

33268-00

ARYNE INTERMEDIATES AND A PROCESS  
FOR THE PREPARATION THEREOF ✓

BACKGROUND OF THE INVENTION

Herbicidal sulfamoyl urea compounds are described in WO 95/29902, EP 661,276, WO 95/29167 and U.S. 4,622,065. A particularly potent and highly cereal selective sulfamoyl urea herbicidal agent is the subject of U. S. patent 5,009,699. This agent is especially useful for the selective control of a variety of weed species in the presence of cereal crops and particularly for controlling broadleaf weeds and sedges in the presence of trans-planted or paddy rice. Therefore, alternate, effective, cost-efficient methods of manufacture of herbicidal sulfamoyl ureas, and particularly cereal-selective sulfamoyl ureas, are of continued interest.

Certain key intermediates in the manufacture of the above-said herbicides and the cereal-selective herbicide, 1-{[*o*-(cyclopropylcarbonyl)phenyl]sulfamoyl}-3-(4,6-dimethoxy-2-pyrimidinyl)urea, such as *o*-aminophenyl cyclopropyl ketone, *o*-nitrophenyl cyclopropyl ketone, 4-halo-*o*-nitrobutyrophenone, and 4-halo-*o*-aminobutyrophenone are described in U. S. patents 5,362,911; 5,364,968; 5,405,998 and 5,414,136. However, alternate and effective methods to prepare these key intermediate alkyl and cycloalkyl phenyl ketones and their derivatives from readily available, non-toxic starting materials are still being sought.

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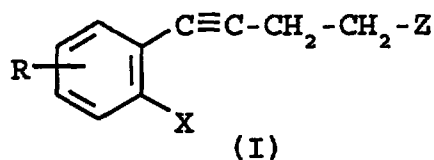
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SUMMARY OF THE INVENTION

The present invention provides aryne compounds of formula I



wherein R is H, CN, F, formyl,  $C_1-C_4$ alkyl optionally substituted with one or more halogen,  $C_1-C_3$ alkoxy,  $C_1-C_3$ alkylthio,  $C_1-C_3$ alkylsulfinyl or  $C_1-C_3$ alkylsulfonyl groups,

10  $C_1-C_4$ alkoxy optionally substituted with one or more halogen,  $C_1-C_3$ alkoxy,  $C_1-C_3$ alkylthio,  $C_1-C_3$ alkylsulfinyl or  $C_1-C_3$ alkylsulfonyl groups,

15  $C_1-C_4$ alkylthio optionally substituted with one or more halogen,  $C_1-C_3$ alkoxy,  $C_1-C_3$ alkylthio,  $C_1-C_3$ alkylsulfinyl or  $C_1-C_3$ alkylsulfonyl groups,

$C_1-C_4$ alkylsulfinyl optionally substituted with one or more halogen,  $C_1-C_3$ alkoxy,  $C_1-C_3$ alkylthio,  $C_1-C_3$ alkylsulfinyl or  $C_1-C_3$ alkylsulfonyl groups,

20  $C_1-C_4$ alkylsulfonyl optionally substituted with one or more halogen,  $C_1-C_3$ alkoxy,  $C_1-C_3$ alkylthio,  $C_1-C_3$ alkylsulfinyl or  $C_1-C_3$ alkylsulfonyl groups,

$C_1-C_4$ alkylcarbonyl optionally substituted with one or more halogen,  $C_1-C_3$ alkoxy,  $C_1-C_3$ alkylthio,  $C_1-C_3$ alkylsulfinyl or  $C_1-C_3$ alkylsulfonyl groups,

25  $C_1-C_4$ alkoxycarbonyl optionally substituted by one or more halogen or  $C_1-C_3$ alkoxy groups,

di( $C_1-C_4$ alkyl)amino optionally substituted by one or more halogen or  $C_1-C_3$ alkoxy groups,

30 di( $C_1-C_4$ alkyl)aminocarbonyl optionally substituted by one or more halogen or  $C_1-C_3$ alkoxy groups,

di( $C_1-C_4$ alkyl)aminosulfonyl optionally substituted by one or more halogen or  $C_1-C_3$ alkoxy groups, or

a heterocyclic ring having 2 to 6 carbon atoms and 1 to 3 nitrogen, oxygen or sulfur atoms and being optionally substituted on the carbon atoms with one or more fluorine, C<sub>1</sub>-C<sub>4</sub>alkyl or C<sub>1</sub>-C<sub>4</sub>haloalkyl groups;

X is NO<sub>2</sub> or NR<sub>1</sub>R<sub>2</sub>;

Z is OH, Br, Cl or OSO<sub>2</sub>R<sub>3</sub>;

R<sub>1</sub> and R<sub>2</sub> are each independently hydrogen, formyl, acetyl, haloacetyl, CO<sub>2</sub>R<sub>4</sub> or benzyl optionally substituted on the aromatic ring with one to three fluorine, nitro, C<sub>1</sub>-C<sub>3</sub>alkyl or C<sub>1</sub>-C<sub>3</sub>alkoxy groups; and

R<sub>3</sub> and R<sub>4</sub> are each independently C<sub>1</sub>-C<sub>6</sub>alkyl, C<sub>1</sub>-C<sub>6</sub>haloalkyl or phenyl optionally substituted with one to three fluorine, nitro, C<sub>1</sub>-C<sub>3</sub>alkyl or C<sub>1</sub>-C<sub>3</sub>alkoxy groups; or when X is NR<sub>1</sub>R<sub>2</sub>, the acid addition salts thereof.

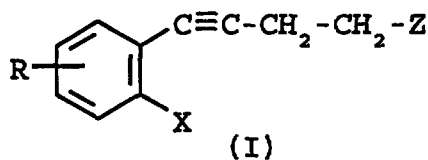
Also provided is a method to prepare the formula I compounds via the palladium catalyzed coupling of an o-halonitrobenzene or o-haloaniline with 3-butyne-1-ol.

The formula I aryne compounds are useful as intermediates in the manufacture of sulfamoyl urea herbicidal agents.

#### DETAILED DESCRIPTION OF THE INVENTION

Sulfamoyl urea derivatives are useful as herbicidal agents, in particular, 1-{[o-(cyclopropylcarbonyl)-phenyl]sulfamoyl}-3-(4,6-dimethoxy-2-pyrimidinyl)urea is a potent, environmentally benign herbicide with important cereal crop selectivity. A key intermediate in the manufacture of this particular herbicide is 1-(o-anilino)-4-halo-1-butanone. This key intermediate may be obtained from the corresponding o-nitrobenzene precursor or alternatively from the 4-hydroxy-anilino- or 4-hydroxy-nitrobenzene-1-butanone precursors.

