Dec. 9, 1952 G. GREISSINGER 2,620,485

ARTIFICIAL FOOT WITH ANKLE-JOINT

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Fig. 1

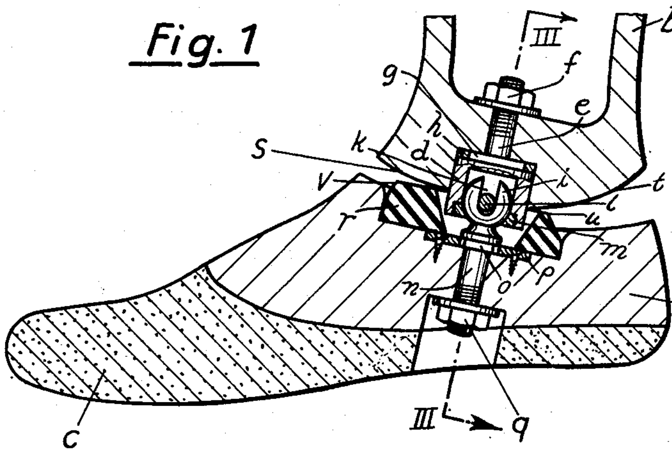


Fig. 2

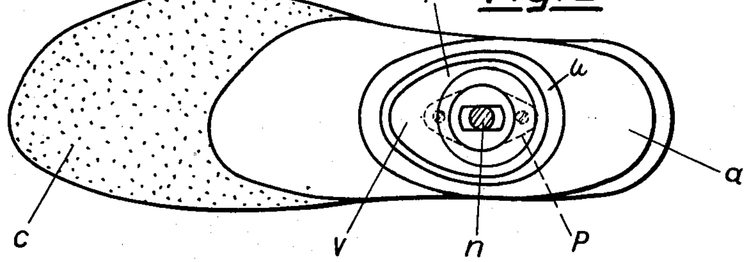


Fig. 3

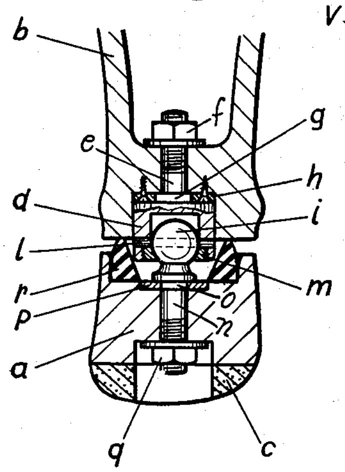


Fig. 4

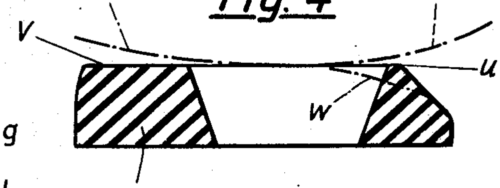
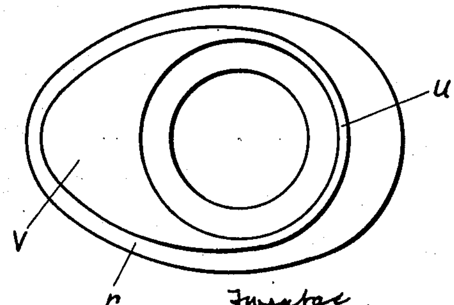


Fig. 5



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ARTIFICIAL FOOT WITH ANKLE-JOINT

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3 Claims. (Cl. 3—6)

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The invention relates to an artificial foot with an ankle-joint which, on the foot part and on the shank part, is provided with cooperating generating surfaces. Such an artificial foot is known and has proved its value. In the known embodiment two generating bodies are provided which are screwed to the foot part and to the shank part. Both of the generating bodies are connected laterally by means of links, while foot part and shank part are held together by means of a spring supported tie-bolt link-supported to the latter.

In contradistinction thereto, the subject of the invention is distinguished by the feature that the ankle-joint has joint parts which are installed rigidly within the foot part and shank part, and that at least one of the generating surfaces appertains to a generating body which is of elastic material, for example, rubber. The same is preferably inserted merely between foot part and shank part, for example, into a recess of one part and the other generating surface is to be provided for directly on the other part. This new conformation signifies a remarkable structural simplification.

