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(72) Inventor: **Emilsson, David**
771 35, Ludvika (SE)

(74) Representative: **Dahlstrand, Björn**
ABB AB
Intellectual Property
Ingenjör Bååths Gata 11
721 83 Västerås (SE)

(71) Applicant: **ABB Technology AG**
8050 Zürich (CH)

(54) **Draw rod mounting arrangement for a high voltage bushing, high voltage bushing comprising such arrangement and high voltage device comprising bushing with such arrangement**

(57) The invention concerns a draw rod arrangement for a hollow conductor (38) in a high voltage bushing, comprising a draw rod attachment part (31) and an outer terminal attachment part (32), wherein the draw rod at-

tachment part and the outer terminal attachment part are made in one piece forming a combined mounting device (33). The invention also concerns a high voltage bushing comprising such an arrangement, and a high voltage device comprising a bushing with such an arrangement.

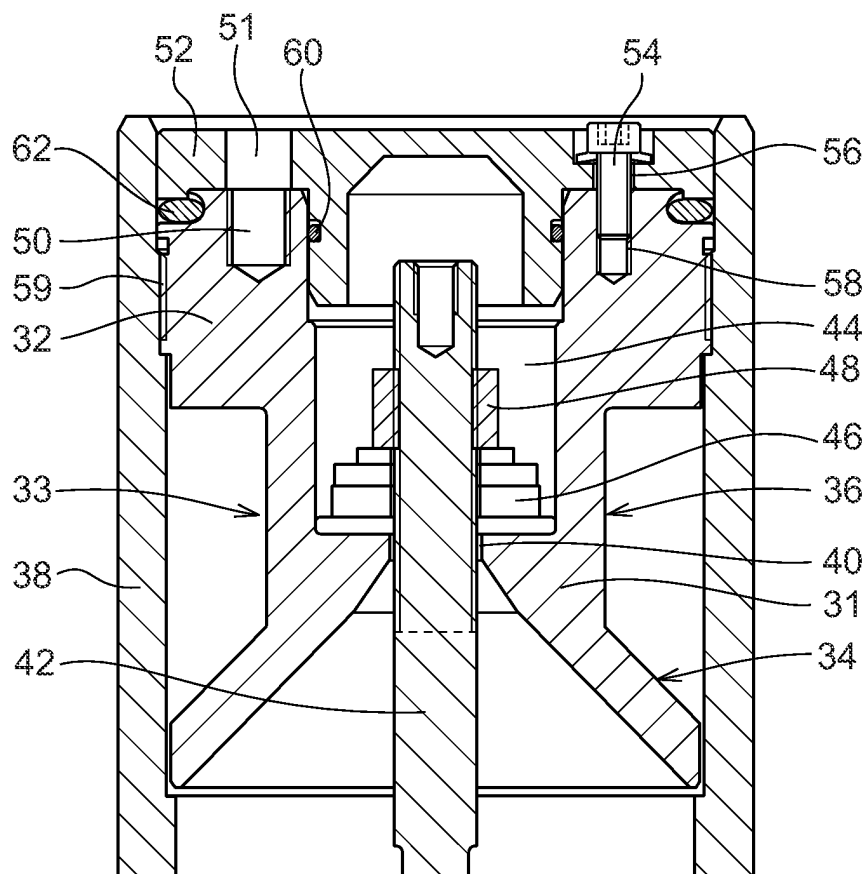


Fig. 2

Description

Technical field of the invention

[0001] The present invention relates to the field of high voltage power systems, and in particular to high voltage bushings used in high voltage devices forming parts of such systems.

Background of the invention

[0002] It is known that high voltage equipment and devices, e.g. high voltage transformers, reactors, switch-gear etc., are usually equipped with bushings that are adapted for carrying current at high potential through a grounded barrier, e.g. a wall or an enclosure of the electric device, such as a transformer tank.

