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(54) **Rotator muscle exercise apparatus.**

(57) This invention relates to a new rotator muscle exercise apparatus. The apparatus comprises a pair of rotatable foot rests (12), each foot rest operably connected to a separate air cylinder (17) whereby the pressure of the air within the cylinder is controlled by the rotation of the foot rests (12). The apparatus allows for development of rotator muscles with particular reference to resistance exercise, including for example strength training, specificity of training, rehabilitation, and preventive conditioning programmes. The apparatus will produce muscle contractions of varying intensities through a full range of motion, yet is simple in design, light-weight and portable. It uses no auxiliary fluid supply source and is completely self-contained and easy to operate.

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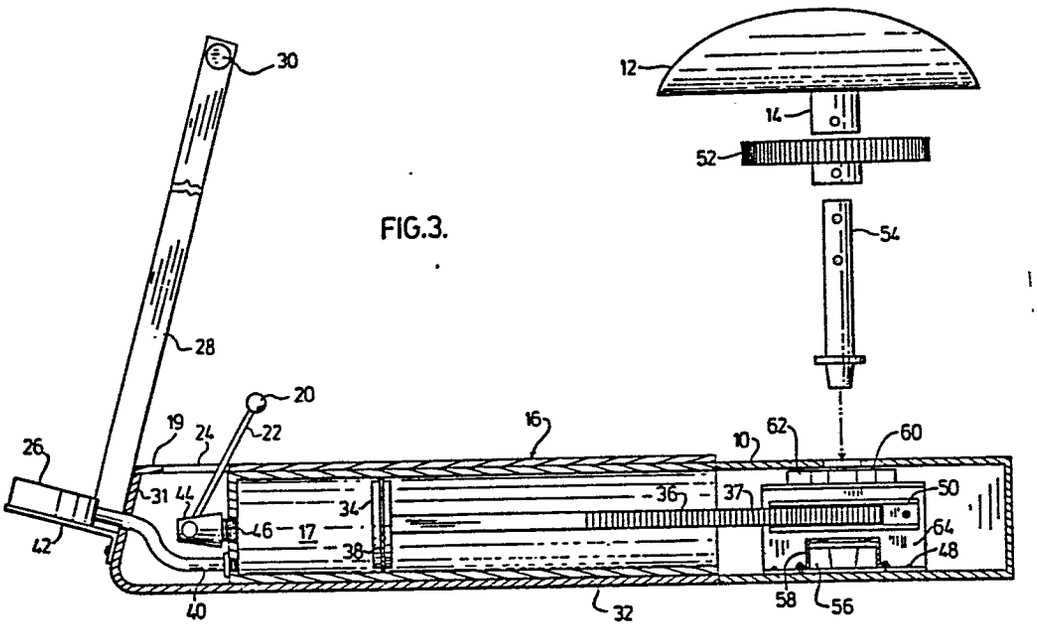
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FIG.3.

ROTATOR MUSCLE EXERCISE APPARATUS

1. Field of the Invention

This invention relates generally to the field of muscle development, exercise and rehabilitation and more particularly, to a new rotator muscle exercise apparatus.

2. Description of the Prior Art

In designing strength or exercise training equipment, consideration must be made of several different factors. These factors include muscle contractions, their types and modes of operation, the specific muscle which the person wishes to develop, the mode of its operation and its particular structure. This latter consideration is commonly referred to as specificity of training or specific muscle isolation.

The present invention relates to the development of rotator muscles with particular reference to resistance exercise. Exercise for the muscles responsible for rotational movement of the leg is advocated for many reasons, including, *inter alia*, to increase strength, to maintain existing strength, to prevent injury, to rehabilitate when injury occurs, and to improve or maintain flexibility. The importance of strength training to conditioning programmes for athletic participation is sometimes overlooked in favour

of cardiorespiratory endurance development, but both should be considered in conditioning programmes.

While the importance of strength to the calibre of athletic performance will vary depending upon the sport, a minimum strength is required for each sport. Strength is required for good performance in each sport, for endurance, acceleration and motor control to co-ordinate the activation of muscles throughout the body to achieve optimal results in producing the desired movement.

Physiologists believe that training of athletes should be as specific as possible to the actual conditions of the sport in which the athlete is involved.

It appears that the central nervous system undergoes adaptions during strength training that permit an individual to more fully use the available muscle capacity. The basic muscle capacity itself, may also increase in the form of hypertrophy and structural changes. The most efficient mode of training would appear to be one in which the muscles are activated in as similar a manner as possible to that of the actual athletic performance, so that the central nervous system uses specific consistent neural pathways.

