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The development and use of a portable apparatus for selected therapeutic exercises

Lewis Thomas Eaton

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THE DEVELOPMENT AND USE OF A PORTABLE APPARATUS
FOR SELECTED THERAPEUTIC EXERCISES

by

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B. A. Intermountain Union College, 1939

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PREFACE

The well or normal person may meet most of his exercise needs through the demands of daily living. The orthopedic patient needs to have a scientific application of bodily movement designed specifically to maintain or restore normal functions to diseased or injured tissues.¹

The task of effectively administering therapeutic exercises to orthopedic patients for the purpose of rehabilitation present a number of problems. One of these problems is to effectively utilize the time of the therapist and the patient; another problem is to devise an exercise apparatus that is versatile enough to meet the majority of the therapeutic exercise needs of orthopedic patients; a third problem is to develop an apparatus which may be easily moved from the therapy department to the patient.

CHAPTER I

THE PROBLEM AND DEFINITIONS OF TERMS USED

THE PROBLEM

Statement of the problem. The purpose of this study is to develop and show the uses of a portable exercise apparatus which will facilitate the work of the therapist and meet the exercise needs of orthopedic patients.

Importance of the Study. There appears to be a number of deficiencies in the exercise equipment available in the field of exercise therapy. The administration of therapeutic exercises is impeded by lack of suitable equipment or by having to use equipment that is too complicated or cumbersome to be efficiently used by the therapist and patient.

An apparatus such as contemplated in the study would permit more effective administration of therapeutic exercise; thus, saving the time of the therapist and the patient, and it would provide greater effectiveness in carrying out the exercise prescriptions.

There is no single piece of exercise equipment which can meet the majority of therapeutic exercise needs of orthopedic patients. This lack is particularly evident in cases which require the body to be supported horizontally or in specific positions of incline for exercise.
Needs for the study. There is a need to develop a portable apparatus for selected therapeutic exercises so that the exercise prescription can be more adequately met.

When patients have reached the stage in treatment as to need muscle strengthening of affected parts and conditioning of unaffected parts, the therapist's problems are those of motivation, technique and time.

If motivation toward the goal of recovery is not present within the patient, it must be inspired by the therapist. Even when the desire to recover is present, discouragement often impedes patient progress and the therapist must "refire" his patient. One of the most common causes of discouragement stems from the patient's inability to see improvement from his long hours of exercise therapy. There is a need to incorporate in a therapeutic exercise apparatus a way of showing the results of exercise attainment of the patients so that both the patient and the therapist can be cognizant of improvement. If the therapist can provide a method of showing the patient that there is progress, no matter how slight, he has tended to avoid one of the stumbling blocks in the path of rehabilitation.

Consideration should be given to the fact that some effective means must be provided to properly support the patient during his treatment. The greater the muscle involvement, the greater the problem of getting the patient into the most advantageous position for exercise. Proper body positioning is necessary before the exercise prescription
can be administered when there is general muscular weakness or extensive muscle involvement in the neck, trunk or lower extremities.

There is a need to devise a therapeutic exercise apparatus which is engineered for time economy and convenience for both therapist and patient.

A tilting table with its possibility of supporting the patient in various degrees of incline from horizontal to vertical serves a multiplicity of needs. Helen Dobbin, B.A., Physical Therapist of the Veterans' Administration Hospital, Coatesville, Pa., lists some of the needs to be filled successfully by a standing bed: It places the patient in advantageous positions for strengthening and stretching exercises; it limits the personnel needed to place patients in various inclines, and spares the physical therapist, where adult patients are concerned, a great deal to time and effort; it promotes balance and coordination by placing the patient in a functional position; it offers an opportunity for observing circulatory changes; it is effective in exercising weak neck and back muscles.

Helen Dobbin also states that muscle rehabilitation of lower extremities can be accomplished to advantage on the standing bed, that quadriceps setting seems to come more easily in this position and that the gastrocnemius-soleus group may be strengthened by having the patient rise up on

his toes. Her article further states that the standing bed has been of great assistance in stretching of back, hamstrings and heel cords.

A tilting table-bed could be utilized: in the rehabilitation of cardiac patients, in debilitating long chronic illnesses and rehabilitation of fractures involving the lower extremities or back.²

Paul R. Harrington, M.D., in concluding his article on the "Standing Bed in Poliomyelitis", states:

I believe it improves calcium metabolism by retention, stimulated by the return to as near normal as possible function of the skeletal system in weight bearing. Also, it improves circulatory vital capacity; rehabilitates the vasomotor system by accommodation; and provides tidal drainage of the respiratory tree. In other words, the standing bed assists in the rehabilitation of the patient, vascularity, skeletally, and muscularily.³

Special exercise consideration should be given patients who will need aids for ambulation. "Should crutch walking be necessary", Hans Kraus, M.D., states, "special strengthening of the upper extremities, especially of the triceps and extensors, should be prescribed."⁴

Special consideration for therapeutic exercises should be given to the stump of the amputee. "Contractures,

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especially flexion and abduction types, are combated by stretching and exercise.  

General conditioning exercises, even though their effects has been studied and are well known, are still not widely enough used for therapeutic purposes. Exercises to keep patients in good shape during prolonged bed-rest are usually neglected.  