[0003] Conventional high voltage bushings comprise an insulator made of ceramic or composite material, which is provided with sheds and which is generally hollow. On the inside of the bushing, voltage grading is performed by a condenser body or some other type of voltage grading device, through which an electrical conductor passes. The electrical conductor connects one side of the bushing, where a high voltage electric device is connected, with the other side of the bushing where another electric device is connected. For example, when the first electric device is a transformer, the bushing is fitted on the transformer enclosure, such as the tank wall, and the conductor of the bushing connects the inside of the transformer with the outside, where another electric device can be connected, e.g. a bus, surge arrester or DC valve.

[0004] An example of a prior art bushing adapted for use with a high voltage transformer will now be described with reference to Fig. 1, showing a schematic cross sectional view of a bushing 1 mounted in a wall 18, such as the tank wall, in the case of a transformer. A high voltage conductor 10 runs through the center of a hollow bushing insulator 12 that forms a housing around the high voltage conductor. A condenser core 14 is provided inside the insulator housing for voltage grading of voltage stress that is built up around the high voltage conductor 10. A flange 16 is provided on the outside of the housing 12, by means of which the housing of the bushing is connected to ground, via the transformer tank wall 18.

[0005] In Fig. 1 is also shown how the bottom end portion of the high voltage conductor 10 forms a bottom contact 20 that is arranged to be connected to the internal components of the transformer. For this purpose, a mating internal contact 22 is provided inside the transformer. An upper outer terminal 24 for the conductor 10 is provided at the upper end of the bushing, opposite the bottom contact 20 end. The outer terminal 24 is electrically connected to the conductor 10 through an essentially planar interface, also forming a top cover of the bushing, in order to electrically connect the conductor and thus the transformer to an external source or device.

[0006] According to prior art transformers, a draw rod system may be used for ensuring electrical connection between the bushing and the transformer. This system requires a hollow conductor, with the inside of the conductor open towards the transformer oil inside the transformer. It is necessary to provide a seal inside the conductor in order for the transformer oil not to leak out to the surroundings, outside the transformer and outside the bushing. A traditional way of sealing off the inside of the conductor towards the outside of the transformer, for example a valve hall, is to use an expander arrangement that is assembled inside the conductor in the field, after the draw rod system is assembled. This expander arrangement has drawbacks in terms of the radial space it requires which entails a disadvantageous reduction in thickness of the conductor wall, and also in terms of fail-safe assembly work that is necessary at the site in the field.

[0007] Further, in prior art bushings where the outer terminal may not be attached directly to the top cover of the bushing, the outer terminal has to be screwed into a steel draw ring or similar located inside the conductor. This draw ring is in turn screwed into the conductor, thereby reducing the wall thickness of the conductor due to the necessary internal threads. This draw ring arrangement also requires that a sealing is provided.

[0008] The term high voltage is conventionally used for voltages above approximately 50 kV. Today, the upper limit in commercial high voltage devices is generally 1100 kV, but higher voltages, such as 1200 kV or even more, are envisaged in the near future. Also, current levels are increasing and may be up to 4000-5000 A or even higher.

[0009] For high voltages in the region of 800 kV and more, and current ratings of 2000 A and above, the demands on the bushings are naturally increased, e.g. when it comes to heat dissipation and cooling, electric fields, electric insulation of the bushing etc. In this context, it becomes essential to have a low loss, in particular to be able to reach the target current. The losses in today's bushings mainly occur due to losses in the conductor and in each contact or joint in the current path between different parts of the bushing. When it concerns the conductor, it becomes increasingly important to minimize every type of arrangement that leads to reductions in the conducting material in the conductor, such as threads, for example. It is also recognized that fewer joints would reduce losses which is advantageous in high voltage and high current applications.

Summary of the invention

[0010] It is an object of the present invention to provide a draw rod mounting arrangement and a high voltage bushing that is an improvement over prior art bushings, and which makes it possible to reach the high voltage levels and high current ratings described above.

[0011] It is also an object of the present invention to

provide a high voltage device comprising such a high voltage bushing.

[0012] These objects, among others, are achieved by a draw rod mounting arrangement, a high voltage bushing and a high voltage device as defined in the independent claims.

