

**NEW BENZOTHAIAZINE AND BENZOTHIADIAZINE COMPOUNDS,
A PROCESS FOR THEIR PREPARATION
AND PHARMACEUTICAL COMPOSITIONS CONTAINING THEM**

The present invention relates to new benzothiazine and benzothiadiazine compounds, to a process for their preparation and to pharmaceutical compositions containing them.

It has now been recognised that the excitatory amino acids, especially glutamate, play a crucial role in the physiological processes of neuronal plasticity and in the mechanisms underlying learning and memory. Pathophysiological studies have clearly shown that a deficit in glutamatergic neurotransmission is closely linked to the development of Alzheimer's disease (Neuroscience and Biobehavioral reviews, 1992, 16, 13-24 ; Progress in Neurobiology, 1992, 39, 517-545).

In addition, innumerable works have in recent years demonstrated the existence of sub-types of excitatory amino acid receptors and their functional interactions (Molecular Neuropharmacology, 1992, 2, 15-31).

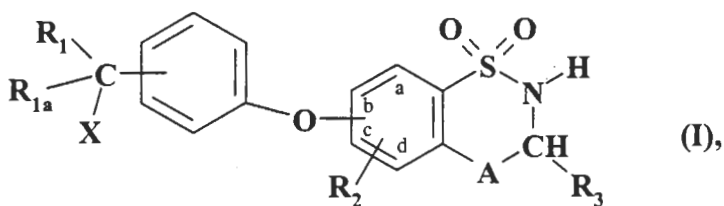
Among those receptors, the AMPA (α -amino-3-hydroxy-5-methyl-4-isoxazole-propionic acid) receptor appears to be involved to the greatest extent in the phenomena of physiological neuronal excitability and, especially, in those phenomena involved in memorisation processes. For example, it has been shown that learning is associated with an increase in the binding of AMPA to its receptor in the hippocampus, one of the areas of the brain essential to processes of memory and cognition. Likewise, nootropic agents such as aniracetam have very recently been described as modulating the AMPA receptors of neuronal cells in a positive manner (Journal of Neurochemistry, 1992, 58, 1199-1204).

In the literature, compounds having a benzamide structure have been described as possessing this same mechanism of action and improving memory performance (Synapse, 1993, 15, 326-329). Compound BA 74, in particular, is the most active of those new pharmacological agents.

Finally, patent specification EP 692 484 describes a benzothiadiazine compound having a facilitating action on the AMPA current, and patent application WO 99/42456 describes *inter alia* particular benzothiadiazine compounds as modulators of AMPA receptors.

The benzothiazine and benzothiadiazine compounds to which the present invention relates, besides being new, **surprisingly** exhibit pharmacological activity on the AMPA current that is markedly superior to the activity of the compounds having similar structures described in the prior art. They are useful as AMPA modulators for the treatment or prevention of disorders of memory and cognition that are associated with age, with **syndromes** of anxiety or depression, with **progressive** neurodegenerative diseases, with Alzheimer's disease, with Pick's disease, with Huntington's chorea, with schizophrenia, with the **sequelae** of acute neurodegenerative diseases, with the sequelae of ischaemia and with the sequelae of epilepsy.

More specifically, the present invention relates to compounds of formula (I) :



wherein :

R₁ represents a hydrogen atom, a halogen atom or a linear or branched (C₁-C₆)alkyl group,

R_{1a} represents a hydrogen atom or a linear or branched (C₁-C₆)alkyl group,

R₂ represents a hydrogen atom, a halogen atom or a hydroxy group,

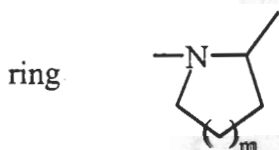
A represents a CR₄R₅ group or an NR₄ group,

R₃ represents a hydrogen atom, a linear or branched (C₁-C₆)alkyl group or a (C₃-C₇)cycloalkyl group,

R₄ represents a hydrogen atom or a linear or branched (C₁-C₆)alkyl group,

or

A represents a nitrogen atom and, together with the adjacent -CHR₃- group, forms the



wherein m represents 1, 2 or 3,

R₅ represents a hydrogen or halogen atom,

X represents an **NR₆R₇**, **S(O)_nR₈** or **OR'₈** group or a heterocyclic group, wherein :

R₆ represents a hydrogen atom, a linear or branched (C₁-C₆)alkyl group, **S(O)_pR₉**, **COR₉** or **P(O)OR₉OR₁₀**,

R₇ represents a hydrogen atom or a linear or branched (C₁-C₆)alkyl group, or **R₆** and **R₇**, together with the nitrogen atom carrying them, form a heterocyclic group,

R₈, **R₉** and **R₁₀**, which may be the same or different, represent a hydrogen atom; a linear or branched (C₁-C₆)alkyl group optionally substituted by one or more halogen atoms; an aryl-(C₁-C₆)alkyl group in which the alkyl moiety is linear or branched; or an aryl group,

R'₈ represents a linear or branched (C₁-C₆)alkyl group or a linear or branched (C₁-C₆)acyl group,

n and **p**, which may be the same or different, represent 1 or 2,

to their enantiomers and **diastereoisomers**, and also to addition salts thereof with a pharmaceutically acceptable acid or base,

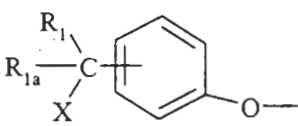
it being understood that :

- a heterocyclic group means a monocyclic or bicyclic, **aromatic or non-aromatic group** containing from one to four identical or different hetero atoms selected from nitrogen, oxygen and sulphur, optionally substituted by one or more identical or different groups selected from halogen, linear or branched (C₁-C₆)alkyl, linear or branched (C₁-C₆)alkoxy, linear or branched (C₁-C₆)polyhaloalkyl, linear or branched (C₁-C₆)alkoxy-carbonyl, oxo, thioxo, carboxy, linear or branched (C₁-C₆)acyl, linear or branched (C₁-C₆)polyhaloalkoxy, hydroxy, cyano, nitro, amino (optionally substituted by one or more linear or branched (C₁-C₆)alkyl groups), aminosulphonyl (optionally substituted by one or more linear or branched (C₁-C₆)alkyl groups) and (C₁-C₆)alkylsulphonylamino,
- an aryl group is understood to mean a monocyclic aromatic group or a bicyclic group in which at least one of the rings is aromatic, optionally substituted by one or more

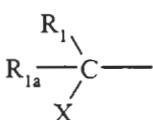
identical or different groups selected from halogen, linear or branched (C₁-C₆)alkyl (optionally substituted by one or more hydroxy groups), linear or branched (C₁-C₆)alkoxy, linear or branched (C₁-C₆)polyhaloalkyl, linear or branched (C₁-C₆)alkoxy-carbonyl, oxo, thioxo, linear or branched (C₁-C₆)alkylthio, carboxy, linear or branched (C₁-C₆)acyl, linear or branched (C₁-C₆)polyhaloalkoxy, hydroxy, cyano, nitro, amino (optionally substituted by one or more linear or branched (C₁-C₆)alkyl or linear or branched (C₁-C₆)acyl groups), aminocarbonyl (optionally substituted by one or more linear or branched (C₁-C₆)alkyl groups), aminosulphonyl (optionally substituted by one or more linear or branched (C₁-C₆)alkyl groups), mono- or di-((C₁-C₆)alkylsulphonyl)amino, mono- or di-(trifluoromethylsulphonyl)amino, PO(OR_a)(OR_b) (wherein R_a and R_b, which may be the same or different, represent a hydrogen atom or a linear or branched (C₁-C₆)alkyl group), benzyloxy and phenyl (optionally substituted by one or more identical or different groups selected from halogen, linear or branched (C₁-C₆)alkyl, linear or branched (C₁-C₆)perhaloalkyl, hydroxy and linear or branched (C₁-C₆)alkoxy).

Among the pharmaceutically acceptable acids there may be mentioned, without implying any limitation, hydrochloric acid, hydrobromic acid, sulphuric acid, phosphonic acid, acetic acid, trifluoroacetic acid, lactic acid, pyruvic acid, malonic acid, succinic acid, glutaric acid, fumaric acid, tartaric acid, maleic acid, citric acid, ascorbic acid, methane-sulphonic acid, camphoric acid etc..

Among the pharmaceutically acceptable bases there may be mentioned, without implying any limitation, sodium hydroxide, potassium hydroxide, triethylamine, tert-butylamine etc..

The grouping  is preferably in position b of the phenyl carrying it.

Preference is given to the R_{1a} and R₂ groups being hydrogen atoms.

The grouping  is preferably in the meta- or para-position of the phenoxy

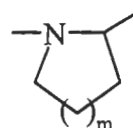
ring structure carrying it.

X preferably represents an NR_6R_7 or $\text{S}(\text{O})_n\text{R}_8$ group or a heterocyclic group.

More especially, the group X is preferably the NR_6R_7 group wherein R_6 represents a hydrogen atom or an $\text{S}(\text{O})_p\text{R}_9$ group and R_7 represents a hydrogen atom, such as, for example, the groups NHSO_2Me , NHSO_2iPr , NHSO_2CF_3 , NH_2 .

Preferred compounds of the invention are compounds wherein A represents a nitrogen

atom and, together with the adjacent $-\text{CHR}_3-$ group, forms the ring



wherein

m represents 1, 2 or 3, preferably 1.

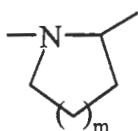
Preferred compounds of the invention are :

- ✓ {3-[(5,5-dioxido-2,3,3a,4-tetrahydro-1*H*-pyrrolo[2,1-*c*][1,2,4]benzothiadiazin-7-yl)-oxy]phenyl}methanamine,
- ✓ *N*-{3-[(5,5-dioxido-2,3,3a,4-tetrahydro-1*H*-pyrrolo[2,1-*c*][1,2,4]benzothiadiazin-7-yl)-oxy]benzyl}methanesulphonamide,
- ✓ *N*-{4-[(5,5-dioxido-2,3,3a,4-tetrahydro-1*H*-pyrrolo[2,1-*c*][1,2,4]benzothiadiazin-7-yl)-oxy]benzyl}methanesulphonamide.

The invention relates also to the processes for the preparation of compounds of formula (I).

