PATENT SPECIFICATION

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COMPLETE SPECIFICATION

Improvements in and relating to Internal Combustion Power Units for Vehicles normally Propelled by Human Power

We, THE HERCULES CYCLE AND MOTOR COMPANY LIMITED, of Rocky Lane, Aston, Birmingham, a British Company, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a power unit for a pedal cycle, tricycle, rickshaw, or other vehicle normally propelled by human power, consisting of a road wheel incorporating a small internal combustion engine enclosed in the wheel hub, the unit being hereinafter referred to as a " power-wheel ".

It has been proposed to incorporate in the wheel of a motor cycle a power unit constituted by a rotary engine, of which the crankcase and cylinders rotate about a stationary crankshaft supported in the wheel-mounting fork and immobilised by means of keys, the wheel-hub being coaxial with the crankcase and geared thereto by means of a layshaft-gear train, incorporating a friction clutch, and the layshaft gears being rotatable on an axle splined into a bridge spanning the two wheel-mounting fork members on one side of the frame.

A construction utilising the conventional type of slotted fork for mounting a wheel with a hub-enclosed power unit has also been proposed, but in this the engine is of the stationary type, the crankcase being unitary with a casing secured to the wheel spindle which is made in two halves and immobilised by flats engaging the fork slots; these latter resist the full torque transmitted to the hub, the connection between the latter and the crankshaft being by a belt drive. The arrangement would appear to require forks of much greater width than the standard pedal cycle fork and of greater strength at the slotted ends in order to resist the hub-driving torque.

A " power-wheel " according to the invention for incorporation in a pedal cycle or like vehicle normally propelled by human power comprises a road wheel with an enlarged hub, a rotary type, single cylinder two-stroke internal combustion engine enclosed coaxially in the hub and having a crankshaft, one end at least of which is hollow and serves as the induction pipe and both ends of which are provided with external flats appropriately dimensioned and axially spaced to fit the standardised slotted fork of a pedal cycle or like vehicle and are externally threaded to receive standardised cycle spindle nuts, a pinion fixed to the crankcase and a coaxial gear fixed to the hub, a stationary plate loosely supported on the crankshaft outside the hub but within the forks of the vehicle when the unit is assembled therein, a detachable means for anchoring the stationary plate to the vehicle frame at a point removed from the crankshaft axis, a gear housing unitary with the stationary plate, two coaxial intermediate gears suported in the gear housing and meshing respectively with the crankcase pinion and the hub gear, and controllable friction clutch means in the gear housing for mutually connecting and disconnecting the two intermediate gears, the whole assembly being removable as a unit from the vehicle (after disconnecting control and fuel feed connections) by unfastening the detachable anchorage of the stationary plate and slacking off the spindle nuts.

The speed-reduction gearing may be of fixed ratio. Alternatively, the gear housing may further enclose variable speed gearing interposed between the two intermediate gears; and the variable speed gearing may be of the single-stage planetary gearing type giving two selectable

ratios, the annulus gear being unitary with the intermediate gear meshing with the crankcase pinion and the planetary cage unitary with the intermediate gear meshing with the hub gear, and the sun wheel having keyed thereto a friction clutch member selectively engageable with the annulus gear or with the gear-housing.

The pinion meshing with the hub gear may be carried by a shaft that is rotatably and slidably mounted in the gear-housing and is connected through a thrust-bearing with an external slidable member, e.g. a gear-housing cap, which can be manually operated to unmesh the pinion from the hub gear.

Or the intermediate gears may be mounted in a sleeve slidable in the gear-housing and provided with a manually operable knob or the like for sliding it; and a manually operable locking device may be provided for locking the sleeve in one of two alternative positions, in one of which the intermediate gears are respectively meshed with the hub gear and the crankcase pinion, and in the other are both unmeshed.

A carburettor may be mounted direct on the hollow end of the crankshaft externally of the fork member of the cycle frame supporting and immobilising the crankshaft and the carburettor union nut may serve at the same time for securing the crankshaft, replacing the standard hub-spindle nut.

In a modified arrangement, both ends of the crank-shaft are hollow and each supports a carburettor, and, if the engine includes a disc valve controlling admission of mixture to the crankcase as hereinafter described, the valve will be duplicated. This arrangement may be desirable if the maximum cross-section available for the admission passage, which depends on the width of the crankshaft across the flats which fit the standard wheel-fork slots, having regard to the provision of an adequate cross-section of metal in the crankshaft at this point, is inadequate to the engine capacity unless duplicated.

Any convenient position, size and shape may be selected for the fuel tank of the improved power-wheel. A flat tank replacing and having similar attachments to those of the conventional rear carrier and usable as such being preferred. Such a tank may be provided with the usual eyes, staples, shackles or the like for retaining the usual baggage securing straps. To enable the cycle to be up-ended, the vent of the fuel tank is preferably provided with an easily manipulated sealing device.

Admission of fuel/air mixture may be regulated by a conventional throttle valve and a mixture control device, such as a choke or starting jet, may also be provided to ensure easy starting.

According to an additional feature of the invention, the throttle and mixture control device have a common control so connected that movement thereof in the throttle-opening direction beyond the fully open position enriches the mixture, and the arrangement includes a stop, spring-loaded to obstruct the control at the fully open position, and manually releasable to enable the control to be moved further to enrich the mixture.

A power-wheel according to this invention may be fitted in either the rear or front forks of a pedal cycle, or in both if required, e.g. in the case of a tandem cycle.

