains to be done is to move the left foot from the axis and place it on the left pedal (fig. 5).

fig. 4.

Overcoming the obstacles of mounting.
The weight of the body supported by the arms and the left leg. Position 1 (Myelitis).

fig. 5.

Mounting from behind over the posterior wheel-axis. Standing on the pedals before sitting down or after rising from the saddle. Position 2 (Myelitis).

The achievement of the latter position can also be made between the different sections of locomotion by the patient getting up from the chair and mounting the stationary machine, this being

done for the purpose of exercising the individual muscles and particularly for the increase of the general mobility and for the control of the general attitude of the body.

The value of this kind of exercise on the wheel is, in my opinion, not sufficiently appreciated, though it is inseparably connected with the gymnastic on the wheel which alone is usually regarded to be of hygienic use, and, also, it leads, in a healthy person, to a considerable improvement in the general dexterity.

In illustration of what has been said above I refer briefly to the clinical history of the following case of a patient who has been under my observation for the last four years.

B. W., 40 years old, showed no signs of a specific infection or of any hereditary taint. Symptoms, however, of pronounced ataxy occurred in March 1897. The patient was able to pass water in a sitting position and in small portions at a time only, the action of the bowels was difficult and the desire for defaecation was entirely absent.

In the Spring of 1897 the patient had gone through a course of treatment at Oeynhausen, but derived no benefit from his sojourn there, and he subsequently visited Bad Nauheim at the end of August 1897. There were symptoms of marked ataxy present and the patient was unable to walk or to stand. If not sufficiently supported — whilst in the act of dressing himself, for instance — his knees gave way under him. The patellar and testicular reflexes were entirely absent; there was also immobility of the pupils present in addition to an advanced state of myopia and of strabismus divergens of the right eye. Romberg's sign was well marked. As regards the condition of the heart there was a considerable increase of the pulse-rate — v. Leyden and Groedel have called attention to the presence of this symptom in such cases — which never amounted to less than 100 in the minute. The sensibility of the entire extent of the lower half of the body was very considerably diminished.

fig. 6.

Tabes.
Summer 1897. First attempt on the tricycle of the patient, who was unable to stand or to walk, after having been taken out of the bath-chair. Very pronounced atactic condition. Body and feet secured.

On the first of September 1897 the treatment by tricycle exercise was commenced. The patient was lifted from the bath-chair and placed on the saddle and the body and feet were secured (fig. 6). He perceived neither the saddle, nor the pedals, nor the back support.

The atactic condition of the patient was so great that the feet frequently freed themselves from the straps and extended further apart from one another. The exercises were carried out at the slowest pace, the patient making the closest observation with his eyes and the strongest effort to succeed.

After being used fourteen days, the straps which were placed around the body and feet were put aside. The feet still lost their position on the pedals at almost each rotation, but they succeeded in regaining their hold during the rotatory movement, that is to say, without the tricycle having to be stopped. The body was bent far forward, in order that the patient might follow up uninterruptedly with the eyes the movements of the feet.

The patient complained, after nearly three weeks daily exercise, that when he pushed down the pedals he experienced a certain sense of pressure on the soles of the feet and above the ankles. He returned, therefore, to a position in which he could hold his head erect, and ceased to control his feet under the observance of his eyes. The patient was obliged to employ all his attention and strength of will in thinking exclusively of the individual phases of rotation and remembering what the right and left foot alternately had to do.

The commencement of the mental effect: the patient did not allow himself to be discouraged at his frequently losing the pedals, he centred his ambition on not using the straps again and was filled with joy and pride when he succeeded in covering a distance of fifty metres without making a mistake.

In the fifth week he exercised in the open air. There was an apparent retrogression in his work owing to the unevenness of the roads, the disturbing external impressions and the necessity of devoting a part of his attention to the guidance of the machine, which, in my exercise-hall, is done almost automatically.

fig. 7.

After 6 weeks exercise in the open air.

After eight days exercise in the open air the condition of the patient was as is depicted in figure 7. He had purchased a tricycle, and could no longer be induced to use a bath chair. His wife accompanied him, sometimes on foot, sometimes on a bicycle, and helped him by pushing the machine when difficulties on the road had to be overcome.