It has now been found that aryne compounds of formula I



wherein R is H, NH<sub>2</sub>, CN, NO<sub>2</sub>, F, formyl, C<sub>1</sub>-C<sub>4</sub>alkyl optionally substituted with one or more halogen, C<sub>1</sub>-C<sub>3</sub>alkoxy, C<sub>1</sub>-C<sub>3</sub>alkylthio, C<sub>1</sub>-C<sub>3</sub>alkylsulfinyl or C<sub>1</sub>-C<sub>3</sub>alkylsulfonyl groups,

C<sub>1</sub>-C<sub>4</sub>alkoxy optionally substituted with one or more halogen, C<sub>1</sub>-C<sub>3</sub>alkoxy, C<sub>1</sub>-C<sub>3</sub>alkylthio, C<sub>1</sub>-C<sub>3</sub>-alkylsulfinyl or C<sub>1</sub>-C<sub>3</sub>alkylsulfonyl groups,

C<sub>1</sub>-C<sub>4</sub>alkylthio optionally substituted with one or more halogen, C<sub>1</sub>-C<sub>3</sub>alkoxy, C<sub>1</sub>-C<sub>3</sub>alkylthio, C<sub>1</sub>-C<sub>3</sub>-alkylsulfinyl or C<sub>1</sub>-C<sub>3</sub>alkylsulfonyl groups,

C<sub>1</sub>-C<sub>4</sub>alkylsulfinyl optionally substituted with one or more halogen, C<sub>1</sub>-C<sub>3</sub>alkoxy, C<sub>1</sub>-C<sub>3</sub>alkylthio, C<sub>1</sub>-C<sub>3</sub>-alkylsulfinyl or C<sub>1</sub>-C<sub>3</sub>alkylsulfonyl groups,

C<sub>1</sub>-C<sub>4</sub>alkylsulfonyl optionally substituted with one or more halogen, C<sub>1</sub>-C<sub>3</sub>alkoxy, C<sub>1</sub>-C<sub>3</sub>alkylthio, C<sub>1</sub>-C<sub>3</sub>-alkylsulfinyl or C<sub>1</sub>-C<sub>3</sub>alkylsulfonyl groups,

C<sub>1</sub>-C<sub>4</sub>alkylcarbonyl optionally substituted with one or more halogen, C<sub>1</sub>-C<sub>3</sub>alkoxy, C<sub>1</sub>-C<sub>3</sub>alkylthio, C<sub>1</sub>-C<sub>3</sub>-alkylsulfinyl or C<sub>1</sub>-C<sub>3</sub>alkylsulfonyl groups,

C<sub>1</sub>-C<sub>4</sub>alkoxycarbonyl optionally substituted by one or more halogen or C<sub>1</sub>-C<sub>3</sub>alkoxy groups,

di(C<sub>1</sub>-C<sub>4</sub>alkyl)amino optionally substituted by one or more halogen or C<sub>1</sub>-C<sub>3</sub>alkoxy groups,

di(C<sub>1</sub>-C<sub>4</sub>alkyl)aminocarbonyl optionally substituted by one or more halogen or C<sub>1</sub>-C<sub>3</sub>alkoxy groups,

di(C<sub>1</sub>-C<sub>4</sub>alkyl)aminosulfonyl optionally substituted by one or more halogen or C<sub>1</sub>-C<sub>3</sub>alkoxy groups, or

a heterocyclic ring having 2 to 6 carbon atoms and 1 to 3 nitrogen, oxygen or sulfur atoms and being optionally substituted on the carbon atoms with

one or more fluorine, C<sub>1</sub>-C<sub>4</sub>alkyl or C<sub>1</sub>-C<sub>4</sub>haloalkyl groups;

X is NO<sub>2</sub> or NR<sub>1</sub>R<sub>2</sub>;

Z is OH, Br, Cl or OSO<sub>2</sub>R<sub>3</sub>;

5 R<sub>1</sub> and R<sub>2</sub> are each independently hydrogen, formyl, acetyl, haloacetyl, CO<sub>2</sub>R<sub>4</sub> or benzyl optionally substituted on the aromatic ring with one to three fluorine, nitro, C<sub>1</sub>-C<sub>3</sub>alkyl or C<sub>1</sub>-C<sub>3</sub>alkoxy groups; and

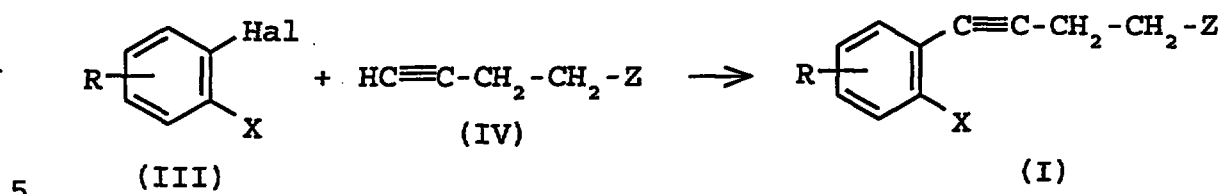
10 R<sub>3</sub> and R<sub>4</sub> are each independently C<sub>1</sub>-C<sub>6</sub>alkyl, C<sub>1</sub>-C<sub>6</sub>haloalkyl or phenyl optionally substituted with one to three fluorine, nitro, C<sub>1</sub>-C<sub>3</sub>alkyl or C<sub>1</sub>-C<sub>3</sub>alkoxy groups; or when X is NR<sub>1</sub>R<sub>2</sub>, the acid addition salts thereof are useful in the preparation of important 4-halo or 4-hydroxy-o-substituted benzene-butanone intermediates in  
15 the manufacture of sulfamoyl urea herbicides.

The term haloacetyl designates an acetyl group substituted by one to three halogen atoms which may be the same or different. The term halogen as used in this definition of haloacetyl designates Cl, Br, I or F.

20 Preferred compounds of formula I are those compounds wherein R is H; Z is OH; and R<sub>1</sub> and R<sub>2</sub> are each independently H.

Advantageously, the aryne compounds of formula I may be prepared from readily available, non-toxic starting  
25 materials such as o-halobenzenes of formula III, preferably o-iodobenzenes or o-bromobenzenes and alkynes of formula IV, preferably 3-butyne-1-ol. In accordance with the method of invention, a formula III o-halobenzene, preferably o-iodoaniline or o-bromoaniline, may be reacted  
30 with at least one molar equivalent of a formula IV alkyne, preferably 3-butyne-1-ol, in the presence of a catalytically effective amount of a palladium(II) catalyst and a copper(I) catalyst and in the presence of an organic amine. The reaction is illustrated in flow diagram I  
35 wherein Hal is I, Cl or Br and R, X and Z are defined hereinabove.

Flow Diagram I



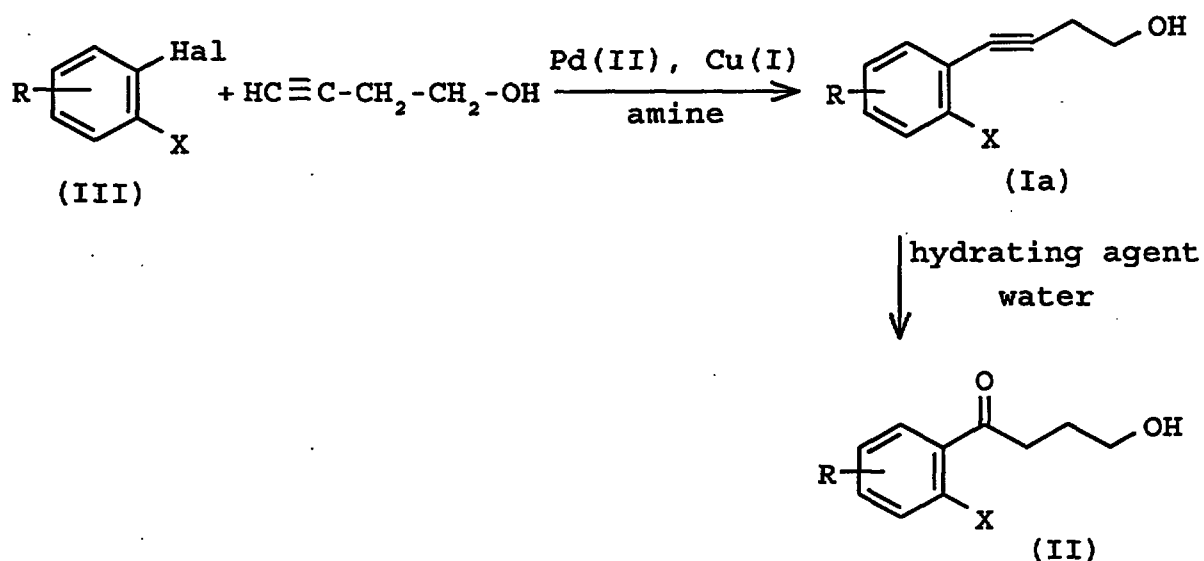
Organic amines suitable for use in the method of invention are any of those commonly used in manufacturing procedures such as triethylamine, diethylamine, tributylamine, diisopropylamine, and the like, preferably triethylamine.

