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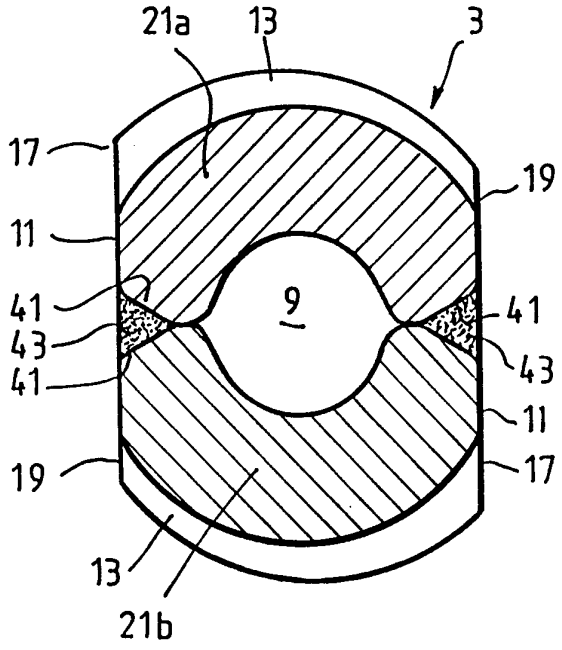

(57) Abstract

A hollow bar (3) and a method of manufacturing the hollow bar are disclosed. Typically, the hollow bar is a threaded rock bolt or a drill rod. The hollow bar (3) comprises two or more elongate members (21a, 21b) connected together along the longitudinal edges (41) of the members (21a, 21b). The method comprises rolling the members (21a, 21b) and welding or gluing the members (21a, 21b) together along the longitudinal edges (41) of the members (21a, 21b).

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HOLLOW BARS AND METHOD OF MANUFACTURE

The present invention relates to hollow bars, particularly hollow bars that are suitable for use as rock bolts and drill rods, and to a method of manufacturing hollow bars.

A known method, commonly referred to as the "pierced-billet method", of manufacturing hollow drill rods comprises drilling a billet of steel, typically up to 150mm in diameter and 1.2m in length from both ends to form a hole that is approximately 20-30mm in diameter and inserting a manganese steel mandrill into the hole. The method further comprises heating the billet with the mandrill inside to about 1150°C and then passing the billet/mandrill through a series of rolls to form the required transverse section (i.e. round, square, hexagonal etc) and to reduce the external diameter to the required dimensions. The method further comprises allowing the rolled billet/mandrill to cool and removing the mandrill to form the final product of a rolled steel bar having a central hole and the required external profile and dimensions. In order to remove the mandrill from the rolled billet/mandrill the mandrill is gripped and pulled in tension to reduce its diameter slightly and the mandrill is cut while in tension so that it flies out of the billet.

The method involves several steps and also necessitates the use of a special manganese steel for the mandrill which has to be scrapped after being removed from

the rolled steel bar. Consequently, the method is relatively expensive and is not suited to large scale production as would be required for rock bolts.

A known method of manufacturing tubes comprises rolling a long, flat strip of steel into a round shape and then continuously welding the two sides of the strip together to form a tube. In practice, the method is carried out on a continuous basis and the welding is completed very quickly.

The method can produce tubes of different sizes within limits, although it is very difficult to produce a relatively thick walled tube as would be required for rock bolts without the further step of "sinking" the tube through a die to reduce the outside diameter and at the same time to increase the wall thickness. In addition, it is very difficult to roll a profile on the outside of the tube as would be required for rock bolts of the type having an external threaded profile.

It is an object of the present invention to provide a method of manufacturing hollow bars which alleviates the disadvantages of the known methods described in the preceding paragraphs.

According to the present invention there is provided a method of manufacturing a hollow bar, comprising:

(a) forming two or more elongate members each of which forms a segment of the hollow bar; and

(b) connecting the members together along the longitudinal edges of the members to form the hollow bar.

The term "hollow bar" as used herein is understood to cover any elongate element, such as hollow rock bolts, drill rods, pipes or tubes.