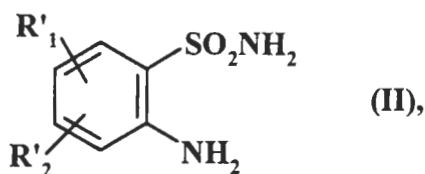
The process for the preparation of compounds of formula (I) wherein A represents an NR_4 group or A represents a nitrogen atom and, together with the adjacent CHR_3 group,

forms the ring



wherein m represents 1, 2 or 3, is characterised in that

there is used as starting material a compound of formula (II) :



wherein :

R'₁ represents a linear or branched (C₁-C₆)alkoxy group,

R'₂ represents a hydrogen atom, a halogen atom or a linear or branched (C₁-C₆)alkoxy group,

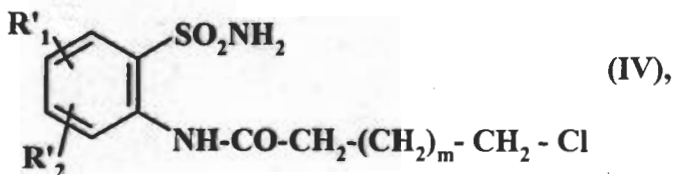
which is :

(a) **either reacted** with the acid chloride of formula (III) in the presence of a base, in a tetrahydrofuran or acetonitrile medium :



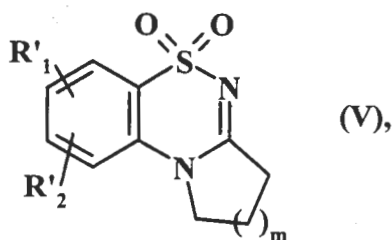
wherein m is as defined for formula (I),

to yield the compound of formula (IV) :



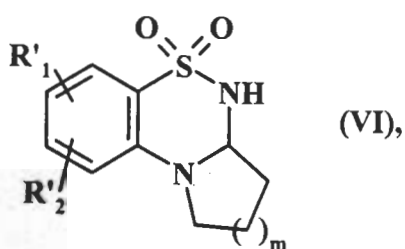
wherein R'₁ and R'₂ are as defined hereinbefore,

which is then cyclised in a basic medium to yield the compound of formula (V) :



wherein R'₁, R'₂ and m are as defined hereinbefore,

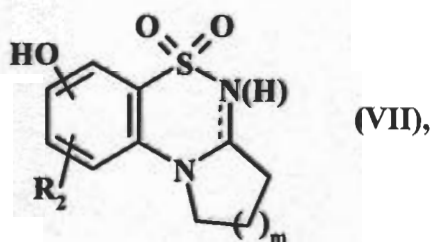
which is optionally subjected to reduction, in an alcoholic or dimethylformamide medium, in the presence of sodium borohydride, to yield the compound of formula (VI) :



wherein R'_1 , R'_2 and m are as defined hereinbefore,

which compound of formula (V) or (VI) is subjected to the action of boron tribromide

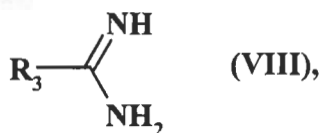
to yield the compound of formula (VII) :



wherein R_2 is as defined for formula (I) and m is as defined hereinbefore,

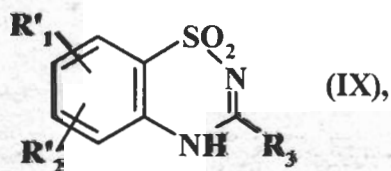
(b) or cyclised :

➤ in the presence of an amidine of formula (VIII) :



wherein R_3 is as defined for formula (I),

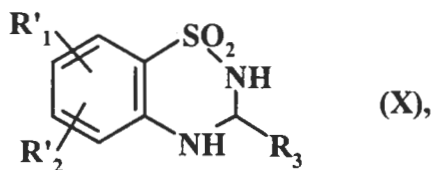
to yield the compound of formula (IX) :



wherein R'_1 , R'_2 and R_3 are as defined hereinbefore,

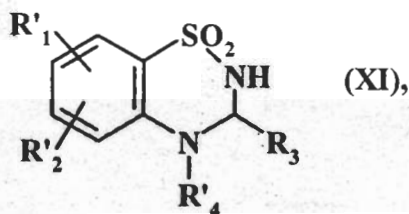
which is :

- ♦ either reduced, using a metallic hydride,
to yield the compound of formula (X) :



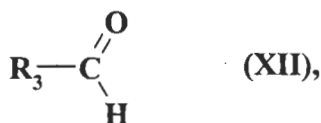
wherein R₁, R₂ and R₃ are as defined hereinbefore,

- ♦ or alkylated by the action of a strong base in the presence of an alkylating agent R₄X, wherein R₄ represents a linear or branched (C₁-C₆)alkyl group and X represents a halogen atom, and then reduced
to yield the compound of formula (XI) :



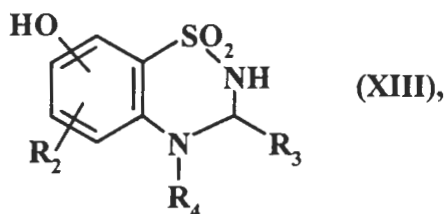
wherein R₁, R₂, R₃ and R₄ are as defined hereinbefore,

- in the presence of an aldehyde of formula (XII) :



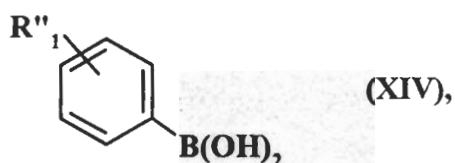
wherein R₃ is as defined for formula (I),
to yield the compound of formula (X) described hereinbefore,

in which compound of formula (X) or (XI)
the group R₁ and, when the group R₂ represents a linear or branched (C₁-C₆)alkoxy group,
the group R₂ are converted into hydroxy groups
to yield the compound of formula (XIII) :



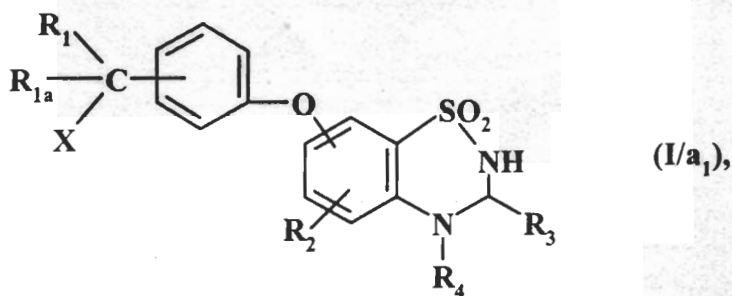
wherein R_2 , R_3 and R_4 are as defined for formula (I),

which compound of formula (VII) or (XIII) is reacted with a boronic acid compound of formula (XIV) :

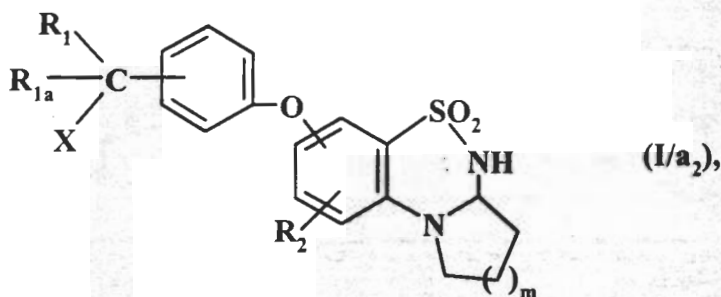


wherein R''_1 represents a cyano group or an $R_1R_{1a}XC-$ group as defined for formula (I),

to yield (after optional conversion of the group R''_1 , when the latter represents a cyano group, into an NR_6R_7 group as defined for formula (I)) the compound of formula (I/a₁) or (I/a₂), particular cases of the compounds of formula (I) :



wherein R_1 , R_{1a} , R_2 , R_3 , R_4 and X are as defined for formula (I),

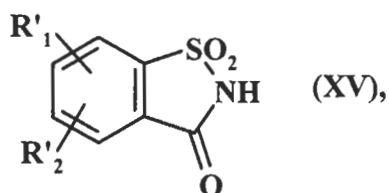


wherein R_1 , R_{1a} , R_2 , m and X are as defined for formula (I),

which compounds of formulae (I/a₁) and (I/a₂) :

are purified, if necessary, according to a conventional purification technique, are separated, if desired, into their isomers according to a conventional separation technique and are converted, if desired, into their addition salts with a pharmaceutically acceptable acid or base.

The process for the preparation of compounds of formula (I) wherein A represents a CR_4R_5 group is characterised in that there is used as starting material a compound of formula (XV) :

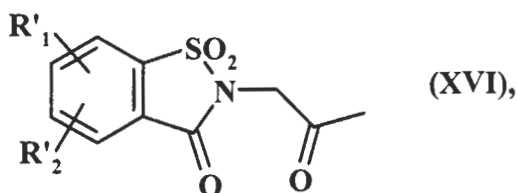


wherein :

R'_1 represents a linear or branched (C_1 - C_6)alkoxy group,

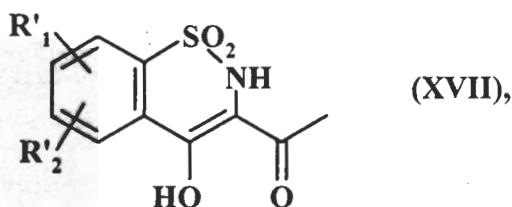
R'_2 represents a hydrogen atom, a halogen atom or a linear or branched (C_1 - C_6)alkoxy group,

which is subjected to the action of chloroacetone in the presence of dimethylformamide to yield the compound of formula (XVI) :



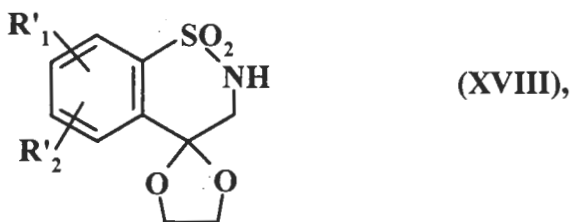
wherein R'_1 and R'_2 are as defined hereinbefore,

which is subjected to a rearrangement in a basic medium to yield the compound of formula (XVII) :



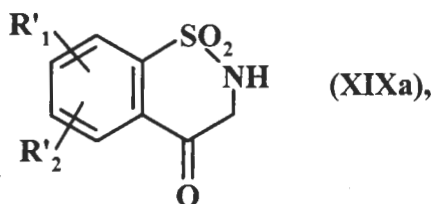
wherein R'_1 and R'_2 are as defined hereinbefore,

which is deacetylated by heating at reflux in a benzene medium in the presence of an excess of ethylene glycol and a catalytic amount of *p*-toluenesulphonic acid to yield the compound of formula (XVIII) :



wherein R'₁ and R'₂ are as defined hereinbefore,

which is subjected to hydrolysis in an acid medium to yield the compound of formula (XIXa) :