[0013] According to the present invention, a draw rod arrangement for a hollow conductor in a high voltage bushing is defined, comprising a draw rod attachment part and an outer terminal attachment part, wherein the draw rod attachment part and the outer terminal part are made in one piece forming a combined mounting device. This inventive draw rod arrangement has the advantage of combining the function of the draw ring and the draw rod mounting, whereby space is saved inside the conductor and also conductor material is saved thanks to less threads. A further advantage is that the personnel at the mounting site does not have to be involved in assembly of mechanical parts, which leads to easier and more fail-safe assembly and cost saving.

[0014] According to a further feature, the draw rod attachment part of the mounting device is provided with an axial hole, through which an end of a draw rod is inserted, that in the axial prolongation of the hole there is an inner bore with a larger diameter than the hole and into which bore a threaded end of the draw rod extends, that the draw rod is mounted by means of a fastening arrangement in the inner bore. This fastening arrangement may comprise a washer arrangement resting against a bottom in the inner bore and a nut screwed onto the threaded end of the draw rod.

[0015] The inner bore extends through the outer terminal attachment part.

[0016] According to a further feature, the outer terminal attachment part is provided with threaded holes adapted to receive screws for mounting an outer terminal contact.

[0017] In addition there may be at least one sealing means arranged between the conductor and the combined mounting device. Such a sealing is used for example when there is a liquid inside an electric device onto which a bushing comprising the draw rod attachment is mounted, and it is desirable to prevent this liquid from leaking out of the electric device, via the conductor and the bushing. This is the case for a transformer filled with insulating oil, for example.

[0018] The invention may also have the feature that it comprises an end plug for mounting over the combined mounting device, inside an open end of the conductor. This end plug also has a sealing function.

[0019] The draw rod arrangement according to the invention may also comprise at least one sealing means arranged between the inner bore and a part of the end plug that extends down into the inner bore. This sealing also prevents leakage of any insulating medium that can be present inside the conductor when it is used in a bushing in a transformer.

[0020] Further, according to the invention, the outer terminal attachment part is provided with a second set

of threaded holes, the end plug is provided with corresponding holes for mounting the end plug onto the outer terminal attachment part by means of screws inserted in said holes and screwed into the second set of holes in the outer terminal attachment part.

[0021] The end plug has also an additional set of holes adapted to receive screws for mounting an outer terminal contact.

[0022] According to the invention is also defined a high voltage bushing comprising a hollow conductor, **characterized in that** it comprises a draw rod arrangement according to any one of the claims related to a draw rod arrangement.

[0023] The high voltage bushing may be **characterized in that** the combined mounting device is connected to the hollow conductor by being welded inside one end of the conductor of the bushing.

[0024] Alternatively, the high voltage bushing may be **characterized in that** the combined mounting device is connected to the hollow conductor by being screwed inside one end of the conductor of the bushing. In that case there is no need for welding.

[0025] Finally, according to the invention is defined a high voltage device comprising a bushing as defined in any one of the claims related to a bushing.

Brief description of the drawings

[0026] The present invention will now be described with reference to the enclosed drawings, illustrating an embodiment of the invention, by way of example only, and in which

Fig. 1 illustrates schematically, in cross section, a high voltage bushing according to prior art, and Fig. 2 illustrates schematically, in cross section, a draw rod arrangement according to the present invention.

Detailed description of the invention

[0027] In this description, the term "high voltage" (HV) will be used for voltages of 50 kV and higher. The present upper limit for commercial high voltage is 1100 kV, but it is foreseen that the invention can be used also for higher voltages, up to 1200 kV or even more. Generally, the present invention will find its applicability from about 200 kV and upwards.

[0028] An embodiment of a draw rod arrangement according to the present invention is shown in Fig. 2, mounted in a conductor 38, for example in a high voltage bushing (not shown). The arrangement comprises a draw rod attachment part 31, and an outer terminal attachment part 32, combined as a one piece element, in the following referred to as a combined mounting device 33. The draw rod attachment part 31 will in the following be referred to as the draw rod part, and the outer terminal attachment part 32 will in the following be referred to as the terminal

part. The draw rod part 31 has a first bottom part 34 with a basic shape of a hollow cone, with the open cone bottom directed towards the inner parts of the hollow conductor 38. The draw rod part 31 has a second upper part 36, basically ring shaped with a central axial hole 40 through which the draw rod 42 is inserted. In the upper part 36, above the hole 40, there is an inner bore 44 with a diameter that is larger than the diameter of the hole 40, and this inner bore 44 extends also all the way through the terminal part 32, in prolongation of the hole 40. The draw rod 42 is mounted by means of a fastening arrangement, such as a washer arrangement 46 or similar resting against the bottom of the inner bore 44, and a nut 48 screwed onto the threaded top end of the draw rod.

