CHAPTER 4
GOVERNOR

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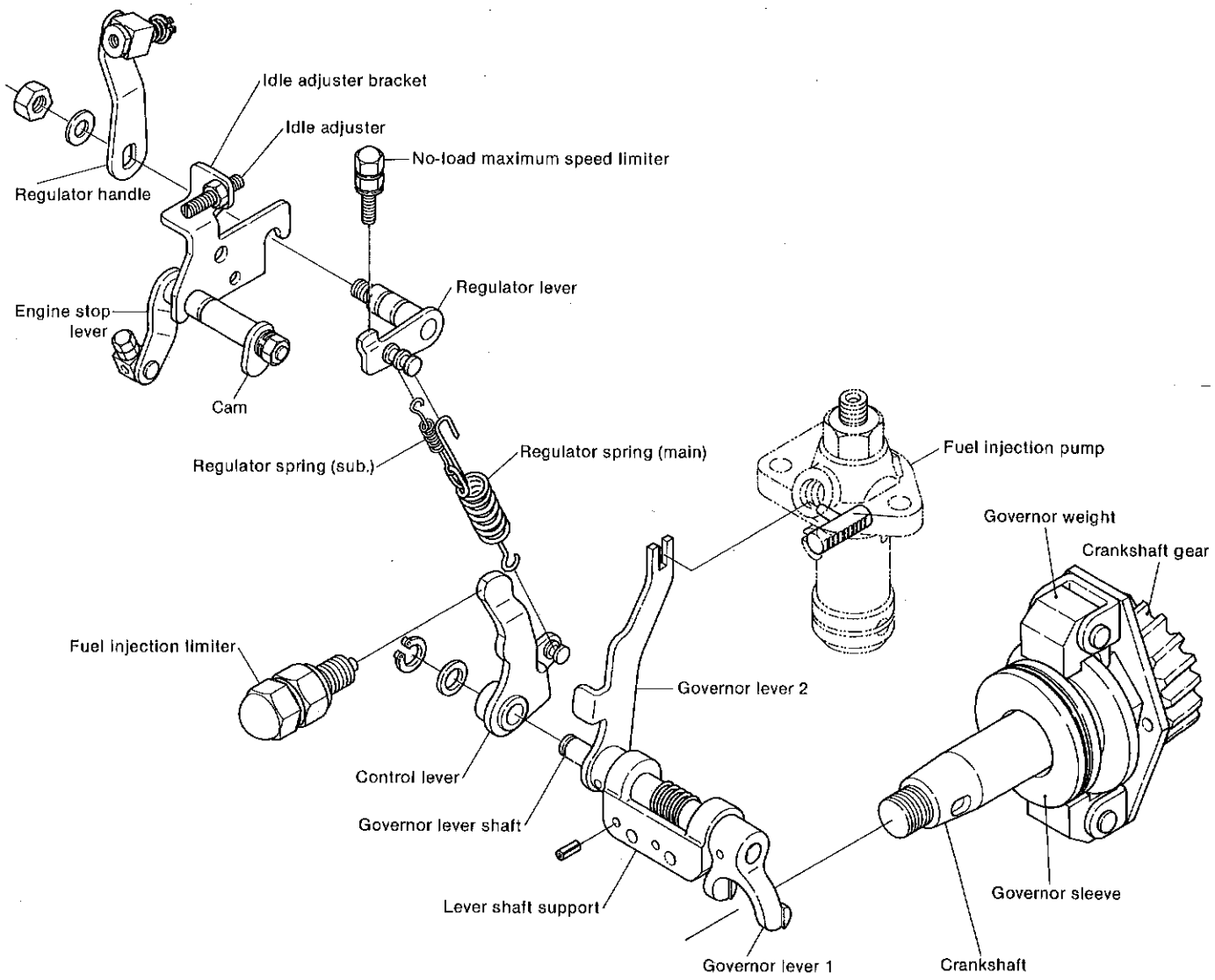
1. Governor

The governor serves to keep engine speed constant by automatically adjusting the amount of fuel supplied to the engine according to changes in the load. This protects the engine against sudden changes in the load, such as sudden disengagement of the clutch, the propeller leaving the water in rough weather, or other cases where the engine is suddenly accelerated.

