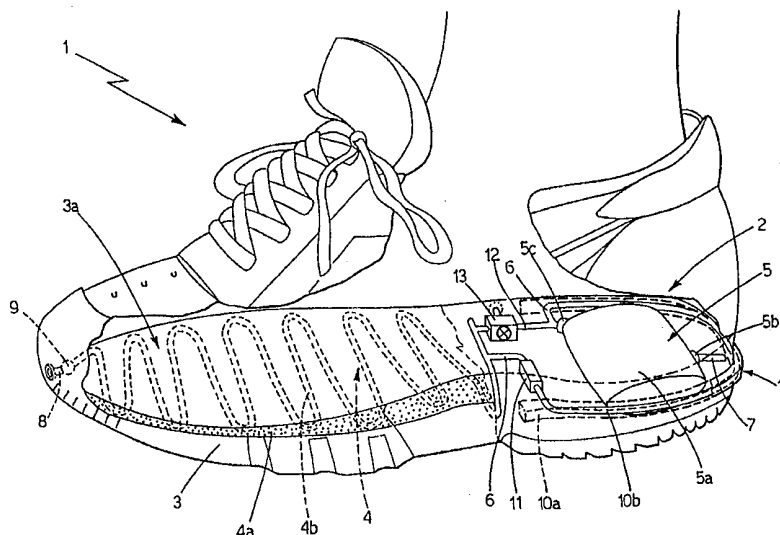




## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification <sup>7</sup> : A43B 7/02	A1	(11) International Publication Number: WO 00/30484 (43) International Publication Date: 2 June 2000 (02.06.00)
(21) International Application Number: PCT/IT99/00384 (22) International Filing Date: 24 November 1999 (24.11.99) (30) Priority Data: BO98A000656 24 November 1998 (24.11.98) IT (71)(72) Applicants and Inventors: RICCO', Bruno [IT/IT]; Via Sant'Apollonia, 2, I-40126 Bologna (IT). VALORI, Domenico [IT/IT]; Galleria del Commercio, 5, I-62100 Macerata (IT). (74) Agents: JORIO, Paolo et al.; Studio Torta S.r.l., Via Viotti, 9, I-10121 Torino (IT).		(81) Designated States: AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, DE, DK, DM, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).  Published With international search report. Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments. In English translation (filed in Italian).

(54) Title: SHOE WITH AN ACTIVE AIR-CONDITIONING DEVICE



## (57) Abstract

A shoe (1) having an active air-conditioning device (2) for maintaining the temperature inside the shoe (1) at a value selectively above or below the temperature of the outside environment; the air-conditioning device (2) being integrated in the sole (3) of the shoe (1), and having a main heat exchanger (4) for exchanging heat with the inside of the shoe (1); an air compressing device (5) for feeding a pressurized air stream to the main heat exchanger (4); an auxiliary heat exchanger (10) located between the air compressing device (5) and the main heat exchanger (4) to reduce the temperature of the pressurized air stream; an expansion valve (11) located immediately downstream from the auxiliary heat exchanger (10) to rapidly expand and so cool the pressurized air stream; and a bypass conduit (12), with a relative on-off valve (13), for connecting the main heat exchanger (4) directly to the air compressing device (5).

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## SHOE WITH AN ACTIVE AIR-CONDITIONING DEVICE

TECHNICAL FIELD

10       The present invention relates to a shoe with an active air-conditioning device.

      In the following description, the term "shoe" is used to indicate, indifferently, shoes, boots, hiking boots, ski boots, army boots, and any other type of  
15       footwear covering a wide range of uses.

BACKGROUND ART

      As is known, numerous types of shoes are currently marketed featuring a built-in ventilation device for circulating a stream of air inside the shoe to air the  
20       foot.

      Currently used ventilation devices are normally built into the sole of the shoe, and normally comprise: a pump unit activated by the wearer as he or she walks; and two connecting conduits for connecting the pump unit to  
25       the inside of the shoe and to the outside environment respectively. The pump unit is normally defined by a variable-volume pumping chamber formed inside the heel of the sole, which is obviously made of rubber, and by two

one-way valves located at the inlets of the two connecting conduits. The one-way valves may be so oriented as to direct a stream of air inwards or outwards of the shoe alongside cyclic variations in the volume of the pumping chamber induced by the alternating weight  
5 exerted on the sole.