Palladium catalysts may be any known catalyst wherein the palladium metal is present with a valence of two, such as bis(triphenylphosphine)palladium(II)-chloride, palladium(II)acetate, palladium(II)chloride, and the like, preferably bis(triphenylphosphine)-palladium(II)chloride. Similarly, the copper catalyst may be any known catalyst wherein the copper metal is present with a valence of one such as a copper(I)halide, preferably copper(I)iodide.

Conveniently the aryne compounds of the invention may be readily converted to key 4-halo or 4-hydroxy-o-substituted benzene-butanone intermediates essential in the manufacture of sulfamoyl urea herbicidal agents. In one embodiment of the invention, compounds of formula I wherein Z is hydroxy may be converted to the desired 4-hydroxyphenyl butanones of formula II in a single hydration step or, preferably, the desired formula II compound may be prepared in a single contiguous or continuous process.

In accordance with one embodiment of the inventive process, an *o*-halobenzene of formula III may be reacted with at least one molar equivalent of 3-butyne-1-ol in the presence of a catalytically effective amount of a  
 5 palladium(II) catalyst and copper(I) catalyst and in the presence of an organic amine to give an aryne intermediate of formula Ia and the formula Ia intermediate may be hydrated with a hydrating agent and water, optionally at an elevated temperature, to give the desired formula II  
 10 compound. The reaction sequence is shown in flow diagram II wherein Hal designates I, Cl or Br and R and X are as described hereinabove for formula I.

Flow Diagram II



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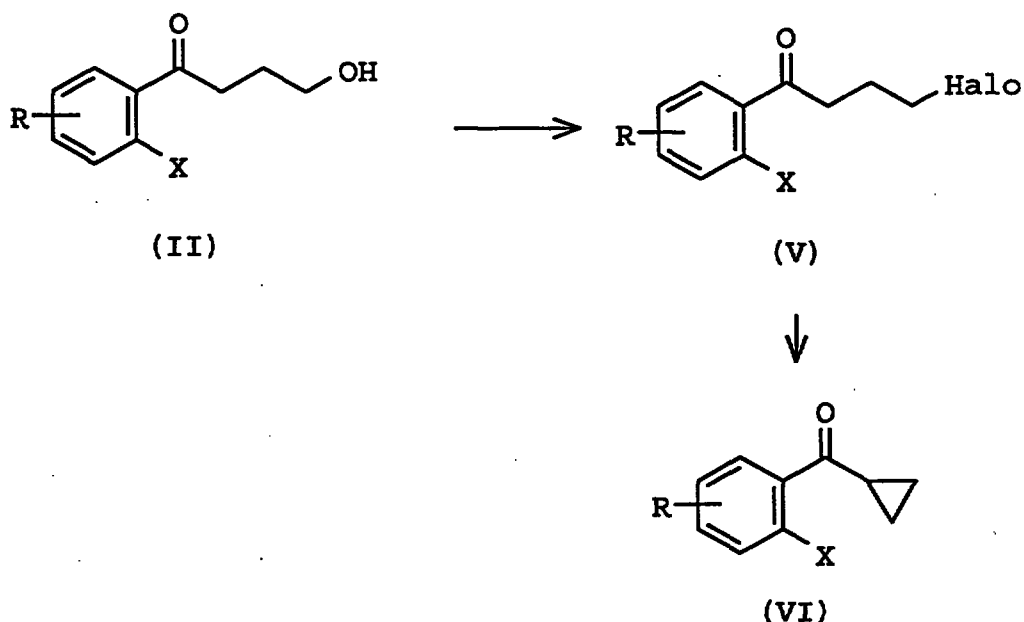
Hydrating agents suitable for use may be those commonly known in the art such as HgO, H<sub>2</sub>SO<sub>4</sub>, Na<sub>2</sub>S, HCl; and the like.

20 Although the inventive process may be practiced at room temperature, it is understood that increased temperatures may decrease reaction time. However, exces-

sively high temperatures may have adverse effects such as decomposition of reactants or products or facilitation of undesired side reactions. Suitable reaction temperatures range from about 0°C to 110°C, preferably about 25°C to 90°C.

The compound of formula II may be converted to the corresponding cyclopropyl ketone by displacing the hydroxy moiety with halogen, for example, by reacting the formula II butanone with a hydrogen halide to form the corresponding 4-halobutanone of formula V and dehydrohalogenating the resultant halobutanone to give the desired cyclopropyl product of formula VI. The reaction sequence is shown in flow diagram III.

Flow Diagram III



Methods to convert compounds of formula V wherein R is hydrogen to corresponding compounds of formula VI are described in U. S. 5,362,911. Methods to convert the formula VI cyclopropyl ketone wherein R is hydrogen and X is NH<sub>2</sub> to a cereal-selective, herbicidal, sulfamoyl urea are described in U. S. 5,008,699. Similarly, methods to

convert the formula VI cyclopropyl ketone wherein R is hydrogen and X is NO<sub>2</sub> to a cereal-selective, herbicidal, sulfamoyl urea are described in U. S. 5,364,968. Methods to convert general phenyl ketones of formula V to their  
5 corresponding sulfamoyl urea herbicidal products are described in WO 95/29902, EP 661,276, WO 95/29167 and U.S. 4,622,065.

In accordance with another embodiment of the invention the halobenzene of formula III may be reacted with  
10 3-butyne-1-ol in the presence of a catalytically effective amount of a palladium(II) catalyst and a copper(I) catalyst and in the presence of an organic amine to form the aryne intermediate of formula Ia. The formula Ia aryne may then be hydrated with hydrating agent to form  
15 the 4-hydroxyphenylbutanone of formula II. The formula II butanone may be halogenated with a hydrogen halide to give the corresponding 4-halo compound of formula V, which may then be dehydrohalogenated to give the cyclopropyl phenyl ketone of formula VI. When the formula VI  
20 compound is the compound wherein X is NH<sub>2</sub>, said compound may be reacted with a 2-aminoaryl compound of formula VIII and chlorosulfonyl isocyanate in the presence of triethylamine and a solvent to give the desired herbicidal product of formula VII. The reaction sequence is  
25 shown in flow diagram IV wherein Halo designates Cl, Br, I or F; A is N or CR<sub>6</sub>;

R<sub>5</sub> is H, halogen, C<sub>1</sub>-C<sub>4</sub>alkyl optionally substituted

with one or more halogen or C<sub>1</sub>-C<sub>3</sub>alkoxy groups,  
C<sub>1</sub>-C<sub>4</sub>alkoxy optionally substituted with one or more  
30 halogen or C<sub>1</sub>-C<sub>3</sub>alkoxy groups,  
C<sub>1</sub>-C<sub>4</sub>alkylthio optionally substituted with one or more halogen or C<sub>1</sub>-C<sub>3</sub>alkoxy groups,  
C<sub>1</sub>-C<sub>4</sub>alkylsulfinyl optionally substituted with one or more halogen or C<sub>1</sub>-C<sub>3</sub>alkoxy groups,  
35 C<sub>1</sub>-C<sub>4</sub>alkylsulfonyl optionally substituted with one or more halogen or C<sub>1</sub>-C<sub>3</sub>alkoxy groups, or

C<sub>1</sub>-C<sub>4</sub>alkylamino or di(C<sub>1</sub>-C<sub>4</sub>alkyl)amino each alkyl group being optionally substituted with one or more halogen or C<sub>1</sub>-C<sub>3</sub>alkoxy groups;