A strength-training unit, designed to specifically exercise the muscles involved in leg rotation, is therefore, more logical than using devices which exercise the same muscles but in other functions. That is, the muscles involved in medial rotational (inward turning) of the tibia or the

femur at the flexed knee joint are the medial hamstring muscles: sartorius, gracilis, semimembranosus and semitendinosus. The biceps femoris muscle acts alone to laterally rotate the knee. It is noted that the popliteus muscle, which lies across the posterior aspect of the knee, unlocks the knee joint from terminal lateral rotation of the tibia. While these hamstring muscles are also active during flexion of the knee and can be trained with this movement, if increasing knee rotational strength is the goal of the exercise program, then knee rotation exercises are more appropriate. A similar statement can be made for the hip rotator muscles, which also are active in two or more movements of the hip joint.

In summary, it is concluded that increased strength for the movements of hip and knee rotation can contribute to improved performance in events where powerful forces are required to be developed by the involved muscles. Optimal training for increased strength, or strength maintenance would appear to take the form of the actual rotation movement, although the involved muscles may receive some benefit from other types of joint movement. The knee rotation strength of the hamstring muscles is not predictable from their flexion strength, a finding which has obvious important implications for strength testing procedures. It thus appears that knee rotation strength should be tested separately from knee flexion strength.

After a period of strenuous training for increased strength has resulted in the attainment of desired strength levels, a less extensive program to simply maintain those levels may be instituted. That is, the muscles are no longer provided with the constant "overload" stimulus that is necessary for strength improvement. Rather, a program of reduced intensity may be utilized to prevent the strength losses which would occur if training activity was completely stopped, that is, in the case of training programs for athletic competition for example, during the off-season. Ideally, the athlete can take his strength-training equipment with him, when travelling during the competitive season, and accurate records of strength levels are kept year-round.

It is apparent that the integrity of a joint depends on several structures, namely, the bony structure of the joint, the supporting ligaments and the muscles surrounding it. While the bony structure of a joint seems fixed, at least after maturation of the skeletal system, it has been observed that the ligaments and muscles of a joint can be strengthened through training programs, thereby adding stability to the joint.

In the case of preventing knee joint injuries, the contribution of the rotator muscles has received little

attention until recently. Commonly, the knee was discussed in terms of its flexion and extension function, with considerable importance being placed on having balanced quadriceps (extensors) and hamstrings (flexors) strength. It appears that rotational knee exercises should also be part of an athlete's conditioning program, because as discussed hereinafter with respect to rehabilitation of joint injuries, the knee is often subject to rotational torques that sometimes cause severe internal derangement.

There can be no question however, that preventive conditioning programs are worth the time and effort, when the considerable money and sport participation time that are lost at all levels of competition due to injuries are considered. Prevention of sport injuries should be a multi-faceted endeavour, including attention to equipment, playing conditions and rules. But the importance of physical conditioning should not be overlooked. The recreational athlete may be particularly prone to injuries stemming from poor conditioning for sport participation. It has been observed that injuries to the knee constituted 45.5% of all injuries seen in a sports medicine clinic that dealt with primarily recreational athletes, a figure which stresses the vulnerability of the knee in this population.

Knee joint injuries are considered to be the most common form of joint injury suffered by athletes, particularly by those who engage in contact sports. One of the major

mechanisms of injury is that of a rotational torque being applied to the femur, while the foot and lower leg are in a state of fixation and the knee joint partially flexed. This rotational torque, which can be the result of a force applied to the lateral side of the knee (e.g. a football tackle), can produce a very serious derangement of the knee joint known as the "unhappy triad": where tearing of

1. the medial collarteral ligament
2. medial meniscus and
3. anterior cruciate ligament occurs. Rotary instability appears to be a consequence of such knee ligament injuries.

A commonly used approach to correct this instability is the surgical procedure known as the pes anserinus transplant, in which the medial hamstrings effectiveness as a medial knee rotator is surgically increased, via a tendon transplant, thereby providing muscular stability to the knee. As a result of the surgery and inactivity, however, muscle atrophy occurs which must be reversed before these muscles can fully contribute in their new stabilizer role. Progressive resistance exercise is advocated for strengthening purposes and specific training devices for the knee rotators appear to be warranted. Further it seems appropriate that in any rehabilitation of a previously inactive knee, the rotator muscles should receive training, as well as the

extensor and flexors, but this is not always done. The same conclusion can be applied to the rehabilitation of hip function.

The devices of the prior art have attempted to consider the foregoing principles but are not in widespread use. Some of the devices use weights for resistance such as that reported by Robertson et al, Medicine and Science in Sports, Vol. 6, No. 4, pp. 277-282 (1974). This device was developed to obtain information concerning the use of active resistive exercise in rotation of the leg and its effect on the stability of the knee, and is quite complicated in structure. Other devices such as the Lumex Isokinetic System and others, do not specifically act on the rotator muscles.