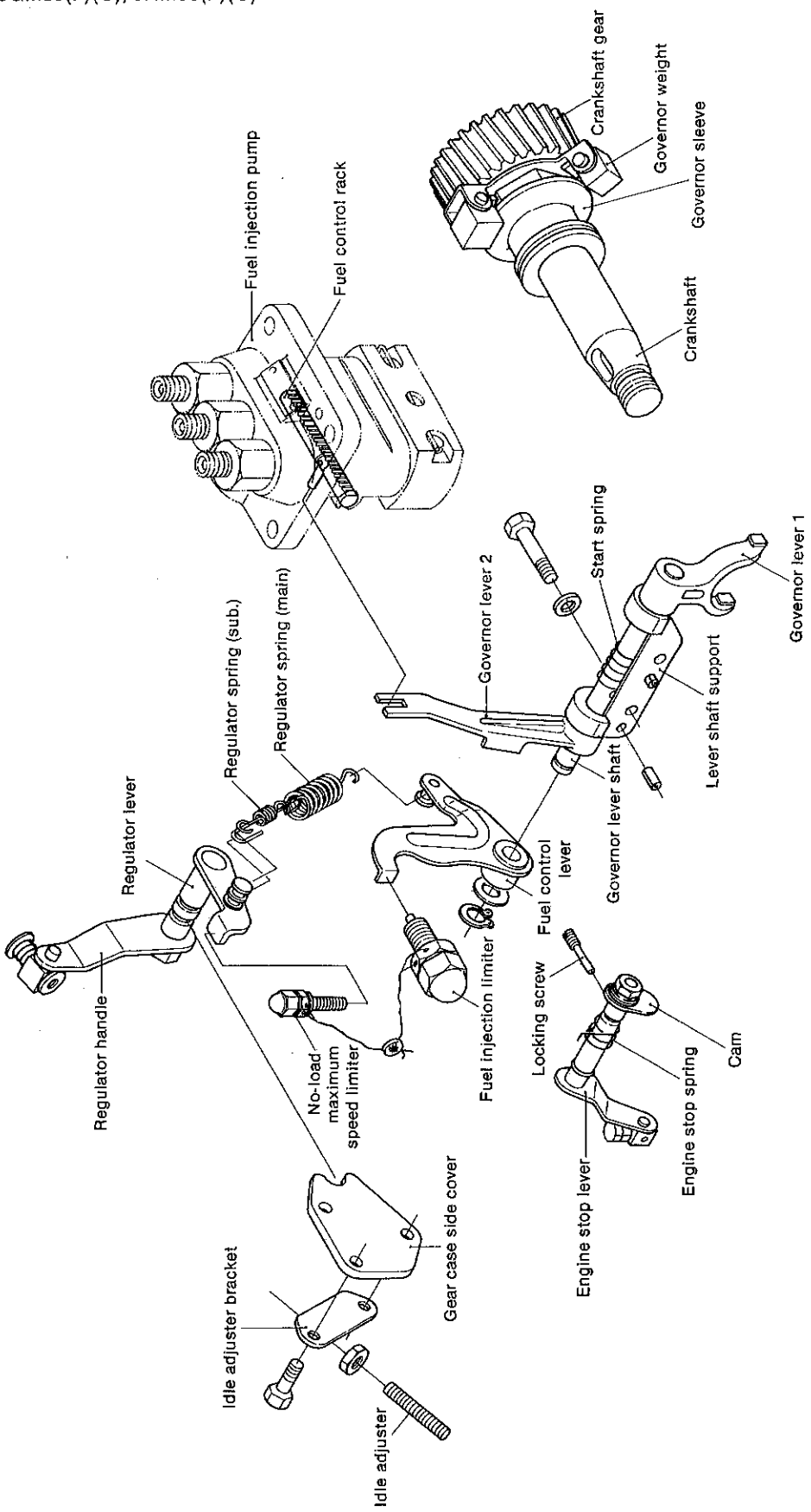
This engine employs an all-speed governor in which the centrifugal force of the governor weight, produced by rotation of the crankshaft, and the load of the regulator spring are balanced.
The governor is remotely controlled by a wire. Refer to the "Control System" chapter for details.

1-1 Construction

(1) 1GM10(C)



(2) 2GM20(F)(C), 3GM30(F)(C), 3HM35(F)(C)



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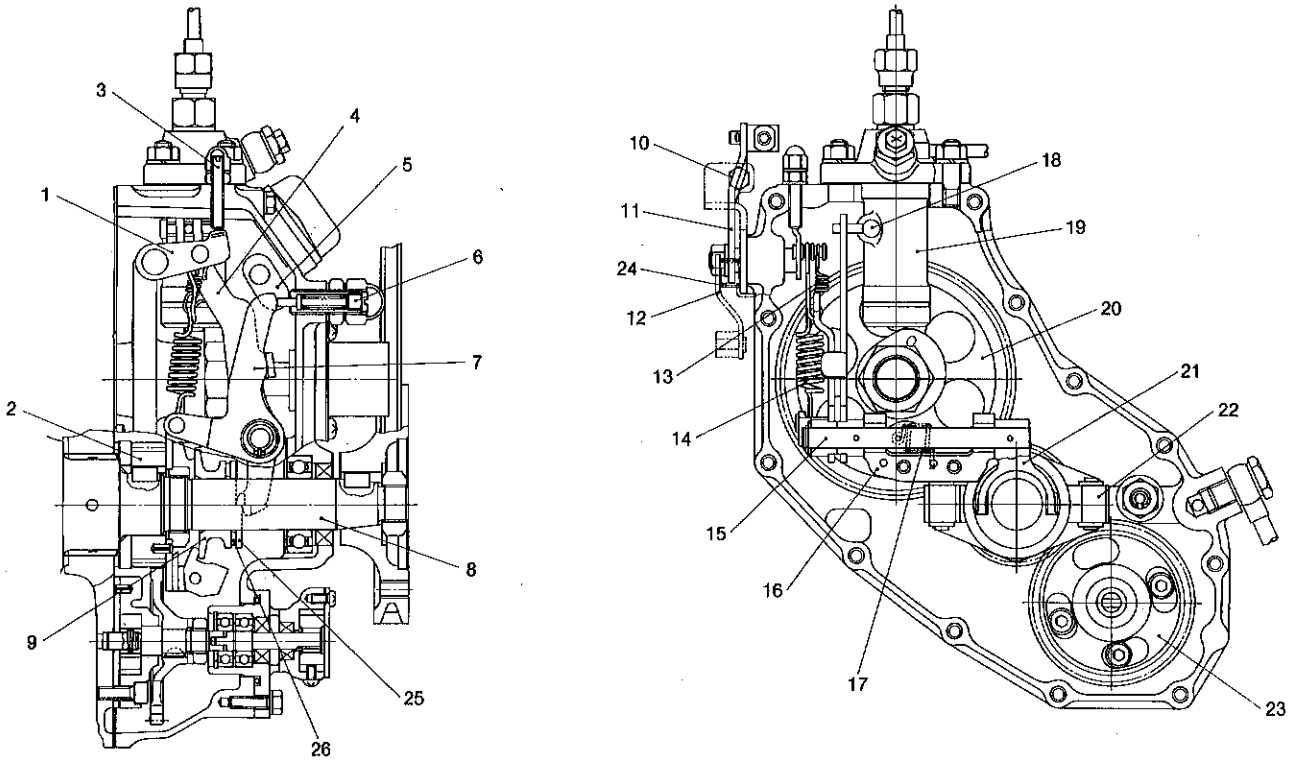
1-1.1 1GM10(C)