To serve the needs of bed patient's general conditioning, a portable exercise apparatus could be taken to the patient's room or ward. The construction of the apparatus would be such that the patients could easily be moved by one person from the bed to the supporting surface of the exercise unit. Pulley weights and gravity would offer the resistance needed for exercise. The weights would offer progressive resistance and the tilting table-bed would vary the degree of gravity pull. The two features would facilitate the administration of the varying needs for exercising the extremities, trunk and neck.

Review of the related studies. Paul R. Harrington, M.D., has a high regard for the value of the tilting table—

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bed, in not only the treatment of patients needing therapeutic exercise, but as an aid in the rehabilitation of the vasomotor system, improving circulatory vital capacity, providing tidal drainage of the respiratory tree and improving calcium metabolism by retenting.  

The standing bed that was used by Doctor Harrington has the following features: When in a horizontal position it has a standard hospital bed height; it is equipped with a stationary footboard; any desired angle of tilt up to 70 degrees can be attained by a motor driven device which is regulated by a push-button; the patient can be secured to the bed by means of wide bands when stabilization or support is necessary.

The role of pulley therapy has found a definite place in the rehabilitation program. Doctor Deaver, an authority on pulley therapy, states that strength is rapidly developed by exercise with load-resistance apparatus, however, increased range of motion may not respond to the resistive-load exercises designed for strengthening. To increase range of motion Deaver recommends the passive stretching type of exercise using pulley therapy.  


through the use of pulley therapy.\textsuperscript{9}

DeLorme and Watkins, since World War II, have popularized progressive resistive exercise. They believe that there are factors in progressive resistive exercise that necessitate the use of a, "mechanically sound, smoothly working, comfortable adjusted apparatus", which should be calibrated sufficiently to make reduplication of position possible. DeLorme and Watkins state:

The use of heavy resistance makes the factors of safety and comfort of the patient of great importance. A large weight improperly fastened could result in injury to the patient. 

Awkward application of the resistance is not only uncomfortable for the patient, but may actually reduce the patient's work capacity.  

Efficient, versatile exercise equipment not only insures correct administration of exercise therapy, but makes it possible to determine the optimum exercise position and arrangement the patient should employ.\textsuperscript{10}

DeLorme and Watkins have designed a table, now manufactured by the Elgin Exercise Appliance Co., Elgin, Illinois, called the Elgin Table.

The Elgin Table as shown in use by DeLorme and Watkins throughout their book on progressive exercise is a steel framed table six feet long, twenty eight and a half inches wide and thirty inches high. It has a total of seventy six accessories and weights approximately one thousand


pounds. The table is well upholstered with plastic over a thick rubbery padding. A brochure of the Elgin Table lists the following exercise possibilities:

1) Knee and hip flexion; 2) abdominal and iliopsoas; 3) quadriceps; 4) gastrocnemius; 5) ankle, for plantar and dorsiflexion, exersion and inversion exercises; 6) hip internal and external rotation, adduction and abduction flexion and extension, and hamstring; 7) shoulder; 8) hyperextension exercises of the back. The exercises may be used for the weakest patient by assisting against gravity by a system of counter balance.11

Limitations. This research will be limited to the study, development and uses of a portable piece of exercise apparatus that will meet the selected therapeutic exercise needs of orthopedic patients.

The exercise apparatus will not include specific provisions for the exering of the fingers, wrists, toes or provide for inversion and eversion movement of the foot.

DEFINITIONS OF TERMS USED

Exercise prescription. Hans Kraus defines the term, as it has been used in this manuscript, as the region to be exercised, the exact type and form of exercise and dosage.12

General conditioning. General conditioning is a complete workout for the body. All joints should go through the full range of motion, and all muscles should contract and relax and cover the full range of activity.13 This definition of general conditioning has been used throughout this manuscript.

Therapeutic exercise. Krusen defined therapeutic exercise as, "The scientific application of bodily movement designed specifically to maintain or to restore normal function to diseased or injured tissues".14 This definition has been applied to the term of therapeutic exercise throughout the manuscript.

13 Ibid., p. 270.
CHAPTER II

THE EXERCISE NEEDS OF ORTHOPEDIC PATIENTS

Therapeutic exercise needs vary with the patient's disabilities and the extensiveness of his involvement. Unaffected parts will need special consideration when it becomes their duty to take over the tasks for the affected parts. In general, therapeutic exercises can be divided into the following divisions:

Passive exercise. "Passive exercise is that type of motion imparted to a segment of the body by another individual or by some outside force." Passive exercise is brought about by the operator's taking the body part through its range of motion without the patient's conscious aid or resistance. It is also possible for the patient to passively exercise one part of his body with the aid of another part.