A specific example of a constructional embodiment of the invention is described below with reference to the accompanying drawings, which illustrate a "power wheel" incorporating a rotary, single-cylinder, two-stroke internal combustion engine, and installation of the power wheel in a pedal cycle. In the drawings:—

Figure 1 is an axial section of the hub, anchor plate and gearing of a power wheel including a hub-enclosed engine, the section being on the lines 1—1 and 1*a*—1*a* of Figure 6;

Figure 2 is a partial section on the line 2—2 of Figure 1 to an enlarged scale;

Figure 3 is a side elevation of the hub and engine in the direction of the arrow 3 of Figure 1 with the nearer side plate of the hub removed and other parts broken away;

Figure 4 is a detail view of the connecting rod and valve disc of the engine;

Figure 5 is a sectional view on the line 5—5 of Figure 4;

Figure 6 is a side elevation of the hub, anchor plate and gear-housing of the power wheel taken in the direction of arrow 6 of Figure 1;

Figure 7 is an end elevation of the hub, anchor plate and gear-housing of the power wheel in the direction of arrow 7 of Figure 6;

Figure 8 is a side elevation in the direction of arrow 6 of Figure 1 illustrating an alternative anchor plate and gear-housing containing a two-speed gear;

Figure 9 is a section on the lines 9—9 and 9*b*—9*b* of Figure 8;

Figure 9*a* is a partial detail view taken in the direction of the arrow 9*a* of Figure 9;

Figure 10 is a view of the hub and engine in perspective from the anchor

plate side, the anchor plate and gearing being removed;

Figure 11 is a detail sectional view illustrating the carburettor and its controls;

Figure 12 is an axial section of a handle-bar extremity and a twist-grip throttle and mixture control incorporated therein (as viewed from in front and below with the cycle inverted);

Figure 13 is an elevation of the same (from behind and above with the cycle upright);

Figures 14 and 15 are detail views, each illustrating one of two modified throttle and mixture control devices, Figure 14 being in plan and Figure 15 in elevation;

Figure 16 is a view in side elevation showing the power wheel installed in a conventional pedal cycle.

Referring to Figures 1 to 5, the power wheel comprises an engine as described in the Complete Specification of cognate Patent Applications Nos. 25809/49 and 27872/49 filed 7th and 31st October 1949 (Serial No. 697,313) respectively. This engine comprises a stationary crankshaft having hollow journal portions 20, 21, crank cheeks 22 and a crankpin 23, the cavity of journal portion 21 being blind. The journal portions 20, 21 carry bearings 24 on which the crankcase 25 is rotatably supported. An arrow in Figure 3 indicates the direction of rotation. To the crankcase is secured the single cylinder 26, in which is disposed the piston 27. The connecting-rod 28 is extended at 29 to form a counterpoise for the piston, small end and gudgeon pin. The cylinder has integral transfer passages 30 terminating at transfer ports 31, 32 of conventional type. The cylinder 26 also has exhaust ports 43 (Figure 1) communicating with exhaust pipes 108 (Figure 3).

Rotatable on the crankpin 23 is a valve disc 33 which is driven by the big end of the connecting rod 28 by means of a projection 79 of the disc 33 engaged in a corresponding recess formed in the counterpoise 29 of the big end (see Figures 4 and 5) and has an aperture 78 which intermittently exposes (once per revolution) the opening constituting the termination on the inner face of the crank cheek 22 of the cavity of the journal portion 20, which serves as the induction pipe, being extended beyond the threads, hereinafter referred to, for attachment of the carburettor (not illustrated), e.g. by means of a pinch clip.

This disc 33 is pressed against the crank cheek 22 by means of two springs 80, one of which is housed in a pocket formed in the counterpoise 29, and the other in a thimble 81, of which the flange fits between the flanges and rests on the web of the I-section connecting rod 28 and the body portion fits in one of the lightening holes of the web (see Figures 4 and 5).

The part of the crankcase 25 opposite the cylinder 26 is extended to accommodate the connecting rod counterpoise 29, and secured to the extension are iron stirrups 38 supporting and magnetically continuous with the iron core 39 of a coil 41 and carrying pole shoes 40, which rotate in close proximity to and complete the magnetic circuit of a two-pole ring-magnet 42, concentric with the crankshaft axis and secured to a spider 107 fast on the end 21 of the crankshaft, which spider also supports an annular cam-plate 82 having a single proud portion. This cam-plate engages a contact breaker arm 83 pivoted on the crankcase and loaded by a spring 84 to close contacts carried respectively by the arm 83 and an insulated plate 85 secured to the crankcase and connected by a lead 86 with one end of the primary winding of coil 41, the other end of which is earthed through a lead 87 and a condenser 88 (see also Figure 3).

The secondary winding of coil 41 is connected by a high tension lead 89 with sparking plug 68.

To avoid dynamic unbalance the pole shoes 40 are matched on the opposite side of the plane of symmetry of the engine by dummy shoes 90 of equal mass-moment, but made of non-magnetic material to prevent magnetic leakage.

The cylinder 26 has a detachable head 67 carrying a sparking plug 68 and having formed in it a pocket 69 closed by a screw-plug 70 and vented by a duct 71 and an external union 72. On the opening of the pocket 69 into the cylinder is seatable a valve poppet 73, whose stem is guided in the plug 70 and which is loaded by a spring 74 to leave its seating, its travel under the effort of the spring 74 being limited by a pin 75 screwed into the cylinder head 67. When the engine is stopped or running slowly the spring 74 keeps the valve poppet 73 off its seating and the cylinder head is vented through pocket 69, duct 71 and union 72, thus relieving the compression to facilitate starting; but when the engine has started and attains a predetermined critical speed, the centrifugal force experienced by the poppet 73, due to rotation of the cylinder about the crankshaft, overcomes the effect of spring 74 and causes the poppet to seat, and thus closes the vent 69, 71, 72 and restores the compression in the cylinder 26 to its full value.