1 Regulator lever
2 Crankshaft gear
3 No-load maximum speed limiter
4 Governor lever 2
5 Engine stop cam
6 Fuel injection limiter
7 Fuel control lever
8 Crankshaft
9 Governor sleeve
10 Idle adjuster
11 Regulator handle
12 Engine stop lever
13 Regulator spring (sub.)
14 Regulator spring (main)
15 Governor lever shaft
16 Governor lever shaft support
17 Start spring
18 Fuel control rack
19 Fuel injection pump
20 Camshaft gear
21 Governor lever 1
22 Governor weight
23 Lubricating oil driving gear
24 Engine stop spring
25 Thrust collar
26 Thrust needle bearing

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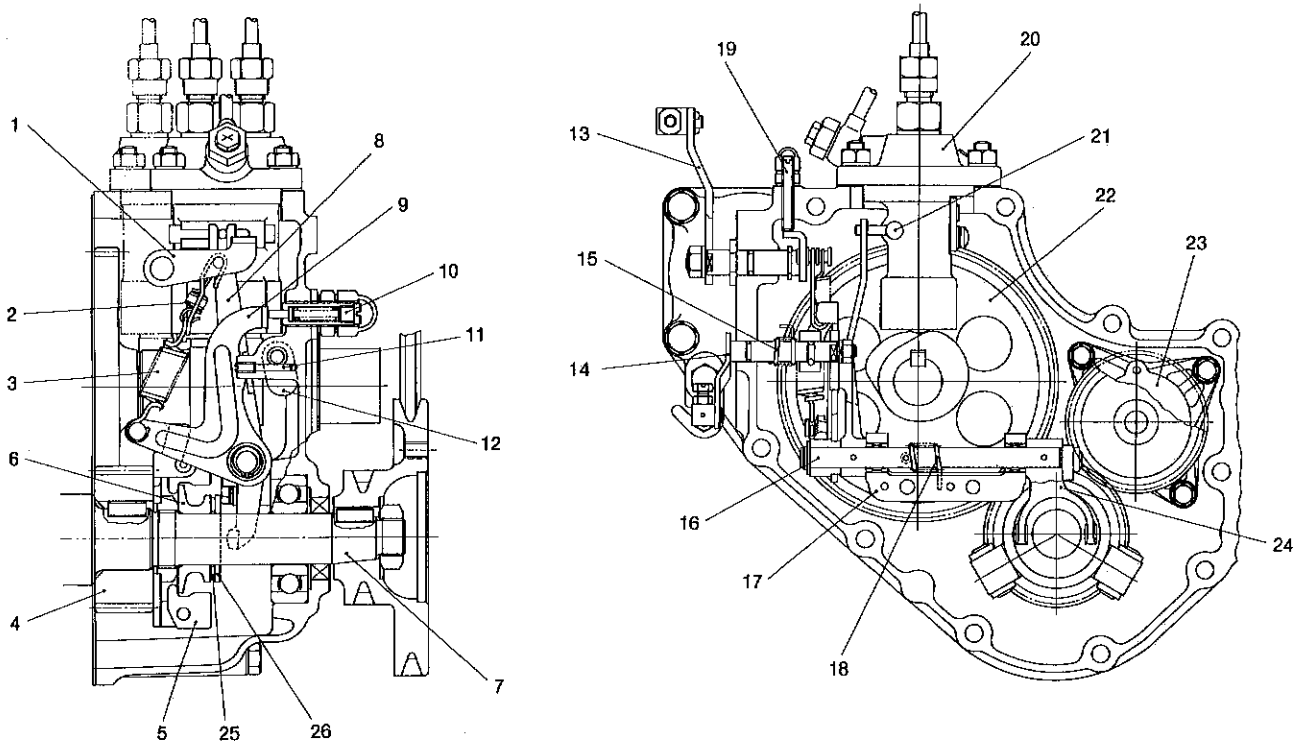
1-1.2 2GM20(F)(C), 3GM30(F)(C), 3HM35(F)(C)