It is preferred that the method comprises forming two members to form the hollow bar.

It is preferred particularly that the two members be identical.

It is preferred that the step of forming the members comprises rolling or die drawing the members.

In one embodiment it is preferred particularly that the step of rolling the members forms sections of a threaded profile on each of the members so that the hollow bar formed by connecting the members together comprises a threaded profile and is suitable for use as a threaded rock bolt.

In another embodiment it is preferred particularly that the step of rolling the members forms a half hexagonal shape on each of the members so that the hollow bar formed by connecting the members together comprises a complete hexagonal profile and is suitable for use as a hexagonal drill rod.

It is preferred that the method comprises connecting the members together by welding or gluing.

It is preferred that the step of connecting the members together comprises feeding the members into a jig, aligning the members, and welding or gluing the members together.

It is preferred that the step of rolling the members forms the longitudinal edges of the members with profiles to maximise the surface area of contact and enable proper alignment when connecting the members together.

It is preferred particularly that the profiles be tongue and groove profiles.

It is preferred that the step of rolling the members forms the longitudinal edges so that when the members are positioned together the adjacent longitudinal edges define the sides of an outwardly opening channel for receiving weld metal or glue.

According to the present invention there is also provided a hollow bar comprising two or more elongate members connected together along the longitudinal edges of the members.

It is preferred that there be two members.

It is preferred particularly that the two members be identical.

It is preferred that the longitudinal edges of the members comprise profiles that maximise the surface area of contact between the longitudinal edges of adjacent members and enable proper alignment of the members.

It is preferred particularly that the profiles be tongue and groove profiles.

It is preferred that the members be connected together by welding or gluing.

It is preferred that the longitudinal edges of the members define outwardly opening channels for receiving weld metal or glue.

It is preferred that the hollow bar be suitable for use as a threaded rock bolt or a drill rod.

It is preferred particularly that each member comprises an external profile that defines part of the threaded profile of the rock bolt or the drill rod.

The present invention is described further by reference to the accompanying drawings in which:

Figure 1 is a side elevation of a preferred embodiment of a self-tapping rock bolt in accordance with the present invention formed by welding together two identical elongate members;

Figure 2 is a cross-sectional view along the line A-A in Figure 1 illustrating the cross-sectional profile of a preferred embodiment of the members;

Figure 3 is a cross-sectional view similar to that shown in Figure 2 but with the members spaced apart; and

Figure 4 is a cross-sectional view along the line

A-A in Figure 1 illustrating the cross-sectional profile of another preferred embodiment of the members.

The rock bolt shown in the figures is of the type disclosed in Figures 7 to 9 in the patent specification of International application PCT/AU91/00503 (WO92/08040) in the name of BHP Engineering Pty Ltd.

The rock bolt 3 comprises:

(a) a leading end 5 for convenient insertion into a pilot hole (not shown);

(b) a trailing end 7;

(c) an axially extending bore 9 (which may be circular or non-circular depending on requirements) to enable water to be pumped through the rock bolt into the pilot hole during insertion of the rock bolt 3;

(d) two diametrically opposed flats 11 extending along the length of the rock bolt 3; and

(e) a plurality of thread sections 13 which form a discontinuous threaded profile.

Typically, the rock bolt 3 has a diameter of 15 to 50mm and a maximum wall thickness of at least 5mm.

As can best be seen in Figures 2 and 4 each thread section 13 extends from a leading edge 17 adjacent to one of the flats 11 to a trailing edge 19 adjacent to

the other of the flats 11. The leading edges 17 of the thread sections 13 define cutting edges of the rock bolt 3.

The rock bolt 3 is formed by welding together two identical elongate members identified by the numerals 21a, 21b in Figures 2 to 4 along the longitudinal edges 41 of the members 21a, 21b. The welds are identified by the numerals 43 in Figures 2 and 4.

In the preferred embodiment shown in Figures 2 and 3 the longitudinal edges 41 of the members 21a, 21b are formed with tongue and groove profiles 27 in order to maximise the surface area of contact between the longitudinal edges 41 and to enable proper alignment of the members 21a, 21b prior to welding together the members 21a, 21b. In addition, the longitudinal edges 41 of the members 21a, 21b are formed to define outwardly opening V-shaped weld metal channels 43 when the members 21a, 21b are in contact.

