HONDA GIKEN KOGYO KABUSHIKI KAISHA

of 27-8, Jingumae 6-chome, Shibuya-ku, Tokyo, Japan

hereby apply for the grant of a standard patent for an invention entitled

"VARIABLE CAPACITY FLYWHEEL MECHANISM"

which is described in the accompanying complete specification.

DETAILS OF BASIC APPLICATION(S)
Number(s) of Basic Application(s)
Name(s) of Convention Country(ies) in which Basic Application(s) were filed
Japan (respectively)

Date(s) of Basic Application(s)
30th September, 1981, 30th September, 1981
30th September, 1981
30th September, 1981 and 30th September, 1981 respectively

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Dated this THIRTIETH
HONDA GIKEN KOGYO KABUSHIKI KAISHA

ABSTRACT
A variable capacity flywheel mechanism for an engine

In support of the Convention Application made for a patent for an invention entitled:

"VARIABLE CAPACITY FLYWHEEL MECHANISM" 88908/82

1. TADASHI KUME, Senior Managing Director
   Of HONDA GIKEN KOGYO KABUSHIKI KAISHA

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do solemnly and sincerely declare as follows:

1. I am We are the applicant(s) for the patent
   (or, in the case of an application by a body corporate)
   1. I am We are authorised by HONDA GIKEN KOGYO KABUSHIKI KAISHA

   the applicant(s) for the patent to make this declaration on
   its/their behalf;

2. The basic application(s) as defined by Section 141 of the
   Act were made
   in: Japan
   on: 30th September, 1981; 30th September, 1981; 30th September,
   by: HONDA GIKEN KOGYO KABUSHIKI KAISHA

3. I am We are the actual inventor(s) of the invention referred
   to in the basic application(s)
   (or where a person other than the inventor is the applicant)

   3. YOSHIKATSU NAKANO, MASAAKI MATSUURA and MASAKI BAN

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   Tomigaya, Shibuya-ku, Tokyo, Japan and 30-3, Tsudamachi
   2-chome, Kodaira-shi, Tokyo, Japan, respectively

   are/are the actual inventor(s) of the invention and the facts upon
   which the applicant(s) is/are entitled to make the application are
   as follows:

   The said applicant is the assignee of the actual inventors.

4. The basic application(s) referred to in paragraph 2 of this
   Declaration was/were the first application(s) made in a Convention
   country in respect of the invention(s) the subject of the application.

Declared at Tokyo, this 7th day of September 1982

To: The Commissioner of Patents

Tadashi Kume, Senior Managing Director
VARIABLE CAPACITY FLYWHEEL MECHANISM

HONDA GIKEN KOGYO KABUSHIKI KAISHA

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YOSHIKATSU NAKANO, MASAAKI MATSUURA AND MASAKI BAN

SF

Claim

1. In a variable capacity flywheel mechanism for an engine having a rotary shaft, the combination of: a main flywheel adapted to be coupled to the rotary shaft, an auxiliary flywheel, and an electromagnetic clutch for selectively coupling said main flywheel and said auxiliary flywheel in response to a magnetizing signal.
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Complete Specification for the invention entitled:
"VARIABLE CAPACITY FLYWHEEL MECHANISM"

The following statement is a full description of this invention, including the best method of performing it known to me/us:
ABSTRACT

A variable capacity flywheel mechanism for an engine employs a small flywheel coupled to the engine crankshaft. An auxiliary flywheel is connected to the main flywheel by means of an electromagnetic clutch, and the clutch is actuated in response to a magnetizing signal in accordance with r.p.m. of the crankshaft. The auxiliary flywheel may also be used for driving a magneto or a pump. The electromagnetic clutch may comprise a friction-type clutch or a powder-type clutch.

This invention relates to a variable capacity flywheel mechanism which is coupled to the rotary shaft of the engine of a motorcycle or an automobile. More particularly, the invention relates to a main flywheel and an auxiliary flywheel together with novel mechanism for connecting them in driving relationship.

It is known to provide flywheel mechanism in which the inertial moment is not constant, but is different for high and low engine speeds. For example, a variable capacity flywheel mechanism is known which has its inertial moment automatically varied in proportion to engine r.p.m.