The cylinder 26, head 67 and crankcase 25 are secured together by long tie rods

187, the heads of which seat on the cylinder head 67, and which pass right through the crankcase and carrying securing nuts 188 seating on flats formed on the part of the crankcase 25 remote from the cylinder, so that the centrifugal loading of the cylinder and cylinder head is resisted in tension by the tie rods and reacts on the crankcase as a compression loading, the cylinder, cylinder head and crankcase being relieved thereby of tensile loading (Figure 3).

The crankshaft 20, 21, 22, 23 is immobilized by means of flats 95, the width across each pair of flats and the axial separation of the two pairs of flats being the same as the corresponding dimensions of a standard pedal-cycle hub-spindle so that the flats can fit into the hub-spindle-receiving slots of a standard pedal-cycle wheel fork. The ends of the crankshaft are threaded to receive clamping nuts corresponding to the conventional hub-spindle nuts of a pedal-cycle. The engine is enclosed in an enlarged wheel-hub comprising a barrel 96 and side plates 97, 98. Plate 97 has a threaded boss 99, to which can be secured a conventional cycle-wheel sprocket 189 (Figure 7) incorporating a free-wheel coupling, and which is rotatably supported on the end 21 of the crankshaft by a bearing 100. Plate 98 is rotatably supported on an extension 101 of the crankcase 25 by means of a bearing 102. The other end of the crankcase is not extended. Crankcase extension 101 carries a gear pinion 103 formed with a sleeve extending within the inner race of bearing 102 and keyed to the crankcase extension 101. A gear 104, concentric with gear 103, is secured to the hub-plate 98. Peripheral air-circulating openings 105 are provided in the hub-plates 97, 98, in which central openings 106 are also provided.

When the crankcase, cylinder and other parts carried by the crankcase are rotating they exert a centrifugal pumping action within the hub and cause air to be drawn in through openings 106 and expelled through openings 105, which also serve for escape of the exhaust gases discharged from the silencers 109 as hereinafter referred to. The circulation of air through the hub, caused by the centrifugal pumping action above mentioned and assisted by the ejector action of the exhaust gases, serves to cool the engine, dissipation of heat from the cylinder and cylinder head being promoted by conventional finning, as shown in Figure 1.

The exhaust is conducted by the pipes 108 into silencers 109 secured to the crankcase by brackets 110, and is discharged into the hub by stub-pipes 111 tangentially and in the direction for assisting rotation of the crankcase by jet-reaction. A pipe 112 connects the blow-off union 72 (see Figure 2) with the interior of the trailing silencer 109. From the point of each silencer most remote from the rotational axis a nozzle 113 extends through a slot 115 in an annular plate 116 attached to the hub plate 98 into the annular channel of an oil collector ring 114 formed in the hub-plate, the channel 114, which has a number of small openings 117, 118, being partially enclosed by plate 116.

The hub barrel 96 is connected by wire spokes 119 to a pedal-cycle road wheel rim 120 (Figure 10).

On the end 20 of the crankshaft is supported a stationary anchor-plate 121 to the rim of which is secured an annular plate 122 formed with an internal peripheral oil-collector groove 123 surrounding the collector-ring 114 (Figure 1).

Integral with the anchor plate 121 is a cylindrical gear-housing 124 (Figures 1 and 6 to 9) containing speed-reduction gearing.

In one form of construction, illustrated in Figures 1, 6 and 7, the gearing is of fixed gear ratio and comprises a gear 125, meshing with the crankcase pinion 103 and secured to a sleeve 126, supported in bearings 127 in the housing 124, and a coaxial gear pinion 128 meshing with the hub gear 104. The shaft 129 of pinion 128 is supported by the gear 125 in a roller bearing 130 and by a gear-housing cap member 131 in a radial and thrust ball bearing 132. Slidably splined on shaft 129 is a clutch plate 133 located between a clutch face on the rear of gear 125 and an axially movable pressure plate 134 loaded by springs 135, which are retained in thimbles 136 carried by a flange extending inwardly from sleeve 126. The pressure plate is withdrawable by a withdrawal ring 137 acting through a thrust bearing 138, the ring 137 being mounted by means of a quick-pitch thread 139 on a flanged boss 140 secured to the gear-housing 124. Rotation of ring 137 in the appropriate direction therefore withdraws the pressure plate and disengages the clutch to disconnect the drive from pinion 103 through gears 25, 128 to gear 104. Ring 137 is provided with an operating lever 141 extending through a slot in the housing 124.

The boss of cap 131 extending into the housing 124 and carrying bearing 132 is slidable in the flanged boss 140 and the cap 131 can therefore be withdrawn, bringing with it the bearing 132, shaft 129 and pinion 128, to unmesh the latter from the hub gear 104 and render the hub quite free from the engine, the outer race

of bearing 130 being extended to allow the bearing rollers to slide in it.

The crankshaft anchorage by means of the flats 95 only takes the (high-speed) engine torque, whereas the anchor-plate takes the (low-speed) hub-torque, to resist which the anchor-plate 121 has fixed to it a torque block 142 (Figure 6) in the form of a yoke embracing one of the cycle fork members 143. Block 142 is detachably secured to the plate 121 by means of two studs and has a pierced lug 144 forming the abutment of the sheath 145 of a "Bowden" control, of which the cable 146 passes through the opening in lug 144 and is attached to a rod 147, which is connected to lever 141 and slides in a tube 148 housing a cable-tensioning and return spring 149. The other end of the control 145, 146 is connected to a hand lever (Figure 16 mounted on the handle-bar of the cycle.

An alternative form of construction, illustrated in Figures 8 and 9, has a variable-speed reduction gearing giving two selectable ratios. As in the fixed-ratio arrangement of Figures 1, 6 and 7, the hub gear 104 meshes with a gear pinion 128 and the crankcase pinion 103 meshes with a coaxial gear 125. Gear 125 is supported by a bearing 150 in a sleeve 151 carrying a female cone 152, and has an integral internal annulus gear 153, and is secured to a male cone 154 supported by a bearing 155 on a shaft 156. Shaft 156 has an integral sun pinion 157 and pinion 128 is formed on one member of a built-up planetary cage 158 supported by a bushing 159 in the gear 125 and enclosing bearings 160 supporting shaft 156. The cage 158 carries planet wheels 161 meshing with the annulus gear and sun pinion.

