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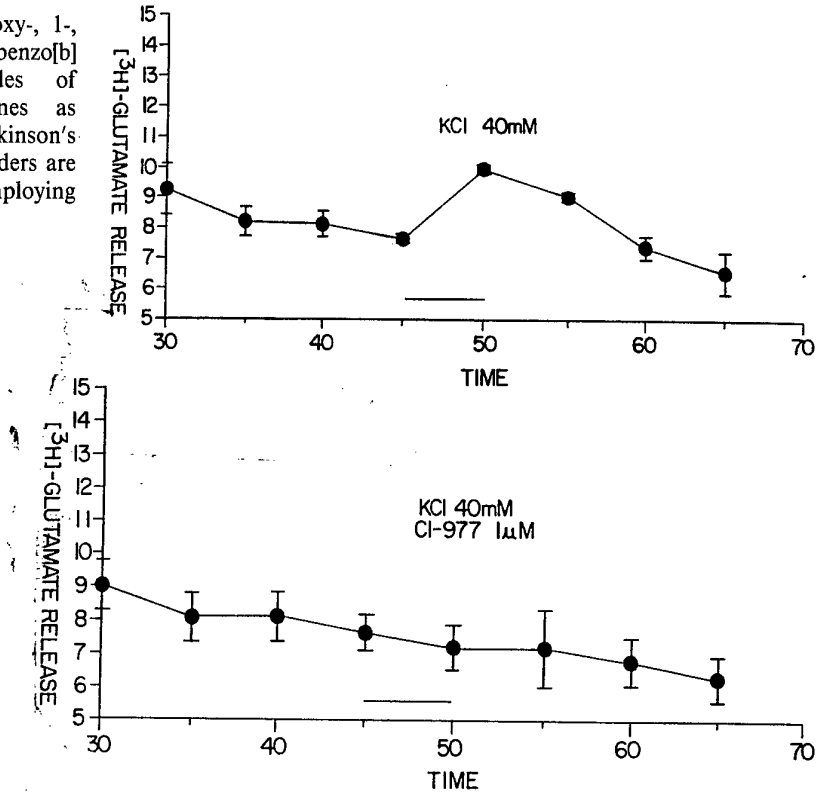
(54) Title: 7-((SUBSTITUTED)AMINO)-8-(((SUBSTITUTED)CARBONYL)-METHYLAMINO)-1-OXASPIRO(4,5)DECANES USEFUL IN PARKINSON'S DISEASE, DYSTONIA, AND OTHER MOVEMENT DISORDERS

(57) Abstract

Methods for using substituted phenoxy-, 1-, and 2-naphthalenyoxy-, indenyl-, indolyl-, benzo[b] furanyl-, and benzo[b]thienylcarboxamides of 7,8-(substituted-diamino)-1-oxaspiro[4.5]decanes as agents for alleviating the symptoms of Parkinson's disease, dystonia, and other movement disorders are disclosed. Pharmaceutical compositions employing the compounds are also disclosed.



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7-((SUBSTITUTED)AMINO)-8-((SUBSTITUTED)CARBONYL)-METHYLAMINO)-1-OXASPIRO(4,5)DECANES USEFUL IN PARKINSON'S DISEASE, DYSTONIA, AND OTHER MOVEMENT DISORDERS

BACKGROUND OF THE INVENTION

The present invention is related to a method of using 7-((substituted)amino-8-((substituted) carbonyl)- methylamino)-1-oxaspiro(4.5)decanes and the pharmaceutically acceptable salts thereof as agents useful in treating Parkinson's disease, dystonia, and other movement disorders. The compounds, processes for preparing them, and pharmaceutical compositions containing them are found in United States Patent 4,737,493, which is herein incorporated by reference. The disclosed utility in the patent is analgesic. The compounds are also disclosed as having sedative, diuretic, and corticosteroid elevating effects and therefore as being useful diuretic and psychotherapeutic agents.

United States Patent 4,965,278 and its divisional 5,063,242 cover use of the above compounds for inflammation, stroke, and cerebrovascular disorders such as cerebral ischemia and infarction. These two patents are hereby incorporated by reference.

United States Patent 4,598,087 covers certain substituted trans-1,2-diamino-cyclohexyl amide compounds which demonstrate selective opioid receptor binding. They are disclosed as useful as analgesics, diuretics, and psychotherapeutic agents.

United States Patent 4,663,343 covers certain substituted naphthalenyloxy-1,2-diaminocyclohexyl amide compounds which possess selective kappa opioid

receptor site binding activity and are useful as analgesics and diuretics.

European Application 258,095A discloses decahydroquinoline derivatives and European application 258,096 covers 1,2-diaminoindane derivatives. The compounds are analgesics with strong affinity for opiate receptors. The compounds are also mentioned as having diuretic, antiarrhythmic, cerebral antiischemic and hypotensive activity.

European Application 260,041 covers 1-acyl-substituted piperidine derivatives useful as analgesics with specific agonist effect on Kappa opioid receptors.

European Application 261,842 covers certain acylated-(1-(phenyl or benzyl)-1,2-ethylene diamines which are K-receptor agonists which act as analgesics through interaction with kappa opioid receptors.

European Application 254,545 covers 1,2-ethylene diamine compounds having analgesic, diuretic and antiinflammatory activity.

United States Patent 4,499,286 covers trans-cyclohexane-1,2-diamine derivatives of thienylacetic acid. The compounds are disclosed as having analgesic activity.

European Application 260,555 covers benzo-fused cycloalkane and oxa- and thia-, cycloalkane trans-1,2- diamine derivatives useful as analgesic and diuretics.

SUMMARY

The present invention relates to a novel therapeutic means for alleviating Parkinsonian symptoms, dystonia, and other movement disorders. The method of treatment comprises administering to a patient in need of such treatment a therapeutically

effective amount of a compound of Formula I as described hereinafter.

Pharmaceutical compositions are also included in the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGURES IA and B

In Figures IA and B the effect of Compound I on excitatory amino acid release in the substantia nigra reticulata is shown. The time in minutes is versus the [^{3}H]glutamate release.

Slices of SNR loaded with [^{3}H]glutamate. Release of this loaded glutamate was monitored using standard superperfusion techniques. At time 45 to 50 minutes test compounds were added.

a) 40 mM K^+ causes Ca^{2+}-dependent release of glutamate.

b) In the presence of 1 μM Compound I the release induced by 40 mM K^+ was completely inhibited.

(Data are means ± SEM, N = 6)

FIGURE II

Figure II shows the anti-Parkinsonian effect of Compound I injections in the rat entopeduncular nucleus. The amount of Compound I is versus the locomotor score.

Rats were rendered Parkinsonian by injection of reserpine (4 mg/kg). This treatment resulted in akinesia and rigidity. Locomotor scores were measured following injections directly into the entopeduncular nucleus unilaterally. Locomotor scores relate to distance moved by the animals. Following injection of vehicle, the animals remained Parkinsonian and attained very low locomotor scores. With increasing doses of Compound I, increasing amounts of locomotor activity were seen. These anti-

Parkinsonian effects were also accompanied by reductions in rigidity.

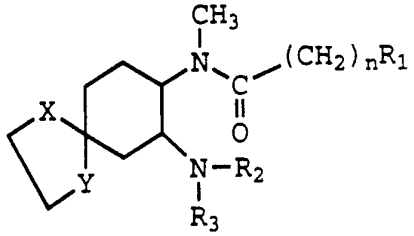
FIGURE III

In Figure III the anti-Parkinsonian effect of Compound I injections in the medial globus pallidus (GPM) in the primate rendered Parkinsonian is shown. The amounts of Compound I are versus the mobility score.