Passive exercise of the patient can also be carried out by means of pulley therapy. George Deaver, M.D., Medical Director of the Institute for Crippled and Disabled in New York, has this to say about the role of pulley therapy

in passive exercise:

There is always the possibility that damage may be done in too vigorous passive stretching as the instructor [therapist] is sometimes unable to determine how far the stretching should be carried. They pulley therapy exercises are completely under the patient's control, and therefore the chance of injuries to the joint are minimized.²

"The chief object of passive movement is to prevent contractures and the formation of adhesions."³

Active or free exercise. Active or free exercise is that type of motion which is brought about by the body's own voluntary contraction and relaxation of muscles. Help is not received from any outside force in active or free exercise.⁴

Under this category of exercise may be listed: practically all postural exercises, such as correction of functional curvatures of the spinal column; correction of flat feet; strengthening abdominal muscles; correction of muscles or circulatory disturbances or to hasten restoration of function following trauma.⁵

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⁴ Ibid., p. 317.

⁵ Loc. Cit.
Active assistive exercise. With this type of exercise an effort is made by the patient. The lacking power for motility is supplied by the operator or some mechanical agent such as a pulley or weight apparatus; hence, the name active assistive exercise.  

Static exercise. This type of exercise is accomplished by tensing and relaxing a muscle without motion occurring in the joint which these muscles normally move. Sometimes when joint movement is cast bound, static exercise is the best way to maintain maximum muscle tone. Static exercises are for the prevention of muscular atrophy and aid in earlier restoration.

Active resistive exercise. This name is given to a type of exercise which calls for an active effort on the part of the patient to move a segment or segments of the body against resistance. The resistance offered may be by an operator, by his own physiologically antagonistic group of muscles, by pulley weights, or by the patient resisting the movement by another segment of the body.

It is generally agreed by authorities on exercise that a warm-up period is essential prior to the strength-building resistive exercise. Hans Krauz writes that not

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7 Ibid., p. 318.
only is a warm-up period prior to exercise and a warm-down after exercise necessary, but that weight increase should be graduated especially for weak muscles.\(^8\)

DeLorme believes that weight should be increased once a week by testing the maximum which can be lifted ten times. He believes that a two day rest period after the test is given is important.\(^9\)

Kraus points out, "Resistive exercise may also be used to produce 'reflex' relaxation for the antagonists of the contracting muscle".\(^10\)

For strength building, DeLorme and Watkins formerly recommended seventy to one hundred movements a day, but in the light of recent experience they now believe that twenty to thirty repetitions per day are more satisfactory. "Fewer repetitions permit exercise with heavier muscular loads, thereby yielding greater and still more rapid muscular hypertrophy".\(^11\)

The present plan of DeLorme for load-resisting exercises is that the first set of ten-repetitions should employ one half of the ten-repetition maximum. The second


\(^10\) Kraus, *op. cit.*, p. 45.

\(^11\) Krusen, *loc. cit.*
set of ten-repetitions should use three fourths of the ten-repetition maximum; and the third set of ten should employ the maximum. Load-assisting exercises should employ the same technique of administration only, of course, weights would be subtracted in the reverse order.

DeLorme now recommends that exercises be done only once a day four times a week, but never more than five times a week. Here are the five guiding principles on which DeLorme basis his theories:

(1) low-repetition, high resistance exercises produce power, (2) high-repetition, low resistance exercise produce endurance, (3) either of these types of exercise is capable of producing the results obtained by the other, (4) weakened and atrophied muscles should not be subjected to endurance building exercises until muscular power has been restored to normal by power-building exercises, (5) it is usually preferable to have a limited range of motion with good power rather than normal range of motion with inadequate power.\(^{12}\)

CHAPTER III

THE DEVELOPMENT OF A PORTABLE APPARATUS FOR SELECTED THERAPEUTIC EXERCISES

INTRODUCTIVE DESCRIPTION

The writer has sought to construct an apparatus which combined the following features in order to meet the selected therapeutic exercise needs: pulley therapy, tilting table-bed and portability.

**Pulley therapy.** One feature of the apparatus accomplishes its purpose by means of pulley weights. Pulley weights are used which can be graded into pounds for offering varying degrees of resistance, or counter balance to aid movement. They are so applied by use of pulleys as to meet most of the exercise needs of the body. Pulley therapy can be used by the patient while exercising in a prone or supine position.

**Tilting table-bed.** The second feature of the exercise apparatus is the tilting table. Its range of movement is ninety degrees, or from a horizontal to a vertical position. Within its range of movement it can be held at any desired angle. The movement of the table is made possible by the use of a crank, screw and lever system combined with the
hinged table-bed.

The pulley therapy exercise system, as previously described, can be applied to the patient at any angle at which the table is placed.

When the table is to be tilted the lower nine inches of the table hinges to become the footboard for body support.

**Portability.** The third feature of the exercise apparatus is its portability. The therapist can move the apparatus from the physical therapy department to the patient's room, or in the case of wards, from bed to bed. The table top is the same height as the hospital bed which makes the transfer of the patient easier.

If the exercise apparatus is to be used only in the physical therapy department, it can be moved aside when not in use.

Portability is made possible by the use of ten inch ball bearing caster wheels; the overall height of six feet nine inches and thirty inches width measurements allow it to pass through hospital single doors; and its seven feet ten inches length allows elevator transportation.

**GENERAL CONSTRUCTION DETAILS**

**The frame.** The Portable Therapeutic Exercise Apparatus was made of welded one inch tubular steel (see figure 1). A one inch by one-fourth piece of strapiron lends the rigidity needed in the undercarriage. The end and
side stabilization was attained by crossing one half inch steel tubing. The crossed tubing has been welded in both ends and in the under-bed frame section.