R<sub>6</sub> is H or halogen; and

5 R<sub>7</sub> is hydrogen, C<sub>1</sub>-C<sub>4</sub>alkyl optionally substituted with one or more halogen or C<sub>1</sub>-C<sub>3</sub>alkoxy groups,

C<sub>1</sub>-C<sub>4</sub>alkoxy optionally substituted with one or more halogen or C<sub>1</sub>-C<sub>3</sub>alkoxy groups,

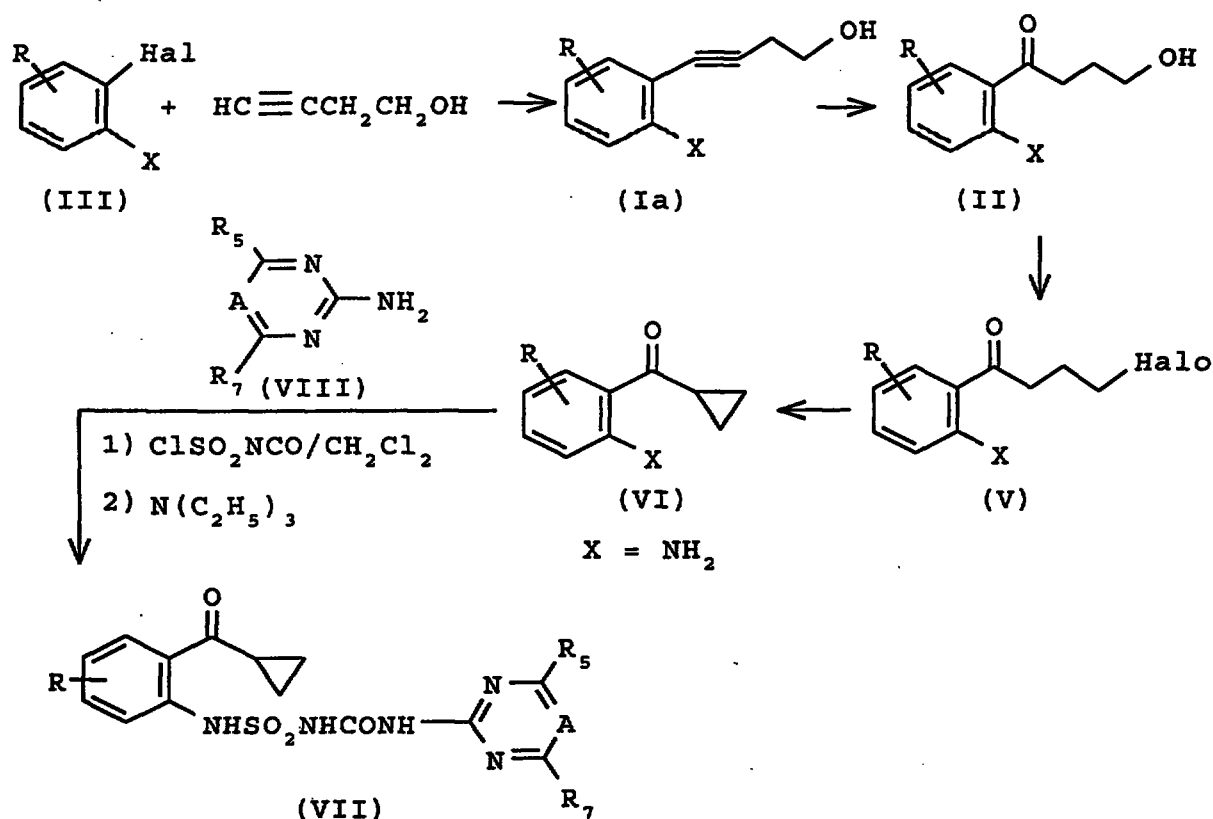
10 C<sub>1</sub>-C<sub>4</sub>alkylthio optionally substituted with one or more halogen or C<sub>1</sub>-C<sub>3</sub>alkoxy groups,

C<sub>1</sub>-C<sub>4</sub>alkylsulfinyl optionally substituted with one or more halogen or C<sub>1</sub>-C<sub>3</sub>alkoxy groups,

C<sub>1</sub>-C<sub>4</sub>alkylsulfonyl optionally substituted with one or more halogen or C<sub>1</sub>-C<sub>3</sub>alkoxy groups, or

15 C<sub>1</sub>-C<sub>4</sub>alkylamino or di(C<sub>1</sub>-C<sub>4</sub>alkyl)amino each alkyl group being optionally substituted with one or more halogen or C<sub>1</sub>-C<sub>3</sub>alkoxy group.

Flow Diagram IV



5 It is understood that compounds of formula II, V or VI wherein X is  $\text{NO}_2$  or  $\text{NR}_1\text{R}_2$  and either or both of  $\text{R}_1\text{R}_2$  is other than hydrogen, may be converted to the corresponding aniline analogues by catalytic reduction or hydrolysis techniques, respectively. For example, when X is  $\text{NO}_2$ ,  
 10 for a compound of formula II, V or VI, said compound may be reduced with hydrogen gas in the presence of a catalyst optionally in the presence of a solvent to give the corresponding compound of formula II, V or VI wherein X is  $\text{NH}_2$ . Similarly, using known hydrolysis methods, a  
 15 compound of formula II, V or VI wherein X is  $\text{NR}_1\text{R}_2$  and either one or both of  $\text{R}_1$  and  $\text{R}_2$  are other than hydrogen may be hydrolyzed to give the corresponding compound of formula II, V or VI wherein X is  $\text{NH}_2$ .

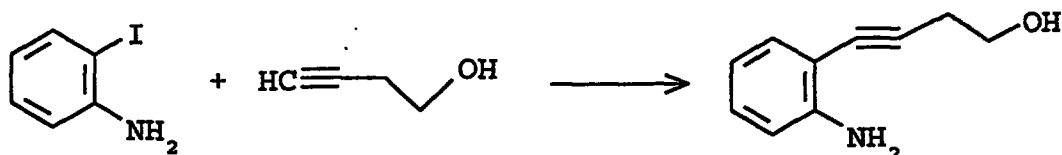
For a more clear understanding of the invention, the  
 20 following examples are set forth below. These examples

are merely illustrative and are not understood to limit the scope or underlying principles of the invention in any way. Indeed, various modifications of the invention, in addition to those shown and described herein, will  
5 become apparent to those skilled in the art from the following examples and the foregoing description. Such modifications are also intended to fall within the scope of the appended claims.

The term NMR designates nuclear magnetic resonance.

EXAMPLE 1

Preparation of 4-(o-anilino)-3-butyne-1-ol

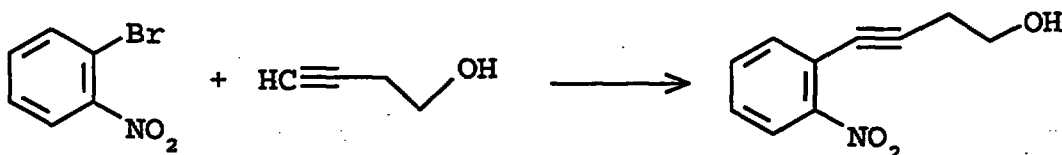


A solution of o-iodoaniline (35.0 g, 0.16 mol) in 640 ml of triethylamine, under nitrogen, is treated sequentially with bis(triphenylphosphine)palladium(II)-chloride (2.24 g, 0.0032 mol), 3-butyne-1-ol (16.8 g, 0.24 mol) and copper(I)iodide (0.3 g, 0.0016 mol), stirred for 4.5 hours and filtered. The filtercake is washed with toluene and the filtrates are combined and concentrated in vacuo to give a dark oil residue. The residue is dissolved in methylene chloride, washed with water and filtered through a silica gel pad. The filtrate is concentrated in vacuo to give the title product as a dark oil, 25.2 g, 98% yield, identified by NMR and mass spectral analyses.