Mobility scores are shown for marmosets pre- and posttreatment with MPTP (N = 4). Mobility scores are derived from a clinical rating scale. Mobility was measured in an MPTP-treated Parkinsonian marmoset following bilateral injections of Compound I into the GPM. Following injections of 20 mM and 50 mM Compound I a marked reversal of Parkinsonian rigidity and akinesia was seen. The animals' locomotor activity returned to near normal levels. At the higher dose, the latency of onset was very short (less than 4 minutes) but some stereotyped movements were seen. At the lower dose of Compound I, the anti-Parkinsonian effects had a longer latency of onset (approximately 25 minutes) but no stereotypy was seen. Further studies are, however, needed to clarify whether these anti-Parkinsonian effects represent a return to normal mobility. The anti-Parkinsonian effects of Compound I were totally inhibited by naloxone (5 mg/kg).

DETAILED DESCRIPTION

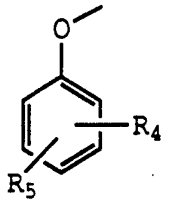
The present invention provides certain substituted oxaspirodiaminocyclohexane compounds which are useful as agents for alleviating Parkinsonian symptoms, dystonia, and other movement disorders. The compounds are



I

wherein n is an integer of from one to six;
either of X or Y is oxygen and the other is $-CH_2-$;
R_1 is selected from

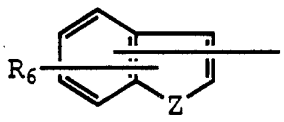
a)



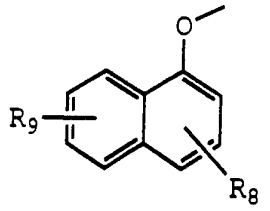
where R_4 and R_5 are independently hydrogen, fluorine, chlorine, bromine, nitro, trifluoromethyl, alkyl of from one to six carbon atoms, alkoxy of from one to six carbon atoms, or aryl;

b) 3,4,5-trimethylphenoxy;

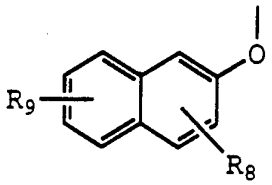
c)



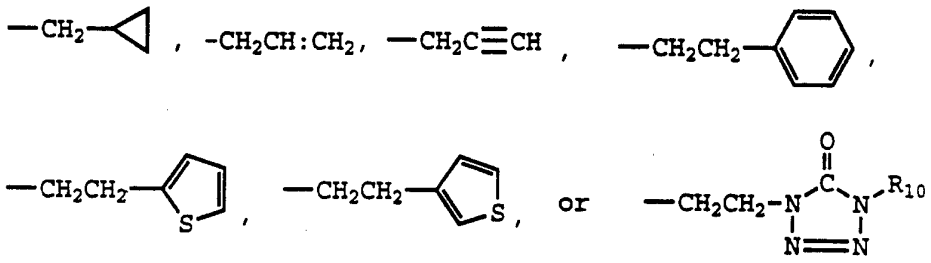
where R_6 is hydrogen, fluorine, chlorine, alkyl of from one to six carbon atoms, or aryl; Z is $-CH_2-$, $-O-$, $-S-$, or $-NR_7-$ where R_7 is hydrogen, alkanoyl of from one to six carbon atoms, or alkyl of from one to six carbon atoms;

d) 

where R_8 and R_9 are independently hydrogen, fluorine, bromine, alkyl of from one to six carbon atoms, or alkoxy of from one to four carbon atoms; or

e) 

where R_8 and R_9 are as defined above;
R_2 is methyl and R_3 is hydrogen, alkyl of from one to six carbon atoms,



where R_{10} is alkyl of from one to four carbon atoms; or where R_2 and R_3 when taken together with the nitrogen atom to which they are attached, form a pyrrolidinyl, piperidinyl, or hexahydro-1H-azepinyl ring; and the pharmaceutically acceptable acid addition salts thereof.

The compounds of the present invention constitute a class of derivatives of certain substituted oxaspirodiaminocyclohexane compounds of Formula I above in which one nitrogen atom is an amine nitrogen substituted with methyl and a second substituent selected from the group R_3 as defined above, or when taken together with the nitrogen atom

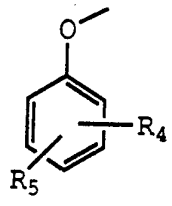
to which they are attached, R_2 and R_3 form a pyrrolidinyl, piperidinyl, or hexahydro-1H-azepinyl ring, and the other nitrogen atom is a N-methyl amide nitrogen further substituted with the group R_1 as defined above.

Compounds of the present invention contain one or more asymmetric carbon atoms and therefore exist in various stereoisomeric forms. Additionally, the compounds of this invention are capable of existing in different geometric isomeric forms. For example, the oxygen atom of the 5-membered spiro-ring may be positioned on the same side of the average plane of the cyclohexane ring as the amide nitrogen, or on the side opposite. The present invention contemplates all geometric and stereoisomeric forms of the compounds of Formula I above.

The individual stereoisomers are obtained, if desired, from mixture of the different forms by known methods of resolution such as the formation of diastereomers, followed by recrystallization.

Compounds of the instant invention include solvates, hydrates, and salts of Formula I above.

Preferred compounds of the present invention are those of Formula I above wherein R_1 is

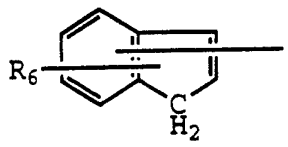


where R_4 and R_5 are independently hydrogen, fluorine, chlorine, bromine, nitro, trifluoromethyl, alkyl of from one to six carbon atoms, alkoxy of from one to six carbon atoms, or aryl.

By the term "aryl" is meant phenyl; phenyl substituted with fluorine, chlorine, alkoxy of from

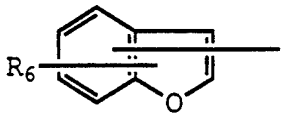
one to four carbon atoms, nitro, or trifluoromethyl; 2- or 3-thienyl; and 2- or 3-thienyl substituted with alkyl of from one to four carbon atoms or alkoxy of from one to four carbon atoms.

Preferred compounds of the present invention are those of Formula I above where R_1 is



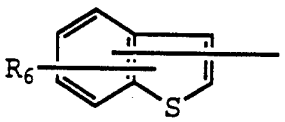
wherein R_6 is as defined above. The most preferred compounds are substituted inden-1-yl compounds of Formula I above.

Other preferred compounds of the present invention are those of Formula I wherein R_1 is



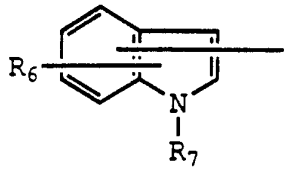
wherein R_6 is as defined above. The most preferred compounds are substituted benzofuran-4-yl compounds of Formula I.

Yet other preferred compounds of the present invention are those of Formula I wherein R_1 is



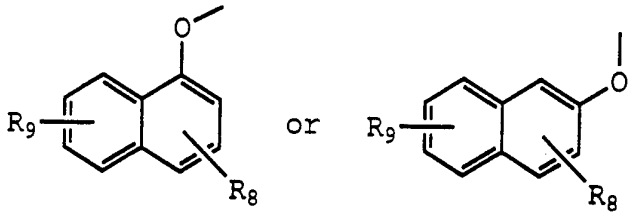
wherein R_6 is as defined above. The most preferred compounds are substituted benzo[b]thiophen-4-yl compounds of Formula I.