The ten inch ball bearing caster wheels, specified to operate with two hundred pound loads each, were castered with a two inch thrust bearing and were bolted to plates which were welded to the frame of the apparatus.

The over all length measures seven feet ten inches, the height is six feet nine inches and the over all width of the apparatus is thirty inches. There is a three inch
FIGURE 2. END VIEW OF THE PORTABLE THERAPEUTIC EXERCISE APPARATUS
clearance from the underslung carriage to the floor.

**Pulley weights.** Pulley weights (figure 2) are paired on each end of the apparatus. The weights operate on two one half inch rods. Each of the four pulley weight systems is made up of a connecting pulley plate weighting three and a half pounds and ten individual two pound weights. Each weight has its own lever catch which allows the weights to be added or subtracted as needed. The operator can change the weights progressively. To obtain a load-resistance greater than generally used through the block and tackle system, the operator can attach the pulley cord directly to the weights; thus, eliminating the bottom pulley of the pulley machine. This decreased the mechanical advantage and doubles the pulley weight resistance. The load-resistance can be varied from one pound to twenty three and three quarters pounds on each of the four weight systems.

The pulley weight system used on the apparatus is the type of pulley weight system found in many gymnasiums throughout the country.

The two and one half inch pulleys are located on the frame so that they will afford the correct angle of pull for any of the many therapeutic exercises.

Adjustable pulleys are located on the tip and ends of the apparatus. They are mounted on cross tubings which are collared to the frame. A set-screw holds these adjustable cross members in the desired location.
The Tilting table. The table-bed is constructed with three quarter inch ply wood framed in one inch by one eighth inch angle iron. Its overall length with the footboard down and used as part of the surface is seven feet one and one half inches. The length of the table-bed when the nine and one half inch footboard is turned up, for support of the patients on inclines or vertical, is six feet four inches. The table bed is thirty inches wide.

The table-bed is upholstered with two inches of rubberized horse hair padding and a layer of cotton batting.
The covering is lined backed plastic material which is resistant to compounds generally used by the therapist (e.g. oil, alcohol, water and etc.).

The table-bed can be tilted to and held at any angle in its ninth degree range from horizontal to vertical.

The tilting table-bed is operated by a hand crank with an eight inch lever advantage; a fourteen inch double screw with two turns to the inch; and a first class lever with a power arm one fifth the length of the arm lifting the table-bed. The tilting table-bed is attached to the apparatus.
FIGURE 5. MECHANISM FOR TILTING THE TABLE-BED
frame by means of four hinges and the sliding lift lever. A two hundred pound patient can be put in any position of tilt with little effort on the part of the operator.

The one half inch rollers (no. 1, figure 6) for attaching belts which hold the patient on the table-bed while he is being tilted to the desired position, are located under the edge of the table-bed. The series of rollers above the hinge of the tilting table-bed are thirty inches in length, the series of rollers below the table hinge are twelve inches.
in length. The rollers are mounted on both sides of the table-bed.

A protractor (no. 2, figure 6) has been attached for measuring the angle of the table-bed. A change has been made in the degree markings of the protractor. They have been changed to read zero degrees at horizontal and ninety degrees at vertical.

The sliding support (no. 4, figure 6) is for the hinged footrest. (A) is four and one quarter inches in length and the locking slot is one quarter inch deep. (B) is the pivot point which is mounted on the hinged footrest. The overall length of the sliding support is eighteen inches.

The tilting table-bed has for leg abduction exercises a pulley mounted in the center of the lower six inches of its structure (figure no. 7). The patient does the exercise on a powder-board forty two by forty eight inches in size. The powder-board is hinged in the middle so that it can be easily stored.

The pulley for abduction exercises can be raised from its recessed position in the upholstered table-bed. The adjustment is made possible by screwing the one and one quarter inch tubing through a flange which is mounted under the table-bed. The pulley is raised to allow clearance for the sash cord over the powder-board.

The cabinets. Cabinets (no. 3 A and B, figure 6) have
FIGURE 7. POWDER-BOARD AND TABLE-BED PULLEY

sliding doors. Cabinet (A) is thirty five and three quarters inches by twenty six and one half inches by fourteen inches. Cabinet (B) is thirty five by three quarters inches by twenty six and one half inches by ten inches.

The cabinets are for holding exercise accessories, towels and linens.

