

TITLE OF THE INVENTION

**2,3-DIHYDRO-1-(2,2,2-TRIFLUOROETHYL)-
2-OXO-5-PHENYL-1H-1,4-BENZODIAZEPINES**

BACKGROUND OF THE INVENTION

Arrhythmias often occur as complications to cardiac diseases such as myocardial infarction and heart failure. In a serious case, arrhythmias give rise to ventricular fibrillation and can cause sudden death.

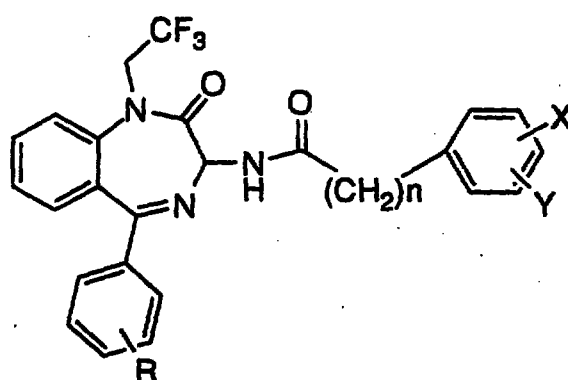
Though various antiarrhythmic agents are now available on the market, agents exhibiting both satisfactory effects and high safety profiles, have not been obtained. For example, antiarrhythmic agents of Class I, according to the classification of Vaughan-Williams, which cause a selective inhibition of the maximum velocity of the upstroke of the action potential (V_{max}) are inadequate for preventing ventricular fibrillation. In addition, they have problems regarding safety, namely, they cause a depression of the myocardial contractility and have a tendency to induce arrhythmias due to an inhibition of the impulse conduction. Beta-adrenoceptor blockers and calcium antagonists which belong to Class II and IV respectively, have a defect in that their effects are either limited to a certain type of arrhythmia or are contraindicated because of their cardiac depressant properties in certain patients with cardiovascular disease. Their safety, however, is higher than that of the antiarrhythmic agents of Class I.

Antiarrhythmic agents of Class III are drugs which cause a selective prolongation of the duration of the action potential without a significant depression of the V_{max} . Drugs in this class are limited. Examples such as sotalol and amiodarone have been shown to possess Class III properties. Sotalol also possesses Class II effects which may cause cardiac depression and be contraindicated in certain susceptible patients. Also, amiodarone is severely limited by side effects. Drugs of this class are expected to be effective in preventing ventricular fibrillations. Pure Class III agents, by definition, are not considered to cause myocardial depression or an induction of arrhythmias due to the

inhibition of the action potential conduction as seen with Class I antiarrhythmic agents.

SUMMARY OF THE INVENTION

This invention is concerned with novel compounds represented by structural formula I



I

where

X and Y are independently hydrogen, chloro, fluoro, bromo, iodo, or trifluoromethyl and n is 0, 1 or 2;

R is hydrogen, fluoro, chloro, bromo, iodo, or trifluoromethyl, methyl, or methoxy;

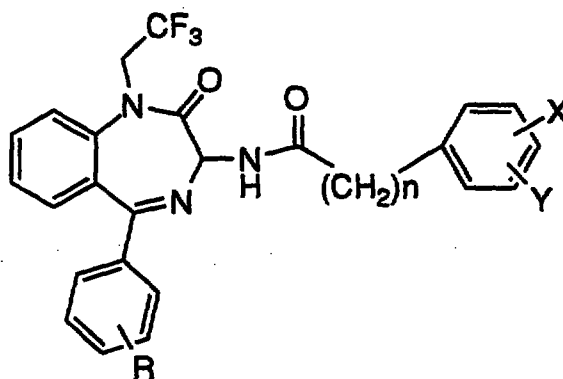
and the racemates, mixtures of enantiomers, individual diastereomers or individual enantiomers with all isomeric forms and pharmaceutically acceptable salts, hydrates or crystal forms thereof, which are antiarrhythmic agents. The invention is also concerned with pharmaceutical formulations comprising one of the novel compounds as an active ingredient.

The compounds of the present invention may have asymmetric centers and occur as racemates, mixtures of enantiomers, individual diastereomers, or as individual enantiomers with all isomeric forms being included in the present invention.

The invention is also concerned with a method of treating arrhythmia by the administration of one of the novel compounds or formulation thereof to a patient in need of such treatment.

DETAILED DESCRIPTION OF THE INVENTION

The novel compounds of this invention are represented by structural formula I

**I**

where

X and Y are independently hydrogen, chloro, fluoro, bromo, iodo, or trifluoromethyl and n is 0, 1 or 2;

R is hydrogen, fluoro, chloro, bromo, iodo, or trifluoromethyl, methyl, or methoxy; and

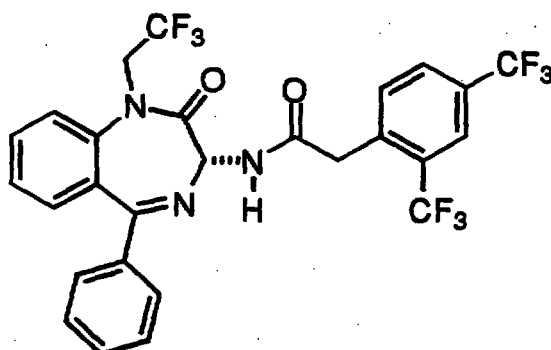
the racemates, mixtures of enantiomers, individual diastereomers or individual enantiomers with all isomeric forms and pharmaceutically acceptable salts, hydrates or crystal forms thereof, which are anti-arrhythmic agents. The compounds of the present invention may have asymmetric centers and occur as racemates, mixtures of enantiomers, individual diastereomers, or as individual enantiomers with all isomeric forms being included in the present invention.

The invention is also concerned with a method of treating arrhythmia by the administration of one of the novel compounds or formulation thereof to a patient in need of such treatment.

The most preferred embodiment of this invention is (-)-2-[2,4-Bis(trifluoromethyl)phenyl]-N-[3R-2,3-dihydro-2-oxo-5-phenyl-1-(2,2,2-trifluoroethyl)-1H-benzo[e][1,4]diazepin-3-yl]acetamide.

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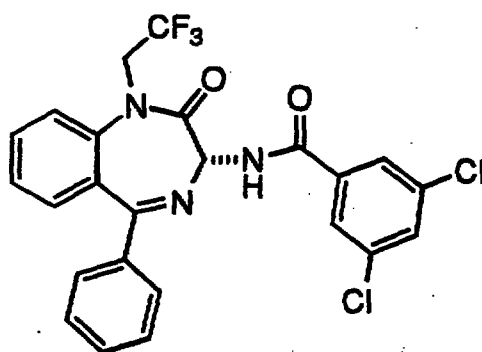
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Another embodiment of the novel compounds of this invention is (+)-3,5-Dichloro-N-[3R-2,3-dihydro-2-oxo-5-phenyl-1-(2,2,2-trifluoroethyl)-1H-benzo[e][1,4]diazepin-3-yl]benzamide.

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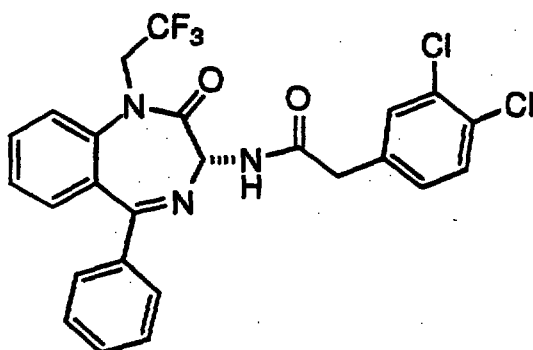


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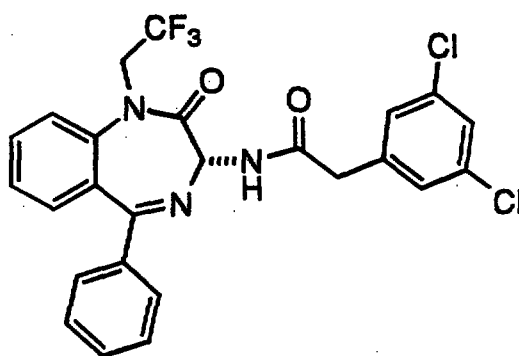
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An additional embodiment of the novel compounds of this invention is (-)-2-(3,4-Dichlorophenyl)-N-[3R-2,3-dihydro-2-oxo-5-phenyl-1-(2,2,2-trifluoroethyl)-1H-benzo[e][1,4]diazepin-3-yl]acetamide.

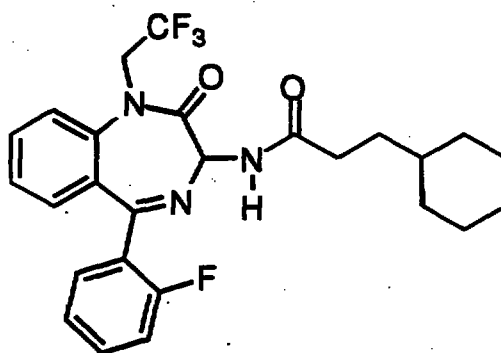
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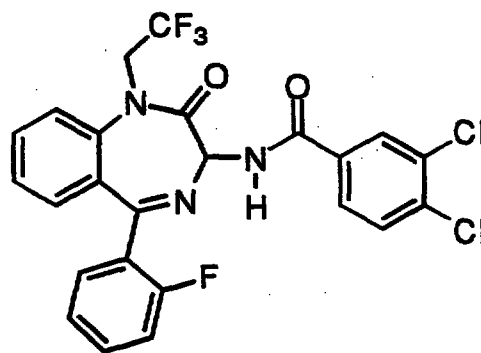
Still another embodiment of the novel compounds of this invention is (-)-2-(3,5-Dichlorophenyl)-N-[3R-2,3-dihydro-2-oxo-5-phenyl-1-(2,2,2-trifluoroethyl)-1H-benzo[e][1,4]diazepin-3-yl]acetamide.



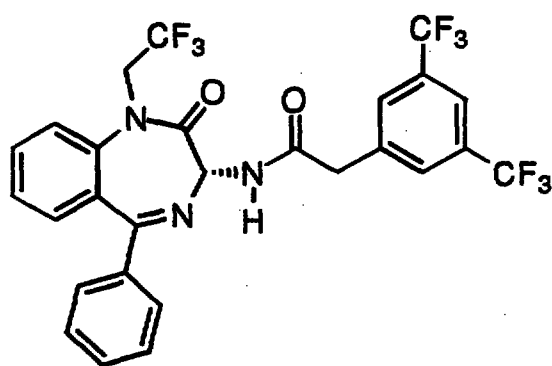
Other examples of embodiments of this invention are:
3-Cyclohexyl-N-[5-(2-fluorophenyl)-2-oxo-1-(2,2,2-trifluoroethyl)-2,3-dihydro-1H-benzo[e][1,4]diazepin-3-yl]propionamide.



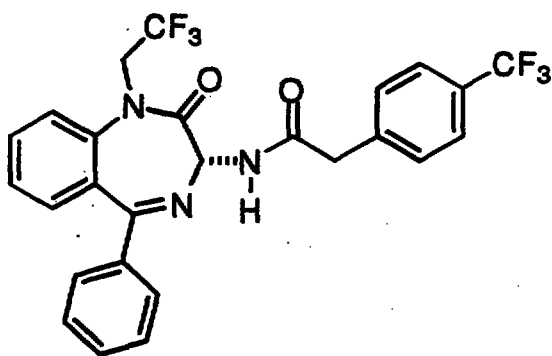
3,4-Dichloro-N-[5-(2-fluorophenyl)-2-oxo-1-(2,2,2-trifluoroethyl)-2,3-dihydro-1H-benzo[e][1,4]diazepin-3-yl]benzamide.