Yet other preferred compounds of the present invention are those of Formula I wherein R_1 is



wherein R_6 and R_7 are as defined above. The most preferred compounds are indol-4-yl compounds of Formula I.

Yet other preferred compounds of the present invention are those of Formula I wherein R_1 is



wherein R_8 and R_9 are independently hydrogen, fluorine, chlorine, bromine, alkyl of from one to four carbon atoms or alkoxy of from one to four carbon atoms.

Preferred substituents for R_2 and R_3 are those where R_2 is methyl and R_3 is lower alkyl, most preferably methyl, or where R_2 and R_3 taken together with the nitrogen atom to which they are attached form a pyrrolidinyl ring.

Preferred compounds of the present invention include but are not limited to:

[5R-(5α,7α,8ß)]-N-Methyl-N-[7-(methyl-2-propynyl-amino)-1-oxaspiro[4.5]dec-8-yl]-2-phenoxy-acetamide,

[5S-(5α,7α,8ß)]-N-Methyl-N-[7-(methyl-2-propynyl-amino)-1-oxaspiro[4.5]dec-8-yl]-2-phenoxyacetamide,

[5R-(5α,7ß,8α)]-N-Methyl-N-[7-(methyl-2-propynyl-amino)-1-oxaspiro[4.5]dec-8-yl]-2-phenoxy-acetamide,

[5S-(5α,7ß,8α)]-N-Methyl-N-[7-(methyl-2-propynyl-amino)-1-oxaspiro[4.5]dec-8-yl]-2-phenoxy-acetamide,

[5R-(5α,7α,8ß)]-2-(4-Fluorophenoxy)-N-methyl-N-[7-(1-pyrrolidinyl)]-1-oxaspiro[4.5]dec-8-yl] acetamide,

[5S-(5α,7α,8ß)]-2-(4-Fluorophenoxy)-N-methyl-N-[7-(1-pyrrolidinyl)]-1-oxaspiro[4.5]dec-8-yl] acetamide,

[5R-(5α,7ß,8α)]-2-(4-Fluorophenoxy)-N-methyl-N-[7-(1-pyrrolidinyl)]-1-oxaspiro[4.5]dec-8-yl] acetamide,

[5S-(5α,7ß,8α)]-2-(4-Fluorophenoxy)-N-methyl-N-[7-(1-pyrrolidinyl)]-1-oxaspiro[4.5]dec-8-yl] acetamide,

[5R-(5α,7α,8ß)]-2-(4-Fluorophenoxy)-N-methyl-N-[7-[methyl-(2-phenylethyl)amino]-1-oxaspiro[4.5]dec-[5R-(5α,7α,8ß)]-2-(4-Fluorophenoxy)-N-methyl-N-8-yl]acetamide,

[5S-(5α,7α,8ß)]-2-(4-Fluorophenoxy)-N-methyl-N-[7-[methyl-(2-phenylethyl)amino]-1-oxaspiro[4.5]dec-8-yl]acetamide,

[5R-(5α,7ß,8α)]-2-(4-Fluorophenoxy)-N-methyl-N-[7-[methyl-(2-phenylethyl)amino]-1-oxaspiro[4.5]dec-8-yl]acetamide,

[5S-(5α,7ß,8α)]-2-(4-Fluorophenoxy)-N-methyl-N-[7-[methyl-(2-phenylethyl)amino]-1-oxaspiro[4.5]dec-8-yl]acetamide,

[5R-(5α,7α,8ß)]-N-Methyl-2-(3-nitrophenoxy)-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl] acetamide,

[5S-(5α,7α,8ß)]-N-Methyl-2-(3-nitrophenoxy)-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl] acetamide,

[5R-(5α,7ß,8α)]-N-Methyl-2-(3-nitrophenoxy)-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl] acetamide,

[5S-(5α,7ß,8α)]-N-Methyl-2-(3-nitrophenoxy)-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl] acetamide,

[5R-(5α,7α,8ß)]-N-Methyl-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]-2-[3-(trifluoromethyl)-phenoxy]acetamide,

[5S-(5α,7α,8ß)]-N-Methyl-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]-2-[3-(trifluoromethyl)-phenoxy]acetamide,

[5R-(5α,7ß,8α)]-N-Methyl-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]-2-[3-(trifluoromethyl)-phenoxy]acetamide,

[5S-(5α,7ß,8α)]-N-Methyl-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]-2-[3-(trifluoromethyl)-phenoxy]acetamide,

[5R-(5α,7α,8ß)]-2-(3,4-Dichlorophenoxy)-N-methyl-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]-acetamide,

[5S-(5α,7α,8ß)]-2-(3,4-Dichlorophenoxy)-N-methyl-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]-acetamide,

[5R-(5α,7ß,8α)]-2-(3,4-Dichlorophenoxy)-N-methyl-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]-acetamide,

[5S-(5α,7ß,8α)]-2-(3,4-Dichlorophenoxy)-N-methyl-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-1]-acetamide,

[5R-(5α,7α,8ß)]-2-(2,6-Dichlorophenoxy)-N-methyl-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]-acetamide,

[5S-(5α,7α,8ß)]-2-(2,6-Dichlorophenoxy)-N-methyl-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]-acetamide,

[5R-(5α,7ß,8α)]-2-(2,6-Dichlorophenoxy)-N-methyl-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]-acetamide,

[5S-(5α,7ß,8α)]-2-(2,6-Dichlorophenoxy)-N-methyl-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]-acetamide,

[5R-(5α,7α,8ß)]-2-(3,5-Dichlorophenoxy)-N-methyl-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]-acetamide,

[5S-(5α,7α,8ß)]-2-(3,5-Dichlorophenoxy)-N-methyl-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]-acetamide,

[5R-(5α,7ß,8α)]-2-(3,5-Dichlorophenoxy)-N-methyl-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]-acetamide,

[5S-(5α,7ß,8α)]-2-(3,5-Dichlorophenoxy)-N-methyl-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]-acetamide,

[5R-(5α,7α,8ß))]-N-Methyl-2-(1-naphthalenyloxy)-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]-acetamide,

[5S-(5α,7α,8ß)]-N-Methyl-2-(1-naphthalenyloxy)-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl] acetamide,

[5R-(5α,7ß,8α)]-N-Methyl-2-(1-naphthalenyloxy)-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl] acetamide,

[5S-(5α,7ß,8α)]-N-Methyl-2-(1-naphthalenyloxy)-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl] acetamide,

[5R-(5α,7α,8ß)]-N-Methyl-2-(2-naphthalenyloxy)-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl] acetamide,

[5S-(5α,7α,8ß)]-N-Methyl-2-(2-naphthalenyloxy)-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl] acetamide,

[5R-(5α,7ß,8α)]-N-Methyl-2-(2-naphthalenyloxy)-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl] acetamide,

[5S-(5α,7ß,8α)]-N-Methyl-2-(2-naphthalenyloxy)-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl] acetamide,

[5R-(5α,7α,8ß)]-N-Methyl-N-[7-[methyl[2-(2-thienyl)ethyl]amino]-1-oxaspiro[4.5]dec-8-yl]-2-(1-naphthalenyloxy)acetamide,