This type of equipment on the market today, in addition to the previously mentioned drawbacks, is extremely cumbersome and expensive. As a result, it is found only at health clubs, rehabilitation centres, and the like with the result that they do not have widespread use by athletes who require a light-weight, inexpensive and portable apparatus which is suitable for home use and also use at training facilities.

SUMMARY OF THE INVENTION

Accordingly, it is an object of the present invention to at least partially overcome these disadvantages

by providing a novel rotator muscle exercise apparatus which will produce muscle contractions of varying intensities through a full range of motion.

It is a further object of this invention to provide a novel rotator muscle exercise apparatus which is simple in design and which may be manufactured and sold for home use.

It is a yet further object of this invention to provide a light-weight and portable rotator muscle exercise apparatus.

A further object of the present invention is to provide a rotator muscle exercise apparatus which uses no auxiliary fluid supply source and is completely self-contained and easy to operate.

A further object of this invention is to provide a novel rotator muscle exercise apparatus which allows for specific muscle isolation and specificity of training for the rotator muscles.

A further object of the present invention is to provide a novel rotator muscle exercise apparatus which allows an athlete to increase the strength of his rotator muscle, maintain the existing strength, prevent injury and to rehabilitate selected injured rotator muscles.

To this end, in one of its aspects, the invention provides a rotator muscle exercise apparatus which comprises a pair of rotatable foot rests, each foot rest operably connected to a separate air cylinder whereby the pressure of the air within said cylinder is controlled by the rotation of said foot rests.

In another of its aspects, the invention further provides a rotator muscle exercise apparatus which comprises a

(i) a pair of rotatable foot rests.

(ii) a pair of air cylinders contained within a housing, each cylinder including a toothed piston rod and a piston seal attached to one end thereof, said seal adapted to control the pressure of the air in said cylinder,

(iii) at least one air valve adapted to regulate the pressure of the air within said cylinder,

(iv) control means adapted to control the operation of said at least one air valve,

(v) a pair of indicator means, each indicator means communicating with one air cylinder and adapted to indicate the air pressure within said cylinder,

(vi) support means adapted to support and balance the user of the apparatus, and

(vii) two drive means adapted to drive the piston rod inwardly or outwardly of the cylinder in response to rotational movement of said foot rests, whereof the amount of air pressure within each cylinder is increased or decreased in response to the rotational movement of the foot rest.

Further objects and advantages of the invention will appear from the following description taken together with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGURE 1 is an end elevational view of the rotator muscle exercise apparatus of the present invention.

FIGURE 2 is a top view of the rotator muscle exercise apparatus of the present invention.

FIGURE 3 is an exploded sectional view along line III-III of figure 2.

FIGURE 4 is a sectional view along line IV-IV of figure 1.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring first to figure 1 and 2, there are shown an end elevational view and a top view, respectively, of the rotator muscle exercise apparatus of the present invention.

The apparatus comprises a base 32 which is a thin plate which extends the length of the apparatus and has an upturned forward portion 31 as shown in figure 3. A forward housing 16 is mounted on the forward part of the base 32 and includes a front part 19 at its forward end which is secured to the top edge of the upturned forward portion 31 of base 32 as shown in figure 3. A rear housing 10 is mounted on the rear of the base 32 and abuts the rear end of the

housing 16. A pair of foot rests 12, each of which is mounted on a separate shaft sleeve 14, are located on the top surface of rear housing 10. A handle 20 is mounted on a lever 22 which moves in slot 24 which is cut centrally in the forward part 19 of the housing 16. A pair of gauges 26 are located on a bracket 42 which is secured to the upturned front part 31 of base 32. A support stand 28 with support base 30 on the top thereof is located at the forward end of the device.

Referring now to figure 3, there is shown an exploded sectional view along line III-III of figure 2. It must be remembered that only one side of the apparatus is shown and will be described although the structure of the apparatus is substantially duplicated on the opposite side, the purpose of which will be explained hereinafter.

Inside housing 16 there is located a pair of air cylinders 17 (only one is shown) which lie parallel along the length and within housing 16. Each air cylinder 17 is contained within housing 16 and includes a piston 34 which comprises a piston rod 36 and a seal 38. The piston 34 is movable along the horizontal axis of each cylinder 17.

A hose 40 is provided at the forward end of each cylinder 17 and communicates with said cylinder 17 and a gauge 26 is mounted on bracket 42 which is in turn secured to the upturned forward portion of the base 32. The support stand 28 is mounted on the upturned forward end 31 of the base 32 with support bar 30 at the top of the stand 28.