In the preferred embodiment shown in Figure 4 the longitudinal edges 41 are formed so that there is a relatively small surface area of contact between the longitudinal edges 41 and relatively large (compared with the preferred embodiments shown in Figures 2 and 3) outwardly opening V-shaped weld channels 43.

The members 21a, 21b are formed by rolling in a normal rolling process at high speed. The rolled members 21a, 21b are fed into a jig and mated together so that the threaded profiles of the members 21a, 21b are matched and form a discontinuous threaded profile. Finally, the members 21a, 21b are welded together using high speed robotic welding equipment.

It is noted that in the case of the preferred embodiment shown in Figures 2 and 3 the tongue and groove profiles 27 ensure proper alignment of the members 21a, 21b and in the case of the preferred embodiment shown in Figure 4 the members 21a, 21b are aligned by the flats 11 and the threaded profiles.

The rock bolt 3 can be manufactured at significantly lower cost than is possible with the known methods and at large scale production.

Many modifications may be made to the preferred embodiment of the rock bolt 3 and the method of manufacturing the rock bolt 3 without departing from the spirit and scope of the present invention.

In this regard, whilst the preferred embodiment comprises welding together the elongate members 21a, 21b, it can readily be appreciated that the present invention is not so limited and extends to any suitable means including the use of adhesives to connect together the members.

Furthermore, whilst the preferred embodiment of the rock bolt 3 is formed from two identical elongate members 21a, 21b, it can readily be appreciated that the present invention is not so limited and the rock bolt 3 could be formed from any suitable number of members.

Furthermore, whilst the preferred embodiment of the rock bolt 3 is formed from steel, it can readily be appreciated that the present invention is not so limited and the rock bolt 3 could be formed from any suitable material.

Furthermore, whilst the preferred embodiments relate to the rock bolt 3 and the method of manufacturing the rock bolt 3, it can readily be appreciated that the present invention is not so limited and extends to any hollow element, such as drill rods, pipes and tubes.

CLAIMS:

1. A method of manufacturing a hollow bar which comprises:

(a) forming two or more elongate members each of which forms a segment of the hollow bar; and

(b) connecting the members together along the longitudinal edges of the members to form the hollow bar.

2. The method defined in claim 1 wherein there are two identical members.

3. The method defined in claim 1 or claim 2, wherein the step of forming the members comprises rolling or die drawing the members.

4. The method defined in claim 3, wherein the step of rolling the members forms sections of a threaded profile on each of the members so that the hollow bar formed by connecting the members together comprises a discontinuous or continuous threaded profile and is suitable for use as a threaded rock bolt.

5. The method defined in claim 3, wherein the step of rolling the members forms a half hexagonal shape on each of the members so that the hollow bar formed by connecting the members together comprises a complete hexagonal profile and is suitable for use as a hexagonal drill rod.

6. The method defined in any one of the preceding claims, wherein the step of connecting the members together comprises welding or gluing the members together.

7. The method defined in claim 6, wherein the step of connecting the members together comprises, feeding the members into a jig, aligning the members, and welding or gluing the members together.

8. The method defined in any one of claims 3 to 5, wherein the step of rolling the members forms the longitudinal edges of the members with profiles to maximise the surface area of contact and enable proper alignment when connecting the members together.

9. The method defined in claim 8, wherein the profiles are tongue and groove profiles.

10. The method defined in any one of claims 3, 4, 5, 8 or 9, wherein the step of rolling the members forms the longitudinal edges so that when the members are positioned together the adjacent longitudinal edges define the sides of an outwardly opening channel for receiving weld metal or glue to connect the members together.

11. A hollow bar comprises two or more elongate members connected together along the longitudinal edges of the members.

12. The hollow bar defined in claim 11, consists of two identical members.

13. The hollow bar defined in claim 11 or claim 12, wherein the longitudinal edges of the members comprise profiles that maximise the surface area of contact between the longitudinal edges of adjacent members and enable proper alignment of the members.