In another variable capacity flywheel mechanism known in the prior art, a main flywheel and an auxiliary flywheel are engaged and disengaged in accordance with the low and high speed ranges, respectively, of the engine, and this is accomplished by the action of a centrifugal clutch, so that the inertial moment may be changed.

In the variable capacity flywheel mechanism using such a centrifugal clutch, however, the clutch repeats the engagement and disengagement when the r.p.m. of the engine
shaft is near the threshold value of the operation of the centrifugal clutch. The clutch exerts as a friction damper its action upon the rotary shaft, i.e., the crankshaft sustains a power loss, thereby inviting deterioration in the fuel economy of the engine. In case abrupt deceleration is effected from that threshold value, moreover, the centrifugal clutch is insufficiently responsive, so that it cannot promptly follow the abrupt deceleration of the rotary shaft and thereby fails to couple the auxiliary flywheel to the main flywheel. It may therefore be possible for the engine to fail to maintain rotations in the idling speed range, so that the engine stops.

It is, therefore, an object of the present invention to provide a variable capacity flywheel mechanism which avoids the problems outlined above and which uses an electromagnetic clutch to provide reliable operation and quick response. In the device of this invention, the auxiliary flywheel can be easily maintained at a predetermined r.p.m. so that the shocks when the clutch is applied or released can be minimized, because the flywheel mechanism has its continued operation insured by the use of the electromagnetic clutch.

In another aspect of this invention, a vehicle such as a motorcycle is equipped with a low-load rotary device such as a pump (referred to hereinafter as "auxiliary devices") for supplying the engine with cooling water, oil, air, and so on, necessary for the operation of the engine. Drive mechanisms are required for driving these auxiliary devices, respectively. It is, therefore, another object of the present invention to provide a variable capacity flywheel mechanism in which the power for driving auxiliary devices is obtained from the auxiliary flywheel.
The variable capacity clutch according to the present invention is constructed such that the selective coupling and the coupling of the main flywheel and the auxiliary flywheel is effected by the electromagnetic clutch, such that the control of the electromagnetic clutch can be accomplished by an external circuit including an r.p.m. detecting circuit applied to the rotary shaft, and such that power from the auxiliary flywheel is used to drive a rotary mechanism of relatively low load.

In another aspect of the present invention, lubricating oil under suitable pressure is supplied to the gaps or spaces between the friction disks of the electromagnetic clutch so that when the clutch is released a portion of the torque of the main flywheel is transmitted to the auxiliary flywheel so that it may be rotated at a predetermined r.p.m. and thereby restrain shocks when the electromagnetic clutch is closed.

Other and more detailed objects and advantages will appear hereinafter.

In the drawings:

Figure 1 is a sectional elevation showing a preferred embodiment of this invention.

Figure 2 is a circuit diagram showing the clutch control circuit for the mechanism shown in Figure 1.

Figures 3 and 4 are diagrams showing the construction of other embodiments of the present invention.

Figure 5 is a sectional elevation showing another modification.

Figure 6 is a detail showing an enlargement of a portion of Figure 5.

Figure 7 is a sectional elevation showing another
modification.

Figure 8 is a sectional elevation partly broken away, showing another modification of this invention.

Figures 9 and 10 are circuit diagrams showing the control circuits of the oil pressure regulator valves.

Figure 11 is a diagram showing another control circuit.

Referring to the drawings, the variable capacity flywheel mechanism shown in Figure 1 and embodying the present invention includes a crankshaft 1 rotatably supported in a crankcase 2 by bearings 3. The crankshaft has a projecting end portion 1a formed into a taper shape and having an internal threaded opening 1b. A sprocket 4 is fixed on the crankshaft 1 and drives a chain, not shown, for operating a cam shaft, not shown.

The main flywheel 5 is seated on the tapered end portion 1a of the crankshaft 1 and is secured thereto by means of the bolt 6. A friction clutch 7 comprising a pile of clutch plates 7a is clamped between the clutch pressure plate 8 and a side face 5a of the main flywheel 5. The main flywheel 5 is formed with an oil passage 5b which communicates between the region adjacent the head of the bolt 6 and the sliding portions of the clutch plates 7a.

A stationary core member 9 is fixed to the crankcase 2 by a bracket 10 and threaded fasteners 11. The core member 9 is generally C-shaped in cross section so that its recess portion is filled with a stationary annular magnetizing coil 12.