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EXAMPLE 2

Preparation of 4-(o-nitrophenyl)-3-butyne-1-ol



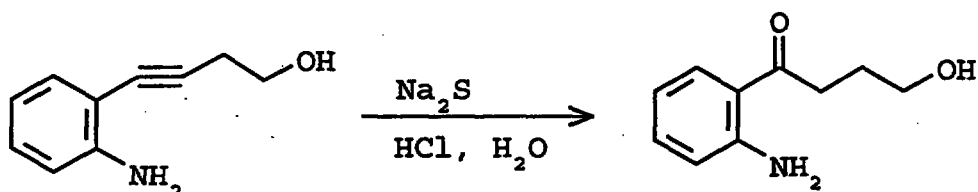
A solution of o-bromonitrobenzene (8.1 g, 0.04 mol) in 160 ml of triethylamine, under nitrogen, is treated sequentially with bis(triphenylphosphine)palladium(II)-chloride (0.28 g, 0.4 mmol), 3-butyne-1-ol (2.81 g, 0.04

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mol) and copper(I)iodide (0.15 g, 0.8 mmol), stirred for about 16 hours and filtered. The filtercake is washed with toluene. The filtrates are combined and concentrated in vacuo to give the title product as a dark oil, 6.0 g, 78.5% yield, identified by NMR and mass spectral analyses.

### EXAMPLE 3

#### Preparation of 4-hydroxy-(o-anilino)-1-butanone

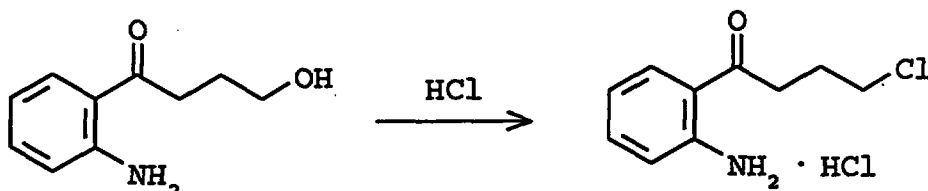


A solution of 4-(o-anilino)-3-butyne-1-ol (28 g, 90% pure, 0.155 mol) in 1.8 L methanol is treated sequentially with 1.35 kg of aqueous sodium sulfide (0.186 mol) and 176 g of dilute HCl (0.46 mol), heated at reflux for 9.4 hours, cooled to room temperature and filtered through celite. The filtrate is concentrated in vacuo and the concentrate is extracted with methylene chloride. The extracts are combined, washed with water and filtered through a silica gel pad. The filtrate is concentrated in vacuo to give the title product as a light orange solid, 16.6 g, 54.8% yield, identified by NMR and mass spectral analyses.

EXAMPLE 4

Preparation of 1-(o-anilino)-4-chloro-1-butanone hydrochloride

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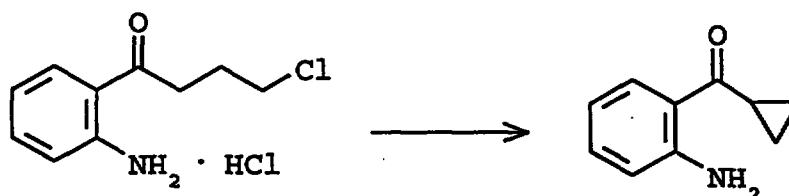


10 A mixture of 1-(o-anilino)-4-hydroxy-1-butanone (9.3 g, 5.1 mmol), 26 ml water and 90 ml of 37% HCl is heated at reflux temperature for 6.5 hours, cooled to room temperature and filtered. The filtercake is dried to give the title product as a white solid, 8.0 g. The filtrate is extracted with methylene chloride; the extracts are combined and the solvent evaporated *in vacuo* to give an additional 1.1 g of the title product, 73% overall yield, mp 142-145°C, identified by NMR and mass spectral analyses.

EXAMPLE 5

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Preparation of o-aminophenyl cyclopropyl ketone



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A solution of 1-(o-anilino)-4-chloro-1-butanone hydrochloride (0.3 g, 1.3 mmol) in a mixture of methylene chloride and ethylene dichloride is treated with 10% NaOH (1.2 g, 3.0 mmol) and 75% aqueous methyl tributylammonium chloride (0.05 g, 0.2 mmol), heated at 50°C for 5 hours

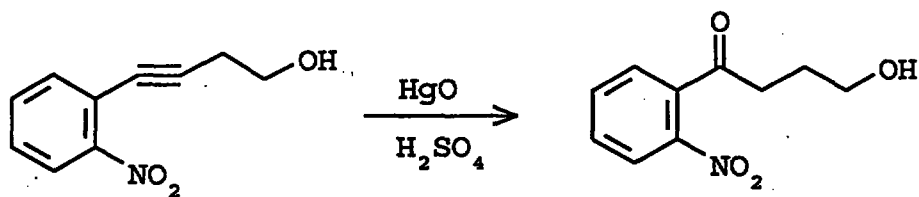
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and cooled to room temperature. The phases are separated and the aqueous phase is extracted with methylene chloride. The organic extracts are combined, washed with water and concentrated in vacuo to give the title product  
5 as a white solid, 0.14 g, 70% yield, mp 46-48°C, identified by NMR and mass spectral analyses.

**EXAMPLE 6**

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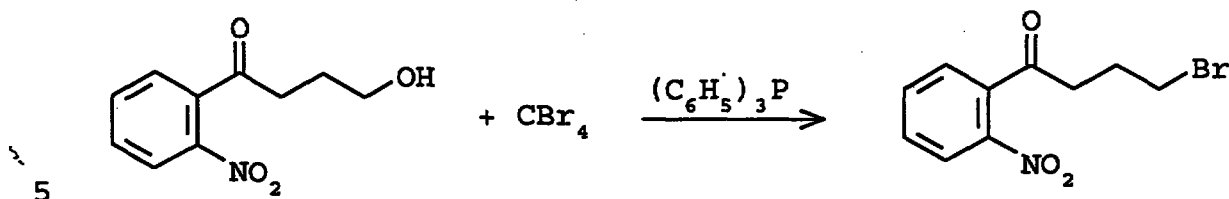
**Preparation of 1-(o-nitrophenyl)-4-hydroxy-1-butanone**



15 A mixture of HgO (0.21 g, 1.0 mmol) in 50 ml of 0.12N H<sub>2</sub>SO<sub>4</sub> is heated to 60°C, treated dropwise with a solution of 4-(o-nitrophenyl)-3-butyn-1-ol (3.70 g, 19.4 mmol) in 25 ml of tetrahydrofuran over a 10 minute period, held at 60°C for 3 hours, treated with additional  
20 HgO (0.84 g, 3.9 mmol) suspended in 25 ml of 0.12N H<sub>2</sub>SO<sub>4</sub>, held at 60°C for 4 hours, cooled to room temperature and diluted with water. The resultant aqueous mixture is extracted with ether. The extracts are combined, washed with brine, dried over Na<sub>2</sub>SO<sub>4</sub> and concentrated in vacuo to  
25 give a residue. The residue is purified by flash column chromatography (silica gel; gradient 1:1→2:1 ethyl acetate: hexanes as eluent) to give the title product as a brown oil, 1.48 g, 37% yield, identified by NMR and mass spectral analyses.