On the 24th November 1897 the patient wrote to me as follows: »I practise cycling exercise industriously and have not as yet missed a single day . . . When indoors I walk about with the aid of a stick, though here and there I also use some other support . . .; I have used the bath-chair only four times and then in the evenings, otherwise I do everything on the wheel.«

During the winter, the snowy weather and the like rendered it impossible »for exercise in the open air, which had become almost[2] a necessity«, to be carried out, and there ensued a deterioration of the condition and of the ability to walk. Since that time the patient has visited Nauheim each year for the purpose of using the effervescent baths and obtaining systematic compensatory exercises (fig. 8). When going to the baths and other necessary places, taking the air, visiting concert-halls, and so on, the patient used his tricycle. By a combination of these methods he was this year (1900) brought to the condition of being able to walk with considerable ability, as is demonstrated in fig. 9. As regards the bladder and rectum, no difficulties have existed since a year and a half ago. The desire, formerly absent, to defaecate has returned, and, further, the patient can now make water whilst in a standing position.

Though in the treatment of tabes cycling exercise promotes principally the transmission of central impulses by way of ameliorating the disturbed coordination, in cases of myelitis, however, there comes also into consideration the peripheral effect of strengthening the extremities, which are paralysed and atrophied to a more or less great extent.

fig. 8.

Summer 1900. Exercise with the walking-chair devised by von Leyden and Jacob.

It is still more so the case in the treatment of polyneuritis, inasmuch as the latter affection leads not only to atrophy of the affected muscles, but also, owing to its exceedingly chronic course, to shortening of the tendons and deformities of the joints.

In illustration of this statement I may quote here the clinical history of a patient who was treated at the Moabit Municipal Hospital and who on account of the severity of the case and the subsequent conditions seemed to be particularly suitable for testing the beneficial effects of this mode of treatment.[8]

F. Clerk, 43 years old, was admitted to the Hospital on November 11, 1897. The patient presented the following symptoms: general emaciation, weakness in the arms and legs, dragging pains, want of appetite. His weight was 46.5 kg. In addition to the symptoms mentioned there were also cough accompanied by copious expectoration, dulness with tympanitic resonance of the upper lobe of the left lung and an exudative process located in the lower part of the left pleura. The liver extended 3 cm below the costal margin. The patient was confined to his bed and unable to sit up without support. The rate of the pulse amounted to 90 in the minute and its tension was slightly pronounced; the spleen was easily felt; the urine contained neither albumen nor sugar; the motor power of the hands, which were kept in palmar flexion and could not be extended above the dorsal surface, was greatly diminished. The function of the knee-joints was considerably reduced; the quadriceps muscles, particularly the right one, were in a flabby condition. The response of the muscles to the galvanic current was but slightly pronounced, while the faradic current produced — either directly or indirectly — no effect whatever. The peronei muscles showed partial Ea R. The sensation of pain in the lower extremities was very considerably reduced; the temperature was normal and pressure on the nerves caused but slight pain.

fig. 9.

Summer 1900.

16—24 November, 1897. There is dulness in the region of the left scapular angle; the vocal fremitus is greatly diminished; exudate of sanguineous fluid.

30 November. Exudate still present.

20 December. There is improvement in the mobility of the arms.

15 February 1898. No effect is obtained upon the peronei muscles by exposing the nerve to the electric current (Ea R).

18 April. The knee-joints are still the seat of severe pain; the extensor muscles are greatly atrophied; the response to the use of the electrical current is considerably reduced.

11 June. Pes equino-varus.

1 August. Application of the iron shoes with straps according to Goldscheider's method.

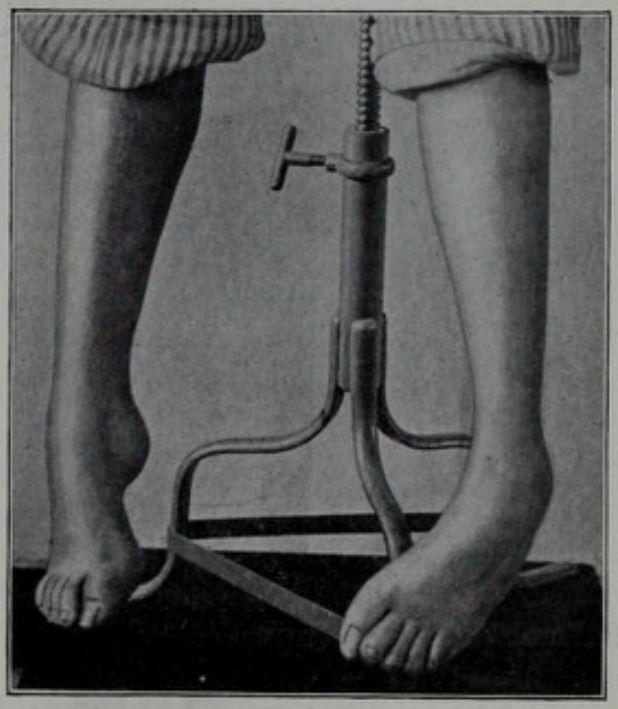
1 Septemher. Attempts at walking by means of the high-chair.