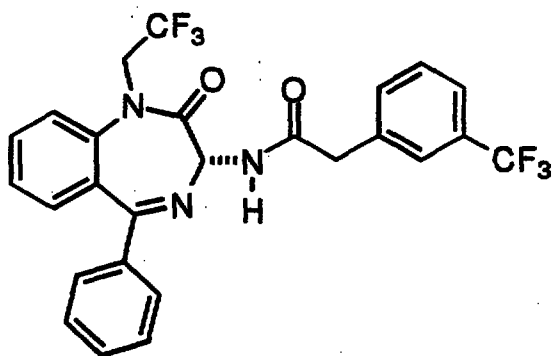
(-)-2-[3,5-Bis(trifluoromethyl)phenyl]-N-[3R-2,3-dihydro-2-oxo-5-phenyl-1-(2,2,2-trifluoroethyl)-1H-benzo[e][1,4]diazepin-3-yl]acetamide.



(-)-2-(4-Trifluoromethylphenyl)-N-[3R-2,3-dihydro-2-oxo-5-phenyl-1-(2,2,2-trifluoroethyl)-1H-benzo[e][1,4]diazepin-3-yl]acetamide

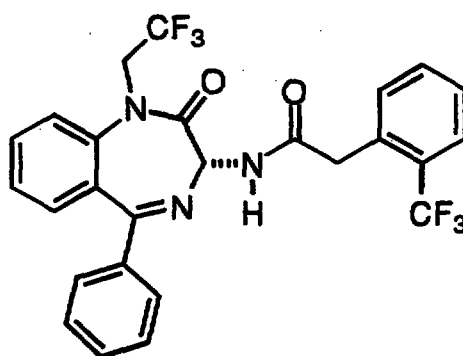


(-)-2-(3-Trifluoromethylphenyl)-N-[3R-2,3-dihydro-2-oxo-5-phenyl-1-(2,2,2-trifluoroethyl)-1H-benzo[e][1,4]diazepin-3-yl]acetamide



(-)-2-(2-Trifluoromethylphenyl)-N-[3R-2,3-dihydro-2-oxo-5-phenyl-1-(2,2,2-trifluoroethyl)-1H-benzo[e][1,4]diazepin-3-yl]acetamide

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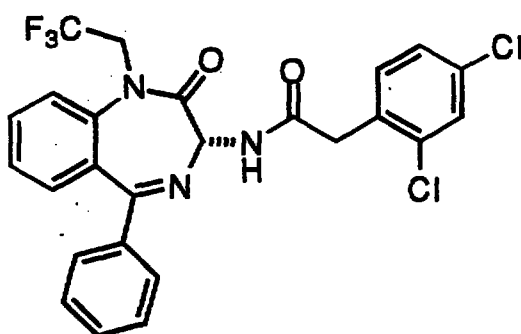


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(-)-2-(2,4-Dichlorophenyl)-N-[3R-2,3-dihydro-2-oxo-5-phenyl-1-(2,2,2-trifluoroethyl)-1H-benzo[e][1,4]diazepin-3-yl]acetamide

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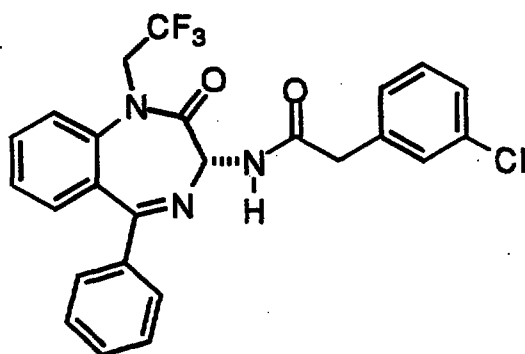


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(-)-2-(3-Chlorophenyl)-N-[3R-2,3-dihydro-2-oxo-5-phenyl-1-(2,2,2-trifluoroethyl)-1H-benzo[e][1,4]diazepin-3-yl]acetamide

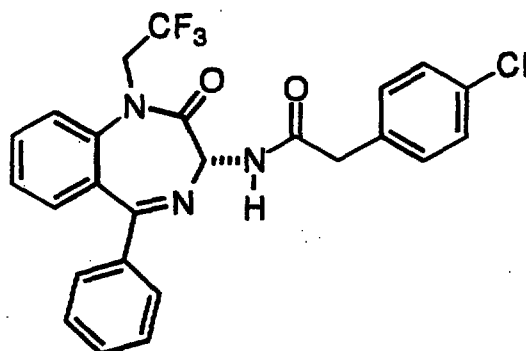
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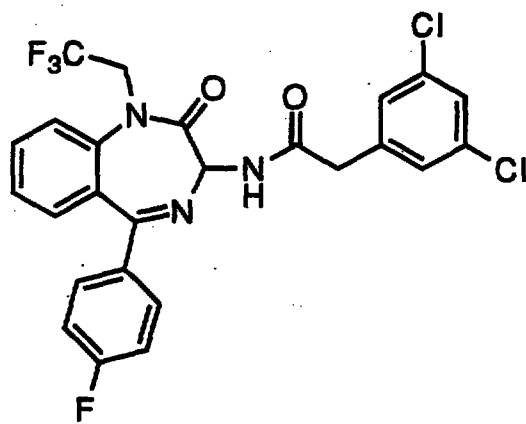
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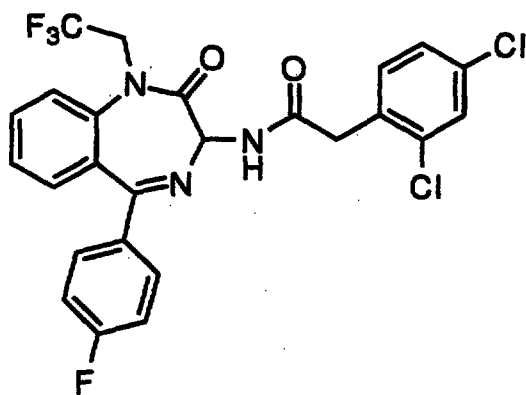
(-)-2-(4-Chlorophenyl)-N-[3R-2,3-dihydro-2-oxo-5-phenyl-1-(2,2,2-trifluoroethyl)-1H-benzo[e][1,4]diazepin-3-yl]acetamide



(+)-2-(3,5-Dichlorophenyl)-N-[2,3-dihydro-2-oxo-5-(4-fluorophenyl)-1-(2,2,2-trifluoroethyl)-1H-benzo[e][1,4]diazepin-3-yl]acetamide



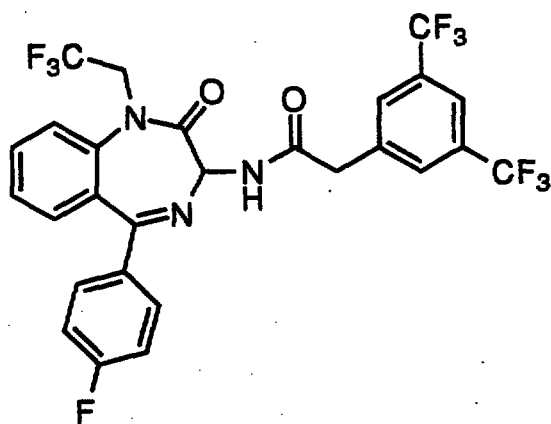
(-)-2-(2,4-Dichlorophenyl)-N-[2-oxo-5-(4-fluorophenyl)-1-(2,2,2-trifluoroethyl)-2,3-dihydro-1H-benzo[e][1,4]diazepin-3-yl]acetamide



(+)-2-[3,5-Bis(trifluoromethyl)phenyl]-N-[2-oxo-5-(4-fluorophenyl)-1-(2,2,2-trifluoroethyl)-2,3-dihydro-1H-benzo[e][1,4]diazepin-3-yl]-acetamide

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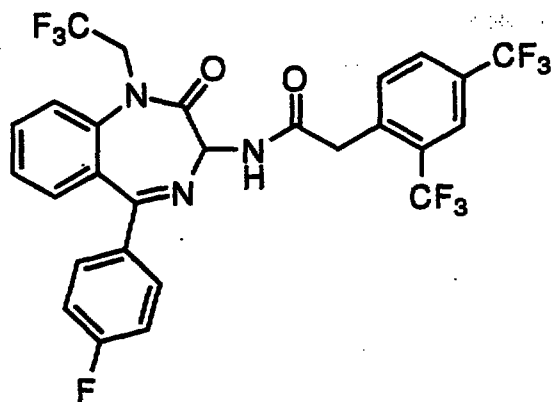


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(-)-2-[2,4-Bis(trifluoromethyl)phenyl]-N-[2-oxo-5-(4-fluorophenyl)-1-(2,2,2-trifluoroethyl)-2,3-dihydro-1H-benzo[e][1,4]diazepin-3-yl]-acetamide

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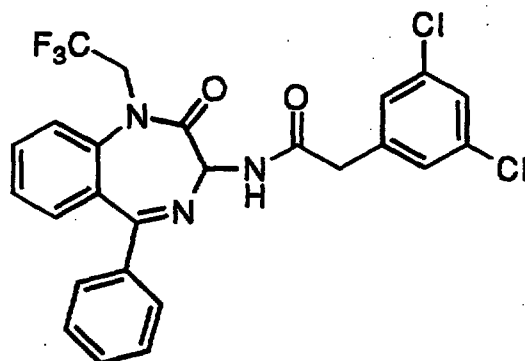
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2-(3,5-Dichlorophenyl)-N-[2,3-dihydro-2-oxo-5-phenyl-1-(2,2,2-trifluoroethyl)-1H-benzo[e][1,4]diazepin-3-yl]acetamide

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A novel process for preparing the compounds of this invention is schematically exemplified below in Scheme I, and these steps are well known in the art and/or described in the Examples that follow.