An opening in an end portion of the crankcase 2 is closed by a flywheel cover 13 to form a casing enclosing both
the main flywheel 5 and an auxiliary flywheel 14. This auxiliary flywheel 14 is annular in shape and is generally C-shaped in cross section. It is supported on bearings 15 encircling a central hollow support member 13a provided on the stationary flywheel cover 13. Accordingly, the auxiliary flywheel 14 is supported for rotation coaxially of the main flywheel 5 and adapted for connection thereto through the friction clutch assembly 7. When the magnetizing coil 12 is supplied with a magnetizing current through its paired input terminals 12a and 12b, the core member 9 attracts the clutch pressure plate 8 to close the clutch assembly 7 and thereby couple the main flywheel 5 and the auxiliary flywheel 14 in driving relationship.

The stationary flywheel cover 13 has its central support member 13a provided with an axial opening 18 which is connected to an oil supply pipe 17. This pipe 17 connects to an oil pump, not shown, through an oil pressure regulator valve 17a. The inner open end of the axial opening 18 is so positioned with respect to the auxiliary flywheel 14 as to face the head of the bolt 6. A generally cylindrical oil guide member 19 is formed with a flanged portion which is fitted in the auxiliary flywheel 14. The oil guide member 19 is formed in its inner side with such an annular oil seal member 20 as contacts with the inner open end of the opening 18.

Around the central support member 13a of the flywheel cover 13 there are equidistantly arranged a plurality of magnetic poles 21 which are wound with electromotive coils 22. An annular magnet 23 is fixed to the inner wall of the auxiliary flywheel 14 so as to face the magnetic poles 21, and
In order to measure the r.p.m. of the crankshaft 1 and the main flywheel 5 coupled thereto, one or more magnetic projections 24 are positioned near the circumferential edge portion of the crankshaft 1, and a stationary magnetic sensor 25 is fixed to the crankcase 2. The magnetic sensor 25 includes a magnet and a coil and its output is carried to its output terminals 25a and 25b. Similarly, in order to measure the r.p.m. of the auxiliary flywheel 14, one or more magnetic projections 26 are positioned on the outer circumference of the auxiliary flywheel 14. A stationary magnetic sensor 27, similar to the magnetic sensor 25, is fixed on the inner wall of the flywheel cover 13 in a manner to face the magnetic projection or projections 26 so that its output is carried to the output terminals 27a and 27b. It will be understood that magnetic sensors for r.p.m. could be replaced by various other sensors such as optical sensors.

Lubricating oil supplied under pressure through the pipe 17 passes through the opening 18, the oil guide member 19, the oil passage 5b and into the restricted clearances between the clutch plates 7a. The torque transmitting characteristics of the electromagnetic clutch 7 provide the torque necessary for rotating the auxiliary flywheel 14 at a predetermined r.p.m., even though the electromagnetic clutch may be in its released state.

The auxiliary flywheel 14 is equipped with the annular magnet 23 by which a dynamic braking operation is effected, so that a predetermined braking force can be applied...
to the auxiliary flywheel 14. Moreover, the torque to be transmitted can be controlled to a suitable value by regulating the flow rate of the oil supplied by way of the pipe 17, by the action of the oil pressure regulator valve 17a.

The magnetizing drive circuit of the electromagnetic clutch of the variable capacity flywheel mechanism shown in Figure 1 is illustrated by way of example in Figure 2. As shown, a pulsing signal having a frequency corresponding to the r.p.m. of the crankshaft 1 is provided by the magnetic sensor 25, and it has its waveform shaped through the terminals 25a and 25b by a waveform shaper 30. It is then fed into an fV converter 31. This fV converter 31 generates a voltage corresponding to the frequency of the input signal, and that voltage is fed to a comparator 32 which is composed of an operational amplifier OP and resistor R₁ and R₂. The comparator 32 generates a "0" signal when the input voltage exceeds a reference voltage V₁ (which corresponds to 3000 r.p.m., for example). The comparator 32 is presented with such hysteresis by the existence of the resistors R₁ and R₂ as to prevent the output voltage from the undesirable so-called "hunting" or repeating between "1" and "0" even if the input voltage fluctuates in the vicinity of the reference voltage V₁. The output of the comparator 32 is fed to the base of a transistor Q₁ which acts as a drive switch 33 of the magnetizing coil 12.