30 September. The right patellar reflex is still absent.

13 October. Weight of the body 64.5 Kg.

When the exercise treatment by cycling was commenced on 21st of November 1898, the neuritic process disappeared, the exudate was absorbed, the bodily weight increased by 18 kg. and the mobility of the arms was nearly normal. However, the patient was still unable to use his lower extremities either for standing or walking purposes. Indeed, both walking and standing were only possible on the toes with the legs wide apart, and, in spite of the greatest efforts on the part of the patient, he was only able to walk a few steps, since the joints of the feet were rigidly fixed in the position of equino-varus (fig. 10), the muscles of both legs were in a state of advanced atrophy and, in addition, the bending of the knees was very limited. Moreover, cold perspiration, exhaustion and severe pain at the respective points of insertion of the shortened Achilles- and peroneus tendon rendered the continuation of the treatment impossible.

fig. 10.



Rigid ankylosis in the position of pes equino-varus as a result of multiple neuritis.

On the 22nd of November 1898 the patient was taken into the open air by an attendant and secured to the tricycle. The extension of the shortened tendons took place in a very gentle manner — by mm. — and the mobilisation of the knee-joints which were ankylosed to an obtuse angle was also very gradual. The ability of the patient to stand on both heels — the joints of the feet occupying a right-angular position — after eight weeks treatment, is shown in fig. 11.

On the 22nd of December 1898, that is in the fifth week, the patient was able, though with support, to walk twenty steps without any great fatigue. On the 25 of February 1899 a pedal rotation of 14 cm. radius — against 7 cm. at the commencement of treatment — was easily made by lowering the saddle by 7 cm.

Both the general and mental condition showed unmistakable improvement and by the 15th of March 1899 the bodily weight had increased to 71.5 kg. (there were 64.5 kg. at the commencement of the treatment).

Though the pain caused by the stretching of individual tendons and the mobilization of the joints was sometimes considerable, yet the patient very reluctantly discontinued the treatment.

As has been shown, the use of the tricycle has been found to be of great value in supplementing the apparatuses which are employed in the way-opening as well as in the compensatory treatment by exercise, and it may now be added that the same remark applies, as will be pointed out later on, to its application as a resistance gymnastic in the treatment of affections of the heart.

fig. 11.

The patient's capacity to stand after treatment.

It was indisputably and greatly to the merit of the late August Schott and his brother Theodore Schott to have proved that contractions of the muscles, if performed cautionsly, act relievingly upon the heart, having, indeed, the same effect as the effervescent brine baths; for the exercised muscle becomes more hyperaemic, and, as can be shown by means of the pletysmograph, it is decidedly increased in size. This of course naturally applies to exercises of the gentlest kind, which can be carried out with subjective benefit even by such patients as those who suffer from affections of the heart, to whom mere walking on the level ground causes difficulty in breathing and palpitation of the heart.

In a case in which exercises are carried out with the aid of a resistance — from which they derive their name resistance-gymnastics — the strength of the resistance should be sufficiently low to enable the patient who suffers from an affection of the heart to overcome it without any difficulty. After the performance of the exercises the patient should not experience fatigue, but subjective relief.

The evidence as to whether the resistance-exercises have been carried out successfully or not is always to be judged from the effect which they have had upon the heart and the respiration. If the necessary amount of gymnastics has been taken, then the respiration and the action of the heart will be retarded, while, at the same time, the latter will be strengthened and the former deepened.

Though Theodore Schott considers the resistance which the instructor of gymnastics gives to the patient, that is to say, the manual resistance, mainly applicable for therapeutic purposes, and condemns the use of apparatuses because he alleges that in employing them there cannot be obtained a sufficient correctness in the amount of exercise [1]), four years experience leads me to incline to the view of those [2]) who are of opinion that the resistance of an apparatus, if given by weights or a lever, is, in point of correctness, considerably superior to manual resistance.