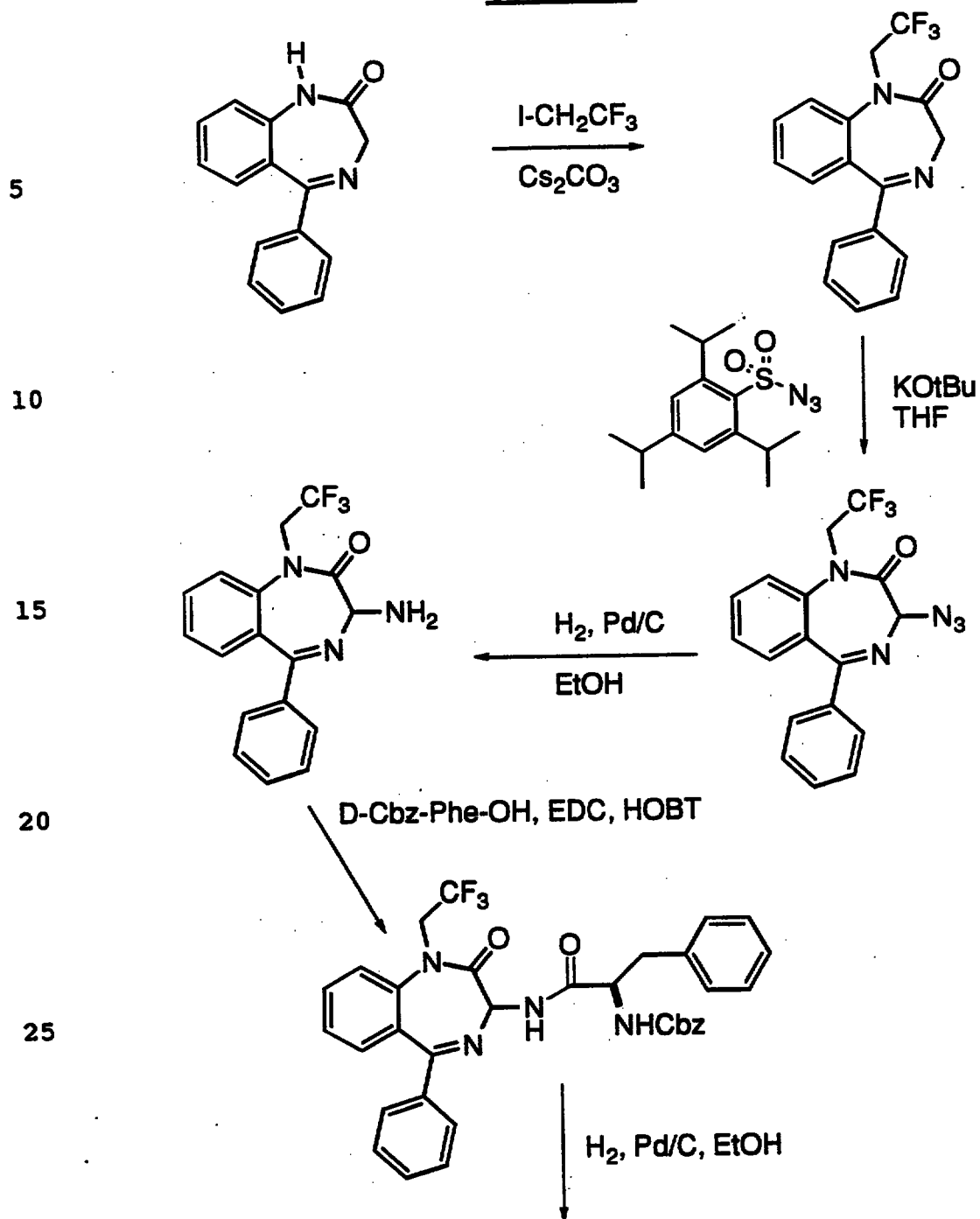
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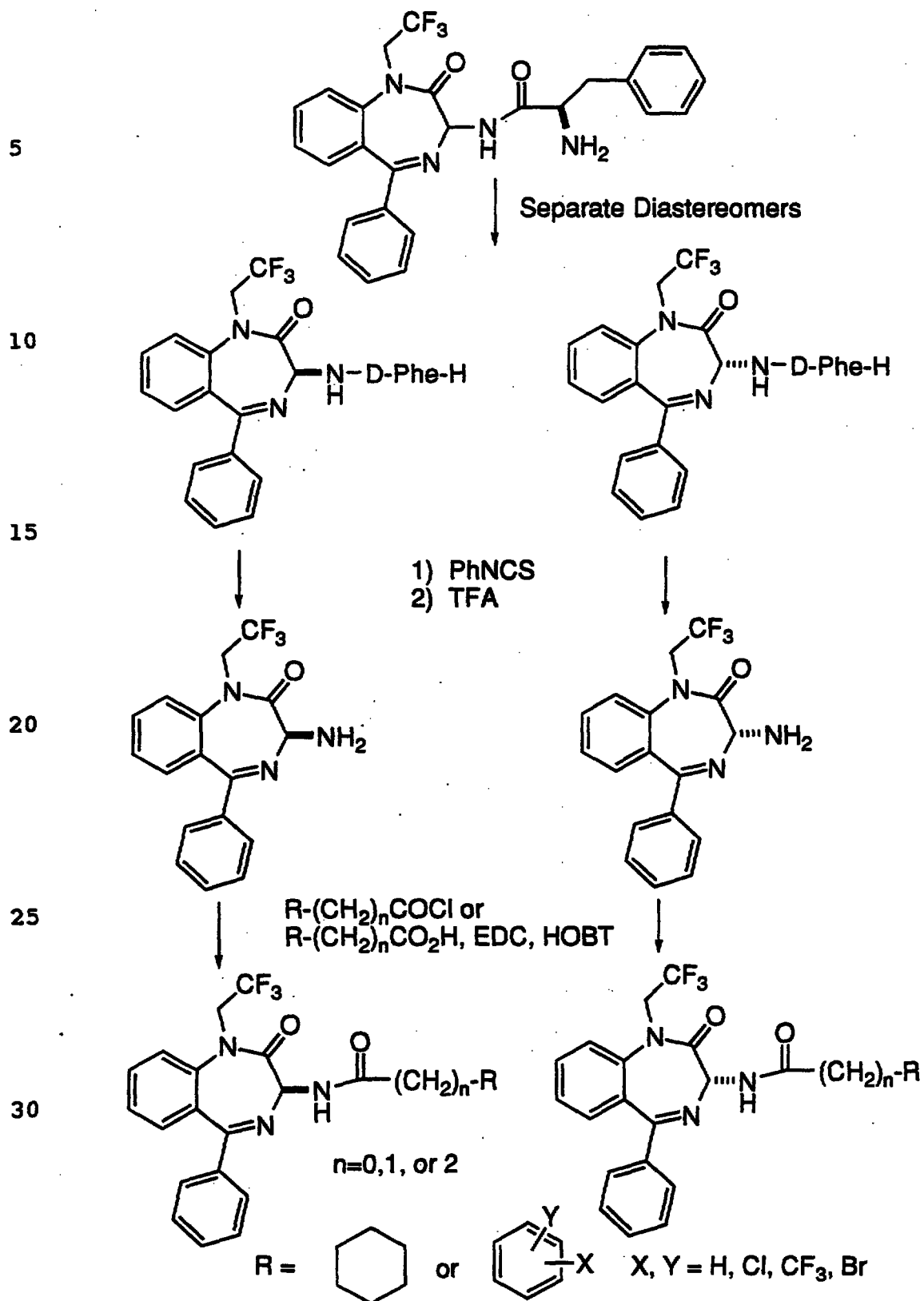
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Scheme 1

Scheme 1 cont'd.

The novel compounds of the present invention have the pharmacological properties required for antiarrhythmic agents of Class III, namely they demonstrate prolongation of QTc-interval , and dose dependent increases in ventricular refractoriness. This is accomplished without effecting heart rate, mean arterial pressure and PR and QRS intervals. Modest increases in LV+dP/dt (left ventricular change in pressure with time) is observed. Further, these compounds suppress the induction of PVS (Programmed Ventricular Stimulation) induced ventricular tachyarrhythmias.

These compounds are effective in treating and preventing all types of arrhythmias including ventricular and atrial (supraventricular) arrhythmias. The compounds of the present invention are especially useful for controlling reentrant arrhythmias and prevent sudden death due to ventricular fibrillation. These compounds are also effective in treating and preventing impaired cardiac pump functions.

In the novel method of this invention of treating arrhythmia, one of the compounds or pharmaceutically acceptable salt thereof, is administered in an amount ranging from about .0001 to about 10 mg per kg of body weight per day, preferably from about .0001 to about 2 mg per kg of body weight per day, and more preferably by intravenous delivery of from about 0.0003 to about 0.3 mg per kg of body weight per day, or when given orally from about 0.03 to about 1 mg per kg of body weight per day, in a single dose or in 2 to 4 divided doses.

These compounds, or pharmaceutically acceptable salts thereof, in the described dosages, are administered orally, intraperitoneally, subcutaneously, intramuscularly, transdermally, sublingually or intravenously. They are preferably administered intravenously or orally, for example in the form of tablets, troches, capsules, elixirs, suspensions, emulsions, syrups, wafers, chewing gum, or the like prepared by art recognized procedures. The amount of active compound in such therapeutically useful compositions or preparations is such that a suitable dosage will be obtained.

These compounds can be administered as the sole active ingredient or in combination with other antiarrhythmic agents or other cardiovascular agents, such as Class I, Class II, or Class IV antiarrhythmic agents, vasodilators, angiotensin converting enzyme inhibitors, angiotensin II antagonists, diuretics or digitalis.

These compounds can be administered as a method of treating arrhythmia and impaired cardiac pump functions in conjunction with defibrillators, including implantable defibrillators. These compounds reduce the frequency of defibrillator firing.

By Class I antiarrhythmic agents is meant those agents which provide for sodium channel blockade, including those compounds which exert a membrane stabilizing effect. Exemplary of this class of compounds are quinidine, procainamide, disopyramide, lidocaine, tocainide, flecainide and propafenone. By Class II antiarrhythmic compounds is meant those agents which block sympathetic activity. Exemplary of this class of compounds are propranolol and acebutolol. By Class III antiarrhythmic agents is meant those compounds which prolong the effective refractory period without altering the resting membrane potential or rate of depolarization. In addition to the novel compounds of this invention, compounds such as amiodarone, bretylium and sotalol are considered to be in this class. Class IV antiarrhythmic agents are effective in calcium channel blockade. Exemplary of this class of compounds are diltiazem and verapamil. Further definition of these classes can be found in Pharma Projects, section C1B, May 1993, which is hereby incorporated by reference.

Exemplary of vasodilators are compounds such as papaverine and isosorbide dinitrate. Examples of angiotensin converting enzyme inhibitors include enalapril, lisinopril and captopril. Examples of diuretics include hydrochlorothiazide and acetazolamide. The pharmaceutical agents listed herein are examples and do not represent a complete listing of the many compounds in these classes which are contemplated by this invention.

The activity of the compounds described herein as antiarrhythmic agents is measured by their ability to block the I_{K_S} and I_{K_R} currents as determined by the following test protocol.

Outward potassium currents are measured in single guinea pig ventricular myocytes using a whole-cell voltage clamp technique described in detail elsewhere (Sanguinetti and Jurkiewicz, 1990, Two components of cardiac delayed rectifier K^+ current: differential sensitivity to block by Class III antiarrhythmic agents. J. Gen Physiol. 96: 195-215). Myocytes are isolated by enzymatic (collagenase and protease) digestion of Langendorf perfused hearts. Single cells are then voltage clamped using 1 mm square-bore pipettes filled with 0.5 M Kgluconate, 25 mM KCl, 5 mM K(2)ATP. Cells are bathed in a solution containing, in mM: 132 NaCl, 4KCl, 1.2 $MgCl_2$, 10 HEPES, 10 glucose: pH 7.2, temp. 35°C.

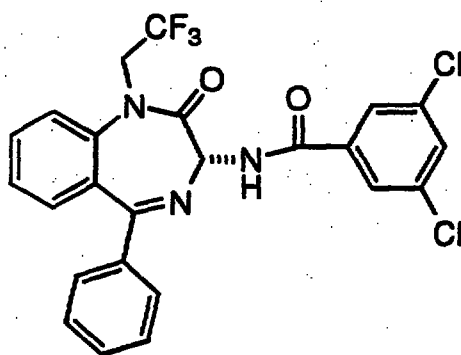
Each cell is maintained at a holding potential of -50 mV. Test depolarizations are applied as voltage ramps from -85 to -50 mV, and as steps to -10 mV (0.5 s) and +50 mV (1.0 s). I_{K_I} is measured as peak outward current during the voltage ramp. I_{K_R} is measured as tail currents upon repolarization from -10 mV to -50 mV. I_{K_S} is measured as time-dependent current during the pulse to +50 mV. Currents are measured during control, then after exposure to drug at two different concentrations.

Employing this test the compounds described herein have an IC_{50} of less than 100 nM as I_{K_S} blockers. The compounds of this invention are at least 10 times more potent in the blockade of I_{K_S} than of blockade of I_{K_R} .

EXAMPLES

Example 1

(+)-3,5-Dichloro-N-[3R-2,3-dihydro-2-oxo-5-phenyl-1-(2,2,2-trifluoroethyl)-1H-benzo[e][1,4]diazepin-3-yl]benzamide.



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Step A: Preparation of 2,3-dihydro-2-oxo-5-phenyl-1-(2,2,2-trifluoroethyl)-1H-benzo[e][1,4]diazepine.

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A solution of 5-phenyl-1,4-benzodiazepine-2-one (*J. Org. Chem.*, 1962, 27, 3788)(50 g, 0.211 mole) in DMF (100 mL) was treated with cesium carbonate (103.5 g, 0.317 mole) and trifluoroethyl iodide (109.7 g, 0.525 mole). The mixture was stirred at 50°C overnight. The reaction mixture was then poured into water (2 L) and extracted with ethyl acetate (3 X 1 L). The combined ethyl acetate fractions were dried over anhydrous magnesium sulfate, filtered and concentrated at reduced pressure. The residue was crystallized from ethyl ether to give 45 g (68 %) of the product. MP = 130 - 131°C; ¹H NMR (CDCl₃, 300 MHz) δ 7.65-7.60 (m, 2H), 7.60-7.45 (m, 5H), 7.40-7.20 (m, 2H), 5.25 (dq, J = 14, 8.6 Hz, 1H), 4.82 (d, J = 10.5 Hz, 1H), 4.15 (app sextet, J = 8.6 Hz, 1H), 3.81 (d, J = 10.5 Hz, 1H)

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Step B: Preparation of 3-Azido-5-phenyl-1-(2,2,2-trifluoroethyl)-1H-benzo[e][1,4]diazepine.