1 Regulator lever
2 Regulator spring (sub.)
3 Regulator spring (main)
4 Crankshaft gear
5 Governor weight
6 Governor sleeve
7 Crankshaft
8 Governor lever 2
9 Fuel control lever
10 Fuel injection limiter
11 Locking screw
12 Engine stop cam
13 Regulator handle
14 Engine stop lever
15 Engine stop spring
16 Governor lever shaft
17 Governor lever shaft support
18 Start spring
19 No-load maximum speed limiter
20 Fuel injection pump
21 Fuel control rack
22 Camshaft gear
23 Lubricating oil pump
24 Governor lever 1
25 Thrust needle bearing
26 Thrust collar

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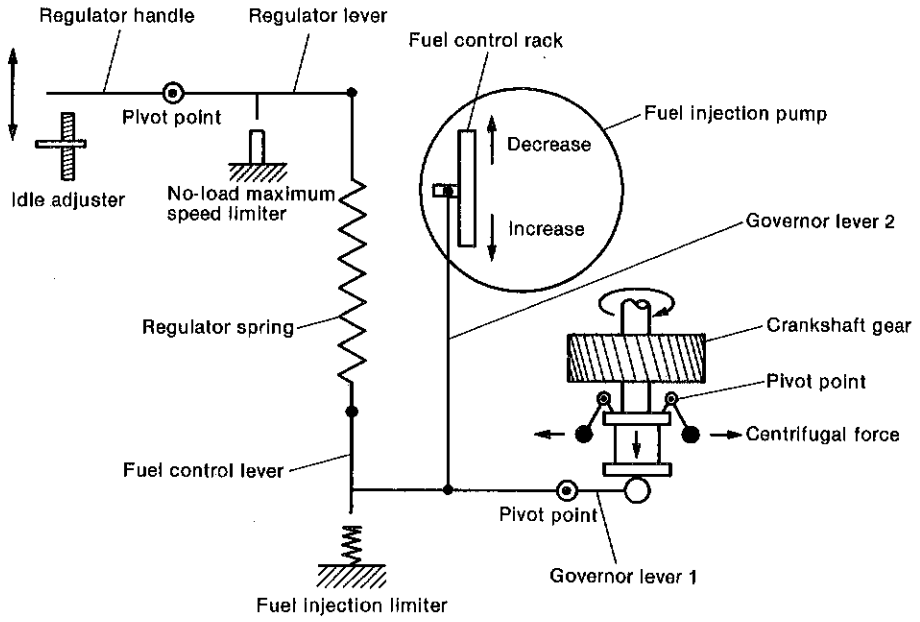
1-2 Operation

The position of the two governor weights (open and closed) is regulated by the speed of the engine. The centrifugal force of the governor weights pivots around the governor weight pin and is converted into an axial force that acts on the sleeve. This force is transmitted to governor lever 2 through governor lever 1, and lever 1 shifts the fuel control rack to increase or decrease the fuel supply. The governor lever is stabilized at the point at which the force produced by the governor weight is balanced with the load of the regulator spring connecting the rsgulator lever and fuel control lever. When the speed is reduced by application of a load, the force of the regulator spring pushes the governor sleeve in the "fuel increase" direction, stabilizing the engine speed by changing the position of the regulator lever.



1-3 Performance

		1GM10(C), 2GM20(F)(C), 3GM30(F)(C)	3HM35(F)(C)
No-load maximum speed		3825^{+50}_{0} rpm	3625±25 rpm
No-load minimum speed		850±25 rpm	
Instant speed regulation	δi	15% or less	
Stabilization time	ts	10 sec. or less	
Stabilized speed regulation	δs	6.5% or less	
Fluctuation of rotation		30 rpm or less	

Instant speed regulation $\delta i = \left|\frac{ni - nr}{nr}\right| \times 100$

Stabilized speed regulation $\delta s = \left|\frac{ns - nr}{nr}\right| \times 100$

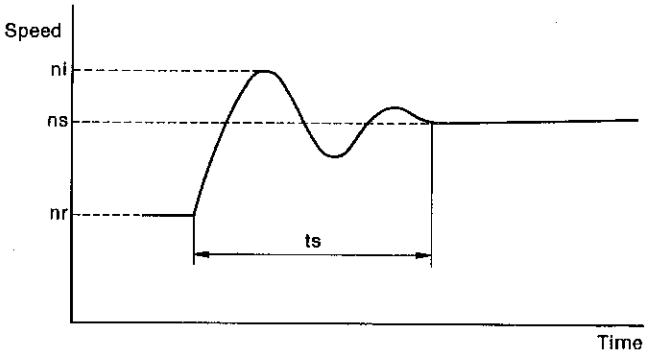
ni: Instant maximum (minimum) speed:
The maximum or minimum engine speed which is momentarily reached immediately after the load has been suddenly changed from the rated load to another load or from an arbitrary load to the rated load.

ns: Stabilized speed:
The speed which is set according to the lapse of time after the load has been changed from a rated load to another load or from an arbitrary load to the rated load.

nr: Rated speed

ts: Stabilization time:
The time it takes for engine to return to the set speed after a change.

(When load is suddenly changed from rated load to low load)



ni: Instant maximum speed (rpm)
ns: Stabilized speed (rpm)
nr: Rated speed (rpm)
ts: Stabilization time (sec.)