Accessories. There are ten accessories for the Portable Therapeutic Exercise Apparatus (figure 8), they are: (1) powder-board previously described; (2) foot stirrups made of leather; (3) hand grips; (4) ankle harness made of leather and secured to the ankle by snaps; (5) two cotton
thirty inch cinches with two inch web cotton belts attached;  
(6) a leather head harness with buckels for adjustments;  
(7) two ankle harnesses made of leather to meet a different  
directional pull than numbers (4); and (8) a single ankle  
harness made of leather and is secured to the ankle by means  
of snaps; (9) foot treadles made of three eights inch ply  
wood, leather and steel, fit on the apparatus in the space  
between the table-bed and the footboard. The treadles will  
handle foot sizes up to thirteen. A leather heel cup  
prevents the foot from slipping down and an elastic bandage  
secures the foot to the treadle. The pivot point for foot  
motion is located three and one half inches above the base of  
the treadle. A one half inch steel tube holds the foot  
treadles twelve inches apart and two five inch by three in  
by one quarter inch plates inserted between the hinged foot-  
board and the table-bed; (10) one chest harness made of a two
inch leather strap and secure to the correct position on the patient by means of a one inch shoulder strap which snaps on.
CHAPTER IV
THE USE OF THE PORTABLE APPARATUS FOR
SELECTED THERAPEUTIC EXERCISES

For a period of three months the writer had the opportunity to test the Portable Therapeutic Exercise Apparatus. During the three months, with the exception of the few days the apparatus was being demonstrated at the Montana State University's Department of Health and Physical Education, it has been in constant use at the St. Vincent's Hospital in Billings, Montana.

At St. Vincent's the writer, working as an exercise therapist, averaged sixteen exercise treatments a day with the exercise apparatus.

A number of doctors and therapists saw the apparatus in patient use and expressed their critical praise of its

1 Louis W. Allard, M.D., Orthopedist, Allard Clinic, Billings, Montana; L. Clayton Allard, M.D., Orthopedist, Allard Clinic; Edward W. Gibbs, M.D., Billings Clinic; Elizabeth Grimm, M.D. & Physical Therapist (’44-'45 in charge of Department of Physical Medicine, State of Wis. General Hospital, Madison, Wis.) now of Billings Clinic; Walter H. Hagen, M.D., Orthopedist (member of the State of Montana Orthopedic Board), Billings Clinic, Billings, Montana.

2 Robert Christensin, M.A., Physical Therapist, St. Vincent's Hospital, Billings, Montana; Richard Cerino, M.A., Physical Therapist, Anaconda, Montana; Jary Jane Hahn, Physical Therapist, C.P. Center, Billings, Montana; Robert Normand, M.A., Physical Therapist, Anaconda, Montana.
exercise versatility and adaptability.

Adult and child patients indicated they liked to use the apparatus. Adult patients expressed confidence in the apparatus because it offered them maximum exercise possibilities. Several patients told the writer they felt their exercise on the apparatus had considerably shortened the hospital stage of their rehabilitation.

The illustrations which follow reveal a method of grading progressive recovery, and illustrate a cross section of the therapeutic exercise possibilities. The pictures were taken in the Physical Therapy Department of the St. Vincent's Hospital. The patients who are demonstrating the various exercises, with one exception of an abdominal exercise (page 44 figure 35, which was demonstrated by the writer, are people who took daily therapeutic exercises on the apparatus.

The figure illustrations are organized in the following order: (1) Method of grading progressive recovery; (2) method of tilting the table-bed to the desired angle for exercise; (3) arm and shoulder exercises; (4) ankle and leg exercises; (5) trunk exercises; (6) neck exercises.
The portable exercise apparatus uses weights which can be progressively increased as the strength of the patient increases.

For easy identification ten different colors were used on each unit.

Another method of grading progress on the apparatus is by means of the protractor attachment on the tilting table-bed.
The operator can easily change the tilt of the table-bed to the desired inclined plane. A protractor showing the degree of tilt is in full view of the operator.

ARM AND SHOULDER EXERCISES

FIGURE 12. ACTIVE RESISTIVE EXERCISE FOR SHOULDER JOINT

HORIZONTAL ABDUCTION
FIGURE 13. ACTIVE RESISTIVE EXERCISE FOR ELBOW FLEXION AND SHOULDER JOINT EXTENSION

FIGURE 14. ACTIVE RESISTIVE EXERCISE FOR SHOULDER JOINT EXTENSION
FIGURE 15. (A) ACTIVE RESISTIVE EXERCISE FOR HORIZONTAL ADDUCTION OF SHOULDER JOINT IN PRONE POSITION

ACTIVE RESISTIVE EXERCISE FOR HORIZONTAL ADDUCTION OF THE SHOULDER JOINT IN SUPINE POSITION

FIGURE 15. (B)
FIGURE 16. USE OF THE POWDER-BOARD FOR ACTIVE ASSISTIVE EXERCISE OF SHOULDER ABDUCTORS

FIGURE 17. ACTIVE RESISTIVE EXERCISE FOR SHOULDER JOINT ADDUCTION

Other exercise possibilities in the position illustrated are: passive or active assistive exercise for shoulder joint abduction.
Another exercise possibility in the position illustrated is passive exercise for elbow joint extension.
FIGURE 20. ACTIVE ASSISTIVE EXERCISE FOR ELBOW EXTENSION AND SHOULDER FLEXION

ACTIVE ASSISTIVE EXERCISE FOR SHOULDER JOINT FLEXION

FIGURE 21.
FIGURE 22. ACTIVE RESISTIVE EXERCISE FOR SHOULDER GIRDLE ELEVATORS

FIGURE 23. ACTIVE RESISTIVE EXERCISE FOR SHOULDER GIRDLE DEPRESSORS
FIGURE 24. ACTIVE RESISTIVE EXERCISE FOR SHOULDER JOINT ABDUCTION

ANKLE AND LEG EXERCISES

FIGURE 25. USE OF FOOT-TREADLE ACCESSORY FOR ACTIVE RESISTIVE PLANTAR FLEXION EXERCISE OF ANKLES
FIGURE 26. ACTIVE RESISTIVE EXERCISE FOR DORSIFLEXION OF ANKLES

FIGURE 27. ACTIVE RESISTIVE EXERCISE FOR EXTENSION OF KNEES AND HIP JOINTS
Another exercise possibility is the position illustrated is active abduction and adduction with the powder-board.
FIGURE 30. ACTIVE RESISTIVE EXERCISE FOR HIP JOINT ABDUCTION

Other exercise possibilities in the position illustrated are passive or active assistive hip abduction.