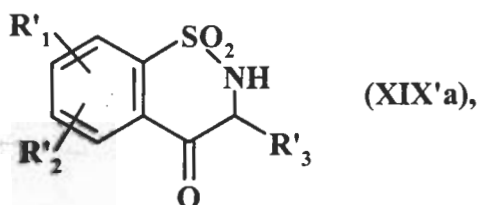


wherein R'₁ and R'₂ are as defined hereinbefore,

the nitrogen atom of which is optionally, depending on the nature of the group R₃ that is desired, protected by a protecting group and which is then, after treatment with a strong base, treated with a compound of formula R'₃-P,

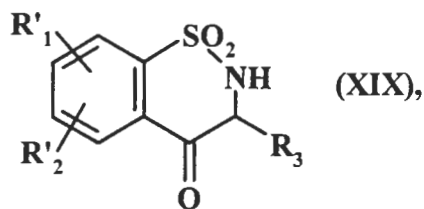
wherein R'₃ represents a linear or branched (C₁-C₆)alkyl group or a (C₃-C₇)cycloalkyl group and P represents a leaving group,

to yield, after deprotection of the nitrogen atom, the compound of formula (XIX'a) :



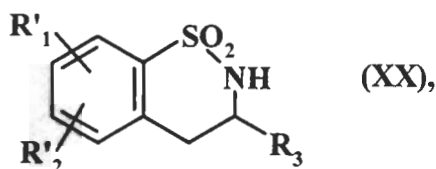
wherein R'₁, R'₂ and R'₃ are as defined hereinbefore,

which compound of formula (XIXa) or (XIX'a), represented by formula (XIX) :



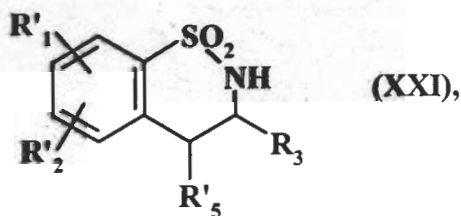
wherein R₁' and R₂' are as defined hereinbefore and R₃ is as defined for formula (I), is :

- either subjected to catalytic reduction to yield the compound of formula (XX) :



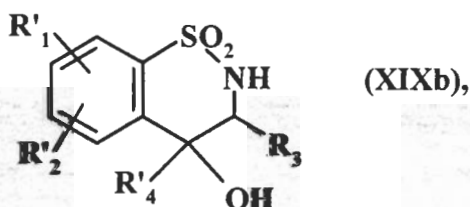
wherein R₁' and R₂' are as defined hereinbefore,

- or converted by the action of a hydride into an alcohol, the hydroxy group of which is converted into a halogen atom by the action of an appropriate reagent to yield the compound of formula (XXI) :



wherein R₁', R₂' and R₃ are as defined hereinbefore and R₅' represents a halogen atom,

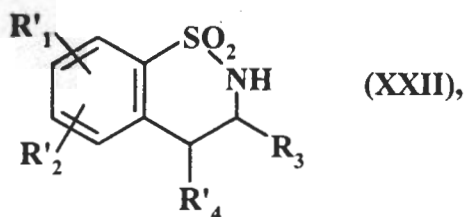
- or subjected to the action of an organomagnesium compound R₄'MgBr, wherein R₄' represents a linear or branched (C₁-C₆)alkyl group, to yield the compound of formula (XIXb) :



wherein R₁', R₂', R₃ and R₄' are as defined hereinbefore,

which compound of formula (XIXb)

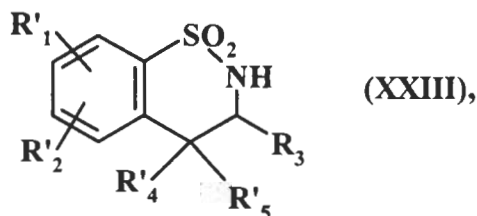
- either is subjected to catalytic reduction to yield the compound of formula (XXII) :



wherein R₁, R₂, R₃ and R₄ are as defined hereinbefore,

- or the hydroxy group thereof is converted into a halogen atom by the action of an appropriate reagent

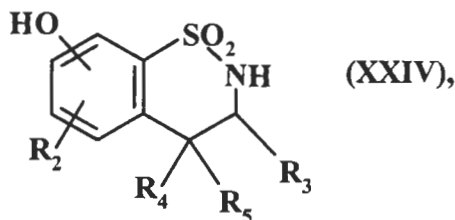
to yield the compound of formula (XXIII) :



wherein R₁, R₂, R₃ and R₄ are as defined hereinbefore and R₅ represents a halogen atom,

in which compounds of formulae (XX) to (XXIII) the group R₁ and, when the group R₂ represents a linear or branched (C₁-C₆)alkoxy group, the group R₂ are converted into hydroxy groups

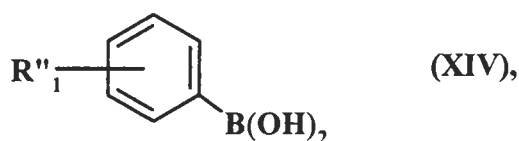
to yield the compound of formula (XXIV) :



wherein R₂, R₃, R₄ and R₅ are as defined for formula (I),

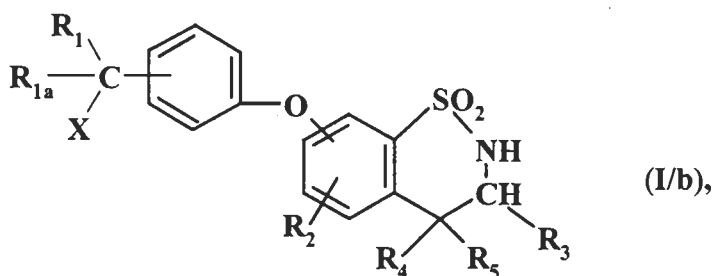
which compound of formula (XXIV)

is reacted with a boronic acid compound of formula (XIV) :



wherein R''_1 represents a cyano group or an $R_1R_{1a}XC-$ group as defined for formula (I),

to yield (after optional conversion of the group R''_1 , when the latter represents a cyano group, into an NR_6R_7 group as defined for formula (I)) the compound of formula (I/b), a particular case of the compounds of formula (I) :



wherein R_1 , R_{1a} , R_2 , R_3 , R_4 , R_5 and X are as defined for formula (I),

which compound of formula (I/b) is purified, if necessary, according to a conventional purification technique, is separated, if desired, into its isomers according to a conventional separation technique and is converted, if desired, into its addition salts with a pharmaceutically acceptable acid or base.

The invention relates also to pharmaceutical compositions comprising, as active ingredient, a compound of formula (I) with one or more appropriate, inert, non-toxic excipients. Among the pharmaceutical compositions according to the invention there may be mentioned more especially those that are suitable for oral, parenteral (intravenous or subcutaneous) or nasal administration, tablets or dragées, sublingual tablets, gelatin capsules, lozenges, suppositories, creams, ointments, dermal gels, injectable preparations, drinkable suspensions etc..

The useful dosage can be varied according to the nature and severity of the disorder, the administration route and the age and weight of the patient and ranges from 1 to 500 mg per day in one or more administrations.

The Examples that follow illustrate the invention but do not limit it in any way.

The starting materials used are products that are known or that are prepared according to known operating procedures.

The structures of the compounds described in the Examples were determined according to the usual spectrophotometric techniques (infrared, NMR, mass spectrometry, ...).

EXAMPLE 1 : {3-[(5,5-Dioxido-2,3,3a,4-tetrahydro-1*H*-pyrrolo[2,1-*c*][1,2,4]-benzothiadiazin-7-yl)oxy]phenyl}methanamine hydrochloride

Step A : 2,3-Dihydro-1*H*-pyrrolo[2,1-*c*][1,2,4]benzothiadiazin-7-ol 5,5-dioxide

A solution of BBr₃ (68.75 mmol) in 25 ml of methylene chloride is added dropwise to a solution, cooled to 0°C, of 27.5 mmol of 7-methoxy-2,3-dihydro-1*H*-pyrrolo[2,1-*c*]-[1,2,4]benzothiadiazine 5,5-dioxide in 350 ml of methylene chloride. Stirring is carried out at ambient temperature for 24 hours. The reaction mixture is poured into a mixture of ice and water, and the suspension is stirred for 30 minutes. The precipitate is filtered off, rinsed several times with water, filtered under suction and dried *in vacuo* to yield the expected product.

Melting point : > 300°C

Elemental micro-analysis :

	C %	H %	N %	S %
Calculated	50.41	4.23	11.76	13.46
Found	50.00	4.19	11.28	13.41

Step B : 3-[(5,5-Dioxido-2,3-dihydro-1*H*-pyrrolo[2,1-*c*][1,2,4]benzothiadiazin-7-yl)-oxy]benzonitrile

A suspension composed of 7.06 mmol of the product obtained in the Step above, 3-cyanophenylboronic acid (11.02 mmol), copper(II) acetate (11.02 mmol), pyridine (22.0 mmol) and about 500 mg of 4Å molecular sieve in 200 ml of methylene chloride is stirred for 24 hours. The reaction mixture is diluted by adding a further 100 ml of

methylene chloride and the suspension is filtered. The filtrate is concentrated and then directly placed on a silica column which is eluted with a methylene chloride/methanol 95/5 system. The fractions containing the expected product are combined and evaporated, and the residue is taken up in a small amount of ethyl ether. After filtering off the solid, the expected product is recovered in the form of a white powder.

Melting point : 229-233°C

Elemental micro-analysis :

	C %	H %	N %	S %
Calculated	60.17	3.86	12.38	9.45
Found	59.42	3.96	12.29	9.63

Step C : {3-[(5,5-Dioxido-2,3,3a,4-tetrahydro-1H-pyrrolo[2,1-c][1,2,4]-benzothiadiazin-7-yl)oxy]phenyl}methanamine hydrochloride

112 mg (2.95 mmol) of LiAlH₄ are added, in small portions, to a solution of 0.58 mmol of the product of the Step above in 20 ml of anhydrous THF and the mixture is stirred at ambient temperature for 1 hour. The excess of hydride is hydrolysed by the successive dropwise addition of 1.5 ml of isopropanol and 1.5 ml of saturated aqueous NaCl solution. The aluminium salts are filtered off and the filtrate is evaporated to dryness. The residue is chromatographed on a silica column, eluting with a mixture of CH₂Cl₂/EtOH/aq. NH₃ 95/5/0.5. After evaporating the fractions containing the amine, the meringue is taken up in ethereal HCl. The solution is evaporated to dryness and the residue is redissolved in a minimum of isopropanol. The expected product crystallises out and is recovered by filtration.