14. The hollow bar defined in claim 13, wherein the profiles are tongue and groove profiles.

15. The hollow bar defined in any one of claims 11 to 14, wherein the members are connected together by welding or gluing.

16. The hollow bar defined in claim 15, wherein the longitudinal edges of the members define outwardly opening channels which receive weld metal or glue.

17. The hollow bar defined in any one of claims 11 to 16, wherein the hollow bar is suitable for use as a threaded rock bolt or a drill rod.

18. The hollow bar defined in claim 17, wherein each member comprises an external profile that defines part of the threaded profile of the rock bolt or the drill rod.

19. A hollow bar manufactured by the method defined in any one of claims 1 to 10.

20. A method of manufacturing a hollow bar substantially as hereinbefore described with reference to the accompanying drawings.

21. A hollow bar substantially as hereinbefore described with reference to the accompanying drawings.

AMENDED CLAIMS

[received by the International Bureau on 16 February 1994 (16.02.94); original claims 1-21 replaced by amended claims 1-22 (4 pages)]

1. A method of manufacturing a rock bolt or a drill rod having an axially extending bore, the method comprising the steps of:

(a) rolling or die drawing two or more elongate members each of which forms a segment of the rock bolt or the drill rod and comprises an internal wall and an external wall; and

(b) connecting the members together along the longitudinal edges of the members to form the rock bolt or the drill rod with the internal walls of the members defining the axially extending bore.

2. The method defined in claim 1 wherein there are two identical members.

3. The method defined in claim 1 or claim 2, further comprising, rolling or die drawing each member to form on the external wall a section of a threaded profile so that the rock bolt formed by connecting the members together comprises the threaded profile.

4. The method defined in claim 3, wherein the threaded profile is continuous.

5. The method defined in claim 1 or claim 2, wherein the step of rolling or die drawing the members forms a half hexagonal shape on each of the members so that the drill rod formed by connecting the members together comprises a complete hexagonal profile.

6. The method defined in any one of the preceding claims, wherein the step of connecting the members together comprises welding or gluing the members together.

7. The method defined in claim 6, wherein the step of connecting the members together comprises, feeding the members into a jig, aligning the members, and welding or gluing the members together.

8. The method defined in any one of claims 3 to 5, wherein the step of rolling or die drawing the members forms the longitudinal edges of the members with profiles to maximise the surface area of contact and enable proper alignment when connecting the members together.

9. The method defined in claim 8, wherein the profiles are tongue and groove profiles.

10. The method defined in any one of the preceding claims, wherein the step of rolling or die drawing the members forms the longitudinal edges so that when the members are positioned together the adjacent longitudinal edges define the sides of an outwardly opening channel for receiving weld metal or glue to connect the members together.

11. The method defined in any one of claims 1 to 4, wherein the rock bolt has a diameter of 15 to 50mm and a maximum wall thickness of at least 5mm.

12. A rock bolt or a drill rod having an axially extending bore, the rock bolt or the drill rod comprising two or more elongate members formed by rolling or die drawing which are connected together along the longitudinal edges of the members, each member having an internal wall and an external wall, and the internal walls defining the

axially extending bore.

13. The rock bolt or the drill rod defined in claim 12 consisting of two identical members.

14. The rock bolt or the drill rod defined in claim 12 or claim 13, wherein the longitudinal edges of the members comprise profiles that maximise the surface area of contact between the longitudinal edges of adjacent members and enable proper alignment of the members.

15. The rock bolt or the drill rod defined in claim 14, wherein the profiles are tongue and groove profiles.

16. The rock bolt or the drill rod defined in any one of claims 12 to 15, wherein the members are connected together by welding or gluing.

17. The rock bolt or the drill rod defined in claim 16, wherein the longitudinal edges of the members define outwardly opening channels which receive weld metal or glue.

18. The rock bolt defined in any one of claims 12 to 17, wherein the external wall of each member comprises a part of a threaded profile.