[5S-(5α,7α,8ß)]-N-Methyl-N-[7-[methyl[2-(2-thienyl)ethyl]amino]-1-oxaspiro[4.5]dec-8-yl]-2-(1-naphthalenyloxy)acetamide,

[5R-(5α,7ß,8α)]-N-Methyl-N-[7-[methyl[2-(2-thienyl)ethyl]amino]-1-oxaspiro[4.5]dec-8-yl]-2-(1-naphthalenyloxy)acetamide,

[5S-(5α,7ß,8α)]-N-Methyl-N-[7-[methyl[2-(2-thienyl)ethyl]amino]-1-oxaspiro[4.5]dec-8-yl]-2-(1-naphthalenyloxy)acetamide,

[5R-(5α,7α,8ß)]-N-Methyl-N-[7-(methyl-2-propenyl-amino)-1-oxaspiro[4.5]dec-8-yl]-1H-indene-3-acetamide,

[5S-(5α,7α,8ß)]-N-Methyl-N-[7-(methyl-2-propenyl-amino)-1-oxaspiro[4.5]dec-8-yl]-1H-indene-3-acetamide,

[5R-(5α,7ß,8α)]-N-Methyl-N-[7-(methyl-2-propenyl-amino)-1-oxaspiro[4.5]dec-8-yl]-1H-indene-3-acetamide,

[5S-(5α,7ß,8α)]-N-Methyl-N-[7-(methyl-2-propenyl-amino)-1-oxaspiro[4.5]dec-8-yl]-1H-indene-3-acetamide,

[5R-(5α,7α,8ß)]-N-Methyl-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]-1H-indene-3-acetamide,

[5S-(5α,7α,8ß)]-N-Methyl-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]-1H-indene-3-acetamide,

[5R-(5α,7ß,8α)]-N-Methyl-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]-1H-indene-3-acetamide,

[5S-(5α,7ß,8α)]-N-Methyl-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]-1H-indene-3-acetamide,

[5R-(5α,7α,8ß)]-N-[7-(Dimethylamino)-1-oxaspiro-[4.5]dec-8-yl]-N-methyl-1H-indole-3-acetamide,

[5S-(5α,7α,8ß)]-N-[7-(Dimethylamino)-1-oxaspiro-[4.5]dec-8-yl]-N-methyl-1H-indole-3-acetamide,

[5R-(5α,7ß,8α)]-N-[7-(Dimethylamino)-1-oxaspiro-[4.5]dec-8-yl]-N-methyl-1H-indole-3-acetamide,

[5S-(5α,7ß,8α)]-N-[7-(Dimethylamino)-1-oxaspiro-[4.5]dec-8-yl]-N-methyl-1H-indole-3-acetamide,

[5R-(5α,7α,8ß)]-N-Methyl-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]-1H-indole-3-acetamide,

[5S-(5α,7α,8ß)]-N-Methyl-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]-1H-indole-3-acetamide,

[5R-(5α,7ß,8α)]-N-Methyl-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]-1H-indole-3-acetamide,

[5S-(5α,7ß,8α)]-N-Methyl-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]-1H-indole-3-acetamide,

[5R-(5α,7α,8ß)]-N-Methyl-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]-2-benzofuranacetamide,

[5S-(5α,7α,8ß)]-N-Methyl-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]-2-benzofuranacetamide,

[5R-(5α,7ß,8α)]-N-Methyl-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]-2-benzofuranacetamide,

[5S-(5α,7ß,8α)]-N-Methyl-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]-2-benzofuranacetamide,

[5R-(5α,7α,8ß)]-N-Methyl-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]-3-benzofuranacetamide,

[5S-(5α,7α,8ß)]-N-Methyl-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]-3-benzofuranacetamide,

[5R-(5α,7ß,8α)]-N-Methyl-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]-3-benzofuranacetamide,

[5S-(5α,7ß,8α)]-N-Methyl-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]-3-benzofuranacetamide,

[5R-(5α,7α,8ß)]-N-Methyl-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]-4-benzofuranacetamide,

[5S-(5α,7α,8ß)]-N-Methyl-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]-4-benzofuranacetamide,

[5R-(5α,7ß,8α)]-N-Methyl-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]-4-benzofuranacetamide,

[5R-(5α,7α,8ß)]-N-[7-[(Cyclopropylmethyl)methyl-amino]-1-oxaspiro[4.5]dec-8-yl]-N,2-dimethyl-3-benzofuranacetamide,

[5S-(5α,7α,8ß)]-N-[7-[(Cyclopropylmethyl)methyl-amino]-1-oxaspiro[4.5]dec-8-yl]-N,2-dimethyl-3-benzofuranacetamide,

[5R-(5α,7ß,8α)]-N-[7-[(Cyclopropylmethyl)methyl-amino]-1-oxaspiro[4.5]dec-8-yl]-N,2-dimethyl-3-benzofuranacetamide,

[5S-(5α,7ß,8α)]-N-[7-[(Cyclopropylmethyl)methyl-amino]-1-oxaspiro[4.5]dec-8-yl]-N,2-dimethyl-3-benzofuranacetamide.

More preferred compounds of the present invention include but are not limited to:

(-)(5α,7α,8ß)-N-methyl-N-[7-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]-4-benzo[b]furacetamide (Compound I), and

(-)-(5α,7α,8ß)-N-7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]-4-benzo[b]thiophene-4-acetamide

The compounds of Formula I of the present invention have a very high kappa opioid affinity, selectivity and potency. For example, (-)-(5α-7α-8ß)- N-methyl-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]-4-benzo[b]furanacetamide gives a Ki of 0.73 nM with a μ/kappa ratio of 798. The MPE_{50} in the rat paw pressure test for analgesia is 0.030 (iv).

This is considerably better than any selective kappa opioid compound known to the inventors.

The effectiveness of the aforementioned compounds as agents for Parkinson's disease, dystonia, and other movement disorders is determined by a pharmacological test procedure as described and illustrated below.

Current therapies for Parkinson's disease rely on dopamine agonist therapies to replace dopamine depletion in the striatum. However, these treatments

are often plagued by debilitating side effects. Recent insights into the neural mechanisms underlying Parkinsonism may point the way to novel nondopaminergic therapies for Parkinsonism.

The neural mechanisms underlying Parkinsonism are characterized by overactivity of an excitatory amino acid (EAA), such as glutamate, utilizing input from the subthalamic nucleus to both the medial segment of the globus pallidus (GPM) and substantia nigra pars reticulata (SNR). Reduction of this overactivity by lesion of the subthalamic nucleus alleviates Parkinsonian symptoms in the primate. Similarly, blockade of EAA receptors locally in the GPM or SNR can also alleviate Parkinsonism.

The ubiquity of EAA transmission throughout the central nervous system (CNS) necessitates the reduction of EAA transmission in the GPM and SNR selectively if one is to develop a novel pharmaceutical that can alleviate Parkinsonism without compromising other EAA-related functions, e.g., learning and memory. One way in which this is achieved is to use compounds that interact with the peptide systems that modulate EAA transmission. In some regions of the CNS kappa opioid agonists can reduce EAA release. The major endogenous agonist for the kappa receptor is thought to be dynorphin. The distribution of dynorphin within the brain is interesting in that it is found in remarkably high levels within those areas receiving overactive EAA input in Parkinsonism, i.e., the GPM and SNR. In these areas dynorphin is thought to be a co-transmitter in the striatopallidal and striatonigral pathways. Kappa opioids might therefore provide an anatomically selective means by which to manipulate EAA transmission in the GPM and SNR.