Melting point : 145 °C

Elemental micro-analysis :

	C %	H %	N %	S %	Cl %
Calculated	53.47	5.28	11.00	8.40	9.28
Found	53.09	5.34	10.65	8.30	9.30

EXAMPLE 2 : *N*-{3-[(5,5-Dioxido-2,3,3a,4-tetrahydro-1H-pyrrolo[2,1-c][1,2,4]-benzothiadiazin-7-yl)oxy]benzyl}methanesulphonamide

Methanesulphonic anhydride (0.20 mmol) dissolved in 2 ml of CH₂Cl₂ is added

dropwise to a solution, cooled in an ice-bath, of the compound obtained in Example 1 (0.136 mmol) in 10 ml of CH₂Cl₂ containing 0.34 mmol of Et₃N. The reaction mixture is stirred at ambient temperature for 3 hours. The reaction solution is washed with water and then with saturated NaCl and is dried over MgSO₄. After evaporation *in vacuo*, the residue is made more solid by triturating in ethyl ether to yield the title product after filtration.

Melting point : 183-190°C

Elemental micro-analysis :

	C %	H %	N %	S %
Calculated	51.06	5.00	9.92	15.14
Found	51.09	5.33	9.58	15.55

The following Examples were prepared according to the procedures described in Examples 1 or 2, starting from appropriate starting materials.

EXAMPLE 3 : *N*-{3-[(5,5-Dioxido-2,3,3a,4-tetrahydro-1*H*-pyrrolo[2,1-*c*][1,2,4]-benzothiadiazin-7-yl)oxy]benzyl}acetamide

Melting point : 58°C

Elemental micro-analysis :

	C %	H %	N %	S %
Calculated	58.90	5.46	10.85	8.28
Found	58.51	5.73	10.36	7.82

EXAMPLE 4 : *N*-(1-{3-[(5,5-Dioxido-2,3,3a,4-tetrahydro-1*H*-pyrrolo[2,1-*c*][1,2,4]-benzothiadiazin-7-yl)oxy]phenyl}ethyl)acetamide

EXAMPLE 5 : *N*-(1-{3-[(5,5-Dioxido-2,3,3a,4-tetrahydro-1*H*-pyrrolo[2,1-*c*][1,2,4]-benzothiadiazin-7-yl)oxy]phenyl}-1-fluoroethyl)acetamide

EXAMPLE 6 : 3-[(5,5-Dioxido-2,3,3a,4-tetrahydro-1*H*-pyrrolo[2,1-*c*][1,2,4]-benzothiadiazin-7-yl)oxy]benzyl isopropyl sulphone

EXAMPLE 7 : 1-{3-[(5,5-Dioxido-2,3,3a,4-tetrahydro-1*H*-pyrrolo[2,1-*c*][1,2,4]-benzothiadiazin-7-yl)oxy]phenyl}ethyl isopropyl sulphone

EXAMPLE 8 : 1-{3-[(5,5-Dioxido-2,3,3a,4-tetrahydro-1*H*-pyrrolo[2,1-*c*][1,2,4]-benzothiadiazin-7-yl)oxy]phenyl}-1-fluoroethyl isopropyl sulphone

EXAMPLE 9 : *N*-{3-[(5,5-Dioxido-2,3,3a,4-tetrahydro-1*H*-pyrrolo[2,1-*c*][1,2,4]-benzothiadiazin-7-yl)oxy]benzyl}(trifluoro)methanesulphonamide

Melting point : 104-113°C

Elemental micro-analysis :

	C %	H %	N %	S %
Calculated	45.28	3.80	8.80	13.43
Found	46.20	3.87	8.58	13.84

EXAMPLE 10 : *N*-(1-{3-[(5,5-Dioxido-2,3,3a,4-tetrahydro-1*H*-pyrrolo[2,1-*c*][1,2,4]-benzothiadiazin-7-yl)oxy]phenyl}ethyl)(trifluoro)methanesulphonamide

EXAMPLE 11 : *N*-(1-{3-[(5,5-Dioxido-2,3,3a,4-tetrahydro-1*H*-pyrrolo[2,1-*c*][1,2,4]-benzothiadiazin-7-yl)oxy]phenyl}-1-fluoroethyl)(trifluoro)methanesulphonamide

EXAMPLE 12 : *N*-{3-[(5,5-Dioxido-2,3,3a,4-tetrahydro-1*H*-pyrrolo[2,1-*c*][1,2,4]-benzothiadiazin-7-yl)oxy]benzyl}-*N*-methylbenzamide

EXAMPLE 13 : *N*-(1-{3-[(5,5-Dioxido-2,3,3a,4-tetrahydro-1*H*-pyrrolo[2,1-*c*][1,2,4]-benzothiadiazin-7-yl)oxy]phenyl}ethyl)-*N*-methylbenzamide

EXAMPLE 14 : *N*-(1-{3-[(5,5-Dioxido-2,3,3a,4-tetrahydro-1*H*-pyrrolo[2,1-*c*][1,2,4]-benzothiadiazin-7-yl)oxy]phenyl}-1-fluoroethyl)-*N*-methylbenzamide

EXAMPLE 15 : 7-{[3-(1*H*-imidazol-4-yl)methyl]phenoxy}-2,3,3a,4-tetrahydro-1*H*-pyrrolo[2,1-*c*][1,2,4]benzothiadiazine 5,5-dioxide

EXAMPLE 16 : 7-{3-[1-(1*H*-Imidazol-4-yl)ethyl]phenoxy}-2,3,3a,4-tetrahydro-1*H*-pyrrolo[2,1-*c*][1,2,4]benzothiadiazine 5,5-dioxide

EXAMPLE 17 : 7-{3-[1-Fluoro-1-(1*H*-imidazol-4-yl)ethyl]phenoxy}-2,3,3a,4-tetrahydro-1*H*-pyrrolo[2,1-*c*][1,2,4]benzothiadiazine 5,5-dioxide

EXAMPLE 18 : *N*-{3-[(5,5-Dioxido-2,3,3a,4-tetrahydro-1*H*-pyrrolo[2,1-*c*][1,2,4]-benzothiadiazin-7-yl)oxy]benzyl}propane-2-sulphonamide

Melting point : 112-118°C

Elemental micro-analysis :

	<i>C</i>	<i>H</i>	<i>N</i>	<i>S</i>
Theoretical %	53.20	5.58	9.31	14.20
Empirical %	53.36	5.80	9.24	14.52

EXAMPLE 19 : 7-[3-(1*H*-Pyrrol-1-ylmethyl)phenoxy]-2,3,3a,4-tetrahydro-1*H*-pyrrolo[2,1-*c*][1,2,4]benzothiadiazine 5,5-dioxide

200 mg (0.58 mmol) of the product obtained in Example 1, in the form of the free amine, and 105 μ l (0.81 mmol) of 2,5-dimethoxytetrahydrofuran are added to a two-phase mixture of 2.5 ml of water, 0.95 ml of AcOH and 2.85 ml of dichloro-1,2-ethane. The mixture is stirred at 80°C for 2 hours, allowed to return to ambient temperature and extracted with CH₂Cl₂. The organic phase is washed with saturated aqueous NaCl solution and dried over MgSO₄. The expected product is purified by chromatography on a silica column (CH₂Cl₂/heptane 75/25).

Melting point : 150-152°C

Elemental micro-analysis :

	<i>C</i>	<i>H</i>	<i>N</i>	<i>S</i>
Theoretical %	63.78	5.35	10.63	8.11
Empirical %	63.65	5.28	10.38	8.41

EXAMPLE 20 : 1-{4-[(5,5-Dioxido-2,3,3a,4-tetrahydro-1H-pyrrolo[2,1-c][1,2,4]-benzothiadiazin-7-yl)oxy]phenyl}methanamine hydrochloride

The procedure is as in Example 1, replacing the 3-cyanophenylboronic acid in Step B by the 4-cyanophenylboronic acid isomer.

Melting point : 165-172°C

Elemental micro-analysis :

	C	H	N	S	Cl
Theoretical %	53.47	5.28	11.00	8.40	9.28
Empirical %	54.08	5.16	10.46	8.25	9.42

EXAMPLE 21 : N-{4-[(5,5-Dioxido-2,3,3a,4-tetrahydro-1H-pyrrolo[2,1-c][1,2,4]-benzothiadiazin-7-yl)oxy]benzyl}methanesulphonamide

The procedure is as in Example 2, starting from the compound obtained in Example 20.

Melting point : 104-110°C

Elemental micro-analysis :

	C	H	N	S
Theoretical %	51.05	5.00	9.92	15.14
Empirical %	51.24	5.45	9.17	14.94

The 2 enantiomers of Example 21 were separated by chiral chromatography on a Chiralpak AD[®] column. Eluant : CH₃CN/iPrOH/DEA 1000/2/1. The 2 enantiomers are listed in Examples 22 and 23 in the order in which they are eluted under the above-mentioned conditions.

EXAMPLE 22 : N-{4-[(5,5-Dioxido-2,3,3a,4-tetrahydro-1H-pyrrolo[2,1-c][1,2,4]-benzothiadiazin-7-yl)oxy]benzyl}methanesulphonamide, enantiomer 1

Elemental micro-analysis :

	C	H	N	S
Theoretical %	51.05	5.00	9.92	15.14
Empirical %	50.48	5.08	9.63	15.53

EXAMPLE 23 : *N*-{4-[(5,5-Dioxido-2,3,3a,4-tetrahydro-1*H*-pyrrolo[2,1-*c*][1,2,4]-benzothiadiazin-7-yl)oxy]benzyl}methanesulphonamide, enantiomer 2

Elemental micro-analysis :

	<i>C</i>	<i>H</i>	<i>N</i>	<i>S</i>
Theoretical %	51.05	5.00	9.92	15.14
Empirical %	50.77	5.06	9.70	15.47

EXAMPLE 24 : *N*-{4-[(5,5-Dioxido-2,3,3a,4-tetrahydro-1*H*-pyrrolo[2,1-*c*][1,2,4]-benzothiadiazin-7-yl)oxy]benzyl}acetamide

The procedure is as in Example 2, replacing the methanesulphonic anhydride by acetyl chloride and using as starting material the amine obtained in Example 20.