EXAMPLE 7

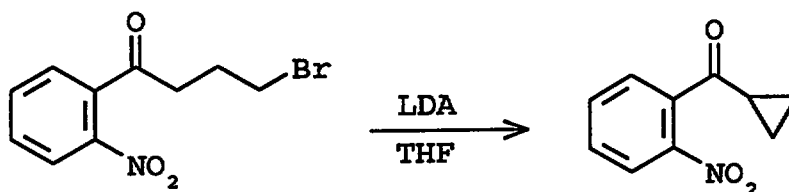
Preparation of 1-(o-nitrophenyl)-4-bromo-1-butanone



A mixture of 1-(o-nitrophenyl)-4-hydroxy-1-butanone (1.33 g, 6.4 mmol) and CBr<sub>4</sub> (2.32 g, 7.0 mmol) in toluene is treated with triphenylphosphine (2.50 g, 9.5 mmol),  
10 heated at 60°C with stirring under nitrogen for 24 hours, cooled to room temperature and poured onto water. The resultant aqueous mixture is extracted with ethyl acetate. The extracts are combined, washed with brine, dried over Na<sub>2</sub>SO<sub>4</sub> and concentrated *in vacuo* to give a  
15 residue. The residue is purified by flash column chromatography (silica gel; gradient 1:4→1:2 ethyl acetate: hexanes as eluent) to give the title product as a brown oil, 0.90 g, 52% yield, identified by NMR and mass spectral analyses.

EXAMPLE 8

Preparation of o-nitrophenyl cyclopropyl ketone



A solution of 1 (o-nitrophenyl)-4-bromo-1-butanone (0.75 g, 2.75 mmol) in dry tetrahydrofuran (THF) under nitrogen is cooled to -78°C with stirring, cautiously  
10 treated with 2.21 ml of 1.5 M lithium diisopropylamide (LDA) in cyclohexane (3.3 mmol LDA), held at -78°C for 1 hour, allowed to warm to 0°C for 2 hours and poured onto a saturated NH<sub>4</sub>Cl solution. The resultant mixture is extracted with ethyl acetate. The extracts are combined,  
15 washed with brine, dried over Na<sub>2</sub>SO<sub>4</sub> and concentrated in vacuo to give a residue. The residue is purified by flash column chromatography (silica gel; gradient 15%→25% ethyl acetate in hexane as eluent) to give the title product as a yellow oil, 0.34 g, 64% yield, identified by  
20 NMR and mass spectral analyses.

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EXAMPLE 9

Preparation of 1-[[o-Cyclopropylcarbonyl)phenyl]sulfamoyl]-  
3-(4, 6-dimethoxy-2-pyrimidinyl) urea

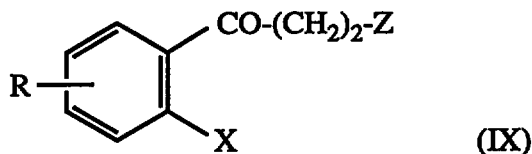
5 The title compound is prepared by adding chlorosulfonyl isocyanate to an equimolar quantity of 2-amino-4, 6-dimethoxypyrimidine in dichloromethane at 0°C. 1-(Chlorosulfonyl) -3- (4, 6-dimethoxy-2-pyrimidinyl) urea is  
 10 thereby formed in situ. o-Aminophenyl cyclopropyl ketone whose preparation is given in Example 5 and triethylamine are subsequently added.

One aspect of the invention resides in a process for the  
 15 preparation of a compound having the formula VII as defined and illustrated above, which comprises

(a) hydrating a compound having the formula I as defined and illustrated above with a hydrating agent and, if Z is -OH,  
 20 reacting the hydration product with a reagent for exchanging hydroxy by chlorine or bromine or with a reactive derivative of a sulfonic acid having the formula  $R_3SO_2OH$  where  $R_3$  is as defined in above so as to convert the OH represented by Z into Br, Cl or  $OSO_2R_3$  where  $R_3$  is as defined above;

25

(b) cyclising the resultant compound having the formula IX

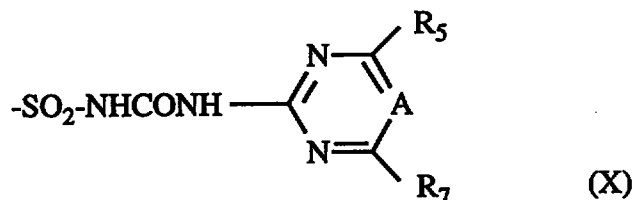


30 where R and X are as defined above and Z is Br, Cl or  $OSO_2R_3$  where  $R_3$  is as defined in claim 1 so as to form a cyclopropylcarbonyl group at the position ortho to X and, if X is other than  $-NH_2$  in the product obtained, converting X into  $-NH_2$  by reduction or hydrolysis; and

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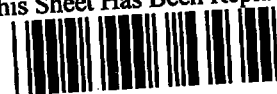
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- (c) reaction of the resultant compound having the formula VI as illustrated above wherein X is NH<sub>2</sub> and R is as defined above with a sulfonamide-forming reagent that introduces a
- 5 group having the formula X



where A, R<sub>5</sub> and R<sub>7</sub> are as defined above.

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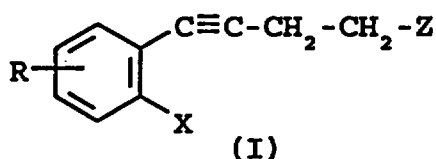
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CLAIMS

1. A compound of formula I



wherein R is H, CN, F, formyl, C<sub>1</sub>-C<sub>4</sub>alkyl optionally substituted with one or more halogen, C<sub>1</sub>-C<sub>3</sub>alkoxy, C<sub>1</sub>-C<sub>3</sub>alkylthio, C<sub>1</sub>-C<sub>3</sub>alkylsulfinyl or C<sub>1</sub>-C<sub>3</sub>alkylsulfonyl groups,  
 C<sub>1</sub>-C<sub>4</sub>alkoxy optionally substituted with one or more halogen, C<sub>1</sub>-C<sub>3</sub>alkoxy, C<sub>1</sub>-C<sub>3</sub>alkylthio, C<sub>1</sub>-C<sub>3</sub>alkylsulfinyl or C<sub>1</sub>-C<sub>3</sub>alkylsulfonyl groups,  
 C<sub>1</sub>-C<sub>4</sub>alkylthio optionally substituted with one or more halogen, C<sub>1</sub>-C<sub>3</sub>alkoxy, C<sub>1</sub>-C<sub>3</sub>alkylthio, C<sub>1</sub>-C<sub>3</sub>alkylsulfinyl or C<sub>1</sub>-C<sub>3</sub>alkylsulfonyl groups,  
 C<sub>1</sub>-C<sub>4</sub>alkylsulfinyl optionally substituted with one or more halogen, C<sub>1</sub>-C<sub>3</sub>alkoxy, C<sub>1</sub>-C<sub>3</sub>alkylthio, C<sub>1</sub>-C<sub>3</sub>alkylsulfinyl or C<sub>1</sub>-C<sub>3</sub>alkylsulfonyl groups,  
 C<sub>1</sub>-C<sub>4</sub>alkylsulfonyl optionally substituted with one or more halogen, C<sub>1</sub>-C<sub>3</sub>alkoxy, C<sub>1</sub>-C<sub>3</sub>alkylthio, C<sub>1</sub>-C<sub>3</sub>alkylsulfinyl or C<sub>1</sub>-C<sub>3</sub>alkylsulfonyl groups,  
 C<sub>1</sub>-C<sub>4</sub>alkylcarbonyl optionally substituted with one or more halogen, C<sub>1</sub>-C<sub>3</sub>alkoxy, C<sub>1</sub>-C<sub>3</sub>alkylthio, C<sub>1</sub>-C<sub>3</sub>alkylsulfinyl or C<sub>1</sub>-C<sub>3</sub>alkylsulfonyl groups,  
 C<sub>1</sub>-C<sub>4</sub>alkoxycarbonyl optionally substituted by one or more halogen or C<sub>1</sub>-C<sub>3</sub>alkoxy groups,  
 di(C<sub>1</sub>-C<sub>4</sub>alkyl)amino optionally substituted by one or more halogen or C<sub>1</sub>-C<sub>3</sub>alkoxy groups,  
 di(C<sub>1</sub>-C<sub>4</sub>alkyl)aminocarbonyl optionally substituted by one or more halogen or C<sub>1</sub>-C<sub>3</sub>alkoxy groups,