19. The rock bolt defined in claim 18, wherein the threaded profile is continuous.

20. The rock bolt defined in claim 18 or claim 19, wherein the rock bolt has a diameter of 15 to 50mm and a maximum wall thickness of at least 5mm.

21. A method of manufacturing a hollow bar substantially as hereinbefore described with reference to the accompanying drawings.

22. A hollow bar substantially as hereinbefore described with reference to the accompanying drawings.

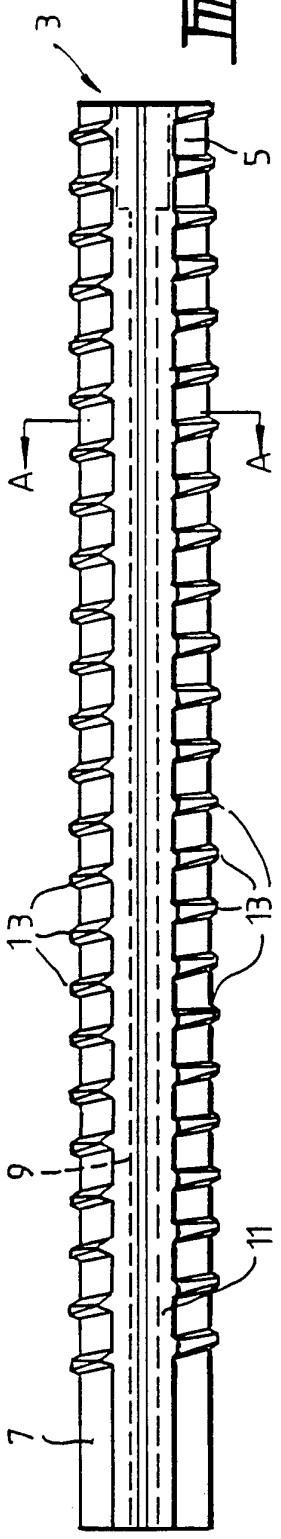

Fig. 1.

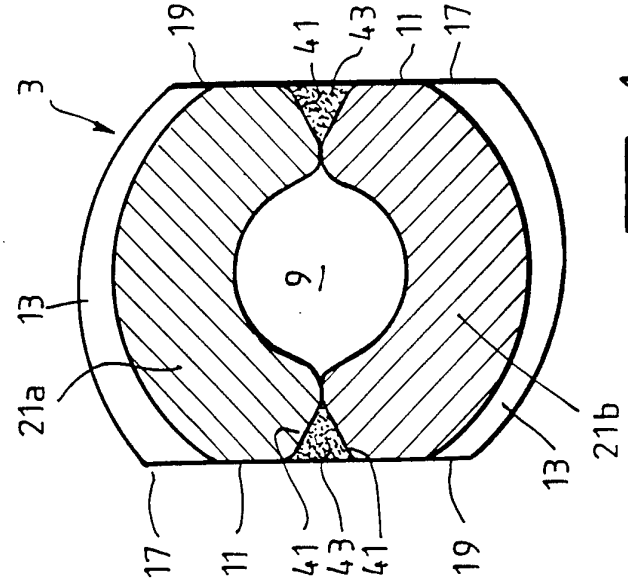

Fig. 4.