The invention further provides for the development of the ankle-joint to be universally movable, for example, as a ball-and-socket joint or as a universal joint. By this means, an ankle-joint is obtained which is movable in every direction as is extant in the human foot, and of gerat importance for unimpaired walking on any kind of surface.

The generating body of elastic material, whose outline may be circular, oval or rectangular, is preferably developed so that it will have the greatest yieldability on the side facing the heel. The objective is that when turning the joint towards the front the resistance is greater than when turning it towards the rear, corresponding to the natural ankle joint.

An artificial foot, with a universally movable ankle-joint, in which both parts are held together by a universal joint, is in itself known. However, in this instance, the matter in question is an artificial foot with an intermediate rubber part which is, when moving the foot part with respect to the shank part, merely deformed, and does not constitute a generating body.

In the drawing an embodiment of the subject of the invention is illustrated in 5 figures, it is shown in:

Fig. 1, a longitudinal section of the artificial foot,

Fig. 2, a top view upon the foot part,

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Fig. 3, a section taken on the line A—B of Fig. 1,

Fig. 4, a longitudinal section of the elastic generating body in somewhat enlarged scale, and

Fig. 5, a top view of the same.

The foot part is designated by *a*, and the shank part by *b*. The lower part and the fore part of the foot may be formed in a conventional manner (see Figs. 1–3) by a yielding foundation *c*, for example, of felt. Foot part *a* and shank part *b* are linked to each other. The joint is universally movable and is developed as a ball-and-socket joint. The one part *d* of the joint having the form of a bushing is inserted into a recess provided in the bottom of the shank part *b*. With its threaded extension *e* it penetrates the bottom of the shank part *b* and by means of a nut *f* it is screwed tightly to the latter. The recess in the shank part is reinforced on its bottom part by a metal plate *h* in which a protection against torsion is effected by an oblong shoulder *g*. The other joint part *i* is a ball which is provided with a slot *k* open at the top, through which a pin *l* extends which is supported in the joint part *d* transverse to the longitudinal direction of the foot. By this, the ball is insured against torsion about the axis of the shank part *b*. A threaded bushing *m*, screwed into the hollow space of the joint part *d*, is developed as a socket for the ball *i*. To fasten the ball *i* on the foot part *a* the former has a threaded extension *n* penetrating the latter, and a nut *q* is screwed on this extension in a recess of the foot part *a*. The threaded extension *n* bearing the ball *i* is secured against torsion by an oblong shoulder *o* in a metal plate *p* fastened to the foot part *a*.

On the upper face of the foot part *a*, within the range of the joint, a recess is provided into which, an annular generating body *r* which, for instance, is of rubber, is inserted. The shank part *b* is supported upon this generating body, whose outline as shown in Figs. 2 and 5, is preferably oval, but it may also be circular or rectangular. The supporting surface of the shank part is developed as a curved generating surface. The front part *s* of the generating surface is curved less than the rear part *t* (see esp. Fig. 4). The generating surfaces *v*, *u* of the elastic body *r* lie in the same plane. The rear part of the surface, as is indicated by dash and dot lines *w*, may also slope somewhat. Owing to the oval form of the generating body *r*, as perceived from Figs. 2 and 5, and to the recess for the joint parts being displaced out of the center towards the rear, the front supporting surface *v* is large, whereas the

rear supporting surface *u* is merely a small semi-annular surface. This has the result that the elastic generating body presents its greatest yieldability on the rear part facing the heel. Consequently, when turning the joint towards the front, the resistance is greater than when turning it towards the rear which is also the case with the human foot. Also, this effect is assisted by the fact that the rear part *t* of the generating surface on the shank part *b* is curved more than the front part *s*.

Because of the ball-and-socket joint, the foot part *a*, with respect to the shank part *b* permits universal movement. During all these movements a mutual generating motion of the surfaces *v*, *s*, respectively *u*, *t* takes place which is attained by an elastic yielding of the elastic material of the generating body, according to the advance or recession of the parts *a* and *b*. Turning motions of the foot transverse to the longitudinal direction are also possible; they are limited by the transverse pin *l* to an extent, corresponding to that in the natural ankle joint.