[1]) Proceedings of the Congress for »innere Medicin« 1898, p. 344. 1899, p. 99.

[2]) Tschlenoff, »Die mechanische Heilgymnastik«. Zeitschrift für diätetische und physikalische Therapie Vol. 3, pt. 4. — Herz, »Neue Prinzipien und Apparate der Widerstandstherapie«. Wiener medicinische Presse 1898. No. 41. — Uebel and others.

I shall in another place give a full explanation of this view as well as a description regarding the use of a number of apparatuses of different construction: here I must confine myself to a brief description of the observations which were made in the course of treating, at the Moabit Municipal Hospital, two patients who suffered from an affection of the heart and who were for a long period subjected to resistance-gymnastics on the tricycle.

As the working of a tricycle, weighted with 150 kilogrammes (330 lbs), on a smooth level surface and in the absence of opposing winds, gives, according to my estimate, a resistance of only 0·3 — 0·5 kilogrammes[1]), therefore the amount of resistance-exercise can be measured according to the estimate just mentioned. As the rhythmical movements of the thighs cause the blood to flow in the direction of the lower extremities, patients who suffer from an affection of the heart, and who, on account of difficulty of breathing, cyanosis, weakness and other complaints are quite unable to walk, must, if my observations are correct, experience a sense of subjective relief after being placed on the tricycle, which is first moved passively, and should, by a course of treatment, gain an improvement of the symptoms, which can objectively be shown, and an increased capacity for work.

For the purpose of observing the effect of these procedures I have compiled tables which contain:

1. The length of each tread-crank. From this is ascertained the frequency of the movements of the legs in passive exercise, and the measure of the lever strength which the patient has to make use of in pushing down the pedal in active exercise.
2. The number of the pedal rotations (P. R.) a minute, that is to say the celerity of the movements.
3. The number of minutes during which the movements are carried out without interruption, that is to say the duration of each period of the exercise.
4. The number of the pulse beats } before and after each part of
5. The number of the acts of respiration } the exercise.
6. The length of the intervals taken for rest between the different parts of the exercise.
7. The temperature of the air, condition of the weather, time, locality, kind of gymnastic (whether active or passive, whether worked by the feet or by the feet and hands, whether the feet are secured to the pedals or otherwise, and so on).

As the exercises are always conducted on level cemented paths and under protection from opposing winds, the external resistance produced by friction and air resistance may be regarded as constant.

The filling in of the different divisions of the table renders possible an exceedingly carefully conducted course of exercise and a complete control of its effect.

If all the preparations are done with the necessary quietude and slowness, the patient having been raised to the saddle of the machine or mounted to it by way of a wooden-step of suitable form and height, there ensues, in the majority of cases in which the pulse is too rapid and the breathing difficult, the remarkable phenomenon of the action of the heart becoming less rapid during the exercise,

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[1]) »Zur Mechanik und Physiologie der Cyklistik«. Deutsche medicinische Wochenschrift 1899. No. 33.

and, at the same time, there is a diminution in the rate of respiration. Accordingly, the effect of tricycle gymnastics upon the affected heart is the same as that produced by special resistance-gymnastics, but the opposite to that which cycling as a sport produces[1]) upon the action of the healthy heart.

The reduction in the frequency of the pulse rate in a minute is at the same time associated with a favourable action on the pulse wave and on the rhythm of the order of the beats, as is made obvious by the Sphygmochronogrammes which are given further on and which were taken down by the reliable Jaquet's apparatus, all precautions being observed, immediately before and after each exercise. The extent, to which the frequency of the heart action is diminished varies within rather broad limits, being between two or three and sixteen to twenty beats in a minute. The pulse wave becomes higher and the ascending curve steeper, and there generally ensues a gradual but more and more pronounced systolic elevation. The respiration shows in every case a retardation and a deepening, particularly in the inspiration. In the case of the respiratory interval being absent it reappears during the course of the treatment.

The patient who was placed under my care at the Moabit Municipal Hospital had been in the ward of Professor Renvers, who, before the commencement of the cycling gymnastics, fixed the limits of the heart. The case was one of cor debilissimum associated with an advanced degree of dilatation, and the patient, in attempting to walk about the ward, was, after taking about five steps, obliged to stop walking or to sit down, on account of difficulty of breating and cyanosis, the latter making not only the lips but also the whole face become blue.