By using the magnetizing drive circuit of Figure 2 as the control circuit of the variable capacity flywheel mechanism of Figure 1, the inertial moment of the variable capacity flywheel mechanism can be reliably varied in accordance with the r.p.m. of the crankshaft 1.
Figure 3 is a diagram showing a modification of the variable capacity flywheel mechanism embodying the present invention. In this modification the main flywheel 5 for the crankshaft 1 is connected to a primary shaft 40 through a gear 41, and the primary shaft 40 is coupled through an electromagnetic clutch 42 to the auxiliary flywheel. The clutch 43 transmits the torque to a transmission 44. The degree of freedom, such as the selection of the inertial moment of the auxiliary flywheel 14, can be increased by suitably selecting the gear ratio of the gears 41.

Figure 4 is a diagram showing another modification of this invention, wherein the crankshaft has its one end coupled to the main flywheel 5 and its other end coupled through the electromagnetic clutch 42 to the auxiliary flywheel. This construction has an advantage that transverse weight balance can be achieved with respect to the engine's cylinders.

Figure 5 shows a further modification of the variable capacity flywheel mechanism embodying the present invention. This modification differs from that shown in Figure 1 mainly in that a single plate clutch is used as the electromagnetic clutch, and in that the auxiliary flywheel is not equipped with an electrical generating mechanism. More specifically, the crankshaft 1 is carried in the crankcase 2 by means of bearings 3 and has its taper-free end 1c externally threaded. A drive disk acting as the main flywheel 5 is fitted on and fastened to the taper portion 1a by means of a nut 51. The drive disk 50 is formed on its circumferential edge portion with a plurality of drive holes 50a which are arranged in an equi-angular position, and an annular armature
is carried on drive pins 52 which are fitted in the drive holes 50a. The annular armature 53 is made of a highly permeable magnetic material. Moreover, the annular armature 53 has its surface formed with an annular groove 53a and with a clutch facing 54. Stop rings 55 are attached to the leading ends of the respective drive pins 52, and return springs 56 are press-fitted between the stop rings 55 and the drive disk 50, thereby to thrust the armature 53 onto the drive disk 50.

Opposite faces of the drive disk 50 and the rotor 14 are provided with first and second groups of projections 59 and 60 which extend axially in opposite directions and toward each other. The projections are arranged equidistantly in the circumferential direction, as in an impeller, thereby to impart a suitable drag to the oil.

Figure 6 shows an enlargement of the portion of Figure 5 which is encircled by a dashed line. A hole 71 is plugged by a valve element 72 thrust from the outside by means of a leaf spring 73, thus providing a relief valve. A governor weight 74 is mounted on the outer side of the valve member 72. This embodiment is similar to that of Figure 4 except that the oil pressure regulator valve 17a can be eliminated because of the provision of the relief valve 72, as described.

Figure 7 shows another of the variable capacity flywheel mechanism embodying the present invention. This modification is different from the mechanism of Figure 1 mainly in that an electromagnetic powder-type clutch is used as the electromagnetic clutch. More specifically, as shown in Figure 7, a drive member 60 fixed to the crankshaft 1 and a rotor 62 carried on a shaft 61 are arranged to hold magnetic powder therebetween. The shaft 61 is supported in the crankcase 2.
The field core 9 having a generally C-shaped section, which is loosely fitted into the drive member 60, is fixed to the inner wall of the crankcase 2 and accommodates the magnetizing coil 12 therein. The remaining parts, other than the aforementioned electromagnetic clutch, are substantially similar to those of the mechanism of Figure 1. The variable capacity flywheel mechanism shown in Figure 7 utilized the electromagnetic powder-type clutch so that the torque to be transmitted by the clutch is proportional to the magnetizing current. By controlling this magnetizing current, therefore, the control of the torque transmission to the auxiliary flywheel 14 can be readily accomplished. As a result, by replacing the comparator 32 of the control circuit of Figure 2 by a mere amplifier, for example, the magnetizing coil 12 can be magnetized by an analog signal corresponding to the r.p.m. of the crankshaft 1.