To a stirring solution of 5-phenyl-1-(2,2,2-trifluoroethyl)-1H-benzo[e][1,4]diazepine (70 g, 0.22 mol) in THF (1500 mL) cooled to -70°C was added potassium tert-butoxide (1.1 eq, 0.24 mol, 240 mL of a 1 N solution in THF) dropwise over 15 min. A solution of 2,4,6-triisopropylbenzenesulfonyl azide (74.8 g, 0.24 mol) in THF (250 mL) was added over 5 min. This was stirred for 10 minutes and acetic acid

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(40 mL, 0.63 mol) was added and the reaction allowed to warm to ambient temperature. The reaction was poured into satd. NaHCO₃ (1500 mL) and ethyl acetate (1L). The phases were separated and the aqueous phase was extracted with ethyl acetate (500 mL). The combined organic layers were washed with water (500 mL) then brine (300 mL). The organic layers were dried with Na₂SO₄ and evaporated to a brown foam. This was triturated with ethyl ether to give 65 g of a white powder. The filtrate was concentrated and chromatographed over silica gel eluting with 30% ethyl acetate/hexane to give another 8.9 g. The combined yield was 74 g (93%). MP = 159 - 160°C;
¹H NMR (CDCl₃, 300 MHz) δ 7.70-7.26 (m, 9H), 5.28-5.12 (m, 1H), 4.63 (s, 1H), 4.35-4.10 (m, 1H).

Step C: Preparation of racemic 3-Amino-5-phenyl-1-(2,2,2-trifluoroethyl)-1H-benzo[e][1,4]diazepine.

To a stirring solution of 3-Azido-2-oxo-5-phenyl-1-(2,2,2-trifluoroethyl)-2,3-dihydro-1H-benzo[e][1,4]diazepine (83.4 mmol, 30g) in 300 mL ethanol and 150 mL THF was added 10% Pd/C (10 wt%, 3.0g). Hydrogen gas was bubbled through the solution for 8h. The reaction was filtered and evaporated under reduced pressure. The residue was crystallized from ethyl ether to give 20.0g of white crystals. Another 4g was recovered from evaporation and recrystallization of the filtrates.

Combined yield, 86.7%.

MP = 141 - 143°C;
¹H NMR (CDCl₃, 300 MHz) δ 7.70-7.26 (m, 9H), 5.28-5.12 (m, 1H), 4.57 (s, 1H), 4.35-4.10 (m, 1H).

Step D: Preparation of 2-Amino-N-[2-oxo-5-phenyl-1-(2,2,2-trifluoroethyl)-2,3-dihydro-1H-benzo[e][1,4]diazepin-3-yl]-3-phenylpropionamide

To a stirring solution of 3-Amino-2-oxo-5-phenyl-1-(2,2,2-trifluoroethyl)-2,3-dihydro-1H-benzo[e][1,4]diazepine (92.2mmol,30.74g) in DMF (300mL) was added N-Benzyloxy-D-Phenylalanine (92.2mmol,27.6g), 1-(3-Dimethylaminopropyl)-3-ethylcarbodiimide hydrochloride(0.12mol,22.95g) and 1-hydroxybenztriazole hydrate (46.1mmol,6.23g). This was stirred at room temperature for 2h. The reaction was then diluted with 1L of 10% KHSO₄ and extracted with ethyl acetate (2x600mL). The organic layers were combined and washed with saturated sodium hydrogen carbonate (600mL). They were dried with brine and sodium sulfate and evaporated under reduced pressure. 66.58g of an orange foam, which contained ethyl acetate by NMR. NMR ¹H (CDCl₃) δ 7.75-7.18 (m, 20H), 5.62-5.55 (m,1H), 5.48-5.00 (m, 4H), 4.72-4.60 (m, 1H), 4.25-4.05 (m,1H) 3.32-3.05 (m, 2H). This material was carried on without further purification.

To a stirring solution of 2-(N-Benzyloxyamino)-N-[2-oxo-5-phenyl-1-(2,2,2-trifluoroethyl)-2,3-dihydro-1H-benzo[e][1,4]diazepin-3-yl]-3-phenyl propionamide in 1L ethanol was added 10% Pd/C (15 wt%) and hydrogen was bubbled through the reaction for 2h and then left stirring under 1 atm. hydrogen overnight. Hydrogen was bubbled through the reaction for an additional three hours the following morning. The reaction was then filtered, the catalyst was rinsed with 1L methylene chloride and evaporated under reduced pressure. The resulting solid was dried under vacuum overnight to give 44.46g of a white solid. This was chromatographed over silica, eluting with 1% MeOH:EtOAc. The pure upper R_f fractions were collected and evaporated under reduced pressure. The mixed fractions were collected, evaporated and rechromatographed. The pure fractions were collected and combined with the above pure fractions to get a combined yield of 18.11g, 83.5% of the upper R_f diastereomer. ¹H NMR (CDCl₃,300 MHz) δ 8.94 (d, J=8.6Hz, 1H), 7.65-7.10 (m, 9H), 5.64 (d, J=8.6 Hz, 1H), 5.28-5.12 (m, 1H), 4.57 (s, 1H), 4.35-4.10 (m, 1H) 3.71 (dd, J=9.8 and 3.9 Hz, 1H), 3.34 (dd, J=13.9 and 3.9 Hz,1H), 2.79 (dd, J=13.9 and 10.0 Hz, 1H). The Absolute

stereochemistry at C-3 of the benzodiazepine ring was determined to be (R) by X-Ray analysis.

The lower R_f material corresponding to C-3(S) was isolated as well.

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Step E: Preparation of 3(R)-(+)-3-Amino-5-phenyl-1-(2,2,2-trifluoroethyl)-1H-benzo[e][1,4] diazepine.

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To a stirring solution of 2-Amino-N-[2-oxo-5-phenyl-1-(2,2,2-trifluoroethyl)-2,3-dihydro-1H-benzo[e][1,4]diazepin-3-yl]-3-phenylpropionamide (13.6 g, 28.3 mmol) in methylene chloride (136 mL) was added phenyl isothiocyanate (3.87 mL, 34.0 mmol). This was stirred overnight at ambient temperature. The reaction was then cooled in ice, trifluoroacetic acid (2.73 mL, 0.283 mol) added and the reaction allowed to warm to ambient temperature. After stirring at ambient temperature for 2.5 hours the reaction was evaporated under reduced pressure, chromatographed with 90:10:1:1 methylene chloride:methanol:acetic acid:water. The low R_f spot was collected and evaporated under reduced pressure with no heat. The residue was taken up in 600 mL methylene chloride and washed with 300 mL saturated NaHCO₃ and 300 mL water. The solution was dried over Na₂SO₄ and evaporated under reduced pressure. The residue was crystallized from ethyl acetate:hexanes to give 6.65 g of a white powder. MP = 162 - 164°C; ¹H NMR (CDCl₃, 300 MHz) δ 7.70-7.26 (m, 9H), 5.28-5.12 (m, 1H), 4.57 (s, 1H), 4.35-4.10 (m, 1H). [α]_D = +72.9° (c=0.7, MeOH).

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The (-)-3S enantiomer was prepared in the same fashion from the Lower R_f product of Step D.
MP = 156 - 158°C;
¹H NMR (CDCl₃, 300 MHz) δ 7.70-7.26 (m, 9H), 5.28-5.12 (m, 1H), 4.57 (s, 1H), 4.35-4.10 (m, 1H).
[α]_D = -71.2° (c=0.66, MeOH)

Step F: Preparation of (+)-3,5-Dichloro-N-[3R-2,3-dihydro-2-oxo-5-phenyl-1-(2,2,2-trifluoroethyl)-1H-benzo[e][1,4]diazepin-3-yl]benzamide:

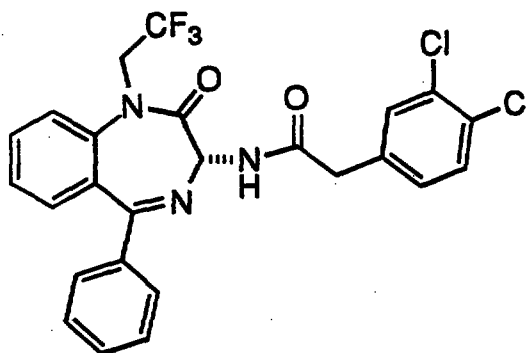
5 To a stirring solution of (+)-3R-3-amino-5-phenyl-1-(2,2,2-trifluoroethyl)-1H-benzo[e][1,4] diazepine (5.6 g, 16.8 mmol) in DMF (50 mL) was added 1-(3-Dimethylaminopropyl-3-ethylcarbodiimide hydrochloride(4.44 g, 23.0 mmol), and 1-hydroxybenztriazole hydrate (3.11 g, 23.0 mmol) and 3,5-Dichlorobenzoic acid (3.21 g, 16.8 mmol).
10 This was stirred at ambient temperature for 2 hours. The reaction was diluted with 500 mL satd. NaHCO₃ and extracted with 2 x 300 mL ethyl acetate. The combined organics were washed with 10% KHSO₄ (200 mL) , brine (200 mL), dried over Na₂SO₄, and evaporated to a white foam. This was chromatographed over a 75 x 200 mm silica column
15 eluting with 20% ethyl acetate:hexane. The pure fractions were collected and evaporated under reduced pressure to give 8.5 g of a white foam which was crystallized from 15% ethyl acetate:hexane to give 5.3 g of a white powder . mp=140-143°C, [α]_D=+47.9°; ¹H NMR (CDCl₃, 300 MHz) δ 7.85-7.75 (m, 2 H), 7.70-7.20 (m, 9 H), 5.78 (d, J=8.1 Hz, 1 H),
20 5.30-5.15 (m, 1H), 4.30-4.15 (m, 1H)
Analysis Calcd. for C₂₄H₁₆Cl₂F₃N₃O₂:
C, 56.93; H, 3.19; N, 8.30; Found: C, 56.81; H, 3.17; N, 8.17.

25 The following examples were prepared by a procedure substantially as described for Example 1, Step F.

Example 2

30 (-)-2-(3,4-Dichlorophenyl)-N-[3R-2,3-dihydro-2-oxo-5-phenyl-1-(2,2,2-trifluoroethyl)-1H-benzo[e][1,4]diazepin-3-yl]acetamide.

21



mp=219-221°C; $[\alpha]_D = -10.8^\circ$;

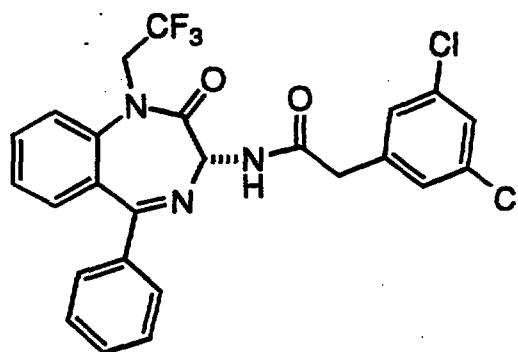
$^1\text{H NMR}$ (CDCl_3 , 300 MHz) δ 7.65-7.15 (m, 12H), 5.78 (d, $J=8.1$ Hz, 1H), 5.25-5.10 (m, 1H), 4.25-4.05 (m, 1H), 3.56 (s, 2H);

Analysis Calcd. for $\text{C}_{25}\text{H}_{18}\text{Cl}_2\text{F}_3\text{N}_3\text{O}_2 \cdot 0.85 \text{H}_2\text{O}$:

C, 56.06; H, 3.71; N, 7.84. Found : C, 56.03; H, 3.53; N, 7.82.