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di(C<sub>1</sub>-C<sub>4</sub>alkyl)aminosulfonyl optionally substituted by one or more halogen or C<sub>1</sub>-C<sub>3</sub>alkoxy groups, or a heterocyclic ring having 2 to 6 carbon atoms and 1 to 3 nitrogen, oxygen or sulfur atoms and being optionally substituted on the carbon atoms with one or more fluorine, C<sub>1</sub>-C<sub>4</sub>alkyl or C<sub>1</sub>-C<sub>4</sub>haloalkyl groups;

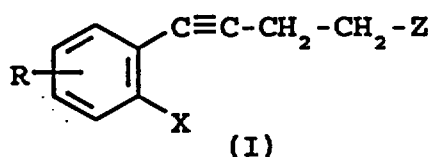
X is NO<sub>2</sub> or NR<sub>1</sub>R<sub>2</sub>;

Z is OH, Br, Cl or OSO<sub>2</sub>R<sub>3</sub>;

R<sub>1</sub> and R<sub>2</sub> are each independently hydrogen, formyl, acetyl, haloacetyl, CO<sub>2</sub>R<sub>4</sub> or benzyl optionally substituted on the aromatic ring with one to three fluorine, nitro, C<sub>1</sub>-C<sub>3</sub>alkyl or C<sub>1</sub>-C<sub>3</sub>alkoxy groups; and

R<sub>3</sub> and R<sub>4</sub> are each independently C<sub>1</sub>-C<sub>6</sub>alkyl, C<sub>1</sub>-C<sub>6</sub>haloalkyl or phenyl optionally substituted with one to three fluorine, nitro, C<sub>1</sub>-C<sub>3</sub>alkyl or C<sub>1</sub>-C<sub>3</sub>alkoxy groups; or when X is NR<sub>1</sub>R<sub>2</sub>, the acid addition salts thereof.

2. The compound according to claim 1 wherein R is H.
3. The compound according to claim 2 wherein X is NO<sub>2</sub> or NH<sub>2</sub>.
4. The compound according to claim 2 or 3 wherein Z is OH.
5. A process for the preparation of a compound of formula I



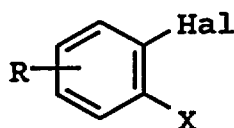
wherein R is defined in claim 1;

X is NO<sub>2</sub> or NR<sub>1</sub>R<sub>2</sub>;

Z is OH, Br, Cl or OSO<sub>2</sub>R<sub>3</sub>;



$R_1$  and  $R_2$  are each independently hydrogen, formyl, acetyl, haloacetyl,  $CO_2R_4$  or benzyl optionally substituted on the aromatic ring with one to three fluorine, nitro,  $C_1-C_3$ alkyl or  $C_1-C_3$ alkoxy groups; and  $R_3$  and  $R_4$  are each independently  $C_1-C_6$ alkyl,  $C_1-C_6$ haloalkyl or phenyl optionally substituted with one to three fluorine, nitro,  $C_1-C_3$ alkyl or  $C_1-C_3$ alkoxy groups which comprises reacting a halobenzene of formula III



(III)

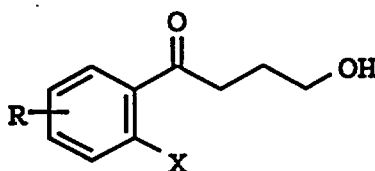
wherein Hal is Cl, I or Br and R and X are as defined for formula I with at least one molar equivalent of a butyne compound of formula IV



(IV)

wherein Z is as defined for formula I in the presence of a catalytically effective amount of a palladium(II)catalyst and a copper(I)catalyst and in the presence of an organic amine.

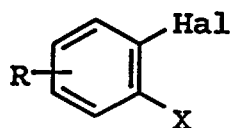
6. A process for the preparation of a compound of formula II



(II)

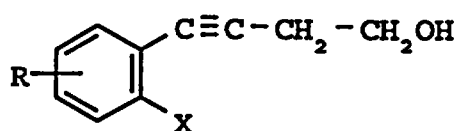


wherein R is defined in claim 1;  
 X is NO<sub>2</sub> or NR<sub>1</sub>R<sub>2</sub>;  
 R<sub>1</sub> and R<sub>2</sub> are each independently hydrogen, formyl, acetyl, haloacetyl, CO<sub>2</sub>R<sub>4</sub> or benzyl optionally substituted on the aromatic ring with one to three fluorine, nitro, C<sub>1</sub>-C<sub>3</sub>alkyl or C<sub>1</sub>-C<sub>3</sub>alkoxy groups; and  
 R<sub>4</sub> is C<sub>1</sub>-C<sub>6</sub>alkyl, C<sub>1</sub>-C<sub>6</sub>haloalkyl or phenyl optionally substituted with one to three fluorine, nitro, C<sub>1</sub>-C<sub>3</sub>alkyl or C<sub>1</sub>-C<sub>3</sub>alkoxy groups  
 which comprises reacting a compound of formula III



(III)

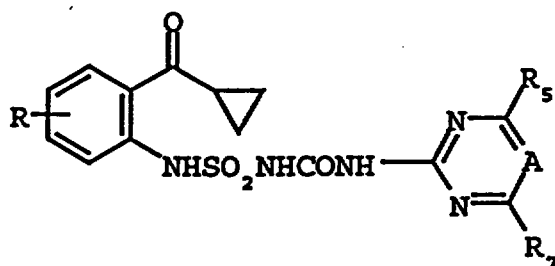
wherein X and R are as defined above and Hal is Cl, I or Br with at least one molar equivalent of 3-butyne-1-ol in the presence of a catalytically effective amount of a palladium(II)catalyst and a copper(I)catalyst and in the presence of an organic amine to give an intermediate of formula Ia



(Ia)

wherein R and X are defined above and hydrating the formula Ia intermediate in the presence of water and a hydrating agent to give the desired formula II compound.

7. A process for the preparation of a compound of formula VII



(VII)

wherein R is defined in claim 1 and

A is N or CR<sub>6</sub>;

R<sub>5</sub> is H, halogen, C<sub>1</sub>-C<sub>4</sub>alkyl optionally substituted with one or more halogen or C<sub>1</sub>-C<sub>3</sub>alkoxy groups, C<sub>1</sub>-C<sub>4</sub>alkoxy optionally substituted with one or more halogen or C<sub>1</sub>-C<sub>3</sub>alkoxy groups, C<sub>1</sub>-C<sub>4</sub>alkylthio optionally substituted with one or more halogen or C<sub>1</sub>-C<sub>3</sub>alkoxy groups, C<sub>1</sub>-C<sub>4</sub>alkylsulfinyl optionally substituted with one or more halogen or C<sub>1</sub>-C<sub>3</sub>alkoxy groups, C<sub>1</sub>-C<sub>4</sub>alkylsulfonyl optionally substituted with one or more halogen or C<sub>1</sub>-C<sub>3</sub>alkoxy groups, or C<sub>1</sub>-C<sub>4</sub>alkylamino or di(C<sub>1</sub>-C<sub>4</sub>alkyl)amino each alkyl group being optionally substituted with one or more halogen or C<sub>1</sub>-C<sub>3</sub>alkoxy groups;