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1-4 Disassembly

1-4.1 Disassembly

(1) Remove the injection limiter and no-load maximum speed limiter from the gear case.
(2) Remove the idle adjuster and adjuster bracket.
(3) Remove the cover at the gear case end [oil supply port in the case of model 1GM10(C)] move the governor lever 2 to match the control rack to the pulled-out position of the fuel injection pump (indicated by a slot in the gear case to show the position); then take out the fuel injection pump.
(4) Remove the gear case from the cylinder block.
(5) Pull the thrust collar, the thrust needle bearing and the governor sleeve from the crankshaft.
(6) Loosen the end nut of crankshaft, and remove the governor weight assembly.
(7) Remove the regulator spring (main·sub.) from the regulator lever 2 and fuel control lever.
(8) Remove the circlip of the regulator lever, and remove the regulator lever and handle. [Without circlip in the case of model 1GM10(C)].
(9) Remove the governor lever shaft support bolt from the rear of the gear case, and take out the governor lever shaft assembly.
(10) Loosen the nut of engine stop lever, and pull the cam.
(11) Draw out the locking screw from the rear of the gear case, and remove the taper pin for setting the return spring.
(12) Remove the engine stop lever and the spring.

1-4.2 Reassembly and precautions

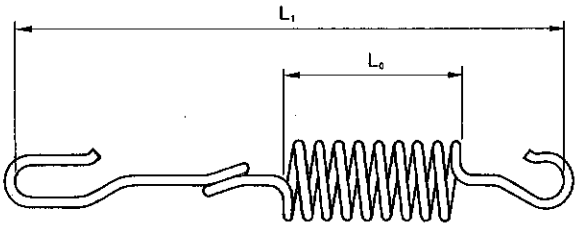
Reassemble in the reverse order of disassembly, paying special attention to the folowing items.
(1) Check the governor weight movement.
(2) Check for the movement of the governor sleeve sliding on the crankshaft.
(3) Since a common taper pin hole is drilled in the governor lever shaft and governor levers 1 and 2, they must be replaced as an ass'y.
(4) Since the movement and play of the governor lever have a direct effect on the governor's performance, they must be carefully checked.

1-5 Parts inspection and replacement

1-5.1 Regulator spring

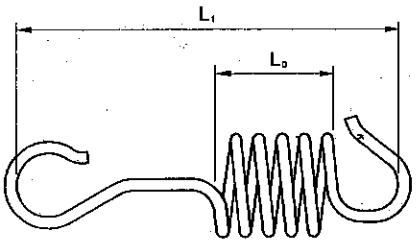
(1) Inspect the spring for coil damage, corrosion and hook deformation, and replace if faulty.
(2) Measure the spring's dimensions and spring constant. Since the spring constant determines the governor's performance, it must be carefully checked.

Spring specifications
1) Regulator spring (main)



		1GM10(C)	2GM20(F)(C), 3GM30(F)(C), 3HM35(F)(C)
Wire diameter		φ1.8mm (0.0709in.)	φ2.3mm (0.0906in.)
Coil outside diameter		φ13.8mm (0.5433in.)	φ18.3mm (0.7205in.)
Nmber of coils		8.5	7.5
Spring constant		0.715 kg/mm (0.400 lb/in.)	0.922 kg/mm (0.516 lb/in.)
Free length	L_0	18mm (0.7087in.)	20mm (0.7874in.)
	M_1	76mm (2.992in.)	78mm (3.0709in.)

2) Regulator spring (sub)



		1GM10(C)	2GM20(F)(C), 3GM30(F)(C), 3HM35(F)(C)
Wire diameter		φ1.8mm (0.0315in.)	φ1.2mm (0.0472in.)
Coil outside diameter		φ6.8mm (0.2677in.)	φ9.2mm (0.3622in.)
Nmber of coils		4	7
Spring constant		0.474 kg/mm (0.265 lb/in.)	0.578 kg/mm (0.3237 lb/in.)
Free length	L_0	5mm (0.1969in.)	10mm (0.3937in.)
	M_1	26mm (1.0236in.)	23mm (0.9055in.)

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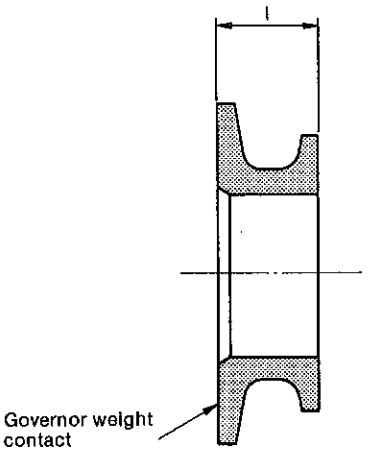
1-5.2 Sleeve

(1) Slide the sleeve on the crankshaft to check that it slides smoothly.
(2) Measure the clearance between the crankshaft and the inside of the sleeve, check the contact between the governor weight.



mm (in.)

	Maintenance standard	Clearance when assembled	Maximum allowable clearance	Wear limit
Crankshaft outside diameter	$\varnothing 25^{-0.007}_{-0.028}$ (0.9831 ~ 0.9840)	0.06 ~ 0.111 (0.0024 ~ 0.0044)	0.2 (0.0079)	—
Governor sleeve inside diameter	$\varnothing 25^{+0.083}_{+0.053}$ (0.9863 ~ 0.9875)			—
Governor sleeve overall length (ℓ)	15 ±0.1 (0.5866 ~ 0.5945)	—		14.8 (0.5827)

1-5.3 Thrust collar

Check the contact between the governor lever 1 and replace the collar when wear exceeds the wear limit.

mm(in.)