Three experiments have provided answers important to relating the compounds of the invention to Compound I and Parkinsonism.

In Vitro EAA Release Studies in the Substantia Nigra

In slices of SNR from rat we have shown that K^+-evoked, Ca^{2+}-dependent release of preloaded [^{3}H]glutamate is attenuated by over 98% in the presence of 1 μM Compound I (Figure 1). Similar results are seen with 10 nM dynorphin.

Intracerebral Injections of Compound I in Parkinsonian Rats

In the reserpine-treated Parkinsonian rat, unilateral injections of Compound I directly into the entopeduncular nucleus (rodent homologue of the GPM) provide a marked dose-dependent alleviation of Parkinsonian symptoms (Figure 2).

Intracerebral Injections of Compound I in the MPTP-Treated Primate

In the MPTP-primate, preliminary results would also suggest that Compound I has powerful anti-Parkinsonian effects (Figure 3). Following injections of Compound I the mobility scores of MPTP-treated marmosets returned to near normal levels.

Methodology of EAA Release Studies

Detailed methodologies for the techniques used for the intracerebral injections and MPTP administration are given in (Brotchic JM, et al, Movement Disorders 1991;6(2):133-8).

Slices (400 μm) of substantia nigra were cut on a McIlwain tissue chopper. Slices were preloaded with [^{3}H]L-glutamate (100 nM) for 30 minutes in Ringer's solution [containing amino-oxyacetic acid (50 μM), 30°C, pH 7.4, aerated with 95% O_2/5% CO_2]. Ca^{2+}-dependent, K^+-evoked release of glutamate from

nigral slices was assayed using a release manifold similar in design to that used to measure release of preloaded radioactivity from rat portal vein (Hamilton TC, Weir SW, Weston AH, Br J Pharmacol 1986;88:103-11). This apparatus permitted the support and constant aeration of six slices at a time. Slices supported in the manifold were immersed in 4 mL of Ringer's containing 100 μM dihydrokainate to prevent reuptake of glutamate. After 5 minutes the slices were moved into a further vial containing 4 mL of Ringer's. The amount of radioactivity released from the slice in each 5-minute period was measured by liquid scintillation counting of an aliquot taken from each 4 mL of Ringer's. Release per 5 minutes was measured in this way for a total of 70 minutes. At the end of the experiment the nigral slice was placed in Triton X-100 for 24 hours to release all remaining radioactivity from the tissue. The amount of radioactivity in the slice was then determined. EAA release was expressed as a fractional release rate (percentage of that present at the start of each time interval). At time 45 minutes the slice was immersed in Ringer's modified to contain 40 mM K^+. This potassium pulse was used to evoke release of glutamate from the slice. The calcium-dependence of the release was demonstrated by replacing the $CaCl_2$ in the Ringer's solution by $CoCl_2$. The effects of Compound I on K^+-evoked release were demonstrated by adding Compound I (1 μM) to the potassium pulse solution.

From these studies we conclude that Compound I and other kappa opioids are able to modulate EAA release in the output regions of the basal ganglia, since these areas receive overactive EAA input from the subthalamic nucleus in Parkinsonism. Furthermore, injection of Compound I directly into the output regions of the basal ganglia alleviates

Parkinsonian symptoms in both primate and rodent models of Parkinsonism.

For the therapeutic uses described above, the usual mammalian dosage range for a 70-kg human subject is from 0.01 to 10 mg per day or 0.001 mg to 1.0 mg per kg of weight per day; optionally in divided portions. Determinations of the proper dosage for a particular situation is within the skill of the art.

Pharmaceutical compositions of the compound of the present invention or its salts are produced by formulating the active compound in dosage unit form with a pharmaceutical carrier. Some examples of dosage unit forms are tablets, capsules, pills, powders, aqueous and nonaqueous oral solutions, and suspensions and parenteral solutions packaged in containers containing either one or some larger number of dosage units and capable of being subdivided into individual doses. Some examples of suitable pharmaceutical carriers, including pharmaceutical diluents, are gelatin capsules; sugars such as lactose and sucrose; starches such as corn starch and potato starch; cellulose derivatives such as sodium carboxymethyl cellulose, ethyl cellulose, methyl cellulose, and cellulose acetate phthalate; gelatin; talc; stearic acid; magnesium stearate; vegetable oils such as peanut oil, cottonseed oil, sesame oil, olive oil, corn oil, and oil of theobroma; propylene glycol; glycerin; sorbitol; polyethylene glycol; water; agar; alginic acid; isotonic saline; and phosphate buffer solutions; as well as other compatible substances normally used in pharmaceutical formulations. The compositions of the invention can also contain other components such as coloring agents, flavoring agents, and/or preservatives. These materials, if present, are usually used in relatively small amounts. The

compositions can, if desired, also contain other therapeutic agents.

The percentage of the active ingredient in the foregoing compositions can be varied within wide limits, but for practical purposes it is preferably present in a concentration of at least 10% in a solid composition and at least 2% in a primarily liquid composition. The most satisfactory compositions are those in which a much higher proportion of the active ingredient is present.

Routes of administration of the subject compound or its salts are oral, parenteral, transdermal, or intranasal. For example, a useful intravenous dose is between 0.001 and 10 mg/kg. A preferred intravenous dose is 0.01 to 1 mg/kg. A still further preferred dose is 0.01 to 0.55 mg/kg. A useful oral dose is 0.01 to 30 mg/kg.

The following examples of formulations are provided to enable one skilled in the art to practice the invention. These examples are not intended to limit the scope of the invention in any way but rather to be illustrative thereof. Compound I is a compound of Formula I as described hereinbefore.

EXAMPLE 1

Injectables

Compound I, Water for injection USP q.s.

The hydrochloride salt of Compound I is dissolved in water and passed through a 0.2-micron filter. Aliquots of the filtered solution are added to ampoules or vials, sealed, and sterilized.

EXAMPLE 2

Syrups

2 mg Compound I/5 ml syrup

Compound I	12.5 g
Purified Water USP	200 ml
Cherry Syrup qu	1000 ml

Compound I is dissolved in the water and to this solution the syrup is added with mild stirring.

EXAMPLE 3

Capsules

0.5 mg, 1 mg, or 2 mg

Compound I	250 g
Lactose USP, Anhydrous q.s. or	250 g
Sterotex Powder HM	5 g

Combine Compound I and the lactose in a tumble, blend for two minutes, blend for one minute with the intensifier bar, and then tumble blend again for one minute. A portion of the blend is then mixed with the Sterotex Powder, passed through a #30 screen and added back to the remainder of the blend. The mixed ingredients are then blended for one minute, blended with the intensifier bar for thirty seconds, and tumble-blended for an additional minute. The appropriately sized capsules are filled with 141 mg, 352.5 mg, or 705 mg of the blend, respectively, for the 50-mg, 125-mg, and 250-mg containing capsules.