Melting point : 158-161°C

Elemental micro-analysis :

	<i>C</i>	<i>H</i>	<i>N</i>	<i>S</i>
Theoretical %	58.90	5.46	10.85	8.28
Empirical %	58.85	5.69	10.65	8.51

EXAMPLE 25 : *N*-{4-[(5,5-Dioxido-2,3,3a,4-tetrahydro-1*H*-pyrrolo[2,1-*c*][1,2,4]-benzothiadiazin-7-yl)oxy]benzyl}-2,2,2-trifluoroacetamide

The procedure is as in Example 2, replacing the methanesulphonic anhydride by trifluoroacetic anhydride and using as starting material the amine obtained in Example 20.

Melting point : 136-138°C

Elemental micro-analysis :

	<i>C</i>	<i>H</i>	<i>N</i>	<i>S</i>
Theoretical %	51.70	4.11	9.52	7.26
Empirical %	51.84	4.24	9.36	7.48

EXAMPLE 26 : *N*-{3-[(5,5-Dioxido-2,3,3a,4-tetrahydro-1*H*-pyrrolo[2,1-*c*][1,2,4]-benzothiadiazin-7-yl)oxy]benzyl}-4-fluorobenzamide

The procedure is as in Example 2, replacing the methanesulphonic anhydride by 4-fluorobenzoyl chloride and using as starting material the amine obtained in Example 20.

Melting point : 104-108°C

Elemental micro-analysis :

	<i>C</i>	<i>H</i>	<i>N</i>	<i>S</i>
Theoretical %	61.66	4.74	8.99	6.86
Empirical %	61.41	4.81	8.72	6.66

EXAMPLE 27 : 7-[4-(1*H*-Tetrazol-5-ylmethyl)phenoxy]-2,3,3a,4-tetrahydro-1*H*-pyrrolo[2,1-*c*][1,2,4]benzothiadiazine 5,5-dioxide

Step A : {4-[(5,5-Dioxido-2,3,3a,4-tetrahydro-1*H*-pyrrolo[2,1-*c*][1,2,4]benzothiadiazin-7-yl)oxy]phenyl} acetonitrile

A suspension composed of 1.15 g (4.77 mmol) of 2,3,3a,4-tetrahydro-1*H*-pyrrolo[2,1-*c*][1,2,4]benzothiadiazin-7-ol 5,5-dioxide, 1.00 g (6.21 mmol) of [4-(cyanomethyl)phenyl]-boronic acid, 1.3 g (7.15 mmol) of copper(II) acetate, 1.16 ml (14.31 mmol) of pyridine and about 500 mg of 4Å molecular sieve in 200 ml of methylene chloride is stirred overnight. The reaction mixture is diluted by adding a further 100 ml of methylene chloride and the suspension is filtered. The filtrate is concentrated and then directly placed on a silica column which is eluted with a methylene chloride/methanol 99/1 system. The fractions containing the expected product are combined and evaporated, and the residue is taken up in a small amount of ethyl ether. After filtering off the solid, the title product is obtained in the form of beige powder.

Melting point : 156-158°C

Step B : 7-[4-(1*H*-Tetrazol-5-ylmethyl)phenoxy]-2,3,3a,4-tetrahydro-1*H*-pyrrolo[2,1-*c*][1,2,4]benzothiadiazine 5,5-dioxide

A suspension of 300 mg (0.844 mmol) of the product obtained in Step A, 164 mg (2.53 mmol) of sodium azide and 113 mg (2.11 mmol) of NH_4Cl in 3 ml of DMF is stirred at 110°C for 24 hours. The reaction mixture is allowed to return to ambient temperature and is poured into 20 ml of 1N HCl. Extraction (AcOEt), drying (MgSO_4) and evaporating to dryness are carried out. The residue is triturated in Et_2O and the precipitate is filtered off to yield the title product.

Melting point : $209\text{-}212^\circ\text{C}$

Elemental micro-analysis :

	C	H	N	S
Theoretical %	54.26	4.55	21.09	8.05
Empirical %	54.18	4.44	20.67	8.05

EXAMPLE 28 : 3-{4-[(5,5-Dioxido-2,3,3a,4-tetrahydro-1H-pyrrolo[2,1-c][1,2,4]-benzothiadiazin-7-yl)oxy]benzyl}-1,2,4-oxadiazole-5(4H)-thione

Step A : 2-{4-[(5,5-Dioxido-2,3-dihydro-1H-pyrrolo[2,1-c][1,2,4]benzothiadiazin-7-yl)oxy]phenyl}-N'-hydroxyethanimidamide

2.51 ml (18.0 mmol) of triethylamine are added to a solution of 1.25 g (18.0 mmol) of hydroxylamine hydrochloride in 4 ml of DMSO and the suspension is stirred for 10 minutes. The precipitate is filtered off and the filtrate is concentrated. 992 mg (3.00 mmol) of the product of Step A of Example 27 are added to the filtrate and the solution is stirred at 75°C for 1 hour 30 minutes. The solution is allowed to return to ambient temperature, and precipitation of the reaction mixture is brought about using water. The precipitate is filtered off to yield the title product.

Step B : 3-{4-[(5,5-Dioxido-2,3-dihydro-1H-pyrrolo[2,1-c][1,2,4]benzothiadiazin-7-yl)oxy]benzyl}-1,2,4-oxadiazole-5(4H)-thione

348 mg (1.95 mmol) of 1,1'-thiocarbonyldiimidazole and then 530 μl (3.516 mmol) of DBU are added to a suspension of the product obtained in Step A (330 mg, 0.85 mmol) in 8 ml of CH_3CN . The reaction solution is stirred at ambient temperature overnight. 20 ml of

1N HCl are added; extraction (CH₂Cl₂), washing (saturated NaCl), drying (MgSO₄) and evaporating to dryness are carried out. The title product is obtained in the form of a yellow wax which is used in the crude state in the following Step.

Step C : 3-{4-[(5,5-Dioxido-2,3,3a,4-tetrahydro-1*H*-pyrrolo[2,1-*c*][1,2,4]-benzothiadiazin-7-yl)oxy]benzyl}-1,2,4-oxadiazole-5(4*H*)-thione

The product obtained in Step B (290 mg, 0.68 mmol) in ethanol (12 ml) in the presence of NaBH₄ (77 mg, 2.03 mmol) is stirred at ambient temperature for 1 hour. 10 ml of 1N HCl are added and extraction (CH₂Cl₂) is carried out. The title product is purified by chromatography on a silica column (CH₂Cl₂/MeOH 99/1).

Melting point : 124-126°C

Elemental micro-analysis :

	<i>C</i>	<i>H</i>	<i>N</i>	<i>S</i>
Theoretical %	53.01	4.21	13.01	14.90
Empirical %	53.05	4.37	12.32	15.20

EXAMPLE 29 : *N*-(1-{4-[(5,5-Dioxido-2,3,3a,4-tetrahydro-1*H*-pyrrolo[2,1-*c*][1,2,4]-benzothiadiazin-7-yl)oxy]phenyl}ethyl)methanesulphonamide

Step A : 1-{4-[(5,5-Dioxido-2,3,3a,4-tetrahydro-1*H*-pyrrolo[2,1-*c*][1,2,4]benzothiadiazin-7-yl)oxy]phenyl}ethanone

A suspension composed of 3.0 g (12.48 mmol) of 2,3,3a,4-tetrahydro-1*H*-pyrrolo[2,1-*c*][1,2,4]benzothiadiazin-7-ol 5,5-dioxide, 3.18 g (18.73 mmol) of (4-acetylphenyl)boronic acid, 3.42 g (18.82 mmol) of copper(II) acetate, 3.03 ml (37.15 mmol) of pyridine and about 500 mg of 4Å molecular sieve in 150 ml of methylene chloride is stirred overnight. The reaction mixture is diluted by adding a further 100 ml of methylene chloride and the suspension is filtered. The filtrate is concentrated and then directly placed on a silica column which is eluted with a CH₂Cl₂/acetone 99/1 system. The fractions containing the expected product are combined and evaporated, and the residue is taken up in ethyl ether. After filtering off the solid, the title product is recovered in the form of white powder.

Melting point : 152-154°C

Step B : (1-{4-[(5,5-Dioxido-2,3,3a,4-tetrahydro-1*H*-pyrrolo[2,1-*c*][1,2,4]benzothiadiazin-7-yl)oxy]phenyl}ethyl)amine

1.65 ml (5.63 mmol) of titanium(IV) isopropoxide are added dropwise to a solution of 1.0 g (2.80 mmol) of the product obtained in Step A in 5 ml of 7N ammoniacal methanol. Stirring is carried out at ambient temperature overnight, 424 mg (11.20 mmol) of NaBH₄ are added and stirring is continued for 2 hours. Precipitation of the reaction mixture is brought about by adding water (2-3 ml); a white precipitate is filtered off. The filtrate is set aside. The precipitate is suspended in AcOEt, stirring is carried out for 30 minutes and filtration is carried out. The filtrate is combined with the first filtrate and the extraction with AcOEt is repeated. The organic phases are combined, washed (saturated NaCl), dried (MgSO₄) and evaporated *in vacuo* to yield the title product.

Step C : *N*-(1-{4-[(5,5-Dioxido-2,3,3a,4-tetrahydro-1*H*-pyrrolo[2,1-*c*][1,2,4]benzothiadiazin-7-yl)oxy]phenyl}ethyl)methanesulphonamide

The procedure is as in Example 2, using the product of Step B above as starting material.

Melting point : 122-127°C

Elemental micro-analysis :

	C	H	N	S
Theoretical %	52.16	5.30	9.60	14.66
Empirical %	51.93	5.81	9.32	14.59

EXAMPLE 30 : *N*-(1-{3-[(5,5-Dioxido-2,3,3a,4-tetrahydro-1*H*-pyrrolo[2,1-*c*][1,2,4]benzothiadiazin-7-yl)oxy]phenyl}ethyl)methanesulphonamide

The procedure is as in Steps A, B and C of Example 29, replacing the (4-acetylphenyl)-boronic acid in Step A by (3-acetylphenyl)boronic acid.