The modification of the variable capacity flywheel mechanism shown in Figure 8 includes a crankshaft 1 rotatably supported in a crankcase 2 by means of bearings 3. The projecting end portion 1a of the crankshaft 1 is tapered and it is provided with an internally threaded opening 1b. A sprocket 4 is fixed on the projecting portion of the crankshaft 1 to be engaged by a chain, not shown, for driving a cam shaft, not shown. The main flywheel is secured to the free end portion 1a of the crankshaft 1 and is fastened thereto by means of a bolt 6. A friction clutch 7 employing a pile of clutch plates 7a operates to connect the main flywheel 5 to the auxiliary flywheel 14. The pressure plate 8 is provided on one side of the clutch plates 7a and the flanged portion 5a of the main flywheel 5 is positioned on the other side. The main flywheel
5 is formed with an oil passage 5b which provides communication between the internal space near the vicinity of the head of the bolt 6 and the sliding portions of the clutch plates 7a. The stationary core member 9 is fixed to the crankcase 2 by means of bracket 10 and threaded fastenings 11. The core member 9 has a generally C-shaped cross section which contains a magnetized coil 12.

A stationary flywheel cover 13 encloses the main flywheel 5 and the auxiliary flywheel 14. This auxiliary flywheel 14 has an annular shape generally C-shaped in cross section and is carried by bearing 15 mounted on the central hollow support member 13a. Accordingly, the auxiliary flywheel 14 is supported for rotation coaxially of the main flywheel 5 and is adapted for connection thereto through the friction clutch assembly 7. When the magnetizing coil 12 is supplied with a magnetizing current through its paired input terminals 12a and 12b, the core member 9 attracts the clutch pressure plate 8 to close the clutch assembly 7 and thereby couple the main flywheel 5 and the auxiliary flywheel 14 in driving relationship.

The hollow support member 13a of the flywheel cover 13 is provided with a through opening 18 which extends axially thereof and which has its outer end connected to the oil supply pipe 17 through an oil pressure regulator valve 17a. The inner open end of the through opening 18 is so positioned in the central recess of the auxiliary flywheel 14 to face the head of the bolt 6. A generally cylindrical oil guide member 19 has a flanged portion which is fitted into a central recess in the auxiliary flywheel 14. This oil guide member has an annular oil seal member provided on its inner side 20 which...
contacts with the inner open end of the through hole 18.

In order to detect the r.p.m. of the crankshaft 1 and the main flywheel 5, one or more magnetic projections are arranged in the vicinity of the circumferential edge portion of the crankshaft 1, and a magnetic sensor 25 comprising a magnet and a coil is fixed to the crankcase 2 so that its output is derived through its output terminals 25a and 25b. In order to detect the r.p.m. of the auxiliary flywheel 14, one or more magnetic projections 26 are placed on the outer circumference of the auxiliary flywheel 14, and a magnetic sensor 27 similar to the magnetic sensor 25 is mounted on the inner wall of the flywheel cover 13 in a manner to face the magnetic projections 26. The output is carried through the output terminals 27a and 27b. Other type sensors such as an optical sensor can be used in place of the magnetic sensors 25 and 27.

Lubricating oil supplied through the oil supply pipe 17 is pumped by way of the through opening 18, the oil guide member 19, the oil passage 5b into the restricted clearance spaces between the clutch plates 7a, to vary the degree of coupling, i.e., the torque transmitting characteristics of the electromagnetic clutch 7 and thereby to effect the so-called "accompanying rotations" of the auxiliary flywheel 14 even in the released state of the electromagnetic clutch 7.

The mechanism of Figure 8 employs an auxiliary device such as an oil pump, an air supply pump or a water pump driven from the constant-speed rotating torque of the auxiliary flywheel 14. As shown, the torque transmitting means comprises a gear 90 fixed to the auxiliary flywheel 14 and a gear 91 which meshes with the gear 90. The gear 91 is fixed on the rotary shaft 94 of a water pump 93. The shaft 94 is carried
in bearings 95 and 96, and an impeller 97 having a plurality of vanes is fitted on the free end portion of the rotary shaft 94. The impeller 97 has a recess 97a at one end and another recess 97b at its other end, and the impeller 97 is clamped in position on the shaft 94 by means of a ring 98 and a bolt 99. A housing 100 encloses the impeller 97 and is provided with a water inlet 101 and a water outlet 102. In the space between the impeller 97 and the bearing 95, there is disposed coaxially with the rotary shaft 94 an annular member 103 having a generally C-shaped cross section. A spring 105 thrusts a ring 104 into the recess 97b and an axially extending rubber member 106 is positioned inwardly of the spring 105. The construction and operation of the water pump are well known in the art and need not be detailed here.