EXAMPLE 4

Tablets

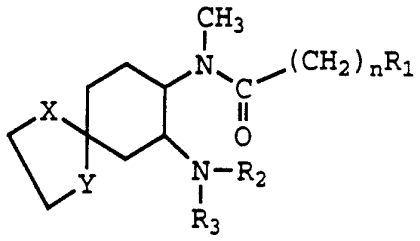
0.5 mg, 1 mg, or 2 mg

Compound I	125 g
Corn Starch NF	200 g
Cellulose, Microcrystalline	46 g
Sterotex Powder HM	4 g
Purified Water q.s. or	300 ml

Combine the corn starch, the cellulose, and Compound I together in a planetary mixer and mix for two minutes. Add the water to this combination and mix for one minute. The resulting mix is spread on trays and dried in a hot air oven at 50°C until a moisture level of 1 to 2 percent is obtained. The dried mix is then milled with a Fitzmill through a #RH2B screen, and added back to the milled mixture and the total blended for five minutes by drum rolling. Compressed tablets of 0.150 mg, 3.75 mg, and 7.50 mg, respectively, of the total mix are formed with appropriate sized punches the 0.50 mg, 1.25 mg, or 5.00 mg containing tablets.

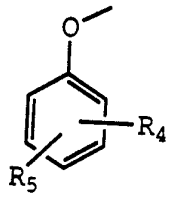
CLAIMS

1. A method for treating Parkinson's disease which comprises administering to a patient in need of said treatment a therapeutically effective amount of a compound in unit dosage form of formula



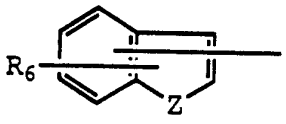
I

or a pharmaceutically acceptable salt thereof wherein n is an integer of from one to six; either of X or Y is oxygen and the other is $-CH_2-$; R_1 is selected from

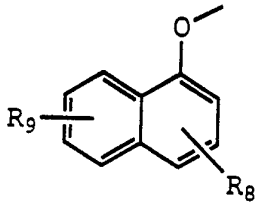
a) 

where R_4 and R_5 are independently hydrogen, fluorine, chlorine, bromine, nitro, trifluoromethyl, alkyl of from one to six carbon atoms, alkoxy of from one to six carbon atoms, or aryl;

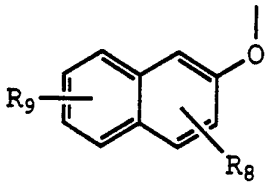
b) 3,4,5-trimethylphenoxy;

c) 

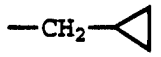
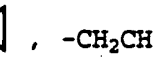
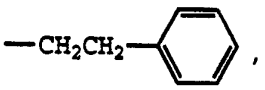
where R_6 is hydrogen, fluorine, chlorine, alkyl of from one to six carbon atoms, or aryl; Z is $-CH_2-$, $-O-$, $-S-$, or $-NR_7-$ where R_7 is hydrogen, alkanoyl of from one to six carbon atoms, or alkyl of from one to six carbon atoms;

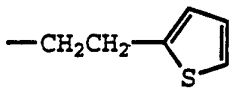
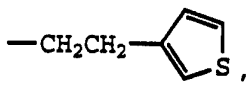
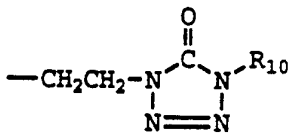
d) 

wherein R_8 and R_9 are independently hydrogen, fluorine, bromine, alkyl of from one to six carbon atoms, or alkoxy of from one to four carbon atoms; or

e) 

where R_8 and R_9 are as defined above;
where R_2 is methyl and R_3 is hydrogen, alkyl of from one to six carbon atoms,

 , $-CH_2CH{:}CH_2$,  ,  ,

 ,  , or 

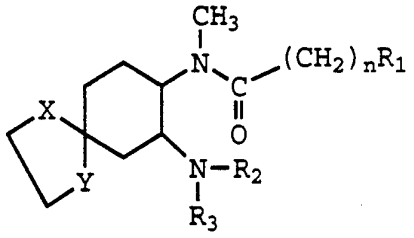
where R_{10} is alkyl of from one to four carbon atoms; or where R_2 and R_3 when taken together with the nitrogen atom to which they are attached, form a pyrrolidinyl, piperidinyl, or hexahydro-1H-azepinyl ring.

2. A method according to Claim 1 wherein the compound is (-)-5α-7α-8ß-N-methyl-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]-4-benzofuranacetamide.

3. A method according to Claim 1 wherein 0.001 mg to 10 mg/kg of weight per day of the compound or the pharmaceutically acceptable salt is administered.

4. A pharmaceutical composition comprising a therapeutically effective amount of a compound as defined above in Claim 1 in combination with a pharmaceutically acceptable carrier.

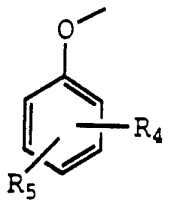
5. A method for treating dystonia which comprises administering to a patient in need of said treatment a therapeutically effective amount of a compound in unit dosage form of formula



I

or a pharmaceutically acceptable salt thereof, wherein n is an integer of from one to six; either of X or Y is oxygen and the other is $-CH_2-$; R_1 is selected from

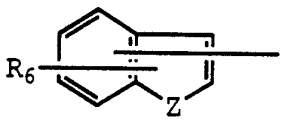
a)



where R_4 and R_5 are independently hydrogen, fluorine, chlorine, bromine, nitro, trifluoromethyl, alkyl of from one to six carbon atoms, alkoxy of from one to six carbon atoms, or aryl;

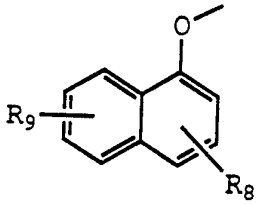
b) 3,4,5-trimethylphenoxy;

c)



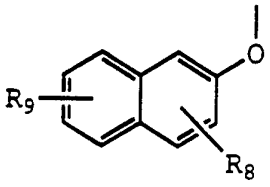
where R_6 is hydrogen, fluorine, chlorine, alkyl of from one to six carbon atoms, or aryl; Z is $-CH_2-$, $-O-$, $-S-$, or $-NR_7-$ where R_7 is hydrogen, alkanoyl of from one to six carbon atoms, or alkyl of from one to six carbon atoms;

d)

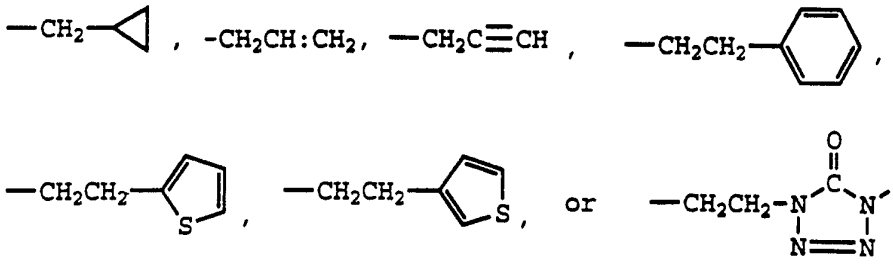


wherein R_8 and R_9 are independently hydrogen, fluorine, bromine, alkyl of from one to six carbon atoms, or alkoxy of from one to four carbon atoms; or

e)



where R_8 and R_9 are as defined above; where R_2 is methyl and R_3 is hydrogen, alkyl of from one to six carbon atoms,



where R_{10} is alkyl of from one to four carbon atoms; or where R_2 and R_3 when taken together with the nitrogen atom to which they are attached, form a pyrrolidinyl, piperidinyl, or hexahydro-1H-azepinyl ring.

6. A method according to Claim 5 wherein the compound is (-)-(5α-7α-8ß)-N-methyl-N-[7-(1-pyrrolidinyl)-1-oxaspiro[4.5]dec-8-yl]-4-benzo[b]furanacetamide.

7. A method according to Claim 5 wherein 0.001 mg to 1 mg/kg of weight per day of the compound or the pharmaceutically acceptable salt is administered.