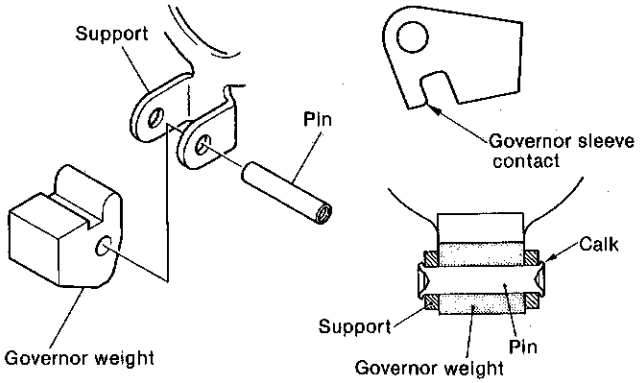
	Maintenance standard	Wear limit
Thrust collar thickness	3 (0.1181)	0.1 (0.0394)

1-5.4 Thrust needle bearing

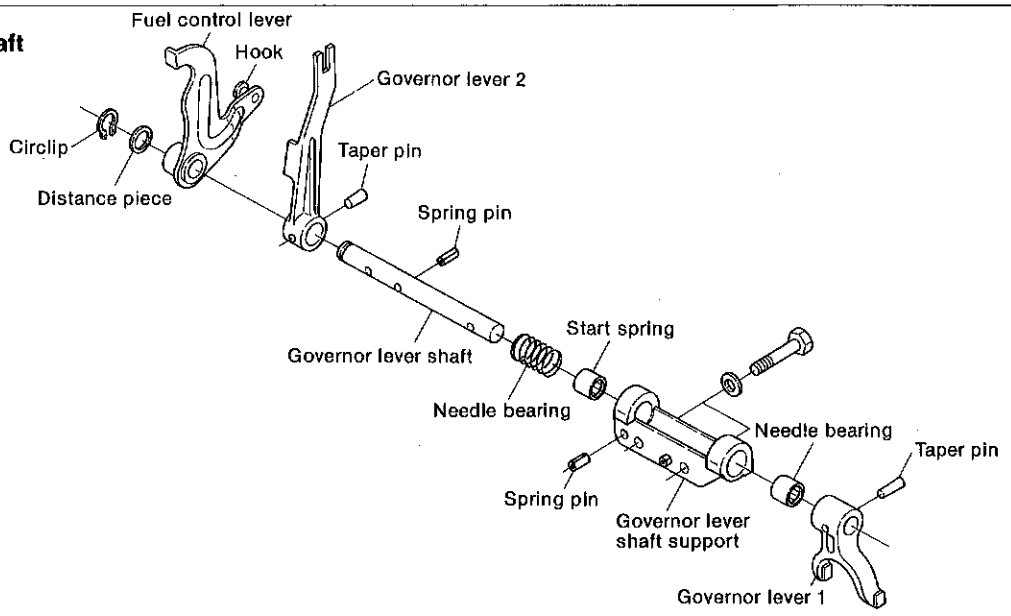
Replace the bearing when wear exceeds the specified limit.

1-5.5 Governor weight

(1) Check contact with the sleeve and for wear.



1-5.6 Governor lever shaft



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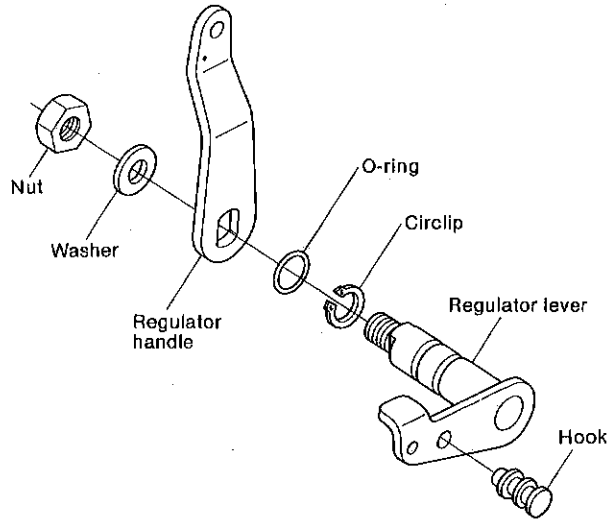
(1) Replace the governor lever shaft if there is play between the shaft and needle bearing, play when the lever is moved, or if the shaft does not move smoothly.
(2) Repair or replace the shaft if there is play between lever 1, lever 2, fuel control lever or support and the shaft, or if the taper pin is loose.
(3) Inspect the contact between the governor lever 1 and the governor sleeve, replace it if it is too damaged.

1·5.7 Regulator lever and handle



(1) Check for play in the regulator lever and regulator handle if faulty, replace them as a set.
(2) Check for O-ring damage. Replace if faulty.