An air valve 44 is provided at the forward end of each cylinder 17 and communicates therewith via the threaded valve connection 46 and is controlled by a single lever 22 which terminates in handle 20. A slot 24 is provided on the top of the housing 16 for movement of the lever 22.

A stand 64 located within rear housing 10 is secured to the base 32 by bolts 48 or any other suitable means.

The piston rod 36 is formed as a rack member with teeth 37 on the peripheral surface thereof and fits within rack guide 50 which is mounted in stand 64. In the assembled condition, the teeth 37 of the piston rod 36 engage the teeth of gear 52 which is fitted on a vertical shaft 54, the bottom end of which is seated in a thrust bearing 56 which is supported by mount 58. The vertical shaft 54 is supported in the vertical position by means of second bearing 60 mounted in brace 62. The brace 62 is mounted on the top surface of the support 64. A foot rest 12 is mounted on the top of each vertical shaft 54 by shaft sleeve 14.

Referring now to figure 4, there is shown a sectional view along line IV-IV of figure 1, which shows the structure of figure 3 in the assembled condition. As seen in figure 4, as gear 52 is rotated in any direction, this will drive the piston rod 36 forwardly or rearwardly.

The operation of the novel apparatus will now be explained. The user of the apparatus, either in the standing or the sitting position, places his feet in the foot rests 12 and performs either of two essential movements by rotating his feet.

The first movement is achieved by rotating both feet in a clock-wise direction then rotating the feet in a counter-clock-wise direction in unison. Basically, this movement involves the use of the hip joint and trunk muscles of the obliques and lower back if the user performs the exercise in an upright or standing position. When the exercise is performed in the seated position, the primary areas affected are the ankle and the knee joint.

The second basic movement involves the use of the ankle, knee and hip joint when performed in a standing position. This is accomplished by rotating the feet toward each other and away from each other. When done in a seated position, the primary areas affected are the ankle and the knee joint.

As can be seen from the drawings, as the foot rest 12 is rotated, this causes gear 52 to drive the piston rod 36 in a forward or a rearward direction. This in turn changes the volume of the area in front of the piston seal and the front wall of the air cylinder 17 thus creating either increased pressure or a partial vacuum therein. By manipulating the handle 20 which controls the air valve 44, the

amount of air pressure in that cavity may be adjusted thereby allowing the operator to adjust the resistance or tension of the exercise to suit his own needs. The level of the air pressure is easily read by the gauges 26 which are attached to the respective cylinders. Support bar 30 is used to allow the user to maintain his balance during the exercise.

The apparatus is very beneficial in developing, strengthening and rehabilitating rotator muscles. The apparatus allows for exercise of various rotator muscles which are essential to development, some of which are now outlined.

The apparatus allows for both inward rotation and outward rotation of the hip joint, thus directly acting on the gluteus medius, gluteus minimus, tensor fascial latae, adductor longus, adductor brevis, adductor magnus, and iliopsoas major muscles (inward rotation) and the gluteus maximus, piriformis, obturator extermust, obturator intermus, gemelli (superior and inferior), quadratus fermoris, sartorius and adductor magnus muscles (outward rotation).

The apparatus also allows for proper exercise of the abdomen since the rectus abdominis, the external and internal oblique muscles all work during rotation.

Although the types of movement allowed by the vertebrae vary considerably, rotation occurs most freely in

the cervical and lumbar regions and to a limited degree in the docsulumbar region. It has been long recognized that all conditioning programmes should include exercise involving the spine or vertebral column to help prevent back injuries. Such exercises includes correction, amelioration or compensation of functional postural deviations, maintenance or increase of the trunk and general body flexibility and increase of trunk and general body strength.

All basic conditioning should include an emphasis on trunk flexibility and the present apparatus allows for maximum range of motion in trunk rotation in lateral flexion. The apparatus develops the extensors and abdominal strength which aids in proper postural alignment. The apparatus also allows for restoration of normal flexibility, strength improvement and postural correction for rehabilition after injury.

The apparatus also allows for good exercise of the knees. Outward rotation of the knee is controlled by the biceps femoris, and inward rotation by the popliteus, the semi-tendinous the semi-membranosus, the sartorius and the gracilis, all of which are properly exercised with this apparatus.

It is also important that with the current popularity of the pes anserinus transplant surgery for rotary instability of the knee, special exercise considerations

must be given. The pes anserinus is the aponeurosis of the internal hamstring muscle and when surgically transplanted, is brought forward to the front of the tibia. In addition to a therapeutic exercise programme to promote flexibility and progressive resistive exercises, the present apparatus allows the athlete to perform internal tibia rotation with progressively increased resistance.