Between the cones 152, 154 is a cone 162 having male and female faces, which is slidably keyed to shaft 156, and is so loaded by a spring 163 retained by an abutment plate 164 fast on shaft 156 as to engage cone 154. It is withdrawable to disengage both cones 152, 154, or further, to engage cone 152, by means of a withdrawal member 165 rotatable and slidable in sleeve 151 and acting through a thrust bearing 166. On the back of member 165 are inclined teeth 167 engaging similar teeth 168 on cone 152 (see Figure 9[a]), so that when member 165 is rotated in the appropriate direction it is moved axially to withdraw cone 162. On the circumference of member 165 is a toothed sector 169 engaged by a rack 170 slidable in the housing 124. Rack 170 is attached to the cable 171 of a "Bowden" control and is loaded by a cable-tensioning and-return spring 172 retained by an abutment nut 173 which also serves as the abutment of the cable sheath 174 (Figure 8). The other end of the control 171, 174 is attached to a handle-bar-mounted lever (Figure 16).

When cone 162 engages cone 154 the annulus gear 153 is locked to the sun pinion 157 giving direct drive from gear 125 to pinion 128; and when cone 162 engages cone 152 the sun pinion is immobilized giving a speed-reduction between gear 125 and pinion 128.

Shock on engaging the high-gear (direct drive) by engagement of cone 162 with cone 154 is prevented by limiting the torque that can be transmitted from cone 154 to cone 162 by using a spring 163 of appropriately limited strength, so that the clutch will slip if excessive torque is applied on engaging high-gear, e.g., after coasting in neutral with the engine stopped.

The sleeve 151 is slidable in the housing 124 and to its outer end is secured a cover 175 having an external knob 176 and formed with an internal boss housing a radial and thrust bearing 177 supporting the outer end of shaft 156 (Figure 9). By pulling out knob 176, sleeve 151 and the whole assembly of gears and clutches contained in it are slid outwards, thus unmeshing both gears 125, 128 from the crankshaft pinion 103 and hub gear 104 respectively. The assembly can be locked in either of two positions, "engaged" and "disengaged", by means of a screwed pin 178 engageable in one or other of two notches 179, 180 in the cone 152, the pin 178 being provided with an external operating handle 181 (Figures 8, 9).

For unmeshing the gears so as to disconnect the engine completely from the wheel hub, as an alternative to the sliding arrangement of shaft 129 controlled by cap 131 (Figure 1) or sleeve 151 controlled by knob 176 (Figure 9), the gears 125, 128 and their associated clutch mechanism, with or without the two-speed gear arrangement of Figures 8 and 9, may be mounted in an intermediate member which is supported in the gear-housing 124 and can be rotated therein about an axis eccentric with respect to the axis of gears 125, 128, so that by rotating the intermediate member the gears 125, 128 can be unmeshed from the pinion 103 and gear 104 respectively.

This modification is not illustrated.

In both forms of construction illustrated, the anchor-plate 121 has openings 182 for the admission of air for cooling the engine (Figures 1, 6, 8 and 9).

Further, an opening 183 (Figure 1) in the annular plate 122 allows oil trapped

by the collector groove 123 to reach the gears in the gear-housing 124, at the lowest point of which is a drain 184 discharging into a sump 185 detachably secured by a spring wire stirrup 186 (see Figures 1, 6, 7, 8 and 9).

Waste oil from the engine, which is preferably lubricated by the "petroil" system, oil being mixed with the liquid fuel in the supply tank in correct proportions and carried into the engine in suspension in the fuel/air mixture, is suspended in the exhaust gases, from which it is centrifuged in the silencers owing to the disposition of the pipes by which the exhaust enters and leaves them (Figure 3) and is discharged by the nozzles 113, disposed at the points of the silencers most remote from the axis of rotation, into the annular channel of the collector ring 114, whence it escapes, or is flung out, through openings 117 or 118 onto the annular plate 122 and is trapped in the collector groove 123, escaping thence through opening 183 to lubricate the gears, and being finally collected in sump 185.

The carburettor is illustrated in Figure 11. It comprises a body 190 bored longitudinally to provide a venturi tube 191 extending from an air inlet 192 to an outlet 193. The throttle is of the sliding barrel type of which the barrel 194 slides in a transverse boring of the body closed by a cap 195 through which extends a "Bowden" control cable 196 attached to the barrel 194. The cap 195 forms the abutment of a throttle-closing spring 197 and of the sheath 198 of the control cable. The body is bored coaxially with the throttle barrel on the opposite side of the tube 191 to house a jet 199 into which a tapered needle 200 mounted on the barrel 194 penetrates, the jet extending into a jet well 201 secured to the body 190. The fuel level is controlled by a float chamber 203 connected to a fuel supply pipe 202.

The carburettor also includes a choke in the form of a shutter 204, which slides through a slot in the entry of the venturi tube 191 and is suspended from a lever 205 pivoted at 206 on the body 190 and carrying a pin 207 engaging in a slot 208 of the throttle barrel 194. Lever 205 is loaded by a spring (not shown) which tends to withdraw the choke shutter 204 from the tube 191. When the throttle barrel 194 reaches the fully open position, the pin 207 bottoms in slot 208 and further movement of the barrel rocks the lever 205 to move the shutter 204 into the tube 191 and partially strangle the air intake.