The clinical history is briefly as follows: P. Sch., chief clerk, 41 years of age, had an attack of rheumatism of the joints three years previously and since then had suffered frequently from palpitation of the heart. On the 10th of September, 1898, the patient, after finishing his work, went from his office to his home, which was about half an hour's walk distant. He was feling quite well at the time. Whilst ascending the stair-case he was suddenly attacked by dyspnoea, general perspiration, palpitation of the heart and vertigo. He sank down and afterwards was carried up to his rooms, at which time his face is said to have been deep blue. He had not been able to walk since.

On the 19th of October 1898 the patient was admitted to the hospital, and during the first five weeks showed no alteration in his condition. An examination taken on the 26th of November 1898 showed that the heart was dilated ad maximum on the right and left sides, the heart dulness extended 5 or 6 centimetres beyond the right margin of the sternum, and, to the left, the M.M.-line 3 centimetres; and the apex beat was neither visible nor palpable. The pulse wave was small and scarcely perceivable, and the tension was exceedingly slight. Respiration, whilst in a sitting posture, was 30 a minute and superficial, but when standing up was from 40 to 42. When walking there appeared, after five or six steps had been taken, a dark bluish colour on the whole face, the eyes protruded, and the veins of the throat and face enlarged and swelled up like chords.

After the tricycle, which was arranged to be used by the hands and feet, had been taken to the bed-side of the patient, the latter was carefully placed on the saddle, and then, when the acceleration of the pulse which had been produced by this procedure had become equal again, the first movement was made passively by pushing the machine, first for a period of two minutes, and afterwards, after an

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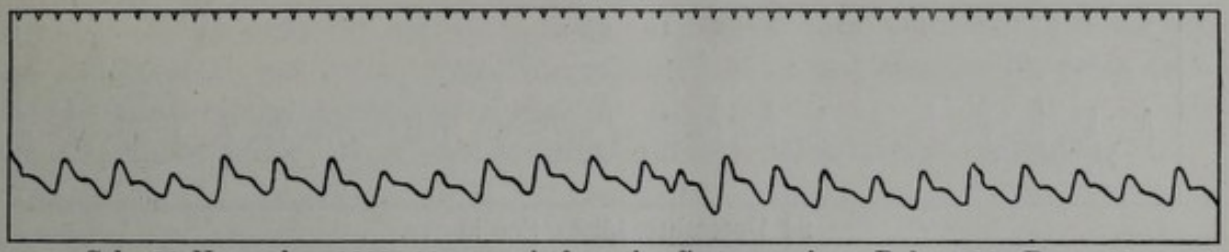
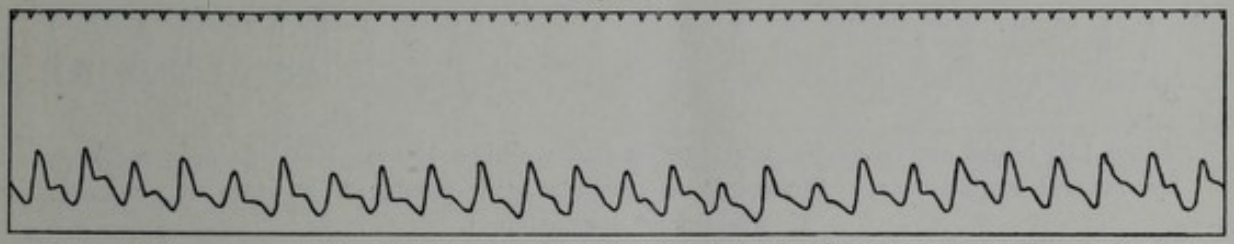
[1]) Acceleration of the frequency of the pulse and respiration is to be regarded as a contra-indication to the continuation of treatment by exercise, provided, of course, that the effect of mental excitement which frequently follows the first attempt at taking exercise in this entirely unusual position can be excluded with certainty.

fig. 12.



Sch. 26 November 1898, 11 a. m., before the first exercise. Pulse 130; Resp. 38.

fig. 13.