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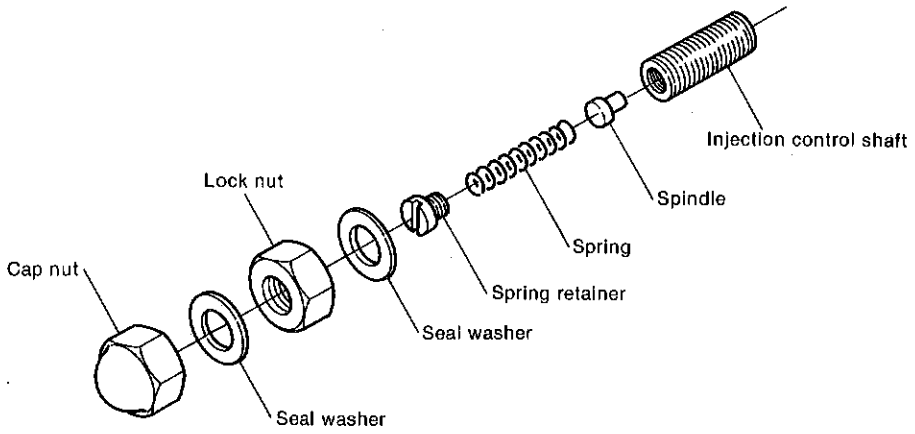
2. Injection Limiter

2-1 Construction

Since surplus power is required from the standpoints of sudden overloads and durability, the engine is equipped with an injection control shaft that limits the amount of fuel injected into the precombustion chamber to a fixed amount. Since the injection control spring (torque spring) affects engine performance by adjusting engine torque, Yanmar has selected the best position for the operating conditions.

Pay close attention when handling the sealed-wire.
If the engine does not accelerate smoothly (i.e. the speed is not well controlled), turn the limiter slightly counter-clockwise.
NOTE: If it is turned back too much, it will produce exhaust smoke.

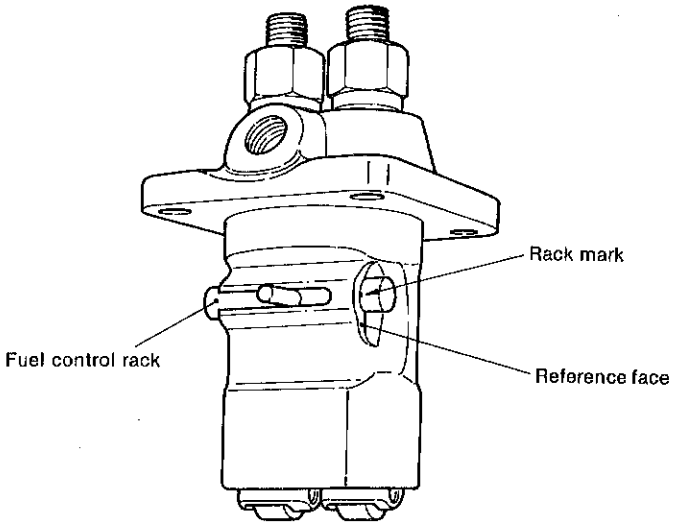


2-2 Inspection

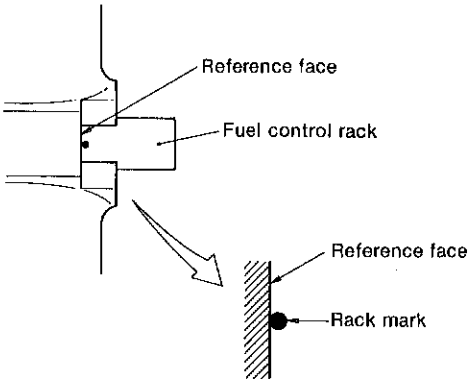
(1) Hold the end of the spindle, and check it for smooth movement.
(2) Replace the spring if it is damaged, corroded or permanently strained.

2-3 Adjustment

In the case of models, 1GM10(C), 2GM20(F)(C), and 3GM30(F)(C)



(1) Set the governor lever to the free position and remove the injection pump adjustment cover [oil supply port in the case of model 1GM10(C)]
(2) Remove the injection control shaft cap nut, loosen the hexagonal lock nut, and loosen the injection control shaft (so that the spring inside the injection control shaft is disabled).
(3) Move governor lever 2 slowly to the left until the rack and injection control shaft touch lightly.
(4) Set the governor lever to the free position and push the rack by slowly turning the injection control shaft clockwise.
(5) Align the center mark of the rack with the reference face.
(6) Lock the injection control shaft with the hexagonal nut and cap nut.



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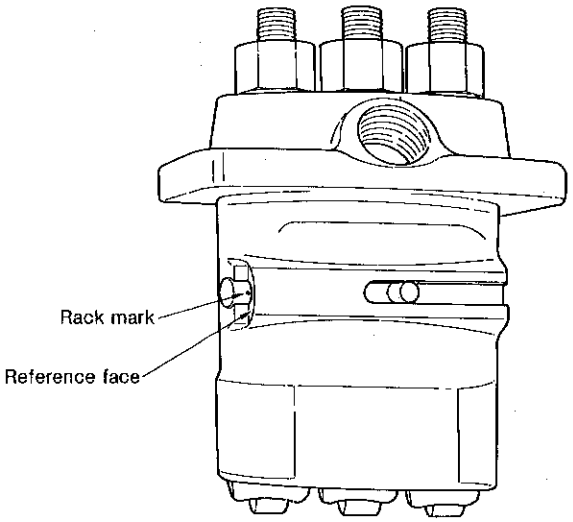
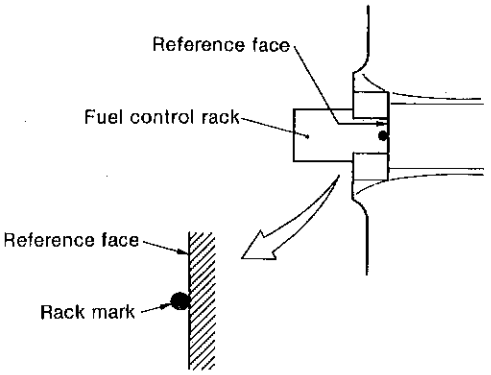
In the case of model 3HM35(F)(C)