Melting point : 83-84°C

Elemental micro-analysis :

	C	H	N	S
Theoretical %	52.16	5.30	9.60	14.66
Empirical %	52.03	5.28	9.20	14.81

EXAMPLE 31 : *N*-{4-[(5,5-Dioxido-2,3,3a,4-tetrahydro-1*H*-pyrrolo[2,1-*c*][1,2,4]-benzothiadiazin-7-yl)oxy]benzyl}-*N*-methylmethanesulphonamide

A suspension composed of 5.74 mg (3.37 mmol) of 2,3,3a,4-tetrahydro-1*H*-pyrrolo[2,1-*c*]-[1,2,4]benzothiadiazin-7-ol 5,5-dioxide, 926 mg (4.04 mmol) of (4-[[methyl(methylsulphonyl)amino]methyl]phenyl)boronic acid, 920 mg (5.06 mmol), of copper(II) acetate, 817 μ l (10.10 mmol) of pyridine and about 4 g of 4Å molecular sieve in 50 ml of CH₂Cl₂ is stirred overnight. The reaction mixture is filtered, rinsing with CH₂Cl₂/MeOH (1/1). The filtrate is concentrated and then directly placed on a silica column which is eluted with a CH₂Cl₂/MeOH 95/5 system. The fractions containing the expected product are combined and evaporated, and the residue is taken up in ethyl ether. After filtering off the solid, the title product is recovered in the form of white powder.

Melting point : 142-144°C

Elemental micro-analysis :

	C	H	N	S
Theoretical %	52.16	5.30	9.60	14.66
Empirical %	51.99	5.55	9.43	14.86

EXAMPLE 32 : {3-[(5,5-Dioxido-2,3,3a,4-tetrahydro-1*H*-pyrrolo[2,1-*c*][1,2,4]-benzothiadiazin-7-yl)oxy]benzyl}dimethylamine

Step A : Methyl 3-[(5,5-Dioxido-2,3-dihydro-1*H*-pyrrolo[2,1-*c*][1,2,4]benzothiadiazin-7-yl)oxy]benzoate

The procedure is as in **Step B** of Example 1, using the compound obtained in **Step A** of Example 1 and [3-(methoxycarbonyl)phenyl]boronic acid as starting materials.

Melting point : 211-214°C

Elemental micro-analysis :

	C	H	N	S
Theoretical %	58.06	4.33	7.52	8.61
Empirical %	57.70	4.54	7.29	8.37

Step B : 3-[3-(Aminosulphonyl)-4-(2-oxopyrrolidin-1-yl)phenoxy]benzoic acid

A suspension of the product obtained in Step A (1.1g, 2.55 mmol) in 18 ml of 1N NaOH is heated at 95°C until a solution is obtained. The solution is allowed to return to ambient temperature, is acidified with 1N HCl and extracted (CH₂Cl₂). The organic phases are combined, washed (saturated NaCl), dried (MgSO₄) and evaporated. The residue is triturated in Et₂O; the title product precipitates out and is recovered by filtration.

Step C : 3-[(2,3-Dihydro-5,5-dioxido-1H-pyrrolo[2,1-c][1,2,4]benzothiadiazin-7-yl)-oxy]benzoic acid

A suspension of the product obtained in Step B (850 mg, 2.26 mmol) in 25 ml of THF in the presence of 675 µl (4.52 mmol) of DBU is refluxed for 1 hour. It is allowed to return to ambient temperature and is acidified with 1N HCl, and the white precipitate corresponding to the title product is filtered off.

Elemental micro-analysis :

	C	H	N	S
Theoretical %	56.98	3.94	7.82	8.95
Empirical %	57.15	4.13	7.68	9.16

Step D : 3-[(5,5-Dioxido-2,3-dihydro-1H-pyrrolo[2,1-c][1,2,4]benzothiadiazin-7-yl)-oxy]-N,N-dimethylbenzamide :

To a suspension of the product obtained in Step C (1.40 g, 3.91 mmol) in 20 ml of CH₂Cl₂ there are added 2 drops of DMF and then, dropwise, 684 µl (7.81 mmol) of oxalyl chloride diluted with 2 ml of CH₂Cl₂. Stirring is carried out at ambient temperature for 2 hours 30 minutes; evaporation to dryness is carried out; the residue is taken up in 15 ml of CH₂Cl₂; 1.1 ml (7.81 mmol) of Et₃N and then 2.94 ml (5.87 mmol) of a 2M solution of

dimethylamine in THF are added. Stirring is carried out at ambient temperature for 1 hour. The reaction mixture is acidified with 0.5N HCl and extracted (CH₂Cl₂). The organic phases are combined, washed (saturated NaCl), dried (MgSO₄) and evaporated. The residue is triturated in Et₂O; the title product precipitates out and is recovered by filtration.

Elemental micro-analysis :

	C	H	N	S
Theoretical %	59.21	4.97	10.90	8.32
Empirical %	59.23	5.09	10.47	7.97

Step E : {3-[(5,5-Dioxido-2,3,3a,4-tetrahydro-1H-pyrrolo[2,1-c][1,2,4]benzothiadiazin-7-yl)oxy]benzyl}dimethylamine

3.72 ml (3.72 mmol) of a 1M solution of LiAlH₄ in THF are added dropwise to a suspension of 577 mg (1.49 mmol) of the product obtained in Step D in 20 ml of THF. The reaction mixture is observed passing into solution and stirring is carried out at ambient temperature for 3 hours. The excess of hydride is hydrolysed by the dropwise addition of water until the evolution of gas ceases. The suspension is stirred for 10 minutes, 20 ml of water are added, and extraction is carried out with AcOEt. The organic phases are combined, washed (saturated NaCl), dried (MgSO₄) and evaporated, and the residue is chromatographed on a silica column (CH₂Cl₂/MeOH 95/5) to yield the title product.

Melting point : 122°C

Elemental micro-analysis :

	C	H	N	S
Theoretical %	61.10	6.21	11.25	8.59
Empirical %	61.32	6.19	11.06	8.52

PHARMACOLOGICAL STUDY OF PRODUCTS OF THE INVENTION

Study of the excitatory currents induced by AMPA in *Xenopus* oocytes

a - Method :

mRNA's are prepared from cerebral cortex of male Wistar rats by the guanidinium thiocyanate/phenol/chloroform method. The poly (A⁺) mRNA's are isolated by

chromatography on oligo-dT cellulose and injected at a level of 50 ng per oocyte. The oocytes are incubated for 2 to 3 days at 18°C to permit expression of the receptors and are then stored at 8-10°C.

Electrophysiological recording is carried out in a Plexiglass® chamber at 20-24°C in OR2 medium (J. Exp. Zool., 1973, 184, 321-334) by the "voltage-clamp" method using two electrodes, with a third electrode placed in the bath serving as reference.

All the compounds are applied *via* the incubation medium and the electric current is measured at the end of the application period. AMPA is used in a concentration of 10µM. For each compound studied, the concentration that doubles (EC2X) or quintuples (EC5X) the intensity of the current induced by AMPA alone (5 to 50 nA) is determined.

b - Results :

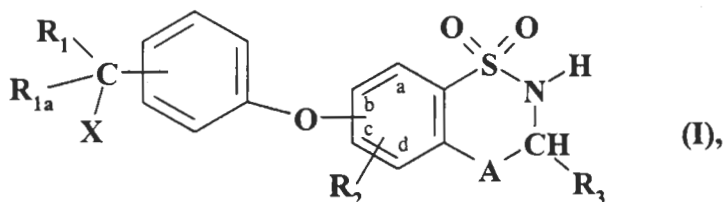
The compounds of the invention potentiate the excitatory effects of AMPA to a very considerable degree and their activity is very clearly superior to that of compounds of reference. The compound of Example 1 especially has an EC2X of 3.5µM and an EC5X of 9.2µM, the compound of Example 2 an EC2X of 0.35µM and an EC5X of 2.6µM, and the compound of Example 21 an EC2X of 0.1µM and an EC5X of 0.56µM.

PHARMACEUTICAL COMPOSITION

Formula for the preparation of 1000 tablets each containing 100 mg of
N-{3-[(5,5-dioxido-2,3,3a,4-tetrahydro-1*H*-pyrrolo[2,1-*c*][1,2,4]benzothiadiazin-7-yl)oxy]benzyl}methanesulphonamide (Example 2)..... 100 g
hydroxypropylcellulose 2 g
wheat starch 10 g
lactose 100 g
magnesium stearate..... 3 g
talc 3 g

CLAIMS

1- Compounds of formula (I) :



wherein :

R₁ represents a hydrogen atom, a halogen atom or a linear or branched (C₁-C₆)alkyl group,

R_{1a} represents a hydrogen atom or a linear or branched (C₁-C₆)alkyl group,

R₂ represents a hydrogen atom, a halogen atom or a hydroxy group,

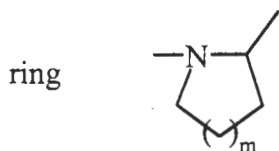
A represents a CR₄R₅ group or an NR₄ group,

R₃ represents a hydrogen atom, a linear or branched (C₁-C₆)alkyl group or a (C₃-C₇)cycloalkyl group,

R₄ represents a hydrogen atom or a linear or branched (C₁-C₆)alkyl group,

or

A represents a nitrogen atom and, together with the adjacent -CHR₃- group, forms the



ring

wherein m represents 1, 2 or 3,

R₅ represents a hydrogen or halogen atom,

X represents an NR₆R₇, S(O)_nR₈ or OR'₈ group or a heterocyclic group, wherein :

R₆ represents a hydrogen atom, a linear or branched (C₁-C₆)alkyl group, S(O)_pR₉, COR₉ or P(O)OR₉OR₁₀,

R₇ represents a hydrogen atom or a linear or branched (C₁-C₆)alkyl group,

or **R₆** and **R₇**, together with the nitrogen atom carrying them, form a heterocyclic group,

R₈, **R₉** and **R₁₀**, which may be the same or different, represent a hydrogen atom; a linear or branched (C₁-C₆)alkyl group optionally substituted by one or more halogen

atoms; an aryl-(C₁-C₆)alkyl group in which the alkyl moiety is linear or branched; or an aryl group,

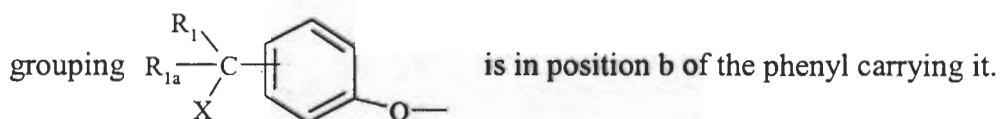
R'₈ represents a linear or branched (C₁-C₆)alkyl group or a linear or branched (C₁-C₆)acyl group,

n and **p**, which may be the same or different, represent 1 or 2,

their enantiomers and diastereoisomers, and also addition salts thereof with a pharmaceutically acceptable acid or base.