A major drawback of ventilation devices of the above type is that of simply circulating air inside the shoe to maintain an acceptable level of humidity, but with  
10 substantially no change in the temperature of the air inside the shoe.

#### DISCLOSURE OF INVENTION

It is an object of the present invention to provide an air-conditioning device designed to eliminate the  
15 aforementioned drawbacks.

According to the present invention, there is provided a shoe, characterized by comprising an air-conditioning device for maintaining the temperature inside the shoe at a value selectively above or below the  
20 temperature of the outside environment.

#### BRIEF DESCRIPTION OF THE DRAWINGS

A non-limiting embodiment of the present invention will be described by way of example with reference to the accompanying drawings, in which:

25 Figure 1 shows a side view, with parts in section and parts removed for clarity, of a shoe in accordance with the teachings of the present invention;

Figure 2 shows a plan view, with parts in section

and parts removed for clarity, of the sole of the Figure 1 shoe.

BEST MODE FOR CARRYING OUT THE INVENTION

Number 1 in Figure 1 indicates as a whole a shoe  
5 having an active air-conditioning device 2 for so  
regulating the temperature inside shoe 1 as to provide  
for improved comfort of the foot inside shoe 1. More  
specifically, depending on the requirements of the user,  
air-conditioning device 2 provides for withdrawing or  
10 yielding heat from or to the foot in shoe 1, so as to  
maintain the temperature inside shoe 1 at a comfortable  
value considerably above or below that of the outside  
environment, as required.

Air-conditioning device 2 is preferably, but not  
15 necessarily, built into the sole 3 of shoe 1, and  
comprises: a heat exchanger 4 housed inside sole 3 of  
shoe 1, close to the upper surface 3a on which the sole  
of the foot rests; an air compressing device 5 for  
emitting a stream of pressurized air (at a pressure of a  
20 few tens of bars); and a feed conduit 6 connecting the  
outlet of air compressing device 5 to heat exchanger 4.

Air-conditioning device 2 also comprises an intake  
conduit 7 connecting air compressing device 5 to the  
outside environment; an exhaust conduit 8 connecting heat  
25 exchanger 4 to the outside environment; and possibly a  
known nonreturn valve 9 located along exhaust conduit 8  
to prevent air from flowing back to heat exchanger 4.

With reference to Figures 1 and 2, in the example

shown, heat exchanger 4 is defined by a layer 4a of good heat-conducting material, inside which is formed a coil 4b along which the pressurized air from air compressing device 5 flows. Layer 4a is preferably, but not necessarily, made of elastically deformable material, and is obviously built into sole 3 of shoe 1 so that coil 4b extends as close as possible to upper surface 3a of sole 3, to maximize heat exchange with the foot inside shoe 1.

The rest of sole 3, on the other hand, is made of poor heat-conducting (i.e. thermally insulating) material so as to minimize heat exchange with the outside environment.

With reference to Figure 1, air compressing device 5 is preferably, but not necessarily, located at the heel of sole 3, and is driven by the mechanical stress to which sole 3 is subjected as the user walks. More specifically, compressing device 5 is driven by the weight exerted cyclically on sole 3 of shoe 1 as the user walks.

It should be stressed that air compressing device 5 provides for substantially adiabatic compression of the outside air, and emits a stream of pressurized air at a higher temperature than that of the outside air.

In the example shown, air compressing device 5 comprises a lenticular, variable-volume chamber 5a formed in the heel - obviously made of elastically deformable material - of sole 3; an intake valve 5b located at the connection between chamber 5a and intake conduit 7; and a

delivery valve 5c located at the connection between chamber 5a and feed conduit 6. Intake valve 5b, which is of known type, only permits airflow from intake conduit 7 to chamber 5a when the pressure inside chamber 5a is less than the outside pressure; whereas delivery valve 5c, which is also of known type, only permits airflow from chamber 5a to feed conduit 6 when the air pressure inside chamber 5a reaches a given value P (a few tens of bars).

Air compressing device 5 may, obviously, also be formed differently.

With reference to Figure 1, air-conditioning device 2 also comprises, along feed conduit 6, a heat exchanger 10 for dissipating heat to the outside environment; and a laminating valve 11 for rapidly expanding and so sharply reducing the pressure of the air stream from heat exchanger 10.