FIGURE 31. USE OF THE FOOT HARNESS FOR ACTIVE RESISTIVE KNEE EXTENSION

Other exercise possibilities in the position illustrated are passive or active assistive knee flexion.
FIGURE 32. USE OF THE FOOT-STIRRUP ON KNEE AND HIP JOINT FOR ACTIVE RESISTIVE EXERCISE

The therapist is giving side stabilization assistance.

FIGURE 33. ACTIVE RESISTIVE EXERCISE FOR HIP FLEXION
FIGURE 34. ACTIVE EXERCISE FOR STRETCHING HIP EXTENSORS

FIGURE 35. (A) GRAVITY GRADED ABDOMINAL FLEXION EXERCISE
FIGURE 35. (B) GRAVITY GRADED ABDOMINAL FLEXION EXERCISE

FIGURE 36. THE USE OF WEIGHTS FOR ACTIVE ASSISTIVE ABDOMINAL FLEXION EXERCISE
FIGURE 37. ACTIVE RESISTIVE EXERCISE FOR BACK EXTENSION WITH THE USE OF A HARNESS

FIGURE 38. ACTIVE RESISTIVE EXERCISE FOR BACK EXTENSION WITH THE USE OF HANDLES
FIGURE 39. ACTIVE RESISTIVE EXERCISES FOR NECK EXTENSION

The head harness used in figure 39 can also be attached to pulley weights for active resistive exercise for neck flexion.

Traction can be applied to the neck either by weights up to forty seven pounds, or by graded gravity body pull through the use of the tilting table-bed.
CHAPTER V

SUMMARY AND CONCLUSIONS

SUMMARY

Much of the therapeutic exercise now performed manually could be more effectively administered through the use of exercise apparatus. The acceptance of therapeutic exercise apparatus has been slow because of the cumbersome, complicated and time consuming nature of present exercise equipment.

One of the factors a therapist must deal with is patient motivation. If a patient can observe progress from the long hours of exercise therapy the therapist's task of motivation is considerably lessened. An exercise apparatus should provide a progressive grading mechanism which will allow the patient and therapist to easily note improvement.

Exercise prescriptions can be more effectively administered through proper body positioning made possible by the tilting table-bed. Placing the patient in a vertical position assists in promoting calcium metabolism by retention. When the table is in an inclined position it improves circulatory vital capacity; rehabilitate the vasomotor system by accommodation; and provides tidal drainage of the respiratory tree.

A portable therapeutic exercise apparatus is space
saving in the small physical therapy department in that it can be pushed aside when additional room for other activities demand more space. Another advantage of a therapeutic exercise apparatus which is portable is the possibilities it unfolds for the treatment of patients in the hospital wards or rooms. The therapist can take the exercise apparatus to the patient; thus, eliminating the overcrowding of the therapy department, and the extra help needed in bringing the patient to the therapy department. It would facilitate the treatment of conditioning cast-bound patients, and would eliminate some of the dangers of excessive moving of certain patients. Time can also be saved by the portable feature, and the scheduling of patients for exercise is simplified by going from bed to bed.

Patients may be exercised on the apparatus for orthopedic defects or for conditioning of unaffected parts needed to take over the task of affected parts. Therapeutic exercise is given to restore normal function to diseased or injured tissue.

The apparatus designed by the writer combines the features of progressive pulley assistive resistive weight system with the tilting table-bed to enable effective administering of various types of therapeutic exercises.

Passive exercise requires no effort for movement on the part of the patient. It is given to prevent contractures and formation of adhesions. There is the possibility that damage may be done by too vigorous passive stretching by the therapist. If the patient can control the limits of the
stretching through the use of self-resistance pulley therapy, the danger of injury is minimized.

Active or free exercise is performed by the individual without assistance or resistance. This exercise can be effectively administered by using the powder-board and the tilting table.

Active assistive exercise calls for outside help to complete the desired movement. Pulley weights can be effectively used as graded counter balances to aid the muscle in performing its actions.

Active resistive exercise, applying a load against which the muscle must work, promote muscle strength beyond the point that would be reached in active type exercise. Pulley weights are an effective means of offering the progressive resistance needed in this type of exercise.

In order to meet the demands made on an apparatus which offers progressive pulley weights, tilting table-bed and portability, a sturdy but light weight frame was constructed by welding steel tubing into a single unit properly designed to meet all points of stress. Pulleys were located to offer the correct angle of pull for the various exercise needs. The combined tilting table-bed and pulley weight system offer the patient comfortable and proper body positioning with correct angle of pull when pulley weights are used.