8. A pharmaceutical composition comprising a therapeutically effective amount of a compound as defined above in Claim 5 in combination with a pharmaceutically acceptable carrier.

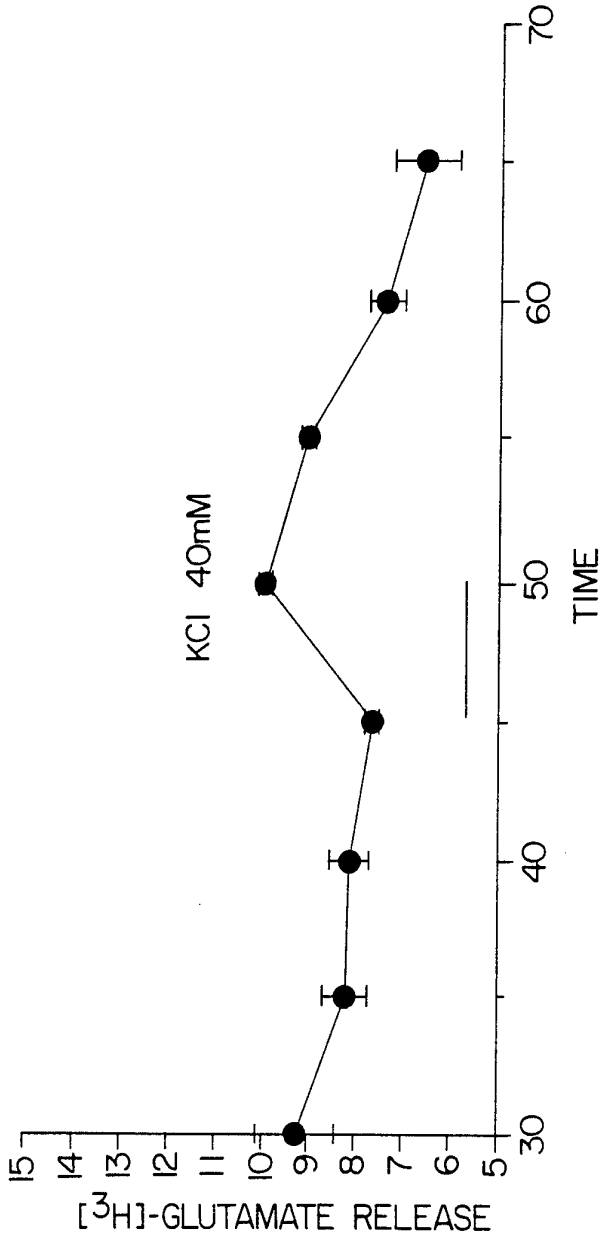

[3H]-GLUTAMATE RELEASE
15
14
13
12
11
10
9
8
7
6
5
30
40
50
60
70
TIME
KCl 40mM

FIG. IA

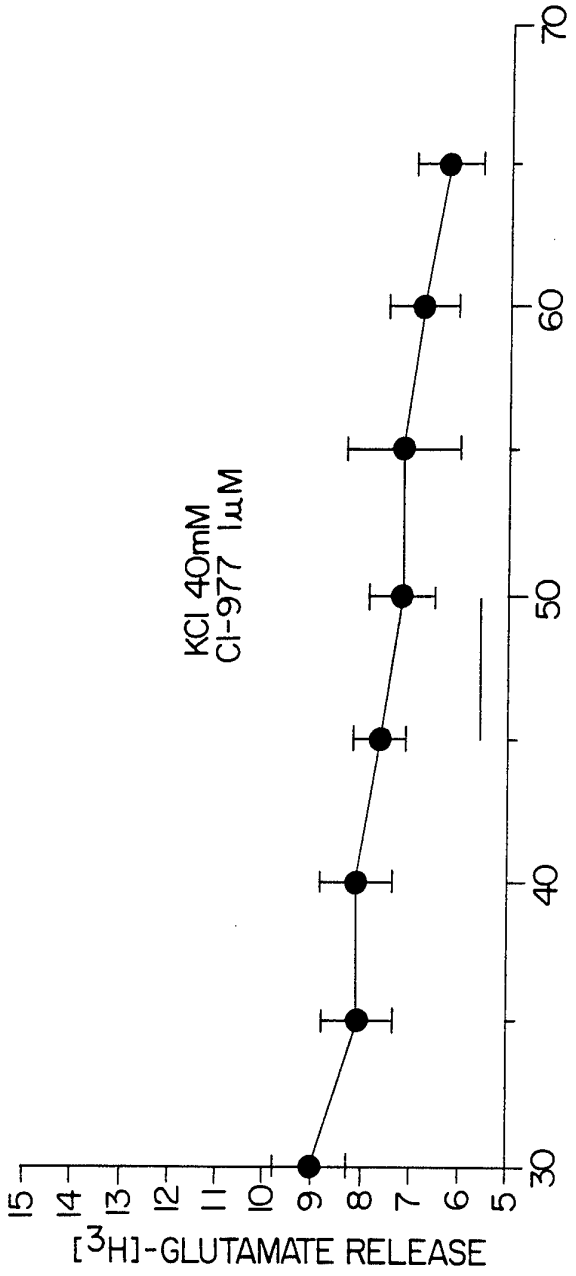

KCl 40mM
Cl-977 1μM
[3H]-GLUTAMATE RELEASE
TIME
15
14
13
12
11
10
9
8
7
6
5
30
40
50
60
70

FIG. 1B

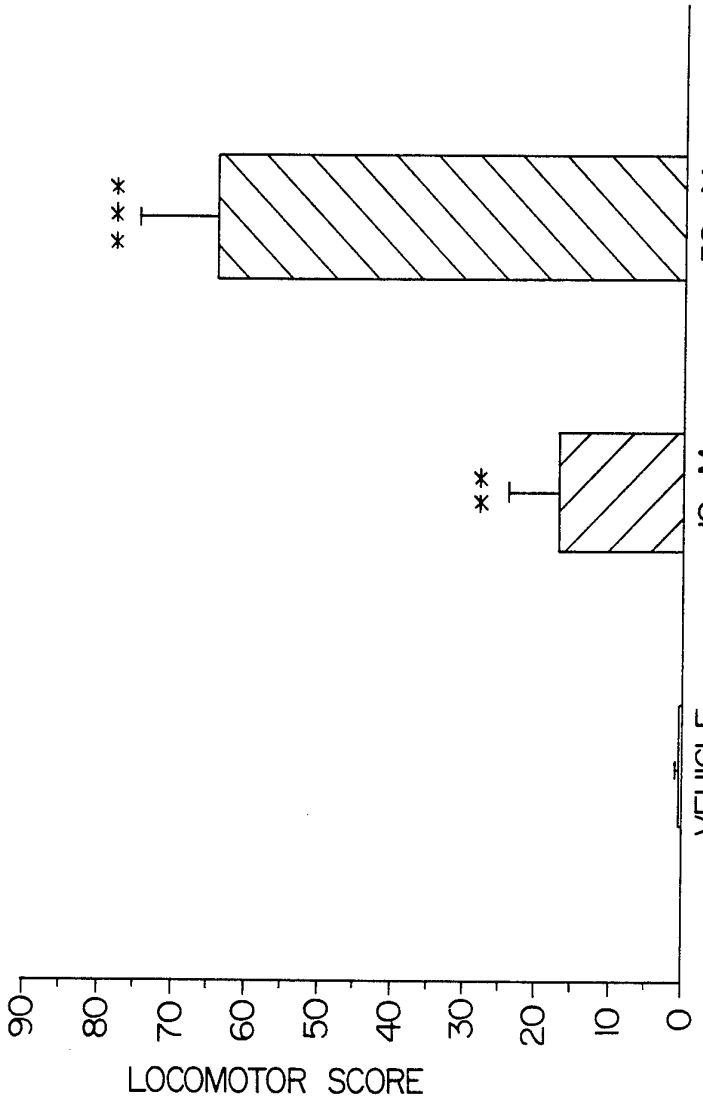

LOCOMOTOR SCORE
0
10
20
30
40
50
60
70
80
90
VEHICLE
n=5
10mM
n=3
50mM
n=4
**
***

FIG. 2

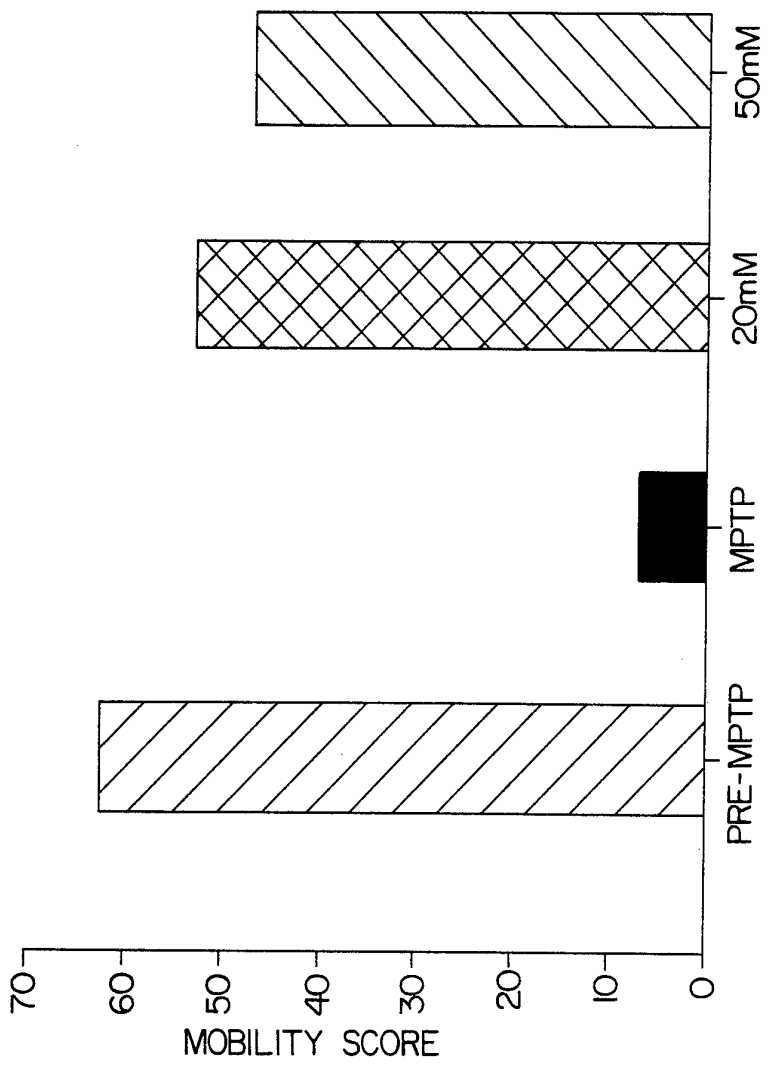


FIG. 3

INTERNATIONAL SEARCH REPORT

Interna al Application No
PCT/US 93/07773

A. CLASSIFICATION OF SUBJECT MATTER
IPC 5 A61K31/34 A61K31/38 A61K31/40 A61K31/41 A61K31/445
A61K31/55

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 5 A61K

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

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP,A,0 393 696 (WARNER-LAMBERT CO.) 24 October 1990 cited in the application see the whole document ---	4,8
X	EP,A,0 207 773 (WARNER-LAMBERT CO.) 7 January 1987 cited in the application see abstract see page 22, line 14 - line 23; claims --- -/--	4,8

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

[X] Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
25 November 1993	08. 12. 93

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax (+31-70) 340-3016	Hoff, P

Form PCT/ISA/210 (second sheet) (July 1992)

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	MOLECULAR NEUROPHARMACOLOGY vol. 1 , 1991 pages 77 - 82 P.D. LAMBERT ET AL. 'INHIBITION OF L-GLUTAMATE RELEASE: A POSSIBLE MECHANISM OF ACTION FOR THE NEUROPROTECTIVE EFFECTS OF THE k-SELECTIVE AGONIST CI-977'	1-3,5-7
X	see the whole document ---	4,8
Y	EUROPEAN JOURNAL OF PHARMACOLOGY vol. 191, no. 3 , 1990 pages 477 - 480 L. SINGH ET AL. 'THE ANTICONVULSANT ACTION OF CI-977 A SELECTIVE k-OPIOID RECEPTOR AGONIST: A POSSIBLE INVOLVEMENT OF THE GLYCINE/NMDA RECEPTOR COMPLEX'	1-3,5-7
X	see the whole document ---	4,8