Sch. 26 November 1898. 11,30 a. m. immediately after the first exercise; (Five minutes, 14 P. R. in the minute) Pulse 120; Resp. 22.

interval of five minutes, for three minutes. As 14 p. r. were made a minute and each p. r. corresponded to a distance of 4 1/2 m., then the patient made in five minutes 70 p. r. and covered 350 m. of ground. During this work the respiration went down from 38 to 22 breaths a minute, and cyanosis was absent. The patient expressed subjective wellbeing. The pulse curve, which was taken at the end of the exercise, showed a diminution of 10 beats in the pulse rate. After adding a few minutes daily, the table, which was made up every day, was, on the 5th of December, 1898, that is to say at the end of ten days, as follows:

Length of crank	P. r. in a minute	Duration	Pulse	Respiration	Interval	Remarks
14	20	8′	120	18	5′	Pulse before exercise 124.
14	20	10′	104	16	—	Respiration » » 20.
						Active exercise.

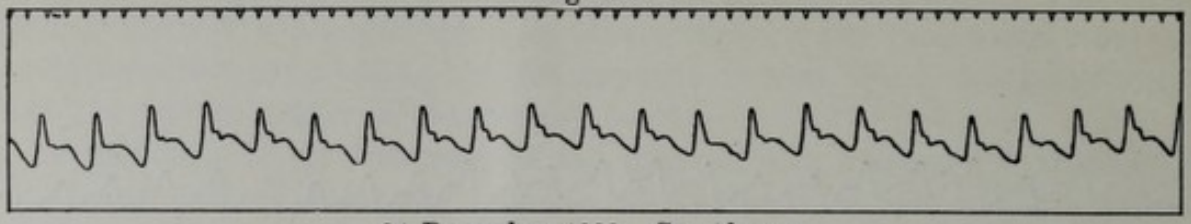
The patient had, therefore, independently moved the weight of his body for 18 minutes, and had covered a distance of 1 1/2 kilometres, and had in this way made 18 × 20 p. r., that is to say, 360 arm and leg movements, or a total of 1440 movements of the four extremities; the effect of which was that the pulse was diminished by 16 beats and the respiration by 2 beats a minute.

22 December 1898. The patient was able to get on the wheel from behind by himself. In doing this one foot was placed on the axis of the posterior wheel, which was 40 centimetres from the ground, and the weight of the body had to be raised on this foot.

Attempts to walk were also made, for the wheel was no longer brought to the ward but was kept outside, and the patient had to go to it. He got off the machine in the open air and made his way back to the ward on foot.

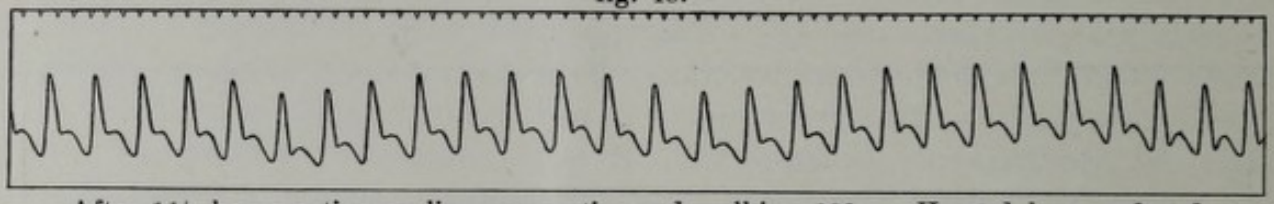
24 December 1898. The sphygmogram, taken after an active exercise of one hour and a half's duration, during which period there were also frequent getting up and sitting down and slow walking to the machine and to the form, making altogether from 50 to 80 steps, showed: pulse 104, respiration 12, air temperature —2° R.

fig. 14.



24 December 1898. See above.

fig. 15.



After $1^1/_2$ hours active cycling-gymnastics and walking 100 m. Heart-dulness reduced by several centimetres. Powerful movements still produced a state of cyanosis. Treatment discontinued.

fig. 16.

Myocarditis. Flexion of the patient's arms by raising the guiding bar, whilst on the tricycle, which is provided with a mechanism that can be controlled by the hands and feet.

fig. 17.

Extension of the patient's arms by lowering the guiding bar.