When body stabilization is needed cinches are provided so that the part or parts can be secured to the table-bed.
A total of ten accessories were provided to fill the various exercise needs.

When the apparatus was put into patient use at the St. Vincent's hospital, Billings, Montana, it proved to be valuable as a versatile and adaptable piece of exercise equipment. It provided a method of grading progressive recovery of the patients. The portable combination of the tilting table-bed and progressive pulley weights afforded simple administration of arm and shoulder exercises, ankle and leg exercises, trunk exercises and neck exercises.

The apparatus provides for comfort and safety in application of exercise prescriptions.

Patients have indicated their confidence in the apparatus.

CONCLUSIONS

Much of the therapeutic exercise now given manually is time consuming for both the therapist and the patient (indicated in appendix A, page 57).

There are accepted methods for effectively administering therapeutic exercise on apparatus, but either the present single units of exercise equipment are too lacking in versatility for fulfilling the exercise prescription, or they are too complicated and cumbersome for economy of time in administration.

Since World War II there have been some efforts to develop exercise apparatus. The table developed by DeLorme
and Watkins provides a weight system for progressive strength-
ing of muscles, but it does not provide the tilting table-
bed and it is not portable. Harrington's tilting table-
bed (standing bed) does not provide pulley weights for
progressive assistive-resistive exercise.

If the body can be put in a functional position on
the tilting table-bed, pulley weights will offer a greater
versatility for therapeutic exercise (indicated in appendix
A, page 59).

The Portable Therapeutic Exercise Apparatus is
original in its combination of features. It's originality is
supported by the patent search conducted by the registered
patent attorneys, McMorrow, Berman and Davidson (indicated
in a letter in appendix B, page 64).

The apparatus can be built at a reasonable cost and is
engineered so that there will be a minimum of upkeep expense.

The exercise apparatus offers the patient adaptable
features to meet nearly all therapeutic and conditioning
exercise needs. It's use will shorten his hospital stage of
treatment. It provides comfortable and correct positioning
for exercising, offers safety to the patient and in the
handling of weights and body positioning and provides visible
goals in a graded progress system.

To the therapist the apparatus is time saving without
slighting any phase of treatment. It calls for minimum
effort on the part of the therapist for fulfillment of the
exercise prescription. It helps the therapist bolster the
morale and motivation of patients through its progressive grading system. Its portable feature offers the therapist the convenience of exercising certain patients in their rooms or wards. This simplifies scheduling, offers greater safety for the patients, and is time saving for both the therapist and patient. The apparatus offers the therapist an effective piece of equipment for conditioning unaffected parts needed by the patient to begin ambulation. It permits the administration of graded resistance exercise, as well as passive exercise in various planes. It is space saving considering the variety of activities possible.

The apparatus offers the hospital a financial saving by taking the place of additional physical therapists and makes it possible at the same time to render better treatment in a shorter length of time.

The foregoing statements concerning the attributes of the Portable Therapeutic Exercise Apparatus to the patient, therapist and hospital are supported by letter from professional people in the field of orthopedics and physical therapy as indicated in the appendix A, pages 56-63.

The writer feels that the Portable Therapeutic Exercise Apparatus has met with success in its limited trial and demonstration period.
BIBLIOGRAPHY

A. BOOKS


B. PERIODICAL ARTICLES


C. BROCHURE

APPENDIX
April 28, 1954

Mr. Thomas Eaton  
Physical Education Department  
University of Montana  
Missoula, Montana

Dear Mr. Eaton:

I wish to thank you for having had the opportunity to be a sideline observer in the final development of your physical therapy apparatus at St. Vincent's Hospital during the past few months.

Your well-devised apparatus has been worked out in such a manner that there are compact appliances for the exercising of nearly any group of muscles and/or joints. From a very practical standpoint, two things particularly impressed me. (1) The time that is saved to the busy physiotherapist without slighting any phase of the treatment. (2) The stimulus to the patient in continuing his own therapy, owing to the fact that the degree of change or the range of motion can be accurately followed and thus, in several ways, they have more of a visible goal to work toward. In discussions with numerous polio patients in particular this was true.

Once again I congratulate you on your apparatus and admire the ingeniousness that went into it and the capabilities of the apparatus.

Sincerely yours,

L. Clayton Allard, M.D.  
Chief of Staff  
St. Vincent Hospital
April 21, 1954

Mr. L. T. Eaton,
Physical Education Department,
Montana State University,
Missoula, Montana

Dear Mr. Eaton:

I have seen your exercise apparatus in use in the physical therapy department at St. Vincent's Hospital in Billings, Montana.

After observing the many advantages on positioning for various therapeutic exercises, it is my opinion that this apparatus would be a great asset to any physical therapy department.

I recommend it highly.