2- Compounds of formula (I) according to claim 1, wherein **R₂** represents a hydrogen atom.

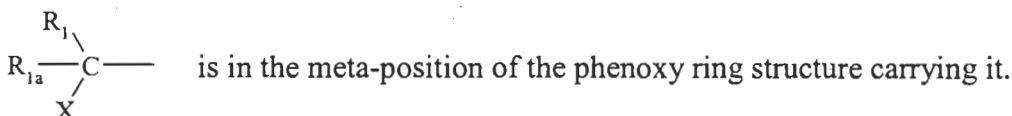
3- Compounds of formula (I) according to either claim 1 or claim 2, wherein the



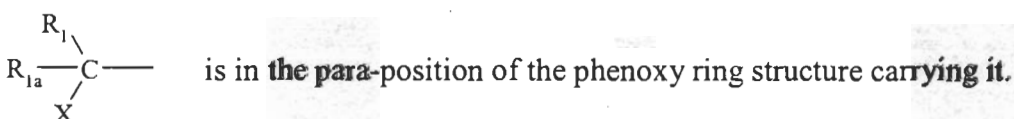
4- Compounds of formula (I) according to any one of claims 1, 2 and 3, wherein **X** is an NR₆R₇ or S(O)_nR₈ group or a heterocyclic group.

5- Compounds of formula (I) according to any one of claims 1, 2, 3 and 4, wherein **X** is an NR₆R₇ group.

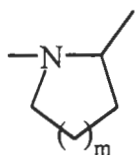
6- Compounds of formula (I) according to any one of claims 1 to 5, wherein



7- Compounds of formula (I) according to any one of claims 1 to 5, wherein



8- Compounds of formula (I) according to any one of claims 1 to 7, wherein **A** represents a nitrogen atom and, together with the adjacent -CHR₃- group, forms the ring



wherein m represents 1, 2 or 3, preferably 1.

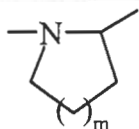
9- Compound of formula (I) according to claim 1, which is {3-[(5,5-dioxido-2,3,3a,4-tetrahydro-1*H*-pyrrolo[2,1-*c*][1,2,4]benzothiadiazin-7-yl)oxy]phenyl}methanamine, and also addition salts thereof.

10- Compound of formula (I) according to claim 1, which is *N*-{3-[(5,5-dioxido-2,3,3a,4-tetrahydro-1*H*-pyrrolo[2,1-*c*][1,2,4]benzothiadiazin-7-yl)oxy]benzyl}methanesulphonamide, and also addition salts thereof.

11- Compound of formula (I) according to claim 1, which is *N*-{4-[(5,5-dioxido-2,3,3a,4-tetrahydro-1*H*-pyrrolo[2,1-*c*][1,2,4]benzothiadiazin-7-yl)oxy]benzyl}methanesulphonamide, and also addition salts thereof.

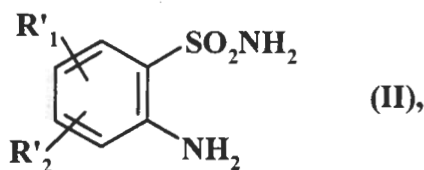
12- Process for the preparation of compounds of formula (I) according to claim 1 wherein A represents an NR_4 group or A represents a nitrogen atom and, together with the adjacent

CHR_3 group, forms the ring



wherein m represents 1, 2 or 3,

characterised in that there is used as starting material a compound of formula (II) :



wherein :

R'_1 represents a linear or branched ($\text{C}_1\text{-C}_6$)alkoxy group,

R'_2 represents a hydrogen atom, a halogen atom or a linear or branched ($\text{C}_1\text{-C}_6$)alkoxy group,

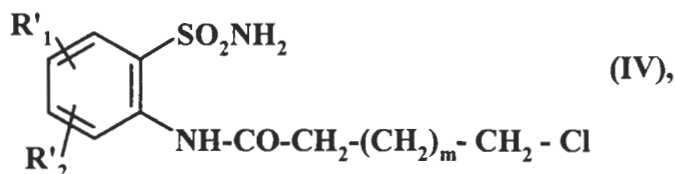
which is :

(a) **either reacted** with the acid chloride of formula (III) in the presence of a base, in a tetrahydrofuran or acetonitrile medium :



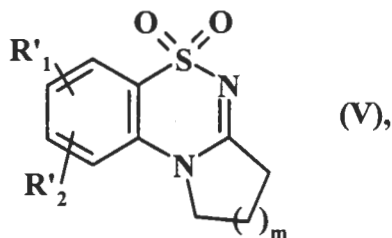
wherein m is as defined for formula (I),

to yield the compound of formula (IV) :



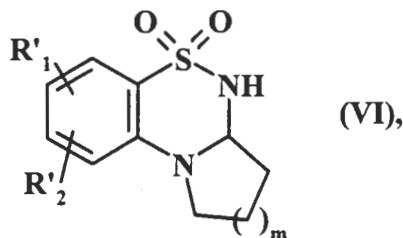
wherein R'1 and R'2 are as defined hereinbefore,

which is then cyclised in a basic medium to yield the compound of formula (V) :



wherein R'1, R'2 and m are as defined hereinbefore,

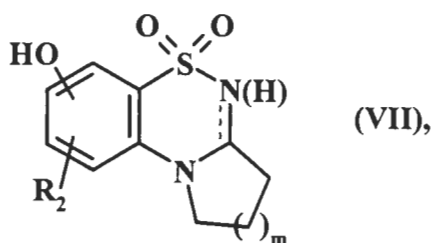
which is optionally subjected to reduction, in an alcoholic or dimethylformamide medium, in the presence of sodium borohydride, to yield the compound of formula (VI) :



wherein R'1, R'2 and m are as defined hereinbefore,

which compound of formula (V) or (VI) is subjected to the action of boron tribromide

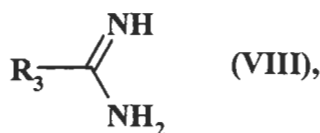
to yield the compound of formula (VII) :



wherein R_2 is as defined for formula (I) and m is as defined hereinbefore,

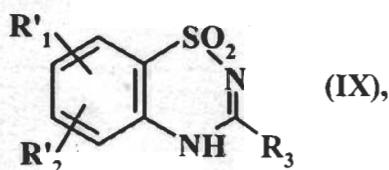
(b) or cyclised :

➤ in the presence of an amidine of formula (VIII) :



wherein R_3 is as defined for formula (I),

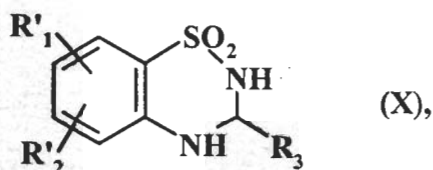
to yield the compound of formula (IX) :



wherein R'_1 , R'_2 and R_3 are as defined hereinbefore,

which is :

- ♦ either reduced, using a metallic hydride,
to yield the compound of formula (X) :

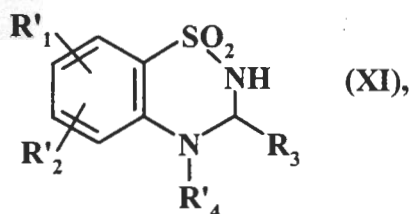


wherein R'_1 , R'_2 and R_3 are as defined hereinbefore,

- ♦ or alkylated by the action of a strong base in the presence of an alkylating agent R'_4X ,

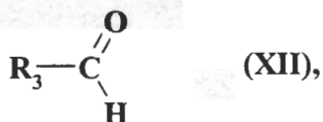
wherein R'_4 represents a linear or branched (C_1-C_6) alkyl group and X represents a halogen atom, and then reduced

to yield the compound of formula (XI) :



wherein R'_1 , R'_2 , R_3 and R'_4 are as defined hereinbefore,

➤ in the presence of an aldehyde of formula (XII) :



wherein R_3 is as defined for formula (I),

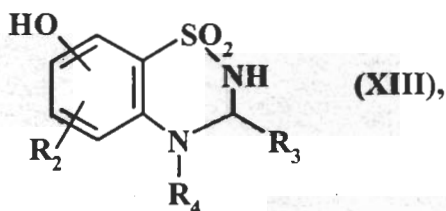
to yield the compound of formula (X) described hereinbefore,

in which compound of formula (X) or (XI)

the group R'_1 and, when the group R'_2 represents a linear or branched (C_1-C_6) alkoxy group,

the group R'_2 are converted into hydroxy groups

to yield the compound of formula (XIII) :



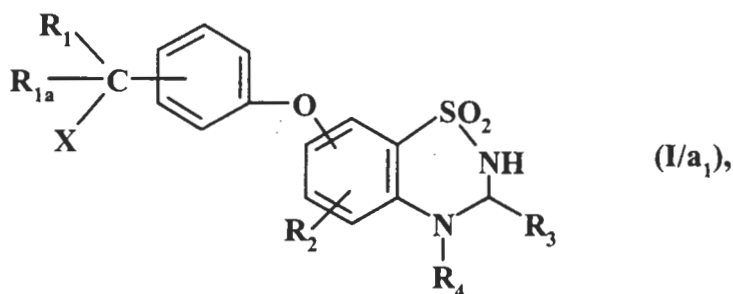
wherein R_2 , R_3 and R_4 are as defined for formula (I),

which compound of formula (VII) or (XIII) is reacted with a boronic acid compound of formula (XIV) :

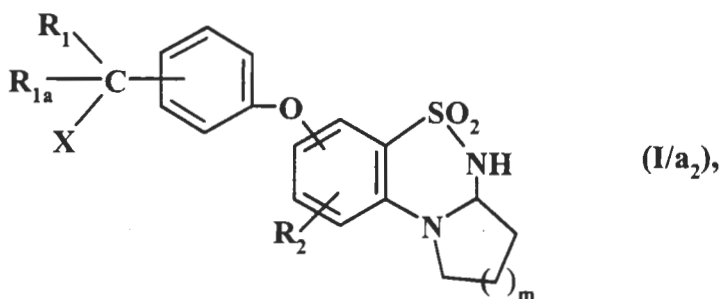


wherein R''_1 represents a cyano group or an $R_1R_{1a}XC-$ group as defined for formula (I),

to yield (after optional conversion of the group R''_1 , when the latter represents a cyano group, into an NR_6R_7 group as defined for formula (I)) the compound of formula (I/a₁) or (I/a₂), particular cases of the compounds of formula (I) :



wherein R_1 , R_{1a} , R_2 , R_3 , R_4 and X are as defined for formula (I),

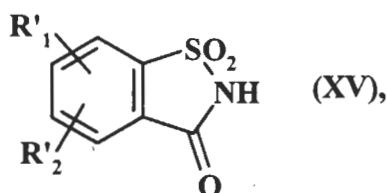


wherein R_1 , R_{1a} , R_2 , m and X are as defined for formula (I),

which compounds of formulae (I/a₁) and (I/a₂) :

are purified, if necessary, according to a conventional purification technique, are separated, if desired, into their isomers according to a conventional separation technique and are converted, if desired, into their addition salts with a pharmaceutically acceptable acid or base.