The other end of the Bowden control 196, 198 is connected to a handle-bar-mounted control which may be of the "twist-grip" type, as illustrated in Figures 12, 13. This comprises a collar 210 secured to the handle bar 211 and including an integral guide 212 for a sliding runner 213, to which the cable 196 is attached. A constriction 214 in the guide provides the abutment for the cable-sheath 198. A sleeve 215, rotatably mounted on the handle bar 211 and carrying a rubber grip 216, extends within the collar 210 and has two slots 217, 218 in it. Slot 217 is in a plane perpendicular to the axis of sleeve 215 and is entered by a peg 219 screwed into the collar 210; peg 219 locates sleeve 215 endwise and determines the limits of rotation of the sleeve. Slot 218 is helically inclined and is entered by a peg 220 formed on the runner 213, so that when sleeve 215 is rotated runner 213 is moved longitudinally to pull or relax the control cable 196.

A lever 221 is pivoted on the collar 210 and is loaded by a spring 222 to hold a stop peg 223 on the end of the lever in engagement with slot 217, the collar 210 having an opening through which peg 223 passes.

When peg 223 is engaged in slot 217 it obstructs the rotation of sleeve 215 in the throttle-opening direction beyond the full-throttle position, by bottoming in one end of slot 217. On releasing the stop peg 223 from slot 217 by pressing down the handle of lever 221, the sleeve 215 can be rotated further, causing the throttle-barrel 194 (Figure 11) to pick up the lever 205 and close the choke 204.

Figures 14 and 15 illustrate alternative arrangements in which the cable 196 is attached to a conventional lever 224. In Figure 14 the throttle-opening movement of lever 224 is obstructed at the full-throttle position by a stop peg 225 on a spring-loaded auxiliary lever 226 meeting a stop 240 on the lever 224, the peg 225 passing through an opening in a lever-shield 227. By pressing down the free end of lever 226, the peg 225 is raised clear of the stop on lever 224.

In Figure 15 a stop 228 on the lever 224, which is held down onto its support 229 by a spring 230 under the shield 227, meets a shoulder 231 on the support, when the full-throttle position is reached. The lever can be raised against the effort of spring 230 to enable the stop 228 to clear the shoulder 231 and allow the lever to be moved further to operate the choke.

Figure 16 shows the power-wheel assembled in the rear forks 232 of a conventional pedal cycle 233 in place of the conventional rear-wheel. The fuel supply pipe 202 which contains a cock 234 is connected to a flat fuel tank 235 which

replaces the usual rear carrier and is attached to the rear fork stays 236 by a clamp (not shown) and by stays 237 in the usual manner. The top of the tank can be used as a carrier, locating eyes or the like anchorages or locating means for the usual straps 238 being provided. The throttle- and choke-operating Bowden control 196, 198 is connected to a twist-grip control, as illustrated in Figure 11, on the right-hand end of the handle bar; and the clutch- or clutch and change-speed-operating Bowden control 145, 146, or 171, 174 is connected to a clutch-operating hand lever 239 on the left-hand end of the handle bar. With the gears disengaged, the power-wheel can be pedalled by means of the usual chain-drive and a jumping sprocket type of multi-speed gear can be fitted to the pedal drive if desired.

The power-wheel can equally well be fitted to the front forks in replacement of the conventional front wheel, in which case a hub-type multi-speed gear may be fitted to the rear wheel for pedalling purposes.

What we claim is:—

1. A power unit for a pedal cycle or like vehicle normally propelled by human power comprising a road wheel with enlarged hub, a rotary type, single cylinder two-stroke, internal combustion engine enclosed coaxially in the hub and having a crankshaft, one end at least of which is hollow and serves as the induction pipe and both ends of which are provided with external flats appropriately dimensioned and axially spaced to fit the standardised slotted fork of a pedal cycle or like vehicle and are externally threaded to receive standardised cycle spindle nuts, a pinion fixed to the crankcase and a coaxial gear fixed to the hub, a stationary plate loosely supported on the crankshaft outside the hub but within the forks of the vehicle when the unit is assembled therein, detachable means for anchoring the stationary plate to the vehicle frame at a point removed from the crankshaft axis, a gear housing unitary with the stationary plate, two coaxial intermediate gears supported in the gear housing and meshing respectively with the crankcase pinion and the hub gear, and controllable friction clutch means in the gear housing for mutually connecting and disconnecting the two intermediate gears, the whole assembly being removable as a unit from the vehicle (after disconnecting control and fuel feed connections) by unfastening the detachable anchorage of the stationary plate and slacking off the spindle nuts.

2. A power unit as claimed in Claim 1, in which the gear housing further encloses variable speed gearing operatively interposed between the two intermediate gears.

3. A power unit as claimed in Claim 2, in which the variable speed gearing is of the single stage planetary type giving two selectable ratios, the annulus gear being unitary with the intermediate gear meshing with the crankcase pinion and the planetary cage unitary with the intermediate gear meshing with the hub gear, and the sun wheel having keyed thereto a friction clutch member selectively engageable with annulus gear or with the gear-housing.

4. A power unit as claimed in any preceding claim in which the pinion meshing with the hub gear is carried by a shaft that is rotatably and slidably mounted in the gear housing and is connected through a thrust bearing with an external slidable member, such as a gear-housing cap, which can be manually operated to unmesh the pinion from the hub gear.

5. A power unit as claimed in any of Claims 1 to 3, in which the intermediate gears are mounted in a sleeve, which is slidable in the gear housing and is provided with a manually operable knob or the like for sliding it, a manually operable locking device being provided for locking the sleeve in two alternative positions, in one of which the intermediate gears are respectively meshed with the hub gear and the crankcase pinion, and in the other are both unmeshed therefrom.

6. A power unit as claimed in any preceding claim including a throttle valve controlling the admission of fuel/air mixture to the engine, a mixture control device, such as a choke, a common control so connected to the mixture control device and to the throttle valve that movement of the control in the throttle opening direction beyond the fully open position operates the mixture control device to enrich the mixture for starting purposes, and a stop loaded by a spring to obstruct the common control at the fully-open position, said stop being manually releasable to enable the control to be moved further to enrich the mixture.