Sincerely,

Richard I. Cerino, M.A.
Physical Therapist.
APPENDIX A

April 1, 1954

Mr. L. T. Eaton
Montana State University
Missoula, Montana

Dear Tom:

The adaptability of your Portable Therapeutic Exercise Apparatus to do the type of exercises that polio patients need, is, I feel, its most outstanding feature. The nature of progression on the exercises against graded resistance can, and has made it possible, to get the patients to a point where they can be sent home much sooner to carry out their exercise programs. In a hospital situation it is desirable to get the patients well enough so that they can go home and continue on their own. In the P.T. Department, this is our objective; but it differs somewhat from the ordinary hospital department in that, as a general rule with the polio patient, many physical handicaps have to be overcome and conquered if possible. Goals such as the ability to use hands and arms to take care of daily needs, and most important, the feeling of doing things for oneself without the need to be dependent on others.

Because of the case load of polio patients that we have had in the past few years, it has been necessary to keep the patients hospitalized for a long period of time in order to meet the needs of everyday living. With the advent of the Portable Exercise Apparatus it has been possible to cut down the average hospital stay considerably. The P.T. staff here
consists of one therapist and an aide. With the use of the apparatus it has been possible to train this aide to help in the administration of the exercises and to allow the therapist to spend more time doing the more complicated procedures that require the special skills of the profession. The simplicity of the operation of the apparatus makes it possible to teach the patient to operate some attachments for special exercises for themselves and to tell the aide what positions are next in the case help is needed, such as weight resistance, tilting the table-bed and etc. This allows the therapist to exercise more patients in the working day.

The functional positions that can be met with the use of the apparatus are of immeasurable value. The tilting table-bed has been used extensively in graded exercises against gravity. The ease of operation in getting the patient to standing position makes the therapist's job easier and is good for the patients in that they don't have to be lifted or held by some awkward contrivance. Many types of exercises can be done by the usage of the tilting table-bed that otherwise could not be done alone or even with help. The severely involved polio patient needs encouragement, and with the table-bed set in such a position that they can do the needed exercises alone and without some outside help, it gives them a great feeling of accomplishment.

The table-bed has been used quite extensively with the pulley weight progressive system in general conditioning
of musculature that is going to be needed in order to begin ambulation. For example, it has been used in strengthening arms, trunk muscles, and shoulder girdle musculature even though they were not involved by the initial attack of polio. These muscles are necessary for crutch walking, especially if the patient is encased in a pair of double long leg braces.

The convenience of the portable feature has made it possible to take the apparatus to the bedside. It has been designed so that it will fit in our elevator and go through our doorway we have here in the hospital.

With the weights attached to the apparatus it is impossible to the patients to drop any of them on themselves or on others who may be nearby.

The apparatus I feel takes the place of an additional physical therapist in the department and makes it possible to render a better treatment and in shorter length of time than would otherwise be possible. The adaptability to meet all situations and exercise all the body musculature either with assistance or with graded resistance will make it an essential in all physical therapy departments in the near future.

Sincerely yours,

Bob Christensen, P.T.
St. Vincent's Hospital
Billings, Montana
April 23, 1954

Mr. L. T. Eaton
Physical Education Department
University of Montana
Missoula, Montana

Dear Mr. Eaton:

I am very much interested in the apparatus which you have devised and I think in the hands of a person trained in muscle re-education and with a good background of kinesiology it can be a useful piece of equipment for a variety of problems needing muscle re-education or mobilization of joints. It is well suited to good localization of movement. It permits the administration of graded resistance exercise as well as passive exercise in various planes and despite its somewhat complicated appearance on one's first view it is relatively simple to operate with a little study. I think it is advantageous that it takes up so little space considering the variety of activity possible. It appears to be sturdily built and Mr. Christensen tells me that so far it has stood up well with use.

My one concern is that in the hands of either inexperienced or lazy individuals the machine might be substituted in place of skilled muscle re-education which might be a better form of therapy in any individual instance. However, this is really no criticism of your apparatus.

If your apparatus can be produced at a cost that is not prohibitive I would think that it might be of interest
to many physical therapy departments and I would be glad to call it to the attention of the University of Wisconsin Medical School with whom I was previously associated.

Sincerely yours,

Elizabeth Grimm, M.D.
Billings Clinic
Billings, Montana
April 21, 1954

Mr. L. T. Eaton,
Physical Education Department,
Montana State University,
Missoula, Montana.

Dear Mr. Eaton:

I have seen your exercise apparatus in use in the physical therapy department of St. Vincent's Hospital, Billings, Montana.

In my opinion, this apparatus is highly effective for therapeutic exercise. Its outstanding feature is the variety of exercises that can be adapted for the patient.

I would recommend this apparatus to any physical therapy department.

Sincerely yours,

Robert H. Normand, M.A.,
Physical Therapist.
McKorrow, Berman & Davidson
Registered Patent Attorneys
Victor Building
9th and G Place, N. W.
Washington, D. C.

Gentlemen:

RE: Invention of L. Thomas Eaton-
"Portable Therapeutic Exercise Apparatus".

This is in reply to your letter of February 11, 1954, in which you state that it is your opinion that Mr. Eaton can obtain patent protection for his exercise apparatus. He has reviewed the three patents which you enclosed with your letter and is of the opinion that these patents are not anticipatory of his invention. Accordingly, following your recommendation, he desires to proceed with the patent application.

Yours very truly,

COLEMAN, JAMESON & LANEY
Attorneys at Law

By Frank A. Gallagher
Billings, Montana