13- Process for the preparation of compounds of formula (I) according to claim 1 wherein A represents a CR_4R_5 group, characterised in that there is used as starting material a compound of formula (XV) :

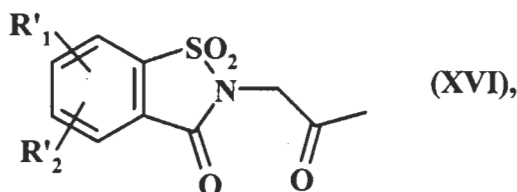


wherein :

R'₁ represents a linear or branched (C₁-C₆)alkoxy group,

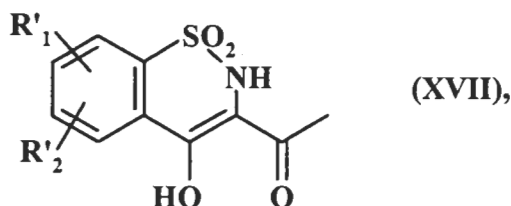
R'₂ represents a hydrogen atom, a halogen atom or a linear or branched (C₁-C₆)alkoxy group,

which is subjected to the action of chloroacetone in the presence of dimethylformamide to yield the compound of formula (XVI) :



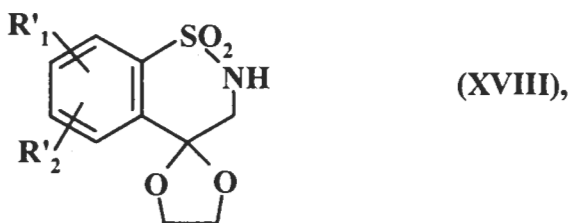
wherein R'₁ and R'₂ are as defined hereinbefore,

which is subjected to a rearrangement in a basic medium to yield the compound of formula (XVII) :



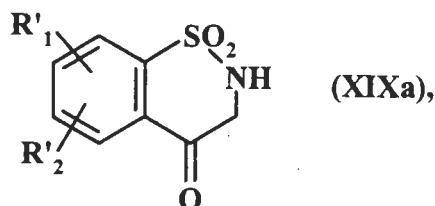
wherein R'₁ and R'₂ are as defined hereinbefore,

which is deacetylated by heating at reflux in a benzene medium in the presence of an excess of ethylene glycol and a catalytic amount of *p*-toluenesulphonic acid to yield the compound of formula (XVIII) :



wherein R'₁ and R'₂ are as defined hereinbefore,

which is subjected to hydrolysis in an acid medium to yield the compound of formula (XIXa) :

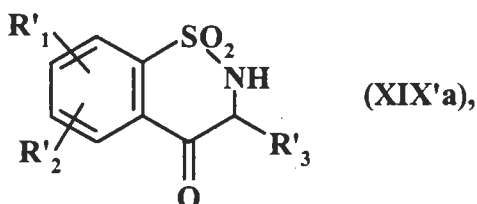


wherein R'_1 and R'_2 are as defined hereinbefore,

the nitrogen atom of which is optionally, depending on the nature of the group R_3 that is desired, protected by a protecting group and which is then, after treatment with a strong base, treated with a compound of formula R'_3 -P,

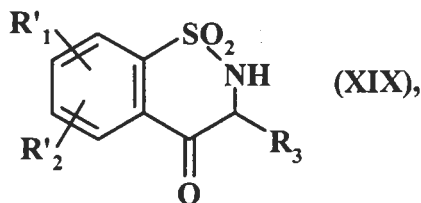
wherein R'_3 represents a linear or branched (C_1-C_6) alkyl group or a (C_3-C_7) cycloalkyl group and P represents a leaving group,

to yield, after deprotection of the nitrogen atom, the compound of formula (XIX'a) :



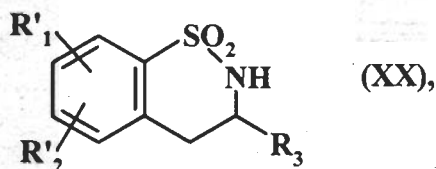
wherein R'_1 , R'_2 and R'_3 are as defined hereinbefore,

which compound of formula (XIXa) or (XIX'a), represented by formula (XIX) :



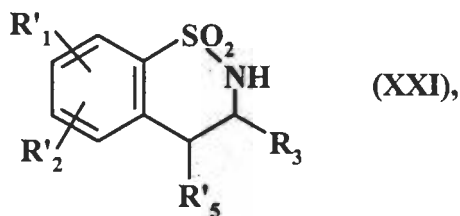
wherein R'_1 and R'_2 are as defined hereinbefore and R_3 is as defined for formula (I), is :

- **either** subjected to catalytic reduction to yield the compound of formula (XX) :



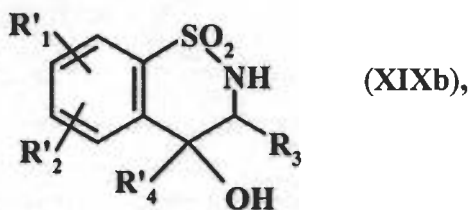
wherein R'_1 and R'_2 are as defined hereinbefore,

- **or** converted by the action of a hydride into an alcohol, the hydroxy group of which is converted into a halogen atom by the action of an appropriate reagent to yield the compound of formula (XXI) :



wherein R'₁, R'₂ and R₃ are as defined hereinbefore and R'₅ represents a halogen atom,

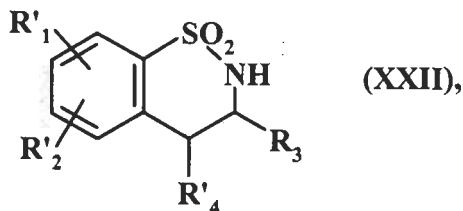
- **or** subjected to the action of an organomagnesium compound R'₄MgBr, wherein R'₄ represents a linear or branched (C₁-C₆)alkyl group, to yield the compound of formula (XIXb) :



wherein R'₁, R'₂, R₃ and R'₄ are as defined hereinbefore,

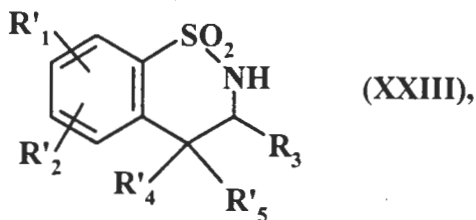
which compound of formula (XIXb)

- **either** is subjected to catalytic reduction to yield the compound of formula (XXII) :



wherein R'₁, R'₂, R₃ and R'₄ are as defined hereinbefore,

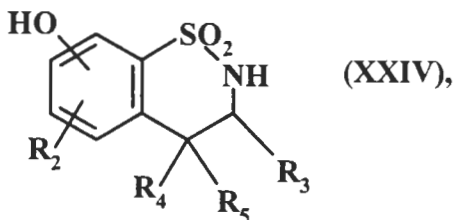
- **or** the hydroxy group thereof is converted into a halogen atom by the action of an appropriate reagent to yield the compound of formula (XXIII) :



wherein R'_1 , R'_2 , R_3 and R'_4 are as defined hereinbefore and R'_5 represents a halogen atom,

in which compounds of formulae (XX) to (XXIII) the group R'_1 and, when the group R'_2 represents a linear or branched (C_1 - C_6)alkoxy group, the group R'_2 are converted into hydroxy groups

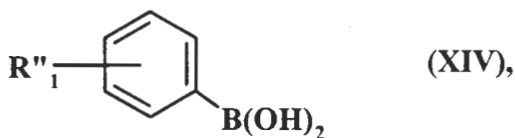
to yield the compound of formula (XXIV) :



wherein R_2 , R_3 , R_4 and R_5 are as defined for formula (I),

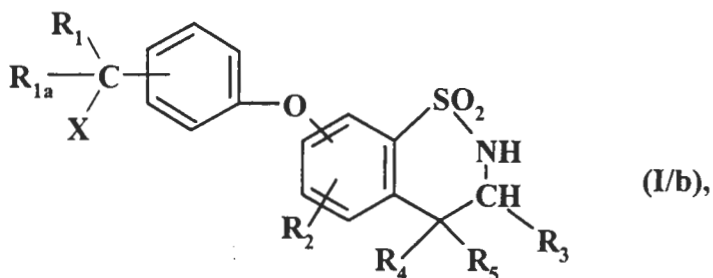
which compound of formula (XXIV)

is reacted with a boronic acid compound of formula (XIV) :



wherein R''_1 represents a cyano group or an $R_1R_{1a}XC-$ group as defined for formula (I),

to yield (after optional conversion of the group R''_1 , when the latter represents a cyano group, into an NR_6R_7 group as defined for formula (I)) the compound of formula (I/b), a particular case of the compounds of formula (I) :



wherein R_1 , R_{1a} , R_2 , R_3 , R_4 , R_5 and X are as defined for formula (I),

which compound of formula (I/b) is purified, if necessary, according to a conventional purification technique, is separated, if desired, into its isomers according to a conventional separation technique and is converted, if desired, into its addition salts with a pharmaceutically acceptable acid or base.

14- Pharmaceutical compositions comprising as active ingredient a compound according to any one of claims 1 to 11 in combination with one or more inert, non-toxic, pharmaceutically acceptable excipients or carriers.

15- Pharmaceutical compositions according to claim 14 comprising as active ingredient a compound according to any of claims 1 to 11, for use as medicaments as AMPA modulators.