In cases of affections of the heart-muscle, in which the treatment aims at attaining a better state of nutrition of the muscle by regulating its physiological action and by providing a greater supply of oxygen to the heart, the beneficial effect derived from the exercises by cycling is still more pronounced than in cases of advanced dilatation of the heart, of which the patient referred to above forms a good instance. In a case of myocarditis — the patient was under the care of Prof. Goldscheider — associated with a small, frequent and sometimes scarcely perceptible pulse, the effect of the first exercise at once became marked in the pulse-curve, inasmuch as the frequency of the pulse was reduced from 100 to 92 and that of the respiration from 22 to 17. Thereupon the exercises by means of

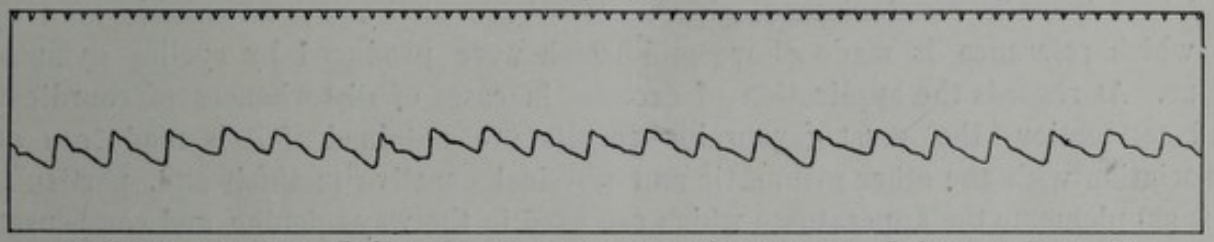
the tricycle (figs. 16 and 17) which could be managed by the hands and feet, were very soon carried out for one hour daily, and they were continued by the patient with the greatest regularity, from November 21. 1898 to February 13. 1899, in spite of unfavourable conditions of weather.

The table given below shows the result after four weeks' treatment.

Length of crank	P. r. in a minute	Duration	Pulse	Respiration	Interval	Remarks
a) 16	24	30′	84	18	10′	Pulse before exercise 90.
b) 16	24	30′	80	16	—	Respiration » » 20.

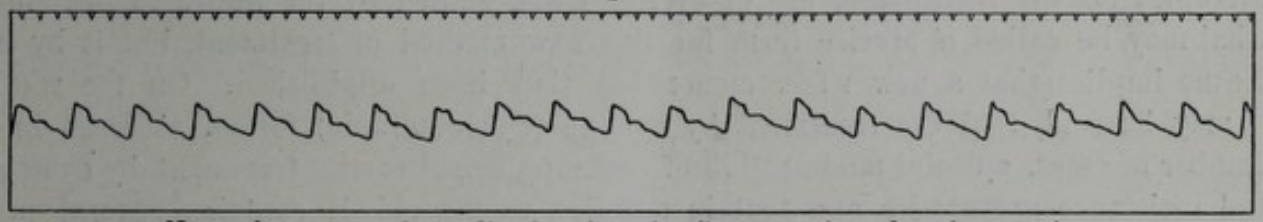
Accordingly, the frequency of the pulse was diminished by ten pulse-beats and that of the respiration by four breaths a minute. In 2×30 minutes the patient covered a distance of $6\,^1/_2$ km. The amelioration of the heart-action is shown in the following pulse curves:

fig. 18.



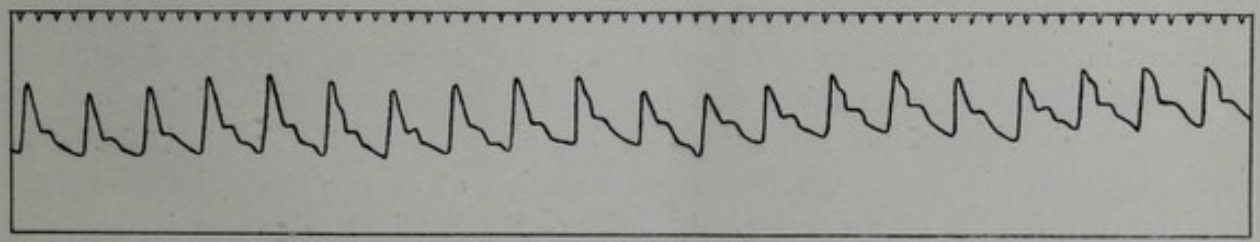
19 November 1898. Before the commencement of treatment. Pulse 100, Resp. 22.

fig. 19.