The present apparatus avoids the use of complex and expensive devices of the prior art and needs no electrical input. It is a relatively simple and efficient apparatus which can be manufactured at a low cost and which can easily be made portable.

Several other advantages of the present apparatus include the following. The present apparatus is based on the air pressure within the cylinder and thus, provides an advantage over the devices which utilize oil pressure to create resistance of movement. No recharging is necessary and no leakage of messy oil can occur.

The present apparatus allows complete freedom of movement and can be used in the standing, the sitting or the kneeling position. Rotation can also be made in either direction.

The present apparatus is completely self-contained and needs little or no maintenance. It allows the user

to adjust to his own needs, the amount of resistance to exercise thus allowing complete specificity of training. It provides for concentric contractions and can be altered to provide this type of contraction easily and quickly by the user.

Various modifications of the apparatus may be made within the spirit and scope of the present invention. These modifications may be made to reduce the amount of material required to produce the apparatus to reduce its costs and weight. Some of these modifications will now be described.

Base 32 may be replaced with a pair of rails which extend rearwardly from the upturned forward portion 31. In this embodiment, housing 16 rests on the rails and the stand 64 is secured directly to the rails by any well known means such as bolts 48. This would reduce the weight of the apparatus.

In another embodiment, the gauges 26 may be located on the top of housing 16 and in direct communication with each air cylinder 17. While gauges 26 are not essential to the invention, they do aid the user in determining the relative air pressure within the cylinder. The location of the gauges is not critical provided that they are large enough for the user to read easily from the operating position.

In a still further variation of the apparatus, the number of valves 44 may be varied and as a result, the number of levers 22 may also be varied. For example, a single valve 44 with a single lever 22 may serve to vary the amount of air present in both cylinders 17 or alternatively, there may be present two valves, each of which communicates separately with one cylinder 17 and one lever or two levers. In the embodiment utilizing two valves and a single lever, the lever opens and closes the two valves simultaneously. If the two levers are used, each lever could operate a single valve and the amount of air in each cylinder would be independently controlled.

Although the disclosure describes and illustrates a preferred embodiment of the invention, it is to be understood the invention is not restricted to this particular embodiment.

What I Claim is:

1. A rotator muscle exercise apparatus which comprises a pair of rotatable foot rests, each foot rest operably connected to a separate air cylinder whereby the pressure of the air within said cylinder is controlled by the rotation of said foot rests.

2. An apparatus as claimed in claim 1 wherein said pair of air cylinders are contained within a housing.

3. An apparatus as claimed in claim 1 wherein each air cylinder includes a piston rod and a piston seal attached to one end thereof, whereby the pressure of the air in the cylinder is variable in response to the position of the seal in the cylinder.

4. An apparatus as claimed in claim 3 further including at least one air valve adapted to regulate the pressure of the air within said cylinders.

5. An apparatus as claimed in claim 4 including two air valves, each valve communicating with one cylinder, and a control means adapted to control the operation of said valves.

6. An apparatus as claimed in claim 5 further including a pair of indicator means, each indicator means communicating with one air cylinder and adapted to indicate the air pressure within said cylinder.

7. An apparatus as claimed in claim 1 further including a support means adapted to support and balance the user of the apparatus.

8. An apparatus as claimed in claim 2 including two drive means adapted to drive the piston rod inwardly or outwardly of the cylinders in response to rotational movement of said foot rests.

9. An apparatus as claimed in claim 8 wherein said piston rod has a toothed peripheral surface and said drive means comprises a gear mounted on a shaft, said shaft seated in a thrust bearing supported on a mount and a second bearing adapted to support said shaft, said shaft adapted to turn said gear in response to the rotational movement of said foot rest.

10. An apparatus as claimed in claim 9 further including a rack guide adaptable to guide and support the terminal portion of said piston rod.

11. A rotator muscle exercise apparatus which comprises a

(i) a pair of rotatable foot rests,

(ii) a pair of air cylinders contained within a housing, each cylinder including a toothed piston rod and a piston seal attached to one end thereof, said seal adapted to control the pressure of the air in said cylinder.

Claim 11 continued

(iii) at least one air valve adapted to regulate the pressure of the air within said cylinder,

(iv) control means adapted to control the operations of said at least one air valve,

(v) a pair of indicator means, each indicator means communicating with one air cylinder and adapted to indicate the air pressure within said cylinder,

(vi) support means adapted to support and balance the user of the apparatus, and

(vii) two drive means adapted to drive the piston rod inwardly or outwardly of the cylinder in response to rotational movement of said foot rests, whereby the amount of air pressure within each cylinder is increased or decreased in response to the rotational movement of the foot rests.