7. A power unit for a pedal cycle or like vehicle comprising a wheel with enlarged hub, a rotary, two-stroke, internal combustion engine, and stationary gear housing means carrying gears intermediate between the hub and engine crank-case constructed and operating substantially as herein described and as illustrated in Figures 1 to 7, 10 to 13 and 16 of the accompanying drawings, or as so illustrated but modified in the manner

illustrated in Figures 8, 9 and 9ª or/and modified in the manner illustrated in either of Figures 14 and 15 of said drawings.

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PROVISIONAL SPECIFICATION

Improvements in and relating to Internal Combustion Power Units for Vehicles normally Propelled by Human Power

We, THE HERCULES CYCLE AND MOTOR COMPANY LIMITED, of Rocky Lane, Aston, Birmingham, a British Company, do hereby declare this invention to be described in the following statement:—

This invention relates to power plants for pedal cycles and is more especially concerned with the provision of a light-weight power plant which can be installed in a standard pedal cycle without modifying the standard frame in any way.

According to the invention, power assistance for a pedal cycle is provided by means of unitary assembly including a standard cycle rim spoked to a diametrically enlarged hub and a small internal combustion engine housed within the hub, which assembly is fully interchangeable as a unit with a standard cycle wheel, being of the requisite axial dimensions to be receivable in the standard cycle wheel fork, and its means of attachment to the cycle being a shaft adapted, by means of threaded ends and flats corresponding to those of a standard cycle wheel spindle, to be secured in the slots of the standard fork.

This unitary assembly or "power-wheels" can be fitted in either the front or rear fork of the cycle replacing the front or rear standard wheel.

Except for the fitting of a fuel tank and piping and necessary controls, all that is involved in converting an existing cycle to power-assistance is a wheel change. If the cycle to be converted is provided with a rear hub-brake or/and hub-type three-speed gear, the power wheel may conveniently be fitted in the front fork; otherwise the rear position may be preferred for the power-wheel; in some cases, e.g., in a tandem cycle, both wheels may be replaced by power-wheels.

Being interchangeable between front and rear positions, the power-wheel is preferably furnished with a standard free-wheeling chain-sprocket to enable the cycle to be pedalled when the power-wheel is in the rear position, means being provided for uncoupling the engine from the hub, e.g., as hereinafter described.

According to a feature of the invention, the engine of the power-wheel is of the rotary piston-type, the fixed crank-shaft of which replaces the conventional cycle-wheel spindle, being suitably dimensioned and provided with flats to fit the standard slotted wheel-fork, and the engine being totally enclosed in a drum-like casing which constitutes the hub of the wheel and is driven by the engine crank-case through reduction gearing.

The reduction gearing preferably comprises a spur gear mounted on the engine crank-case and a concentric spur gear mounted on the hub respectively meshing with one and the other of two coaxial idlers, the bearings of which are mounted in a bearing-housing supported in a hollow boss formed integrally on an anchor plate keyed to the engine crank-shaft. The latter is prevented from rotating by its flats engaging in the fork slots; and the anchor plate is preferably keyed to the crank-shaft by these flats, either by means of a flatted hole in the plate or by means of loose keys, the plate being gripped between the cycle fork and a shoulder formed on the crank-shaft or on a bush abutting on the crank-cheek.

To protect the gears from the weather the circumference of the anchor plate is preferably flanged so as to have only a small clearance from the hub.

In a simple form of construction, the reduction gearing is of fixed ratio, the two idler gears being integral with a single lay-shaft supported in the bearing housing.

Alternatively, the reduction gearing may include a two- or multi-speed gear mechanism, the idlers being fast on separate coaxial lay-shafts, connected through the two- or multi-speed gearing. Preferably the latter is of simple two-speed epicyclic type, the planetary cage being fast on the inner lay-shaft carrying the idler meshing with the hub-gear, the annulus being integral with the outer lay-shaft carrying the idler meshing with the crank-case gear and the sun-wheel being clutchable either to the annulus, for direct drive (high speed), or to the housing, for indirect drive (low speed), preferably by means of a double-faced cone friction clutch.

The two-speed gear may be controlled

697,383 COMPLETE SPECIFICATION
8 SHEETS

This drawing is a reproduction of the Original on a reduced scale.

SHEETS 5 & 6

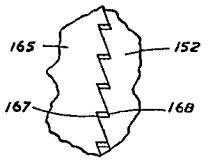

FIG. 9a.

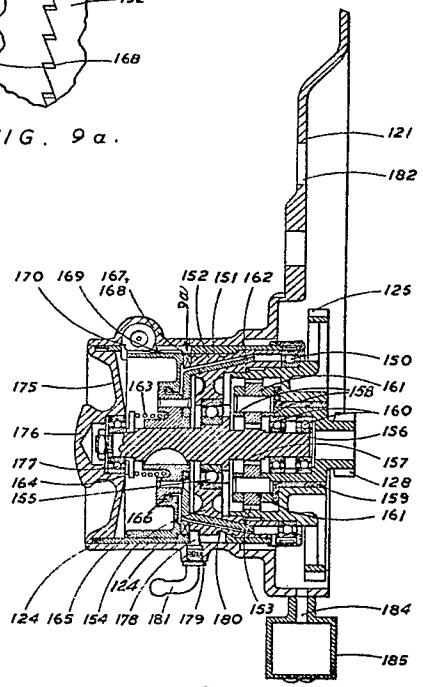

FIG.9.