[0029] The terminal part 32 of the draw rod arrangement is essentially ring shaped with an inner bore 44 as described above. In the upper end of the terminal part, there are arranged threaded holes 50, adapted to cooperate with screws for mounting an outer terminal contact (not shown).

[0030] In addition to the mounting device 33, the draw rod arrangement comprises an end plug 52, inserted in the open end of the conductor 38, and covering the mounting device 33. The end plug is mounted to the upper end of the terminal part 32 by means of screws 54 inserted in wholes 56 in the end plug and screwed into corresponding threaded holes 58 arranged in the upper part of the terminal part 32.

[0031] One function of the end plug is to seal off the inside of the conductor with the draw rod arrangement from the outside. In order to complete this sealing, the draw rod arrangement also comprises at least one sealing 60 between the end plug 52 and the inside of the bore 44. This sealing ensures that the inside of the conductor is sealed off from the outside of the conductor. For example, when the draw rod arrangement is mounted in a conductor in a transformer, the conductor is generally open to the cooling medium inside the transformer, normally oil, and it is very important that oil cannot leak out through the end of the conductor, to the outside. The seal can be provided by means of an annular sealing, such as an O-ring, mounted in a groove provided in a part of the end plug 52 that extends down into the inner bore 44 of the terminal part 32, or alternatively the groove can be provided in the wall of the bore. Naturally, there may be variants and alternative locations for the sealing, e.g. provisions for more than one sealing. It should also be mentioned that there may be applications where the end plug and its sealing function is not needed.

[0032] In order for an outer terminal contact to be mounted at the end of the conductor, and screwed into the mounting holes 50 of the terminal part 32, as described above, the end plug must also have corresponding holes 51 for the screws to pass through. It may also be mentioned that, instead of fastening an outer terminal contact in the terminal part 32, an intermediate part may be arranged externally of the end plug and the outer terminal may be attached to this part.

[0033] The mounting device can either be screwed into the end of the conductor or welded. In the case of screwing, the mounting device is provided with external threads 59 for cooperation with corresponding internal threads in the wall of the end of the conductor. An additional sealing must then be provided between the inside of the conductor and the draw rod arrangement. An example of this is illustrated in Fig. 2, where a sealing 62 is shown. This sealing is located in a groove provided between the end plug 52 and the terminal part 32. The sealing has an annular shape, e.g. an O-ring, and is compressed so that it fills the groove all the way out to the conductor wall. Naturally there may be more than one sealing, if necessary. Also alternative locations are possible for this sealing, as long as it performs sealing between the inside of the conductor and the outside of the draw rod arrangement.

[0034] The described draw rod arrangement may be used in a bushing both for DC and AC applications.

[0035] In the illustrative embodiment, it has been indicated that a transformer may be a high voltage device in which the inventive draw rod arrangement and high voltage bushing are used. However, it is emphasized that the inventive draw rod arrangement and high voltage bushing may also be used with other types of high voltage devices, such as reactors, breakers, generators, switchgear or any other suitable device finding an application in high voltage systems. Further, the terms electric device and high voltage device should also be interpreted as including cables, buses, surge arrestors, DC valves etc., within the context of the present invention.

[0036] When the inventive draw rod arrangement and bushing is used in a transformer, oil is used as insulating medium inside the transformer and on the other side of the bushing the medium is air, for example in a HVDC valve hall. This type of bushing is generally referred to as an air-oil or air-liquid bushing. However, as indicated above, the draw rod arrangement and bushing according to the invention is suitable for use in many electric devices, irrespective of the media on the respective sides of the bushing, such as air-air (wall bushing), air-gas (gas switchgear), etc. It should also be mentioned that the present invention bears no restriction as to the choice of insulation medium inside the bushing. It may for example be gas, oil, gel, or combinations thereof.