The variable capacity flywheel mechanism having the construction shown in Figure 8 and described above employs a gear driven water pump instead of a magneto. The flywheel cover 13 is formed with an opening large enough for insertion of the gear 91 to mesh with the gear 90. Thus, the auxiliary flywheel 14 may be rotated at a desired constant speed. As a result, the water pump 93 is driven at a desired r.p.m.

The magnetizing drive circuit of the electromagnetic clutch 7 is similar to that previously described.

Having fully described our invention, it is to be understood that we are not to be limited to the details herein set forth but that our invention is of the full scope of the appended claims.
The following statement is a full description of this invention, including the best method of performing it known to me/us:

CLAIMS
The claims defining the invention are as follows:

1. In a variable capacity flywheel mechanism for an engine having a rotary shaft, the combination of: a main flywheel adapted to be coupled to the rotary shaft, an auxiliary flywheel, and an electromagnetic clutch for selectively coupling said main flywheel and said auxiliary flywheel in response to a magnetizing signal.

2. A variable capacity flywheel mechanism comprising: an engine having a rotary shaft, a main flywheel coupled to the rotary shaft, an auxiliary flywheel, means for supplying a magnetizing signal, and an electromagnetic clutch for selectively coupling said main flywheel and said auxiliary flywheel in response to the magnetizing signal.

3. The device of claim 2 in which said electromagnetic clutch is a friction-type clutch.

4. The device of claim 2 in which said electromagnetic clutch is a powder-type clutch.

5. In a variable capacity flywheel mechanism for an engine having a rotary shaft, the combination of: a main flywheel coupled to the rotary shaft, an auxiliary flywheel, an electromagnetic clutch for selectively coupling said main flywheel and said auxiliary flywheel in response to a magnetizing signal, and a control circuit for supplying said magnetic signal to said electromagnetic clutch in accordance with a parameter indicative of the running state of the engine.

6. The combination set forth in claim 5 in which said control circuit generates said magnetizing signal in accordance with the r.p.m. of the shaft.

7. The combination set forth in claim 5 in which said magnetizing signal is an on-off signal.
8. The combination set forth in claim 5 in which said magnetizing signal is an analog signal, the electromagnetic clutch being a powder-type clutch.

9. In a variable capacity flywheel mechanism for the rotary shaft of an engine, the combination of: a main flywheel coupled to the rotary shaft, an auxiliary flywheel, an electromagnetic clutch for selectively coupling said main flywheel and said auxiliary flywheel in response to a magnetizing signal, control means for controlling the electromagnetic clutch to rotate said auxiliary flywheel at a predetermined rate, and means for transmitting torque from said auxiliary flywheel to a rotary device imposing a relatively low load.

10. The combination set forth in claim 9 in which the rotary device is a magneto.

11. The combination set forth in claim 9 in which the rotary device is a pump.

12. In a variable capacity flywheel mechanism for an engine having a rotary shaft, the combination of: a main flywheel adapted for connection to the rotary shaft, an auxiliary flywheel, an electromagnetic clutch for connecting said flywheels for conjoint operation, said electromagnetic clutch being of the friction-disk type, means for generating a magnetizing signal to operate said electromagnetic clutch, and oil supply means for supplying oil into clearance spaces between the friction disks of the electromagnetic clutch.

13. In a variable capacity flywheel mechanism, the combination of: a main flywheel adapted to be coupled to the rotary shaft of an engine, an auxiliary flywheel, a friction-disk type electromagnetic clutch for selectively coupling said
means for supplying oil to the gaps between the friction disks of said clutch, and groups of projections on each of said flywheels in the vicinity of the friction disks and adjacent to each other.

DATED this SEVENTEENTH day of SEPTEMBER, 1982

HONDA GIKEN KOGYO KABUSHIKI KAISHA

Patent Attorneys for the Applicant
SPRUSON & FERGUSON
DRAWINGS
FIG. 3

FIG. 4

FIG. 9