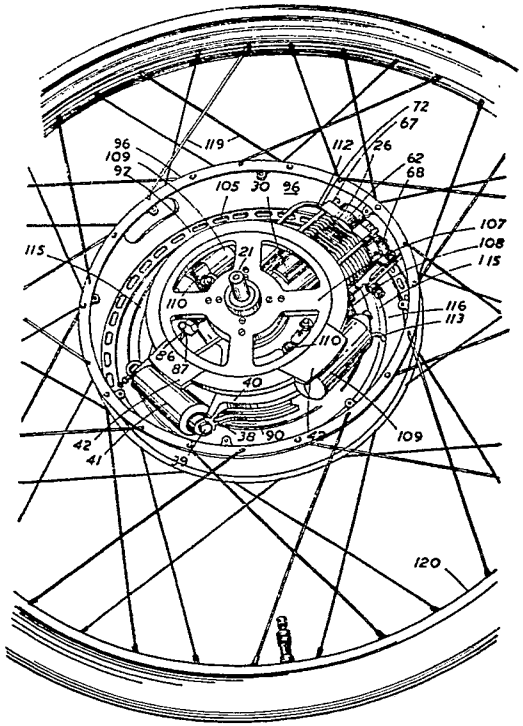

FIG.10.

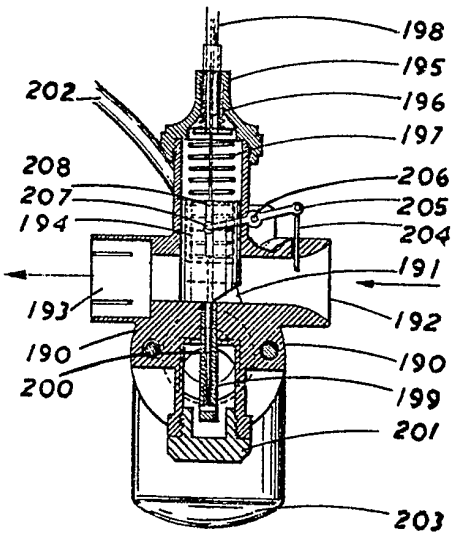
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FIG. 11

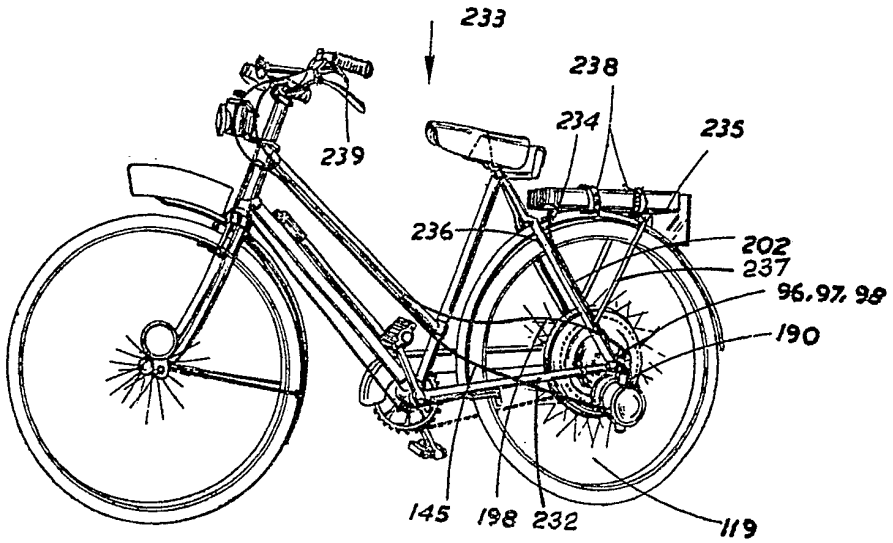
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FIG. 16.

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8 SHEETS
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SHEETS 7 & 8

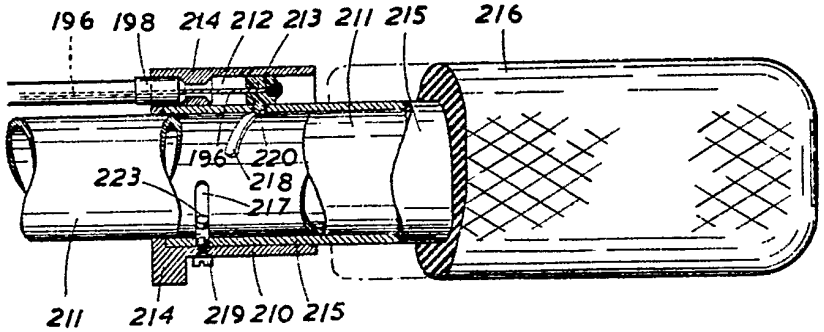

FIG. 12.

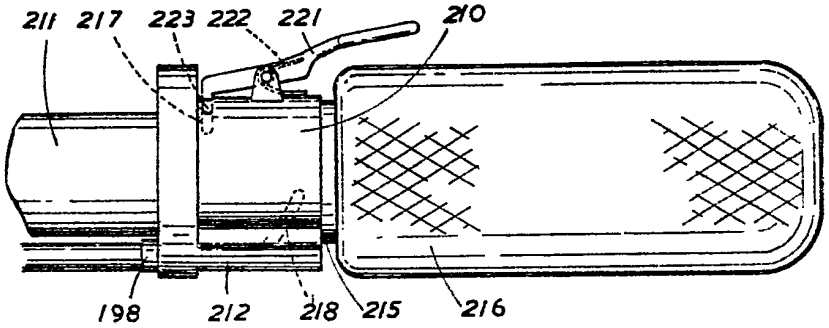

FIG. 13

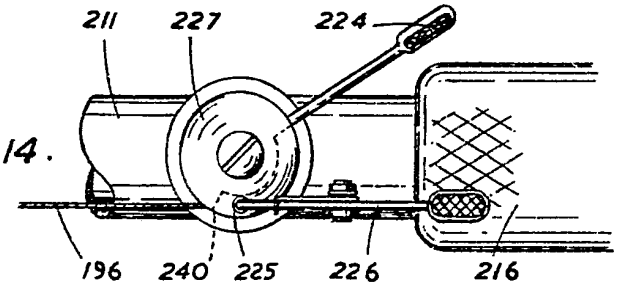

FIG. 14.