Finally, air-conditioning device 2 also comprises a bypass conduit 12 connecting air compressing device 5 directly to heat exchanger 4 so as to bypass heat exchanger 10 and laminating valve 11; and an on-off valve 13 located along bypass conduit 12. On-off valve 13 is movable between an open position permitting pressurized airflow directly from air compressing device 5 to heat exchanger 4, and a closed position closing bypass conduit 12 in fluidtight manner, so that, to reach heat exchanger 4, the pressurized air stream is forced to flow along feed conduit 6 fitted with heat exchanger 10 and laminating valve 11.

With reference to Figures 1 and 2, in the example shown, heat exchanger 10 is defined by a member 10a made of good heat-conducting material, and in which is formed a conduit 10b along which the pressurized air stream from air compressing device 5 flows. Member 10a is fitted to the heel of sole 3, with part of the surface of the member facing the outside, so that the outside air flowing over said surface withdraws heat from the pressurized air stream flowing along conduit 10b.

Operation of air-conditioning device 2 will now be described, firstly assuming on-off valve 13 is open, and then assuming on-off valve 13 is closed.

As the user walks along with on-off valve 13 open, the pressurized air stream from air compressing device 5 flows along bypass conduit 12 directly to heat exchanger 4 where, before being exhausted to the outside along exhaust conduit 8, heat is yielded to and so heats the foot inside shoe 1, on account of the pressurized air stream from air compressing device 5, as stated, being at a far higher temperature than the outside air.

With on-off valve 13 open, air-conditioning device 2 therefore provides for maintaining the foot inside shoe 1 at a far higher temperature than the outside environment.

As the user walks along with on-off valve 13 closed, the pressurized air stream from air compressing device 5 flows along feed conduit 6 and successively through heat exchanger 10, where the temperature of the air stream is reduced by yielding heat to the outside, and through



laminating valve 11 where rapid expansion produces a sharp fall in temperature.

The fall in temperature produced by rapid expansion (substantially adiabatic) reduces the pressurized air stream to a temperature lower than that inside shoe 1, so that, as it flows through heat exchanger 4, the pressurized air stream withdraws heat from and so cools the foot inside shoe 1.

With on-off valve 13 closed, air-conditioning device 2 therefore provides for maintaining the foot inside shoe 1 at a lower temperature than the outside environment.

The effect of air-conditioning device 2 may, obviously, be regulated accurately by choking the opening of on-off valve 13, so that the pressurized air stream can flow along both feed conduit 6 and bypass conduit 12.

Unlike currently marketed shoes, shoe 1 as described and illustrated herein has the major advantage of air-conditioning device 2 controlling the temperature inside shoe 1 and so greatly improving comfort of the foot. Moreover, the adjustments afforded by on-off valve 13 provide for regulating the local temperature inside shoe 1 according to individual users' requirements.

A further advantage lies in air-conditioning device 2 being integrated relatively cheaply inside sole 3.

Yet a further advantage lies in the fact that air compressing device 5, by absorbing part of the mechanical stress produced as the user walks along, considerably reduces the mechanical stress transmitted from the ground

to the foot.

Clearly, changes may be made to shoe 1 as described and illustrated herein without, however, departing from the scope of the present invention.

5 In particular, according to a first variation not shown, air-conditioning device 2 may be designed solely to heat or cool the foot inside shoe 1.

In the example shown, in the first case, air-conditioning device 2 has no heat exchanger 10, no  
10 laminating valve 11, no bypass conduit 12, and no on-off valve 13, so that the pressurized air stream from air compressing device 5 flows directly to heat exchanger 4. In the second case, air-conditioning device 2 has no bypass conduit 12 and no on-off valve 13, so that the  
15 pressurized air stream from air compressing device 5 can only reach heat exchanger 4 by flowing through heat exchanger 10 and laminating valve 11.

According to a second variation not shown, heat exchanger 4 may also be built into the upper of shoe 1.

20 According to a third variation not shown, intake conduit 7 and exhaust conduit 8 are connected to each other to form a closed circuit. In which case, a gas other than air can be circulated inside air-conditioning device 2.

25

## CLAIMS

1) A shoe (1), characterized by comprising an active air-conditioning device (2) for maintaining the temperature inside the shoe (1) at a value selectively above or below the temperature of the outside environment.