12. An apparatus as claimed in claim 11, wherein said drive means comprises a toothed gear mounted on a shaft, said shaft seated in a thrust bearing supported on a mount, and a second bearing adapted to support said shaft, said shaft adapted to turn said gear in response to the rotational movement of said foot rest.

13. An apparatus as claimed in claim 12 further including a rack guide adapted to guide and support the terminal end of said piston rod.

FIG.1.

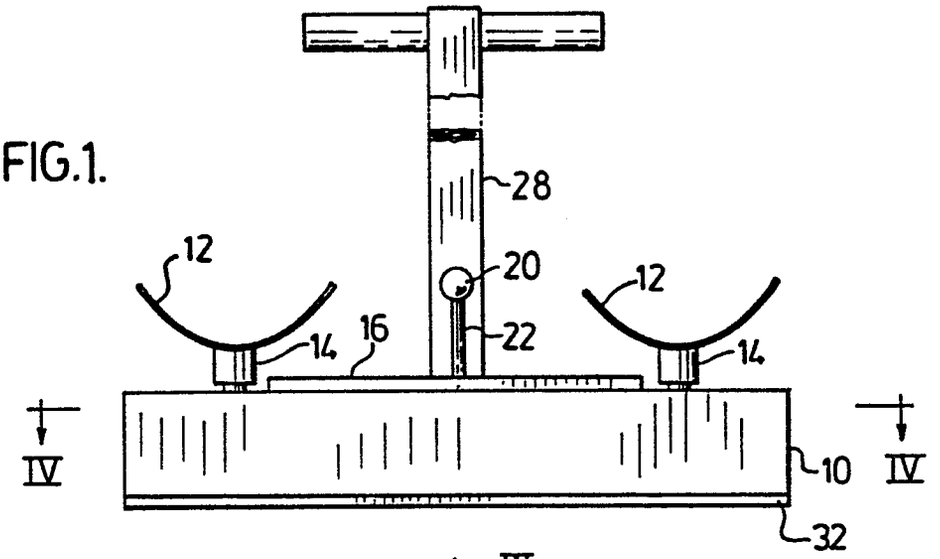
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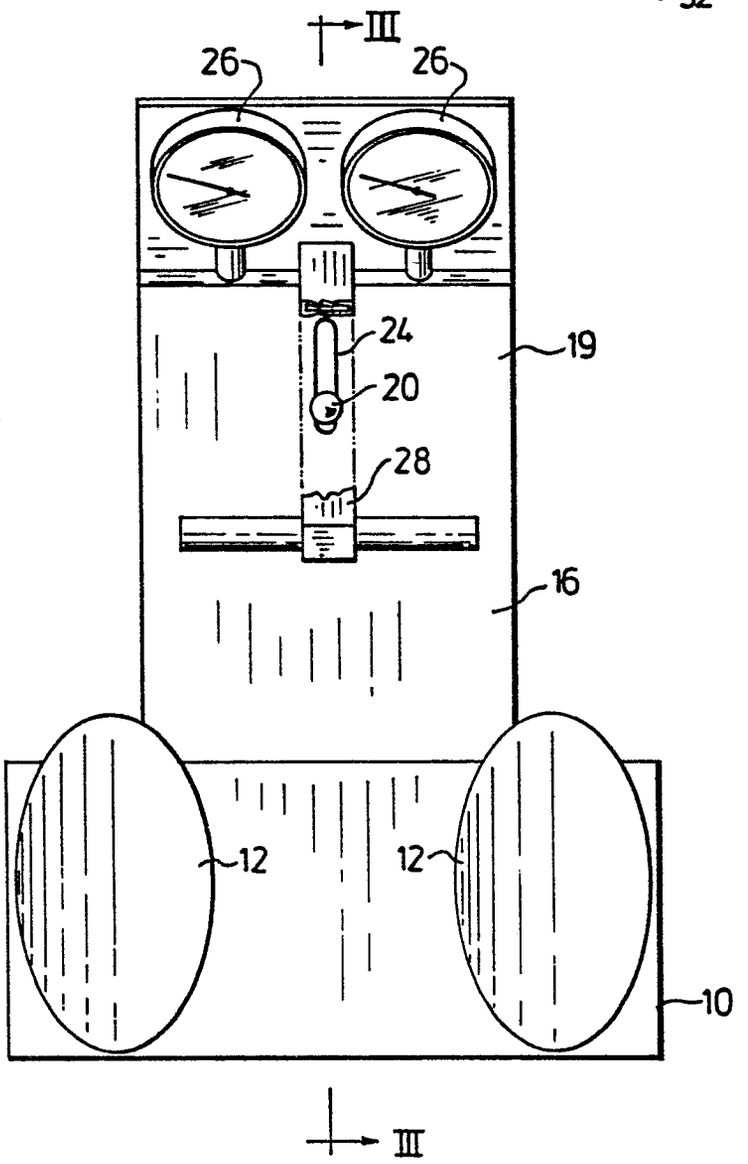
FIG.2.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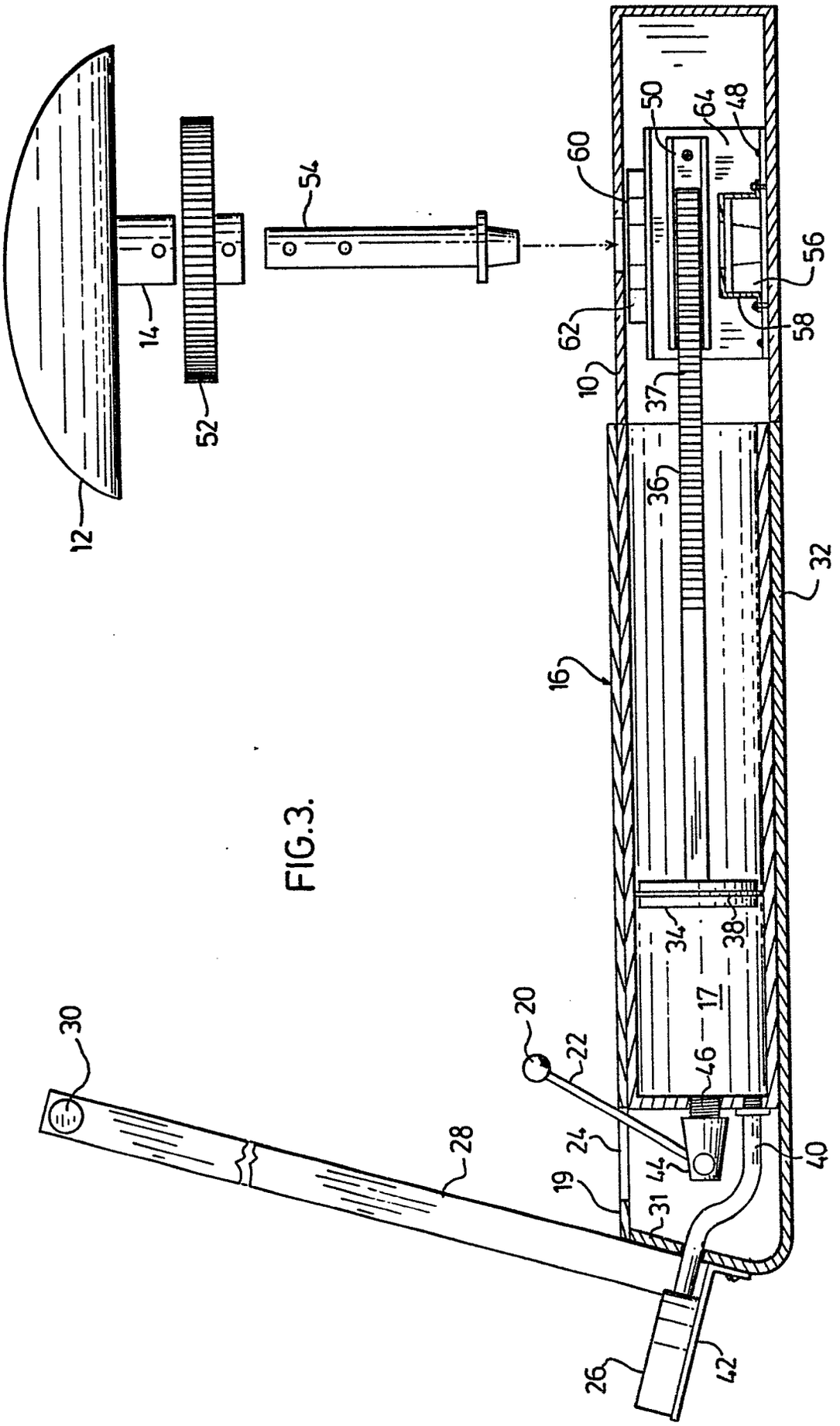
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FIG.3.