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- 96, 97, 98
-190

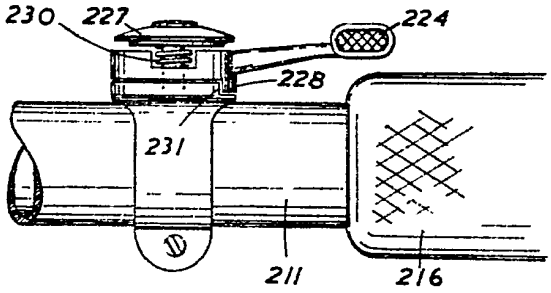

FIG. 15.

697,383 COMPLETE SPECIFICATION
8 SHEETS
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SHEETS 7 & 8

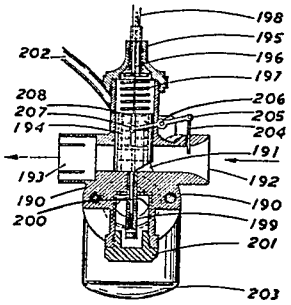

FIG. 11

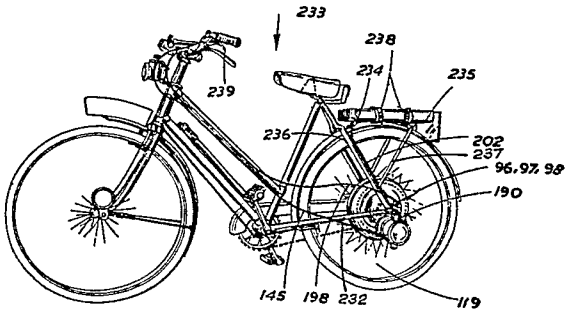

FIG. 16.

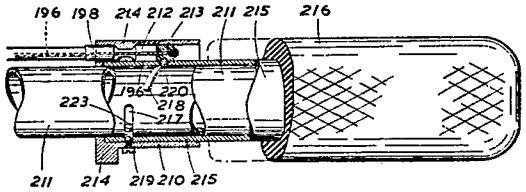

FIG. 12.

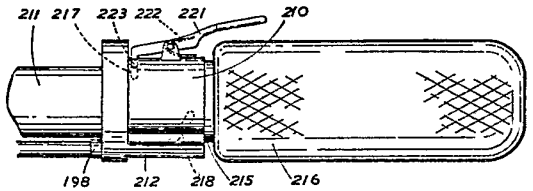

FIG. 13

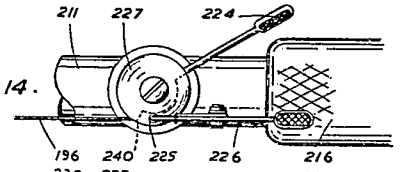

FIG. 14.

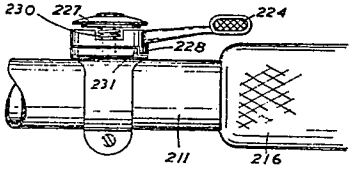

FIG. 15.

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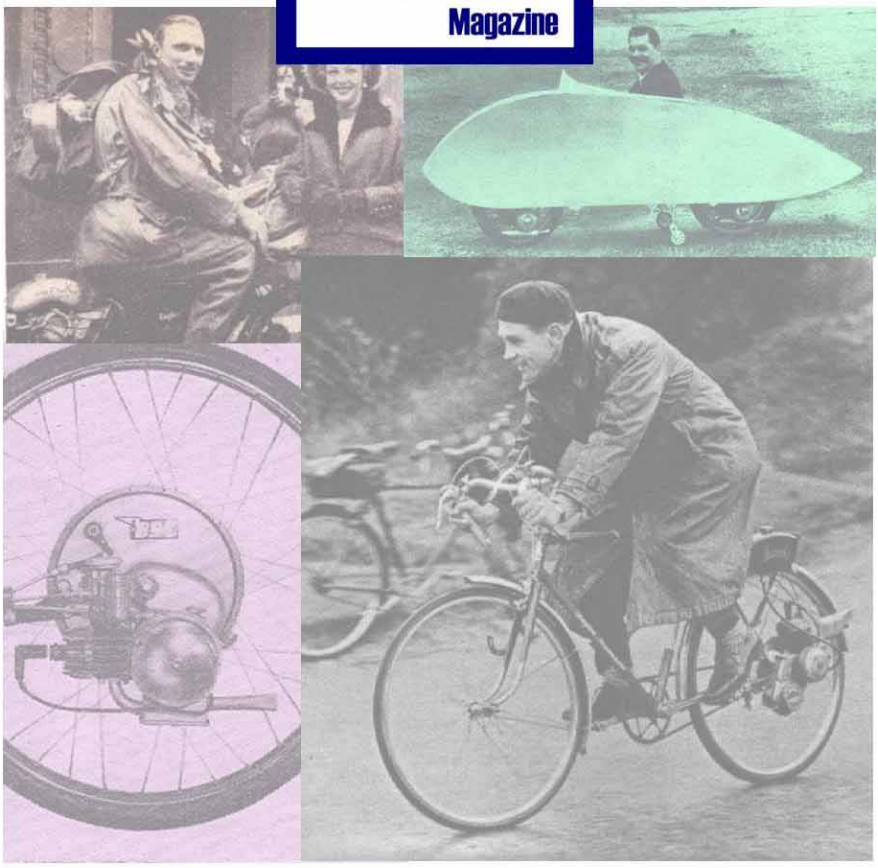

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