Example 3

(-)-2-(3,5-Dichlorophenyl)-N-[3R-2,3-dihydro-2-oxo-5-phenyl-1-(2,2,2-trifluoroethyl)-1H-benzo[e][1,4]diazepin-3-yl]acetamide



mp=93-100°C, $[\alpha]_D = -5.7^\circ$;

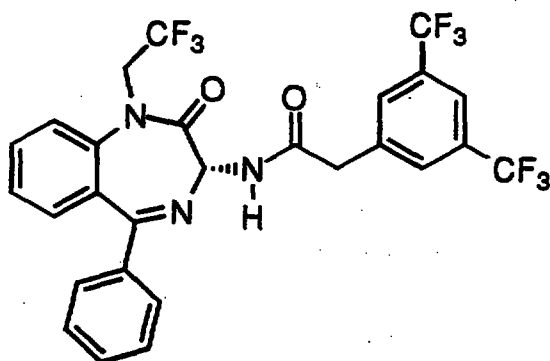
$^1\text{H NMR}$ (CDCl_3 , 300 MHz) δ 7.65-7.15 (m, 12H), 5.78 (d, $J=8.1$ Hz, 1H), 5.25-5.10 (m, 1H), 4.25-4.05 (m, 1H), 3.65 (s, 2H);

Analysis Calcd. for $\text{C}_{25}\text{H}_{18}\text{Cl}_2\text{F}_3\text{N}_3\text{O}_2$:

C, 57.71; H, 3.49; N, 8.08; Found : C, 57.41; H, 3.48; N, 8.12.

Example 4

(-)-2-[3,5-Bis(trifluoromethyl)phenyl]-N-[3R-2,3-dihydro-2-oxo-5-phenyl-1-(2,2,2-trifluoroethyl)-1H-benzo[e][1,4]diazepin-3-yl]acetamide



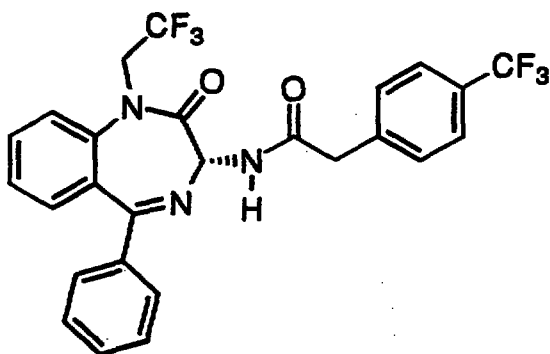
m.p. foam °C, $[\alpha]_D = -9.7^\circ$ ($c=0.59$, MeOH).

Anal. Calcd. for $C_{27}H_{18}F_9N_3O_2 \cdot 0.75 H_2O$:

C, 53.96; H, 3.27; N, 6.99. Found: C, 53.96; H, 3.1; N, 6.98%.

Example 5

(-)-2-(4-Trifluoromethylphenyl)-N-[3R-2,3-dihydro-2-oxo-5-phenyl-1-(2,2,2-trifluoroethyl)-1H-benzo[e][1,4]diazepin-3-yl]acetamide

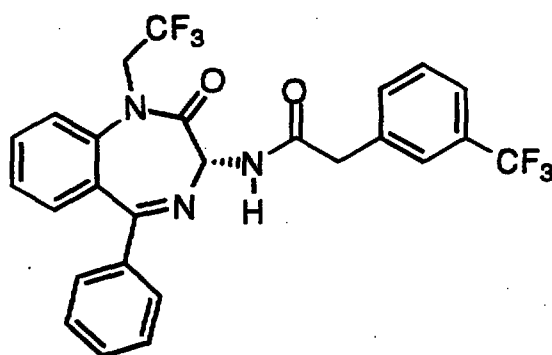


m.p. 253-255 °C, $[\alpha]_D = -9.2^\circ$ ($c=0.25$, MeOH).

Anal. Calcd. for $C_{26}H_{19}F_6N_3O_2 \cdot 0.05$ ethyl ether 0.55 H_2O :
C, 59.03; H, 3.9; N, 7.88. Found: C, 59.05; H, 3.82; N, 7.78%.

Example 6

2-(3-Trifluoromethylphenyl)-N-[3R-2,3-dihydro-2-oxo-5-phenyl-1-(2,2,2-trifluoroethyl)-1H-benzo[e][1,4]diazepin-3-yl]acetamide



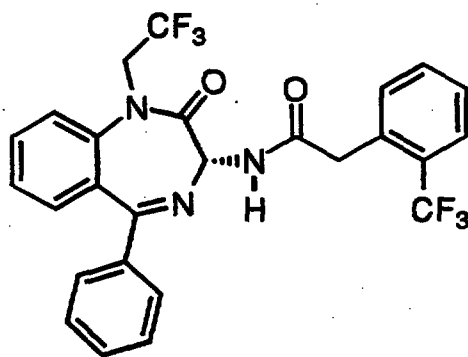
m.p. 172-173 °C, $[\alpha]_D = +5.9^\circ$ ($c=0.56$, $CHCl_3$).

Anal. Calcd. for $C_{26}H_{19}F_6N_3O_2 \cdot 0.60$ H_2O :

C, 58.89; H, 3.84; N, 7.92. Found: C, 58.92; H, 3.71; N, 7.98%.

Example 7

(+)-2-(2-Trifluoromethylphenyl)-N-[3R-2,3-dihydro-2-oxo-5-phenyl-1-(2,2,2-trifluoroethyl)-1H-benzo[e][1,4]diazepin-3-yl]acetamide



m.p. 170-171 °C, $[\alpha]_D = +9.0^\circ$ (c=0.48, CHCl₃).

Anal. Calcd. for C₂₆H₁₉F₆N₃O₂·0.25 H₂O:

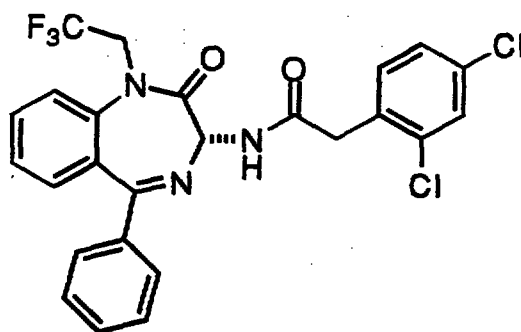
C, 59.6; H, 3.75; N, 8.02. Found: C, 59.64; H, 3.68; N, 7.97%.

5

Example 8

(-)-2-(2,4-Dichlorophenyl)-N-[3R-2,3-dihydro-2-oxo-5-phenyl-1-(2,2,2-trifluoroethyl)-1H-benzo[e][1,4]diazepin-3-yl]acetamide

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m.p. 143-145 °C, $[\alpha]_D = -22.6^\circ$ (c=0.73; MeOH).

Anal. Calcd. for C₂₅H₁₈N₃O₂Cl₂F₃:

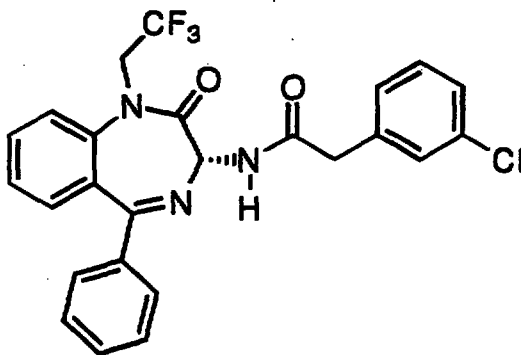
20

C, 57.71; H, 3.49; N, 8.08. Found: C, 57.75; H, 3.52; N, 8.09%.

Example 9

(-)-2-(3-Chlorophenyl)-N-[3R-2,3-dihydro-2-oxo-5-phenyl-1-(2,2,2-trifluoroethyl)-1H-benzo[e][1,4]diazepin-3-yl]acetamide

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m.p. 188-189 °C, $[\alpha]_D = -5.4^\circ$ (c=1.03, MeOH).

Anal. Calcd. for $C_{25}H_{19}ClF_3N_3O_2 \cdot 0.10$ ethyl ether:

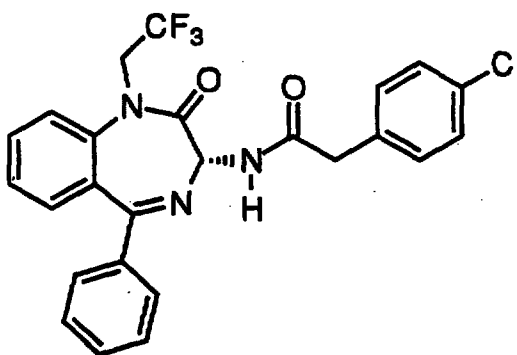
C, 61.84; H, 4.09; N, 8.52. Found: C, 61.84; H, 4.05; N, 8.5%.

5

Example 10

(-)-2-(4-Chlorophenyl)-N-[3R-2,3-dihydro-2-oxo-5-phenyl-1-(2,2,2-trifluoroethyl)-1H-benzo[e][1,4]diazepin-3-yl]acetamide

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m.p. 246-247 °C, $[\alpha]_D = -10.1^\circ$ (c=0.45, MeOH).

20 Anal. Calcd. for $C_{25}H_{19}ClF_3N_3O_2 \cdot 0.20$ H₂O 0.15 ethyl ether:

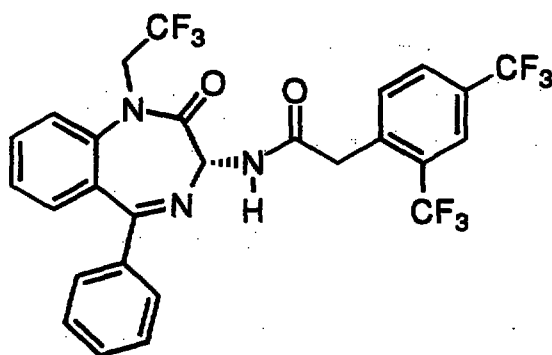
C, 61.42; H, 4.21; N, 8.39. Found: C, 61.46; H, 4.15; N, 8.39%.

25

Example 11

(-)-2-[2,4-Bis(trifluoromethyl)phenyl]-N-[3R-2,3-dihydro-2-oxo-5-phenyl-1-(2,2,2-trifluoroethyl)-1H-benzo[e][1,4]diazepin-3-yl]acetamide

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Step A. 2,4-Bis(trifluoromethyl)benzonitrile

To a stirring biphasic mixture of 100mL ethanol and 250mL of phosphate buffer (1g of $\text{NaH}_2\text{PO}_4 \cdot \text{H}_2\text{O}$ per 5 mL H_2O adjusted to pH=7.0 with 50% NaOH) and NaCN (81.3mmol, 4.0g) heated to 60°C was added 2,4-bis(trifluoromethyl) benzyl bromide (32.5mmol, 10g) in 50mL EtOH dropwise over 30min. The reaction was heated at 60°C for 24h. The reaction was then evaporated under reduced pressure. The remaining aqueous was extracted with 2x150mL EtOAc. The organic layers were combined, dried with brine and Na_2SO_4 . The organic phase was evaporated under reduced pressure and the residue chromatographed over silica eluting with 10% EtOAc:Hexanes. The pure fractions were collected and evaporated to give 7.0g of a pale yellow oil, 85.1% NMR ^1H (CDCl_3) δ 8.0-7.85 (m, 3H), 4.03 (s, 2H)

25

Step B. 2,4-Bis(trifluoromethyl)phenyl acetic acid

2,4-Bis(trifluoromethyl)benzonitrile (41.5mmol, 10.51g) was taken up in 100mL acetic acid, 50mL conc. H_2SO_4 , and 20mL water. This was heated to 120°C for 3h. The reaction was then diluted with 1L ice water, and extracted with 2x300mL ethyl acetate. The combined organics were washed with 2x200mL water, dried with brine and Na_2SO_4 , and evaporated under reduced pressure. The residue was taken up in a minimum of diethyl ether and crystallized by adding sufficient hexane to

30

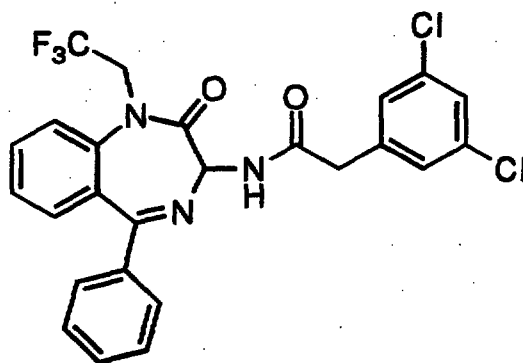
precipitate the product. The solid was collected to give 7.74g of 2,4-bis(trifluoromethyl) phenyl acetic acid as white crystals, 68.5%. NMR ^1H (CDCl_3) δ 7.93 (s, 1H), 7.80 (d, $J=7.9\text{Hz}$, 1H), 7.55 (d, $J=7.9\text{Hz}$, 1H), 3.94 (s, 2H).