Y	NEUROSCIENCE LETTERS vol. 133, no. 1 , 1991 pages 57 - 60 A. RICHTER ET AL. 'ANTIDYSTONIC EFFECTS OF THE NMDA RECEPTOR ANTAGONISTS MEMANTINE, MK-801 AND CGP 37849 IN A MUTANT HAMSTER MODEL OF PAROXYSMAL DYSTONIA' see the whole document ---	1-3,5-7
Y	TRENDS IN NEUROSCIENCE vol. 13, no. 2 , 1990 pages 46 - 47 W.J. SCHMIDT AND T. KLOCKGETHER 'EXCITATORY AMINO ACIDS AND PARKINSON'DISEASE' see the whole document ---	1-3
Y	MOVEMENT DISORDERS vol. 6, no. 2 , 1991 pages 133 - 138 J.M. BROTCHIE ET AL. 'ALLEVIATION OF PARKINSONISM BY ANTAGONISM OF EXCITATORY AMINO ACID TRANSMISSION IN THE MEDIAL SEGMENT OF THE GLOBUS PALLIDUS IN RAT AND PRIMATE' see the whole document -----	1-3

INTERNATIONAL SEARCH REPORT

Inter. .onal application No.
PCT/US93/07773

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. [X] Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
REMARK: Although claims 1-3, 5-7 are directed to a method of treatment of the human/animal body the search has been carried out and based on the alleged effects of the compound/composition.

2. [ ] Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. [ ] Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. [ ] As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. [ ] As all searchable claims could be searches without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. [ ] As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. [ ] No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

[ ] The additional search fees were accompanied by the applicant's protest.

[ ] No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

Information on patent family members

Intern. ...al Application No
PCT/US 93/07773

Patent document cited in search report	Publication date	Patent family member(s)		Publication date
EP-A-0393696	24-10-90	US-A-	4965278	23-10-90
		AU-B-	622312	02-04-92
		AU-A-	5368690	25-10-90
		CA-A-	2014957	21-10-90
		JP-A-	2292218	03-12-90
		US-A-	5063242	05-11-91
EP-A-0207773	07-01-87	US-A-	4737493	12-04-88
		AU-B-	578837	03-11-88
		AU-A-	5919486	08-01-87
		CA-A-	1264321	09-01-90
		JP-A-	62059271	14-03-87