2) A shoe as claimed in Claim 1, characterized in that said active air-conditioning device (2) comprises at least one main heat exchanger (4) for exchanging heat with the inside of the shoe; at least one air compressing device (5) for emitting a pressurized air stream; and at least one feed conduit (6) connecting said main heat exchanger (4) to the outlet of said air compressing device (5).

3) A shoe as claimed in Claim 2, characterized in that said main heat exchanger (4), said air compressing device (5), and said feed conduit (6) are built into the sole (3) of the shoe (1).

4) A shoe as claimed in Claim 2 or 3, characterized in that said active air-conditioning device (2) comprises, along said feed conduit (6), an auxiliary heat exchanger (10) for cooling the pressurized air stream circulating inside; and an expansion valve (11) for rapidly expanding and so sharply reducing the pressure of the air stream from the auxiliary heat exchanger (10).

5) A shoe as claimed in Claim 4, characterized in that said active air-conditioning device (2) comprises a

bypass conduit (12) connecting the air compressing device (5) directly to the main heat exchanger (4) so as to bypass the auxiliary heat exchanger (10) and the expansion valve (11); and an on-off valve (13) located  
5 along the bypass conduit (12) to regulate passage of the pressurized air stream along the bypass conduit (12).

6) A shoe as claimed in any one of the foregoing Claims, characterized in that said main heat exchanger (4) is defined by a layer (4a) of good heat-conducting  
10 material, in which is formed a coil (4b) along which the pressurized air stream from said air compressing device (5) flows; said layer (4a) being integrated in the sole (3) of the shoe (1) so that said coil (4b) extends close to the upper surface (3a) of the sole (3).

15 7) A shoe as claimed in any one of the foregoing Claims, characterized in that said active air-conditioning device (2) comprises an intake conduit (7) connecting said air compressing device (5) to the outside environment; and an exhaust conduit (8) connecting said  
20 main heat exchanger (4) to the outside environment.

8) A shoe (1) with an active air-conditioning device (2), characterized in that said air-conditioning device (2) comprises at least one main heat exchanger (4) for exchanging heat with the inside of the shoe (1); and at  
25 least one air compressing device (5) for feeding a pressurized air stream to said main heat exchanger (4); said pressurized air stream having a temperature higher than that of the outside environment.

9) A shoe as claimed in Claim 8, characterized in that said main heat exchanger (4) is defined by a layer (4a) of good heat-conducting material, in which is formed a coil (4b) along which the pressurized air stream from said air compressing device (5) flows; said layer (4a) being integrated in the sole (3) of the shoe (1) so that said coil (4b) extends close to the upper surface (3a) of the sole (3).

10) A shoe as claimed in Claim 8 or 9, characterized in that said active air-conditioning device (2) comprises an intake conduit (7) connecting said air compressing device (5) to the outside environment; and an exhaust conduit (8) connecting said main heat exchanger (4) to the outside environment.