5 Step C. Preparation of (-)-2-[2,4-Bis(trifluoromethyl)phenyl]-N-[3R-2,3-dihydro-2-oxo-5-phenyl-1-(2,2,2-trifluoroethyl)-1H-benzo[e][1,4]diazepin-3-yl]acetamide

10 To a stirring solution the 3R-3-Amino-2-oxo-5-phenyl-1-(2,2,2-trifluoroethyl)-2,3-dihydro-1H-benzo[e][1,4]diazepine (28.4mmol, 9.47g) in DMF (100mL) was added 2,4-Bis(trifluoromethyl)phenyl acetic acid (28.4mmol, 7.74g), 1-(3-Dimethylaminopropyl)-3-ethylcarbodiimide hydrochloride (42.6mmol, 8.16g) and 1-Hydroxybenzotriazole hydrate
15 (14.2mmol, 1.92g). This was stirred for 1h at room temperature. The reaction was then diluted with 750mL of 10% KHSO_4 and extracted with ethyl acetate (2x300mL). The organic layers were combined and washed with saturated sodium hydrogen carbonate (1x600mL). The organics were then dried with brine, and sodium sulfate and evaporated under
20 reduced pressure. The residue was chromatographed over silica eluting with 20% EtOAc:Hexane. Pure fractions were collected and evaporated. The residue was taken up in 100 mL of warm 75% isopropanol:water. This was allowed to cool slowly and stirred overnight (16 hr) at room temperature. The suspension was cooled briefly to @5°C and filtered. The white solid was dried overnight at 60°C to give 10.5 g of material
25 that melted at 132-134°C. X-Ray diffraction confirms crystallinity. NMR ^1H (CDCl_3) δ 7.95-7.25 (m, 13H), 5.60 (d, $J=8.1\text{Hz}$, 1H), 5.30-5.10 (m, 1H), 4.25-4.06 (m, 1H), 3.96 (s, 2H)
Anal. Calcd. for $\text{C}_{27}\text{H}_{18}\text{F}_9\text{N}_3\text{O}_2$:
30 C, 55.20; H, 3.09; N, 7.15. Found: C, 55.03; H, 3.14; N, 7.10%.

Example 12

(±)-2-(3,5-Dichlorophenyl)-N-[2,3-dihydro-2-oxo-5-phenyl-1-(2,2,2-trifluoroethyl)-1H-benzo[e][1,4]diazepin-3-yl] acetamide



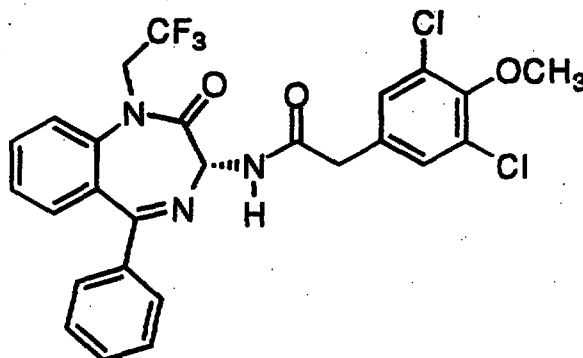
15 m.p. 219-220 °C. racemic

Anal. Calcd. for $C_{25}H_{18}N_3O_2Cl_2F_3$:

C, 57.71; H, 3.49; N, 8.08. Found: C, 57.94; H, 3.48; N, 8.02%.

Example 13

2-(3,5-dichloro-4-methoxyphenyl)-N-[3R-2,3-dihydro-2-oxo-5-phenyl-1-(2,2,2-trifluoroethyl)-1H-benzo[e][1,4]diazepin-3-yl]acetamide



m.p. 100-104 °C, $[\alpha]_D = -8.9^\circ$ (c=0.55, MeOH).

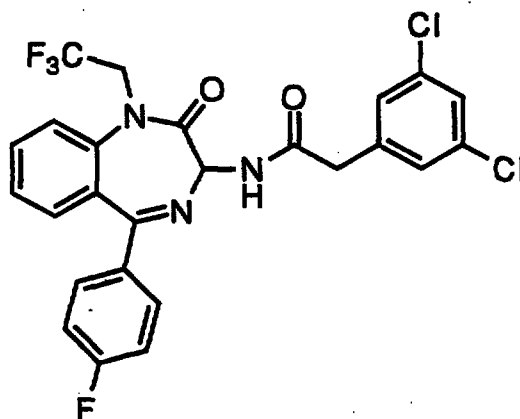
Anal. Calcd. for $C_{26}H_{20}Cl_2F_3N_3O_3$:

C, 56.74; H, 3.66; N, 7.63. Found: C, 55.67; H, 3.47; N, 7.41%.

- 5 The following examples were prepared by procedures substantially as described in example 1 except substituting the appropriate fluoro substituted aminobenzophenone in step A.

10 Example 14

(+)-2-(3,5-Dichlorophenyl)-N-[2,3-dihydro-5-(4-fluorophenyl)-2-oxo-1-(2,2,2-trifluoroethyl)-1H-benzo[e][1,4]diazepin-3-yl]acetamide



m.p. foam °C, $[\alpha]_D = +3.4^\circ$ (c=0.55; MeOH).

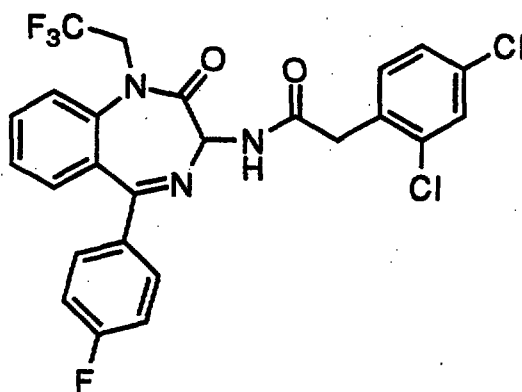
25 Anal. Calcd. for $C_{25}H_{17}N_3O_2Cl_2F_4$:

C, 55.78; H, 3.18; N, 7.81. Found: C, 55.73; H, 3.25; N, 7.72%.

Example 15

- 30 (-)-2-(2,4-Dichlorophenyl)-N-[2,3-dihydro-5-(4-fluorophenyl)-2-oxo-1-(2,2,2-trifluoroethyl)-1H-benzo[e][1,4]diazepin-3-yl]acetamide

30



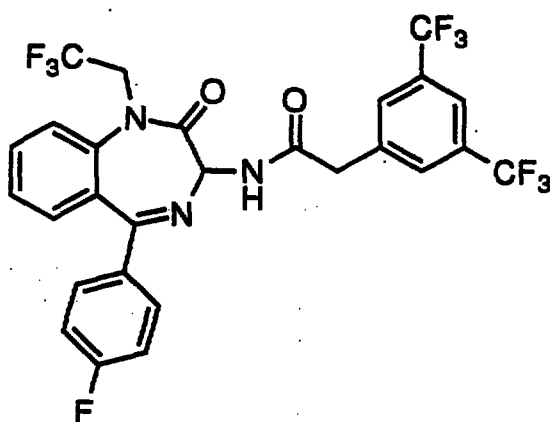
m.p. foam °C, $[\alpha]_D = -11^\circ$ ($c=0.68$; MeOH).

Anal. Calcd. for $C_{25}H_{17}N_3O_2F_4$:

C, 55.78; H, 3.18; N, 7.81. Found: C, 55.82; H, 3.41; N, 7.42%.

Example 16

(+)-2-(3,5-Bis(trifluoromethyl)phenyl)-N-[2,3-dihydro-5-(4-fluorophenyl)-2-oxo-1-(2,2,2-trifluoroethyl)-1H-benzo[e][1,4]diazepin-3-yl]-acetamide



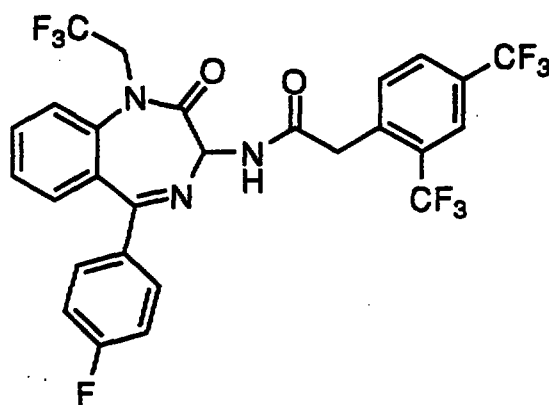
m.p. foam °C, $[\alpha]_D = +2.8^\circ$ ($c=0.67$; MeOH).

Anal. Calcd. for $C_{27}H_{17}N_3O_2F_{10}$:

C, 53.56; H, 2.83; N, 6.94. Found: C, 53.56; H, 2.93; N, 6.91%.

Example 17

(-)-2-[2,4-Bis(trifluoromethyl)phenyl]-N-[2,3-dihydro-5-(4-fluorophenyl)-2-oxo-1-(2,2,2-trifluoroethyl)-1H-benzo[e][1,4]diazepin-3-yl]acetamide



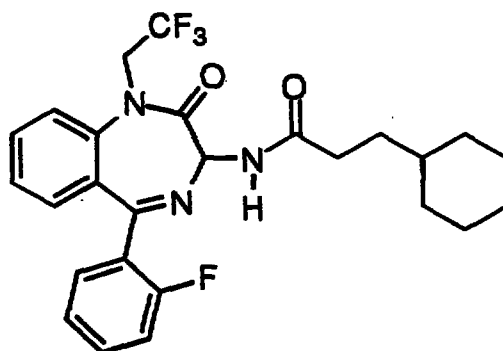
$[\alpha]_D = -14^\circ$ ($c=0.63$; MeOH).

Anal. Calcd. for $C_{27}H_{17}N_3O_2F_{10}$:

C, 53.56; H, 2.83; N, 6.94. Found: C, 53.3; H, 2.89; N, 7.05%.

Example 18

3-Cyclohexyl-N-[2,3-dihydro-5-(2-fluorophenyl)-2-oxo-1-(2,2,2-trifluoroethyl)-1H-benzo[e][1,4]diazepin-3-yl]propionamide



m.p. 202-204 °C.

$^1\text{H NMR } \delta$ (CDCl_3) 7.72 (m, 8H), 5.65 (d, $J=8.3\text{Hz}$, 1H), 5.35-5.08

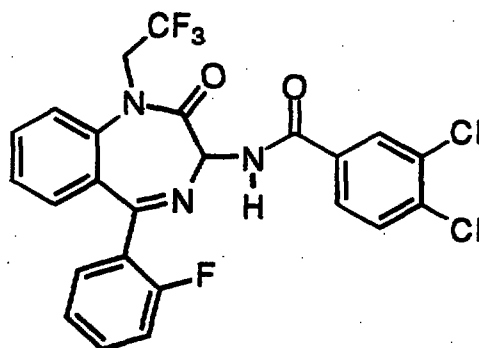
(m,1H), 4.32-4.15 (m,1H), 2.37 (t,J=7.8Hz,2H), 1.80-1.55 (m,7H), 1.45-

Anal. Calcd. for C₂₆H₂₇F₄N₃O₂:

C, 63.8; H, 5.56; N, 8.58. Found: C, 63.82; H, 5.54; N, 8.56%.