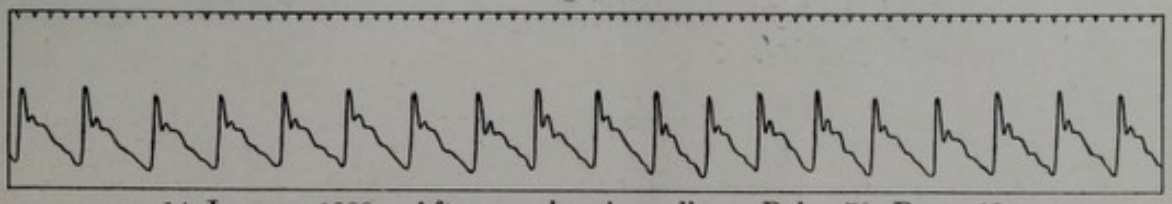
19 November 1898. Immediately after the first exercise; duration 5 minutes, temperature + 5° R, Pulse 82, Resp. 17.

fig. 20.



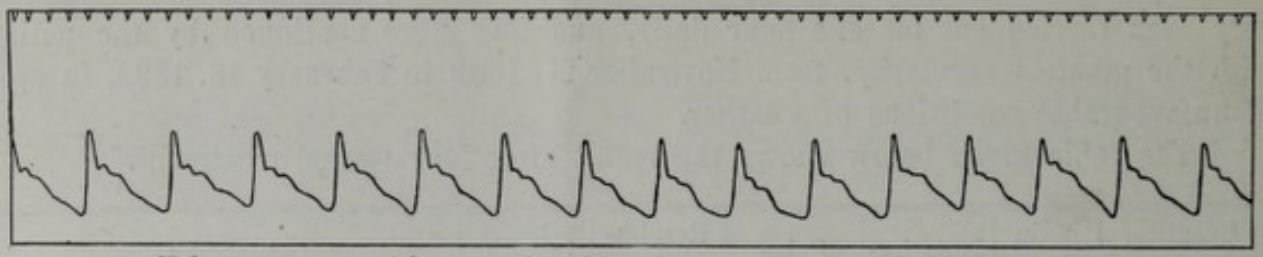
8 December 1898. After $^1/_2$ hour's cycling. Pulse 80, Resp. 16.

fig. 21.



14 January 1899. After one hour's cycling. Pulse 78, Resp. 12.

fig. 22.



15 February 1899. After one hour's cycling gymnastics. Pulse 74, Resp. 10.

On the 14th of February 1899 the patient was discharged from the Hospital as cured.

During the summers of the preceding two years I treated, in an Institute at Nauheim specially etablished for the employment of the method described above, a great number of cases of affection of the heart, and thus was enabled to observe that the results obtained by the simultaneous combination of the treatment by exercise and the use of the baths of Nauheim — provided, of course, that great care is exercised in the selection of individual cases and in the duration of the treatment, and that there is constant medical control — are still more favourable than those to which reference is made above and which were produced by cycling gymnastics alone. As regards the application of exercise in cases of disturbances of coordination and conduction, the most favourable results are obtained if it is made use of in association with the other gymnastic and physical curative methods and, particularly, if it supplements the apparatuses which are used in the way-opening and compensatory treatment by exercise.

It must, however, be borne in mind that in suggesting the name of »Cyklotherapie« for the therapeutic use of cycling I was guided by the desire to introduce what may be called a precise term for this new method of treatment, but it by no means implies that a new »Treatment« has thus been established. On the whole it may be said, that the treatment by cycling (Cyklotherapie) forms, at least in a number of cases, a useful modification of and supplement to the treatment by exercise and resistance-gymnastics and that in addition to the old it contains several new curative factors, and, therefore, its use is continued with great readiness and perseverance. On the other hand — in order to avoid disappointment — it requires constant medical control. This latter remark applies particularly to the use of the treatment by cycling as a resistance-gymnastic in cases of affection of the heart, in which it ought to be regarded as a law, that must never be violated, that the patient should perform these exercises in the presence of a physician only and that he should under no circumstances be allowed to introduce without permission alteration in either the prescribed duration of or the form of the exercises.

The carrying out of the treatment, as far as the medical attendant is concerned, is not only difficult, but also requires a great deal of time, and, therefore, can only be conducted, with satisfactory results, by the physician who has time, personal inclination and opportunity to direct his main attention to this department of treatment by physical exercise.

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