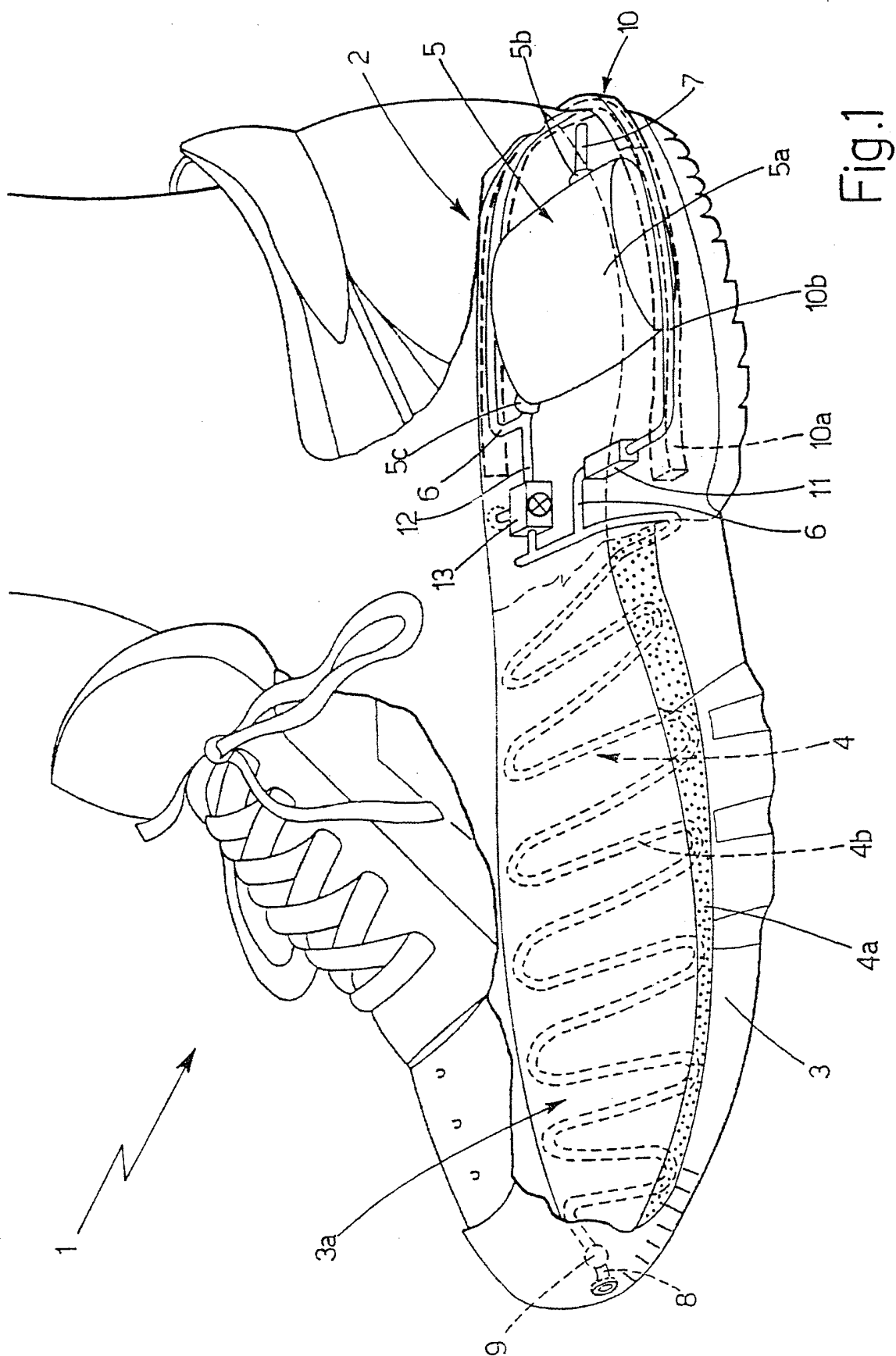
11) A shoe (1) with an active air-conditioning device (2), characterized in that said active air-conditioning device (2) comprises at least one main heat exchanger (4) for exchanging heat with the inside of the shoe (1); at least one air compressing device (5) for feeding a pressurized air stream to said main heat exchanger (4); at least one auxiliary heat exchanger (10) interposed between said air compressing device (5) and said main heat exchanger (4) to cool the pressurized air stream from the air compressing device (5); and at least one expansion valve (11) for rapidly expanding and so sharply reducing the pressure of the air stream from said auxiliary heat exchanger (10); the pressurized air stream entering said main heat exchanger (4) having a