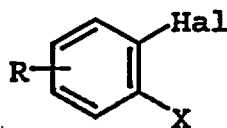
R<sub>6</sub> is H or halogen; and

R<sub>7</sub> is hydrogen, C<sub>1</sub>-C<sub>4</sub>alkyl optionally substituted with one or more halogen or C<sub>1</sub>-C<sub>3</sub>alkoxy groups, C<sub>1</sub>-C<sub>4</sub>alkoxy optionally substituted with one or more halogen or C<sub>1</sub>-C<sub>3</sub>alkoxy groups, C<sub>1</sub>-C<sub>4</sub>alkylthio optionally substituted with one or more halogen or C<sub>1</sub>-C<sub>3</sub>alkoxy groups, C<sub>1</sub>-C<sub>4</sub>alkylsulfinyl optionally substituted with one or more halogen or C<sub>1</sub>-C<sub>3</sub>alkoxy groups, C<sub>1</sub>-C<sub>4</sub>alkylsulfonyl optionally substituted with one or more halogen or C<sub>1</sub>-C<sub>3</sub>alkoxy groups, or C<sub>1</sub>-C<sub>4</sub>alkylamino or di(C<sub>1</sub>-C<sub>4</sub>alkyl)amino each alkyl group being optionally substituted with one or more halogen or C<sub>1</sub>-C<sub>3</sub>alkoxy group



which comprises the following steps:

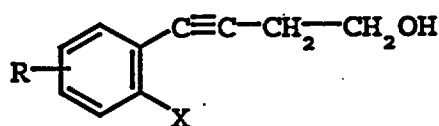
a) reacting a halobenzene of formula III



(III)

wherein R is defined in claim 1;

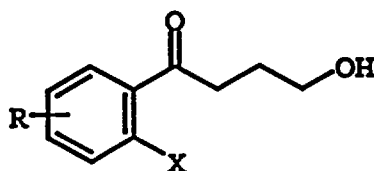
X is NO<sub>2</sub> or NH<sub>2</sub>, and Hal is Cl, I or Br with at least one molar equivalent of 3-butyne-1-ol in the presence of a catalytically effective amount of a palladium(II)catalyst and a copper(I)catalyst and in the presence of an organic amine to form an aryne compound of formula Ia



(Ia)

wherein R and X are defined hereinabove;

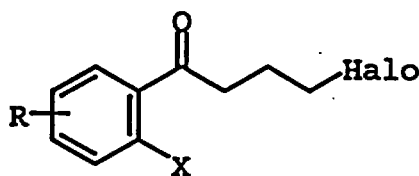
b) hydrating said formula I aryne with a hydrating agent to give a 4-hydroxy-(o-nitrophenyl)butanone or 4-hydroxy-o-aminophenyl)butanone of formula II



(II)

wherein R and X are defined hereinabove;

c) halogenating said 4-hydroxy-butanone with a hydrogen halide to give a 4-halo-butanone compound of formula V

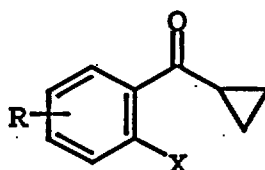


(V)

wherein R is defined above;

X is NO<sub>2</sub> or NH<sub>2</sub>, and Halo is Cl, Br, I or F;

d) dehydrohalogenating said formula V compound in the presence of a base and a phase transfer catalyst and optionally in the presence of a solvent to form an *o*-nitrophenyl cyclopropyl ketone or *o*-aminophenyl cyclopropyl ketone of formula VI

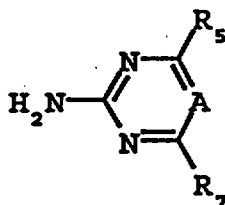


(VI)

wherein R is defined above and X is NH<sub>2</sub> or NO<sub>2</sub>;

e) when X is NO<sub>2</sub>, reducing said *o*-nitrophenyl cyclopropyl ketone of formula VI in the presence of hydrogen and a catalyst optionally in the presence of a solvent to form the corresponding *o*-aminophenyl cyclopropyl ketone of formula VI wherein X is NH<sub>2</sub>; and

f) reacting said formula VI *o*-aminophenyl cyclopropyl ketone with a 2-aminoaryl compound of formula VIII



(VIII)



wherein A, R<sub>5</sub> and R<sub>7</sub> are defined above

and chlorosulfonyl isocyanate in the presence of triethylamine and a solvent to give the desired sulfamoyl urea compound of formula VII.

8. The process according to claim 5, 6, or 7 wherein the palladium(II)catalyst is bis(triphenylphosphine)-palladium-(II)chloride and the copper(I)catalyst is copper(I)iodide; the organic amine is triethylamine or diethylamine; the process employs a formula III compound wherein R is H and X is NO<sub>2</sub> or NH<sub>2</sub>.

9. The process according to claim 6 or 7 wherein the hydrating agent is HgO, H<sub>2</sub>SO<sub>4</sub> or Na<sub>2</sub>S, HCl.

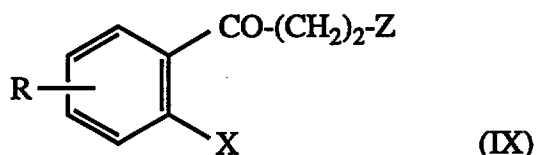
10. The process according to claim 7 for preparing a compound of formula VII wherein A is CR<sub>6</sub>; R and R<sub>6</sub> are each H; and R<sub>5</sub> and R<sub>7</sub> are each methoxy.



11. A process for the preparation of a compound having the formula VII as defined and illustrated in claim 10, which comprises

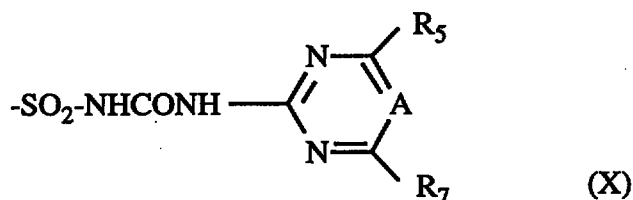
(a) hydrating a compound having the formula I as defined and illustrated in claim 1 with a hydrating agent and, if Z is -OH, reacting the hydration product with a reagent for exchanging hydroxy by chlorine or bromine or with a reactive derivative of a sulfonic acid having the formula  $R_3SO_2OH$  where  $R_3$  is as defined in claim 1 so as to convert the OH represented by Z into Br, Cl or  $OSO_2R_3$  where  $R_3$  is as defined above;

(b) cyclising the resultant compound having the formula IX



where R and X are as defined in claim 1 and Z is Br, Cl or  $OSO_2R_3$  where  $R_3$  is as defined in claim 1 so as to form a cyclopropylcarbonyl group at the position ortho to X and, if X is other than  $-NH_2$  in the product obtained, converting X into  $-NH_2$  by reduction or hydrolysis; and

(c) reaction of the resultant compound having the formula VI as illustrated in claim 7 wherein X is  $NH_2$  and R is as defined in claim 1 with a sulfonamide-forming reagent that introduces a group having the formula X



where A,  $R_5$  and  $R_7$  are as defined in claim 7.

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12. A process as claimed in claim 5, carried out substantially as described herein with reference to any one of the Examples.
13. A process as claimed in claim 6, carried out substantially as described herein with reference to any one of the Examples.
14. A process as claimed in claim 7 or 11 carried out substantially as described herein with reference to any one of the Examples.
15. A compound as claimed in claim 1, substantially as described herein with reference to any one of the Examples.
16. A compound having the formula I whenever prepared by a process as claimed in claim 5 or 12.
17. A compound having the formula II whenever prepared by a process as claimed in claim 6 or 13.
18. A compound having the formula VII whenever prepared by a process as claimed in any one of claims 7 to 11 and 14.

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