[0037] The present invention is not limited to the described embodiment, given as example only, but may be varied and modified in many ways within the scope of the appended claims, as will be realized by a person skilled in the art.

Claims

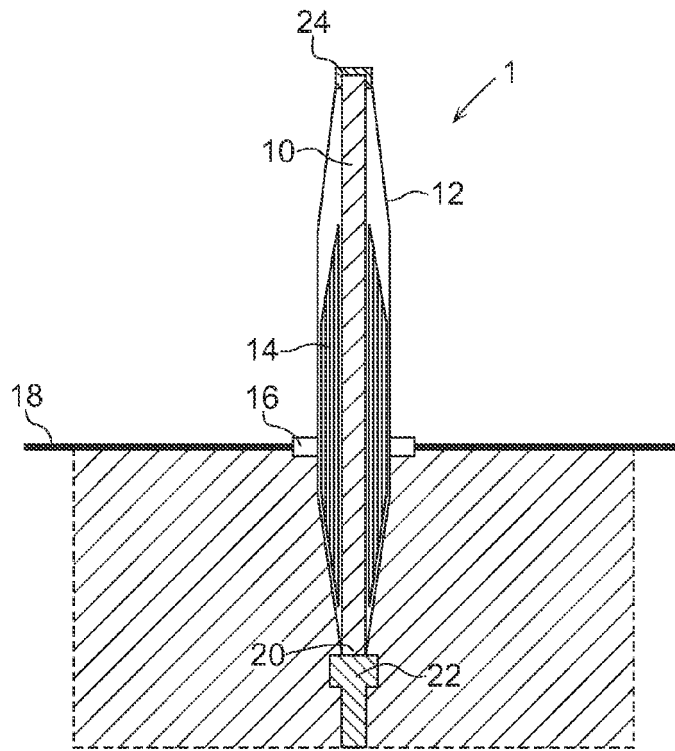
1. Draw rod arrangement for a hollow conductor (38) in a high voltage bushing, comprising a draw rod attachment part (31) and an outer terminal attachment part (32), wherein the draw rod attachment part

and the outer terminal attachment part are made in one piece forming a combined mounting device (33).

2. Draw rod arrangement according to claim 2, **characterized in that** the draw rod attachment part (31) of the mounting device is provided with an axial hole (40), through which an end of a draw rod (42) is inserted, that in the axial prolongation of the hole there is an inner bore (44) with a larger diameter than the hole and into which bore a threaded end of the draw rod (42) extends, and that the draw rod is mounted by means of a fastening arrangement (46, 48) in the inner bore. 5
3. Draw rod arrangement according to claim 2, **characterized in that** the inner bore (44) extends through the outer terminal attachment part (32). 10
4. Draw rod arrangement according to any one of the preceding claims, **characterized in that** the outer terminal attachment part (32) is provided with threaded holes (50) adapted to receive screws for mounting an outer terminal contact. 15
5. Draw rod arrangement according to any one of the preceding claims, **characterized in that** it comprises at least one sealing means (62) arranged between the conductor (38) and the combined mounting device (33). 20
6. Draw rod arrangement according to any one of the preceding claims, **characterized in that** it comprises an end plug (52) for mounting over the combined mounting device (33), inside an open end of the conductor (38). 25
7. Draw rod arrangement according to any one of claims claim 6, **characterized in that** it comprises at least one sealing means (60) arranged between the inner bore (44) and a part of the end plug (52) that extends down into the inner bore. 30
8. Draw rod arrangement according to claim 7, **characterized in that** the outer terminal attachment part (32) is provided with a second set of threaded holes (58), that the end plug (52) is provided with corresponding holes (56) for mounting the end plug onto the outer terminal attachment part by means of screws (54) inserted in said holes (56) and screwed into the second set of holes (58) in the outer terminal attachment part. 35
9. Draw rod arrangement according to claim 7 or 8, **characterized in that** the end plug (52) has an additional set of holes (51) adapted to receive screws for mounting an outer terminal contact. 40
10. High voltage bushing comprising a hollow conductor, 45

characterized in that it comprises a draw rod arrangement according to any one of claims 1-9.