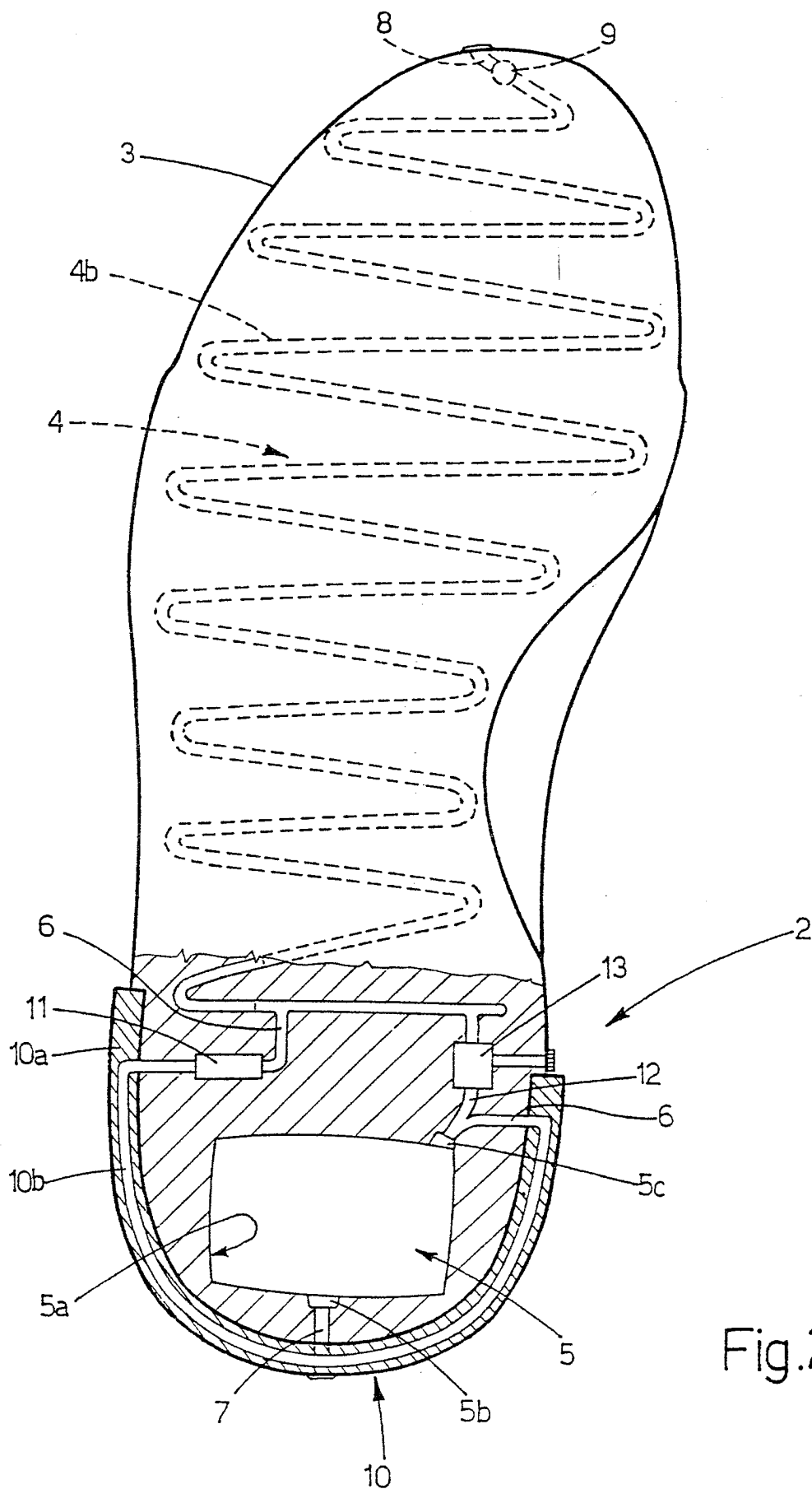
temperature lower than that inside said shoe (1).

12) A shoe as claimed in Claim 11, characterized in that said main heat exchanger (4) is defined by a layer (4a) of good heat-conducting material, in which is formed  
5 a coil (4b) along which the pressurized air stream from said expansion valve (11) flows; said layer (4a) being integrated in the sole (3) of the shoe (1) so that said coil (4b) extends close to the upper surface (3a) of the sole (3).

10 13) A shoe as claimed in Claim 11 or 12, characterized in that said active air-conditioning device (2) comprises an intake conduit (7) connecting said air compressing device (5) to the outside environment; and an exhaust conduit (8) connecting said main heat exchanger  
15 (4) to the outside environment.

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## INTERNATIONAL SEARCH REPORT

International Application No.

PCT/IT 99/00384

## A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 A43B7/02

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 A43B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 606 806 A (O'DWYER JAMES M) 4 March 1997 (1997-03-04) column 8, line 40 - line 50 column 9, line 66 - column 10, line 5; figures 4,5	1,2,8
X	FR 2 469 886 A (PEREZ CONDE JOSE) 29 May 1981 (1981-05-29) page 1, line 1 - line 4 figure 2	1
P,X	FR 2 777 637 A (BERNIER JACQUES) 22 October 1999 (1999-10-22) page 6, line 26 - page 11, line 25 figures 1-5	1-3,6-10
	-/-	

☒ Further documents are listed in the continuation of box C.☒ Patent family members are listed in annex.

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Date of the actual completion of the international search

31 March 2000

Date of mailing of the international search report

10/04/2000

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