A Cardan joint may of course take the place of the ball-and-socket joint. Abandoning the lateral movability of the foot part *a*, a simple rule-joint would also lie within the scope of the invention.

It will be obvious that the details of construction may be varied from those shown in the drawing. I therefore do not limit myself to such details.

Having described my invention I claim:

1. Artificial ankle joint apparatus comprising in combination, an artificial foot portion; an artificial limb having a lower end portion located directly above and in spaced relation to said foot portion; and universal joint means located between said portions and being fixedly connected thereto so that said portions may rotate with respect to each other but may not move toward or away from each other; first resilient means located on the toeward side of said joint means for yieldingly resisting rotation of said artificial limb toward the toe of said artificial foot portion, said first resilient means comprising a substantially semicircular block of resilient material mounted on one of said portions and having a substantially flat, broad outer surface confronting and at least partially spaced from the other of said portions; and second resilient means located on the heelward side of said joint means for yieldingly resisting rotation of said artificial limb toward the heel of said foot portions, said second resilient means comprising a substantially semicircular block of resilient material mounted on said one of said portions, being of substantially less volume than said first resilient means and having an outer surface confronting said other portion, being of substantially less area than said outer surface of said first resilient means and being located in the same plane as the latter.

2. Artificial ankle joint apparatus comprising in combination, an artificial foot portion; an artificial limb having a lower end portion located directly above and in spaced relation to said foot portion; and universal joint means located between said portions and being fixedly connected thereto so that said portions may rotate with respect to each other but may not move toward or away from each other; first resilient means located on the toeward side of said joint means for yieldingly resisting rotation of said artificial limb toward the toe of said artificial foot portion, said first resilient means comprising a substantially semicircular block of resilient material mounted on one of said portions and having a substantially flat, broad outer surface confronting the other of said portions; and second resilient means located on the heelward side of said joint means for yieldingly resisting rotation of said artificial limb toward the heel of said foot portions, said second resilient means comprising a substantially semicircular block of resilient material mounted on said one of said portions, being of substantially less volume than said first resilient means and having an outer surface confronting said other portion, being of substantially less area than said outer surface of said first resilient means and being located in the same plane as the latter, said lower end portion of said artificial limb having curved surfaces confronting said first and second resilient means and said curved surface which confronts said first resilient means being generated on a radius which is substantially larger than the radius on which said curved surface confronting said second resilient means is generated.

3. Artificial ankle joint apparatus comprising, in combination, an artificial foot portion formed with a recess in its upper surface and with a bore extending therethrough and communicating with a central part of said recess; an artificial limb having a lower end portion located in overlying and spaced relation with respect to said recess, said lower end portion having a curved surface confronting said recess with the portion of the curved surface located on the toeward side of said end portion being generated on a radius which is substantially larger than the radius on which the portion of the curved surface located on the heelward side of said end portion is generated, and said end portion being formed with a bore extending therethrough; ball and socket joint means located between said foot portion and end portion, said ball being integral with a shaft extending through said bore in said foot portion and fixedly mounted against movement therein, said socket being integral with a shaft extending through said bore in said end portion and being fixedly mounted against movement therein, whereby the limb is prevented from moving as a unit toward and away from the foot portion as in a natural ankle joint, said ball being formed with a slot extending therethrough and said socket having a cross shaft fixedly connected therein and located in said slot, said shaft being of slightly less thickness than said slot so as to permit said ball and socket to rotate slightly about the longitudinal axis of said artificial limb as in a natural ankle joint; a substantially oval block of resilient material mounted in said recess in said foot portion and being formed with a central substantially circular opening in which said joint means is located, said block having a broad substantially flat upper surface located on the toeward side thereof and confronting the portion of the curved surface located on the toeward side of said end portion so as to contact the same during movement of said limb toward the toe of said foot portion and said block having a narrow upper surface of substantially less area than said flat upper surface, located on the heelward side thereof and confronting said portion of the end portion curved surface located on the heelward side thereof so as to contact the same during rotation of the limb toward the heel of the foot member, whereby the

limb may be moved toward the heel with greater ease than toward the toe as in a natural ankle joint.

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