11. High voltage bushing according to claim 10, **characterized in that** the combined mounting device (33) is connected to the hollow conductor (38) by being welded inside one end of the conductor of the bushing. 50
12. High voltage bushing according to claim 10, **characterized in that** the combined mounting device (33) is connected to the hollow conductor (38) by being screwed inside one end of the conductor of the bushing. 55
13. High voltage device comprising a bushing as defined in any one of claims 10-11.



Prior art

Fig. 1

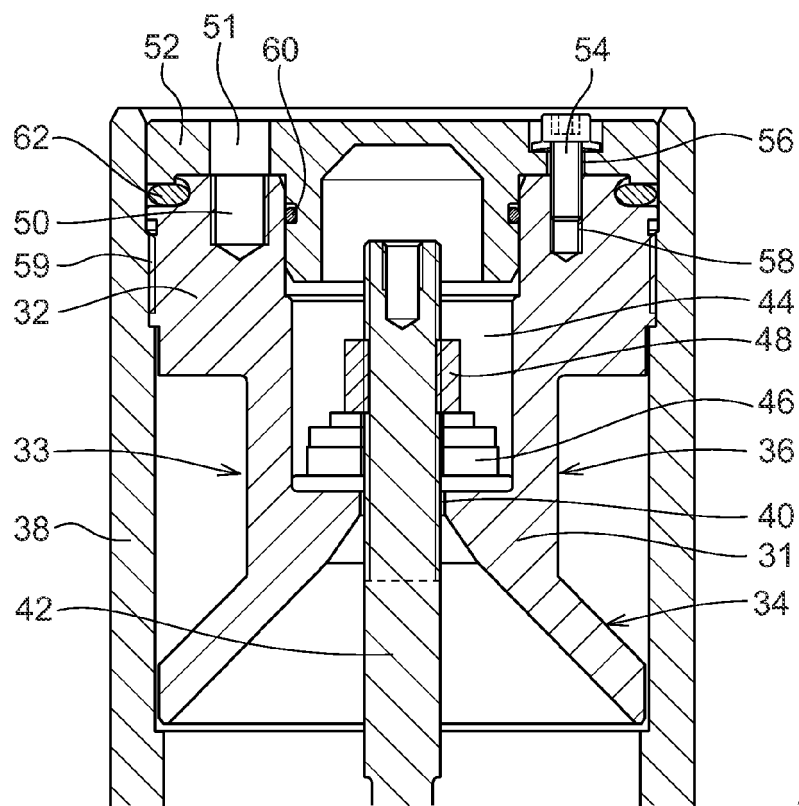


Fig. 2



EUROPEAN SEARCH REPORT

Application Number
EP 08 15 5702

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	ABB POWER T&D COMPANY INC.: "Supplementary Instructions for Installation of Draw Rod Bushings 115kV and Above With Glass Bowl Sight Glass; IL 44-670A" [Online] 17 June 1998 (1998-06-17), ABB , XP002498246 Retrieved from the Internet: URL:http://library.abb.com/GLOBAL/SCOT/sco t252.nsf/VerityDisplay/90726447478BE9DD852 56F6A00742347/\$File/IL44670A.PDF> [retrieved on 2008-10-02] * page 3, line 1 - line 2; figure 1 *	1-5,7-13	INV. H01B17/26
A	US 1 967 653 A (AUSTIN ARTHUR O) 24 July 1934 (1934-07-24) * page 2, line 1 - line 2; figure 2 *	1	
A	US 6 194 986 B1 (WEATHERBEE ERIC [US] ET AL) 27 February 2001 (2001-02-27) * figure 2a *	1	
			TECHNICAL FIELDS SEARCHED (IPC)
			H01B H01F
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 3 October 2008	Examiner Hillmayr, Heinrich
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 O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

3
EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 08 15 5702

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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03-10-2008

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