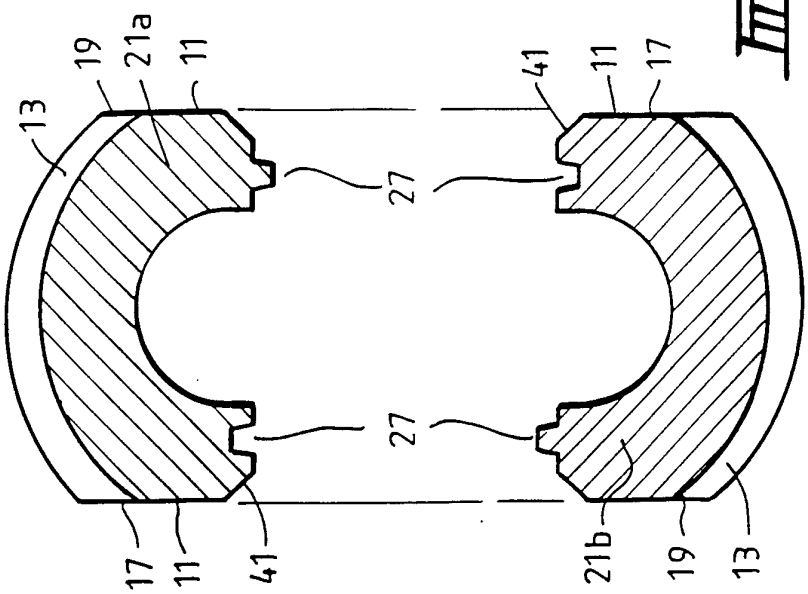

Fig. 3.

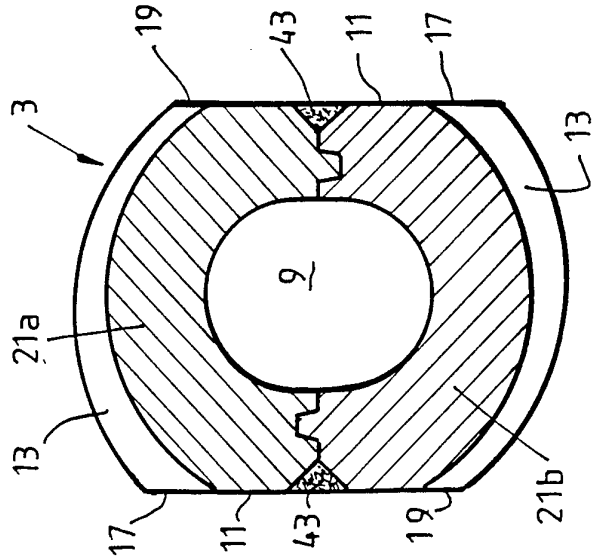

Fig. 2.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU 93/00486

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl.[5] B21C 37/06, 37/08, 37/10, B21H 8/00

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 B21B 1/00, B21H 3/04, 8/00, B21C 37/06, 37/08, 37/20, B21K 1/44, 21/00

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

AU : IPC as above

Electronic data base consulted during the international search (name of data base, and where practicable, 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	Patent Abstracts of Japan, M-94, page 82, JP,A, 56-95440 (YOSHIICHI SAKAMURA) 1 August 1981 (01.08.81) Abstract	1,2,6,11,12,15
X	Derwent Abstract Accession No 88-328394/46, Class P51, SU,A, 1391753 (BRONFEN) 30 April 1988 (30.04.88) Abstract	1,2,6,11,12,15
X	Derwent Soviet Inventions Illustrated, December 1972, Metallurgy, Page 33, SU 341619 (BORISOV et al) 4 July 1972 (04.07.72) Abstract	1,2,6,11,12,15

[X] Further documents are listed in the continuation of Box C.

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29 November 1993 (29.11.93)	20 DEC 1993 (20.12.93)

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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate of the relevant passages	Relevant to Claim No.
X	Derwent Abstract Accession No 07185 E/04, Class M23, P51, SU,A, 254452 (ALIEV) 7 September 1981 (07.09.81) Abstract	1,2,6,11,12,15
X	Derwent Abstract Accession No 00662 E/01, Class M21, P51, P52, JP,A, 6154217 (MATSUSHITA) Abstract	1,2,6,11,12,15
X	Patent Abstracts of Japan, M-675, Page 156, JP,A, 62-220215 (KAWASAKI STEEL CORP) 28 September 1987 (28.09.87) Abstract	1,2,6,11,12,15
A	AU,B, 74446/81 (536627) (TITAN MANUFACTURING) 25 February 1982 (25.02.82) Pages 6,6a	
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A	AU,B, 45736/85 (578964) (ALLIED STEEL AND WIRE LTD) 13 February 1986 (13.02.86) Page 1	

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member					
AU	74446/81	FR	2488820				
AU	45736/85	EP	171965	GB	2162915	HK	621/93
		JP	61071142	ZA	8505837		
							END OF ANNEX