Example 19

3,4-Dichloro-N-[2,3-dihydro-5-(2-fluorophenyl)-2-oxo-1-(2,2,2-trifluoroethyl)-1H-benzo[e][1,4]diazepin-3-yl]benzamide



m.p. 168-170 °C.

¹H NMR δ (CDCl₃) 8.03 (d,J=2.0,1H), 7.86 (d,J=7.8Hz,1H), 7.78-7.05

(m,9H), 5.80 (d,J=7.8Hz,1H), 5.27-5.15 (m,1H), 4.35-4.20 (m,1H)

Anal. Calcd. for C₂₄H₁₅Cl₂F₄N₃O₂:

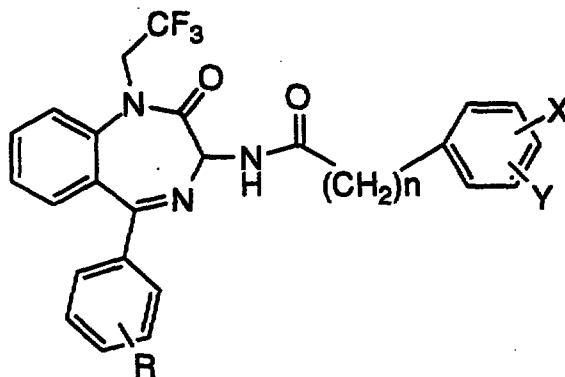
C, 54.98; H, 2.88; N, 8.01. Found: C, 54.96; H, 2.89; N, 8.12%.



33

THIS SHEET HAS BEEN
REPLACED**WHAT IS CLAIMED IS:**

1. A compound of the structural formula I



I

where

X and Y are independently hydrogen, chloro, fluoro, bromo, iodo, or trifluoromethyl and n is 0, 1 or 2;

R is hydrogen, fluoro, chloro, bromo, iodo, or trifluoromethyl, methyl, or methoxy; and

the racemates, mixtures of enantiomers, individual diastereomers or individual enantiomers with all isomeric forms and pharmaceutically acceptable salts, hydrates or crystal forms thereof, which are antiarrhythmic agents.

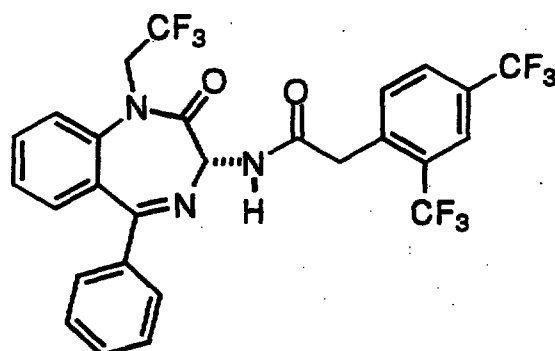
2. The compound of Claim 1 selected from the group consisting of:

(-)-2-[2,4-Bis(trifluoromethyl)phenyl]-N-[3R-2,3-dihydro-2-oxo-5-phenyl-1-(2,2,2-trifluoroethyl)-1H-benzo[e][1,4]diazepin-3-yl]acetamide



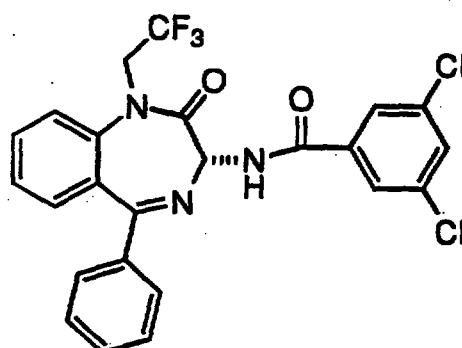
34

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10 (+)-3,5-Dichloro-N-[3R-2,3-dihydro-2-oxo-5-phenyl-1-(2,2,2-trifluoroethyl)-1H-benzo[e][1,4]diazepin-3-yl]benzamide;

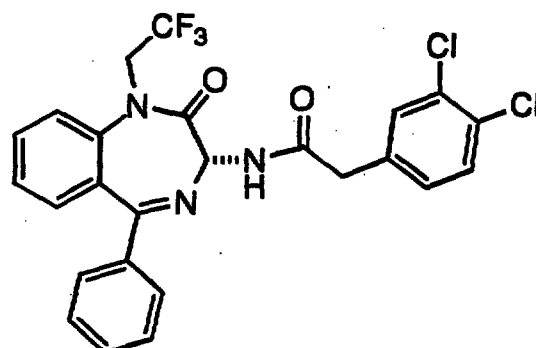
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(-)-3,4-Dichlorophenyl-1-yl-N-[3R-2,3-dihydro-2-oxo-5-phenyl-1-(2,2,2-trifluoroethyl)-1H-benzo[e][1,4]diazepin-3-yl]acetamide;

25



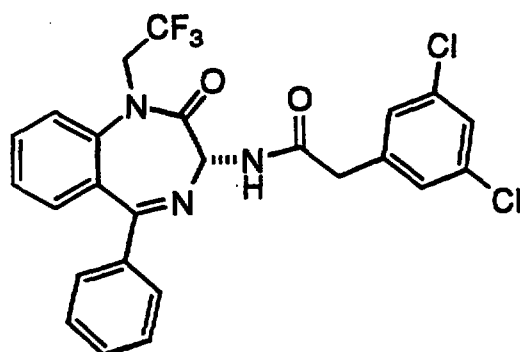
30

(-)-2-(3,5-Dichlorophenyl)-N-[3R-2,3-dihydro-2-oxo-5-phenyl-1-(2,2,2-trifluoroethyl)-1H-benzo[e][1,4]diazepin-3-yl]acetamide.



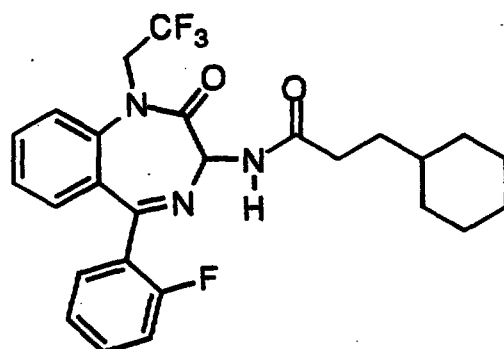
35

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10 3-Cyclohexyl-N-[2,3-dihydro-5-(2-fluorophenyl)-2-oxo-1-(2,2,2-trifluoroethyl)-1H-benzo[e][1,4]diazepin-3-yl]propionamide

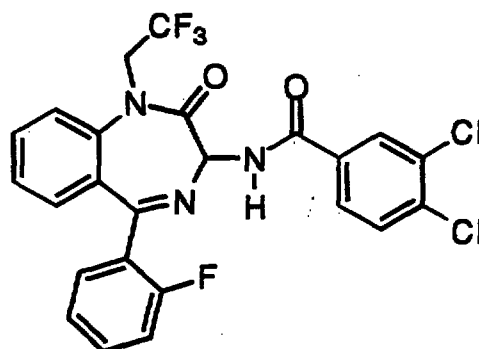
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3,4-Dichloro-N-[2,3-dihydro-5-(2-fluorophenyl)-2-oxo-1-(2,2,2-trifluoroethyl)-1H-benzo[e][1,4]diazepin-3-yl]benzamide

25



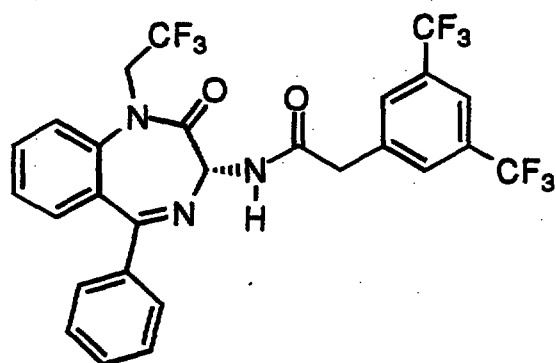
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(-)-2-[3,5-Bis(trifluoromethyl)phenyl]-N-[3R-2,3-dihydro-2-oxo-5-phenyl-1-(2,2,2-trifluoroethyl)-1H-benzo[e][1,4]diazepin-3-yl]acetamide



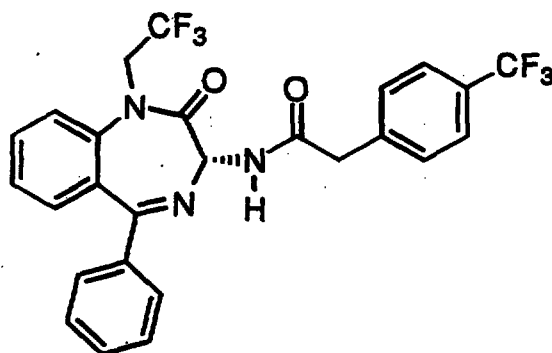
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10 (-)-2-(4-Trifluoromethylphenyl)-N-[3R-2,3-dihydro-2-oxo-5-phenyl-1-(2,2,2-trifluoroethyl)-1H-benzo[e][1,4]diazepin-3-yl]acetamide

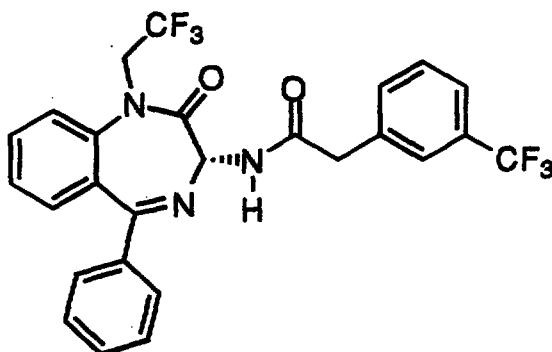
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(-)-2-(3-Trifluoromethylphenyl)-N-[3R-2,3-dihydro-2-oxo-5-phenyl-1-(2,2,2-trifluoroethyl)-1H-benzo[e][1,4]diazepin-3-yl]acetamide