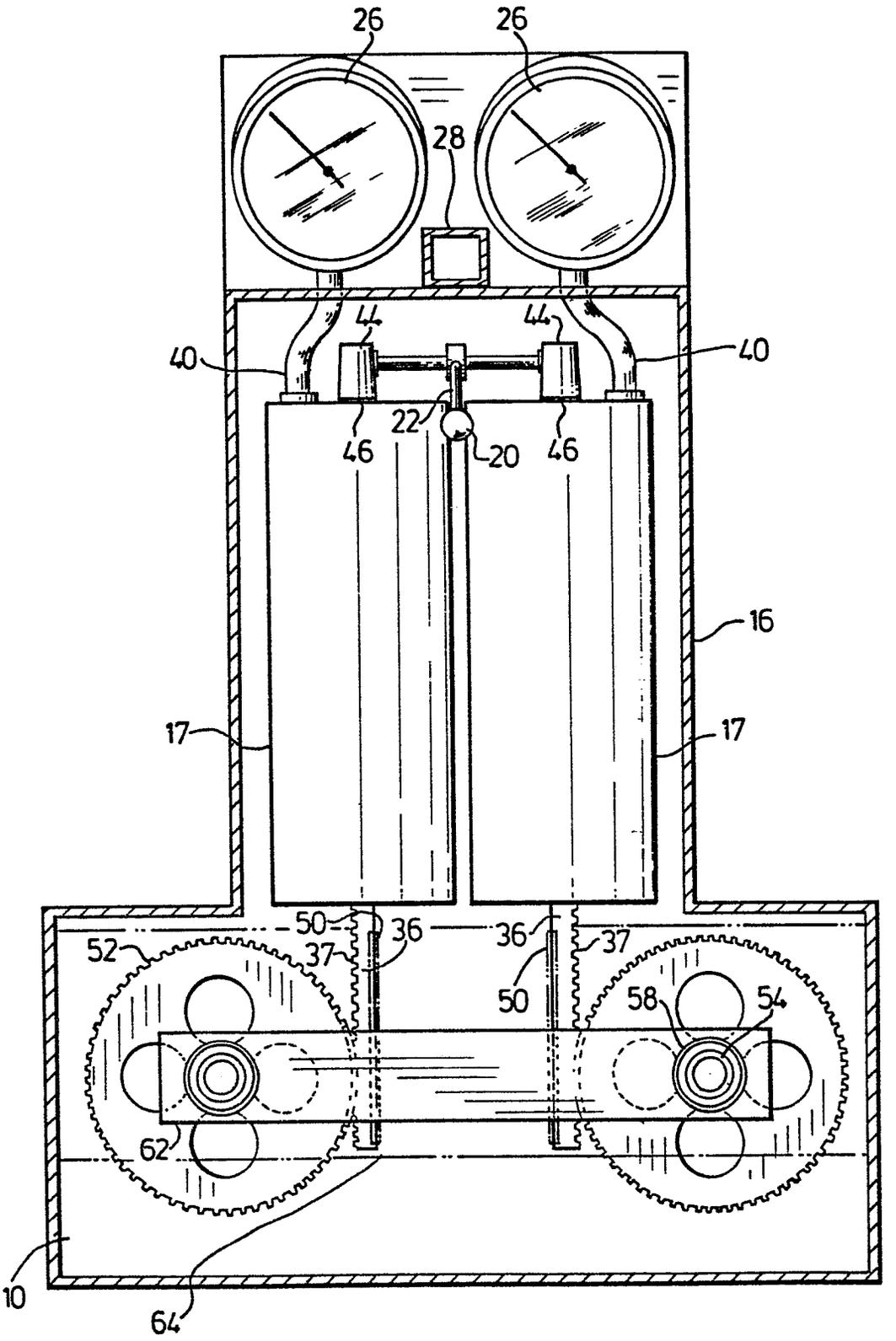
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FIG.4.

European Patent Office

EUROPEAN SEARCH REPORT

0155415
. Application number

EP 84 30 1765

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int Cl 4)
X	FR-A-1 291 700 (COSTA) * Page 2, colum 2; figures *	1-3,8	A 63 B 23/04 A 63 B 21/00H
Y	---	4-7,9-13	
Y	US-A-3 702 188 (PHILLIPS) * Column 2, line 68 - column 3, line 52; figures * ---	4-6,9-13	
Y	US-A-3 529 474 (OLSON) * Column 1, line 41 - column 3, line 64; figures * ---	5-7,11-13	
X	US-A-3 756 595 (HAGUE) * Abstract; column 3, lines 15-27; figures 1,6 * ---	1,3,7,8	TECHNICAL FIELDS SEARCHED (Int. Cl.4) A 63 B
A	EP-A-0 073 744 (FISCHER) * Page 8, line 32 - page 9, line 30; figures 1,2 * ---	1-5,10,11,13	
A	EP-A-0 060 063 (WARREN) * Figure 4 * -----		

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	19-11-1984	GERMANO A.G.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
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E : earlier patent document, but published on, or after the filing date
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