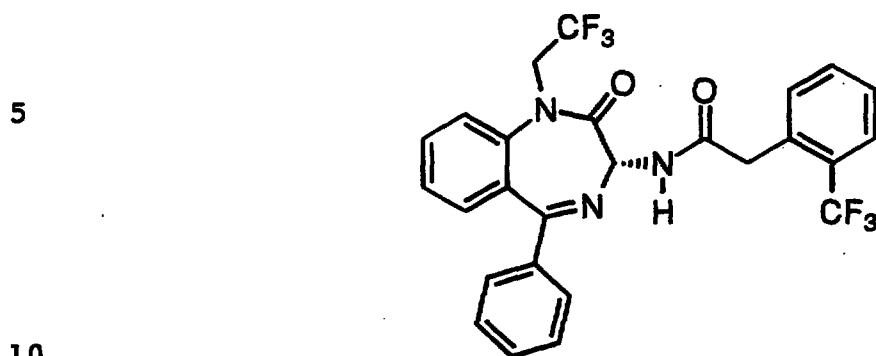
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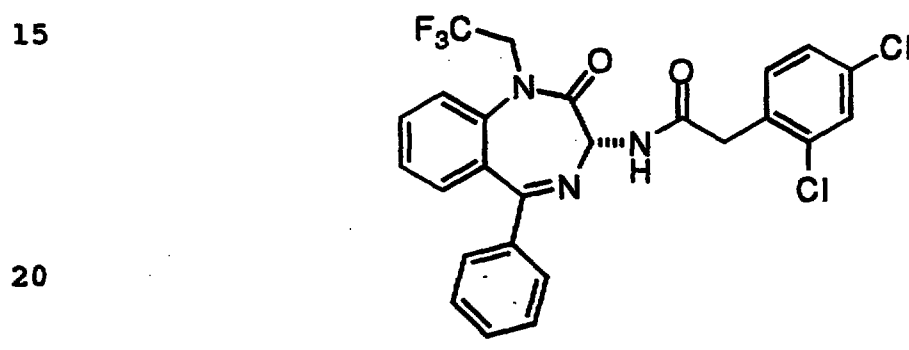
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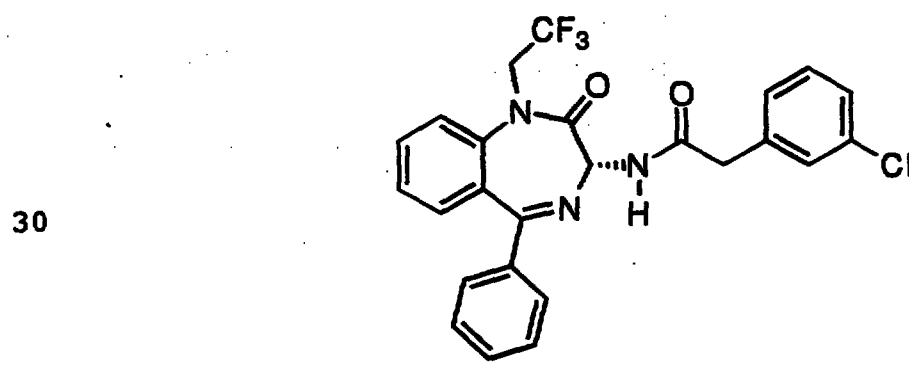
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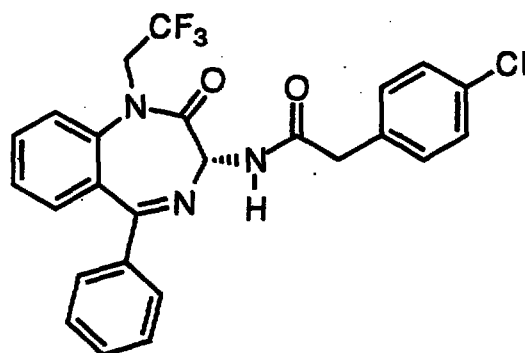
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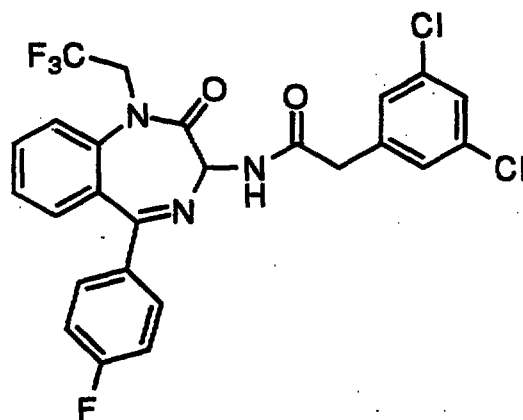
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(-)-2-(4-Chlorophenyl)-N-[3R-2,3-dihydro-2-oxo-5-phenyl-1-(2,2,2-trifluoroethyl)-1H-benzo[e][1,4]diazepin-3-yl]acetamide



(+)-2-(3,5-Dichlorophenyl)-N-[2,3-dihydro-5-(4-fluorophenyl)-2-oxo-1-(2,2,2-trifluoroethyl)-1H-benzo[e][1,4]diazepin-3-yl]-acetamide

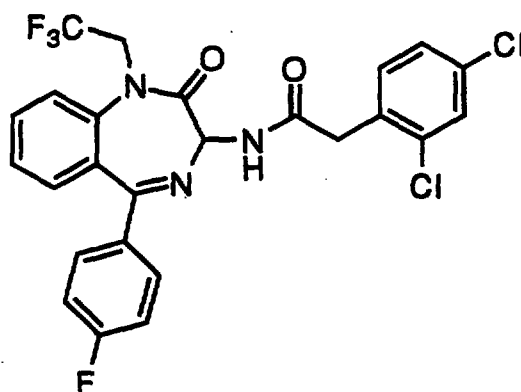


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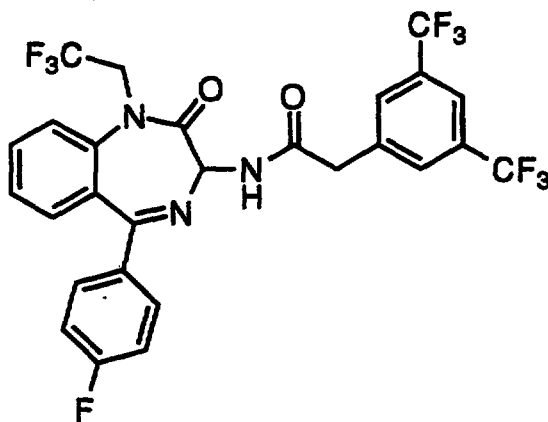
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(+)-2-[3,5-Bis(trifluoromethyl)phenyl]-N-[2,3-dihydro-5-(4-fluorophenyl)-2-oxo-1-(2,2,2-trifluoroethyl)-1H-benzo[e][1,4]diazepin-3-yl]acetamide

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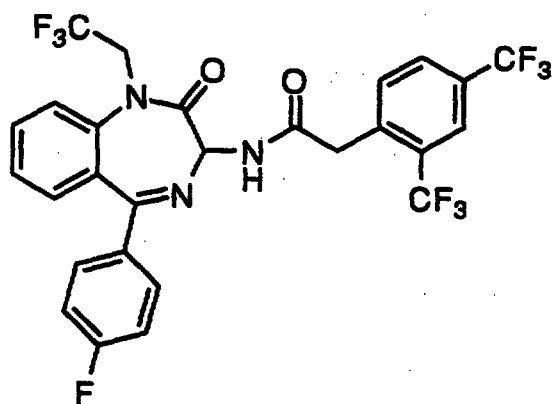
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(-)-2-[2,4-Bis(trifluoromethyl)phenyl]-N-[2,3-dihydro-5-(4-fluorophenyl)-2-oxo-1-(2,2,2-trifluoroethyl)-1H-benzo[e][1,4]diazepin-3-yl]acetamide

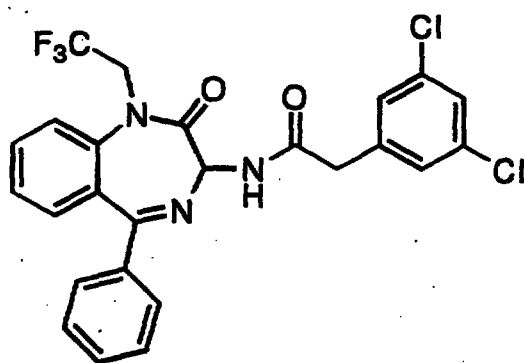
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(±)-2-(3,5-Dichlorophenyl)-N-[2,3-dihydro-2-oxo-5-phenyl-1-(2,2,2-trifluoroethyl)-1H-benzo[e][1,4]diazepin-3-yl]acetamide

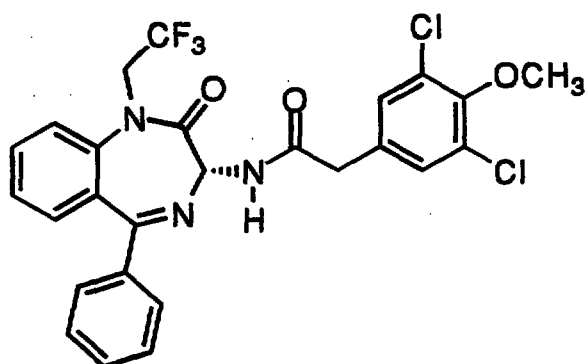


2-(3,5-dichloro-4-methoxyphenyl)-N-[2,3-dihydro-2-oxo-5-phenyl-1-(2,2,2-trifluoroethyl)-1H-benzo[e][1,4]diazepin-3-yl]acetamide



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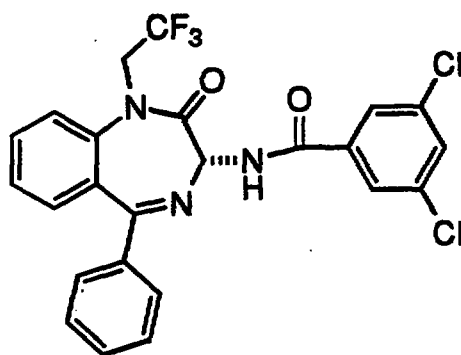
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3. The compound of Claim 1 which is (+)-3,5-Dichloro-N-[3R-2,3-dihydro-2-oxo-5-phenyl-1-(2,2,2-trifluoroethyl)-1H-benzo[e][1,4]diazepin-3-yl]benzamide

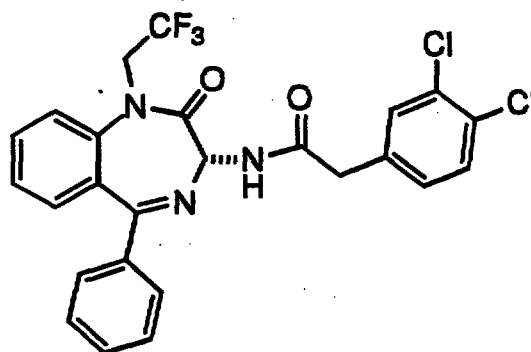
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4. The compound of Claim 1 which is (-)-2-(3,4-Dichlorophenyl)-N-[3R-2,3-dihydro-2-oxo-5-phenyl-1-(2,2,2-trifluoroethyl)-1H-benzo[e][1,4]diazepin-3-yl]acetamide:

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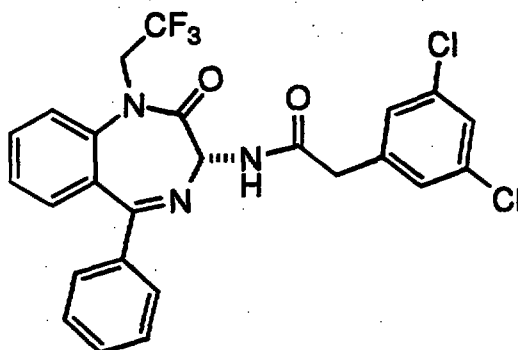


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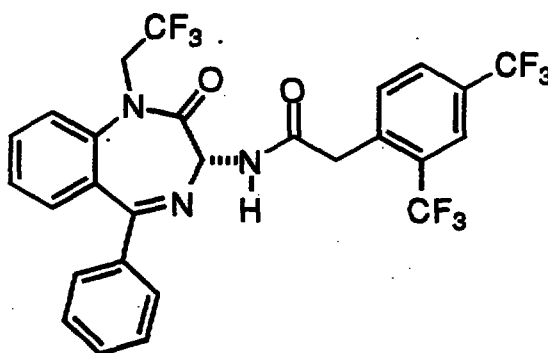
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5. The compound of Claim 1 which is (-)-2-(3,5-Dichlorophenyl)-N-[3R-2,3-dihydro-2-oxo-5-phenyl-1-(2,2,2-trifluoroethyl)-1H-benzo[e][1,4]diazepin-3-yl]acetamide



6. The compound of Claim 1 which is (-)-2-[2,4-Bis(trifluoromethyl)phenyl]-N-[3R-2,3-dihydro-2-oxo-5-phenyl-1-(2,2,2-trifluoroethyl)-1H-benzo[e][1,4]diazepin-3-yl]acetamide



7. A pharmaceutical formulation comprising a pharmaceutically acceptable carrier and a therapeutically effective amount of the compound of Claim 1 or a pharmaceutically acceptable salt, crystal form or hydrate thereof.

8. The pharmaceutical formulation of Claim 7 comprising in addition another antiarrhythmic agent or other cardiovascular agent.





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9. A method of preventing or treating arrhythmia which comprises the administration to a patient in need of such treatment of an antiarrhythmically effective amount of the compound of Claim 1.

5 10. The method of Claim 9 comprising the concomitant administration of another antiarrhythmic agent or other cardiovascular agent.

10 11. A pharmaceutical formulation comprising a pharmaceutically acceptable carrier and a therapeutically effective amount of the compound of Claim 6 or a pharmaceutically acceptable salt, crystal form or hydrate thereof.

15 12. The pharmaceutical formulation of Claim 11 comprising in addition another antiarrhythmic agent or other cardiovascular agent.

20 13. A method of preventing or treating arrhythmia which comprises the administration to a patient in need of such treatment of an antiarrhythmically effective amount of the compound of Claim 6.

25 14. The method of Claim 13 comprising the concomitant administration of another antiarrhythmic agent or other cardiovascular agent.

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