NOTE: When the engine is stopped, the control rack will automatically stay at the position which allows the maximum fuel injection volume.
Therefore, to match the rack mark, move the engine stop lever to the position where the mark is matched and fix the lever at that position, then adjust so that the fuel limiter comes into contact with the lever.

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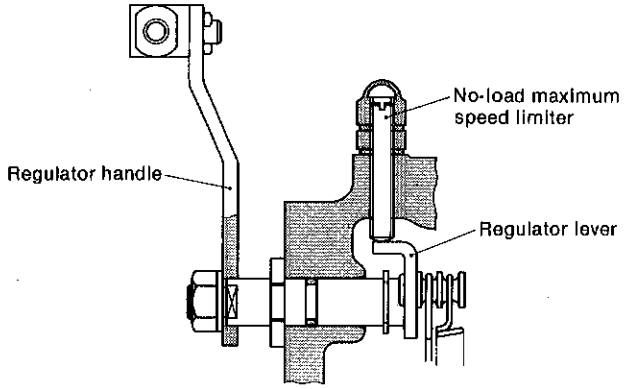
3. No-Load Maximum Speed Limiter

3-1 Construction

A stopper is installed on the regulator lever so that the engine speed at no-load does not exceed a fixed speed. The fuel control rack is stopped when the regulator lever contacts the stopper.



3-2 Handling precautions

The no-load maximum speed is adjusted during bench testing at the factory, and is locked with wire and sealed with lead. Care must be taken to keep the seal from being accidentally broken.

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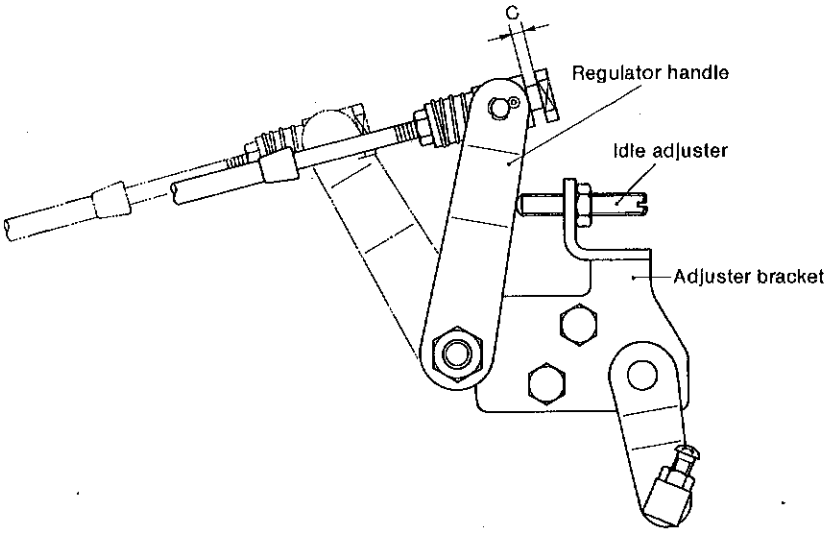
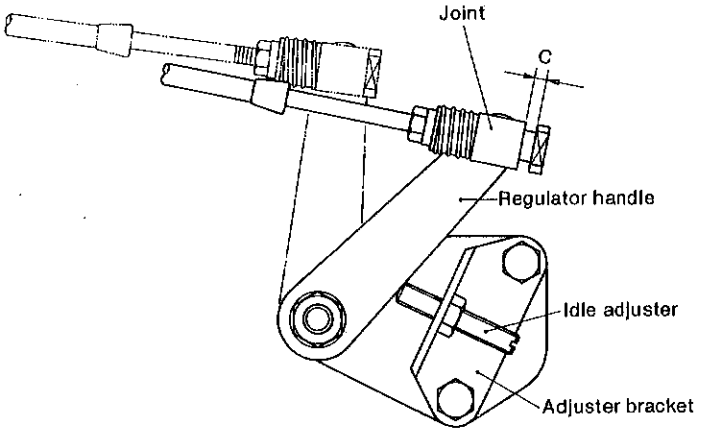
4. Idling Adjuster

When controlling the speed with the push-pull remote control, the idling adjustor operates so that the regulator handle does not move beyond the idling position in order to keep the engine running.

4-1 1GM10(C)



4-2 2GM20(F)(C), 3GM30(F)(C), and 3HM35(F)(C)



(1) When the control lever is in the neutral position, set the push-pull cable so that clearance C is 1 to 3mm (0.0397 ~ 0.1181in.).
(2) Take care not to fit the joint in the wrong direction.

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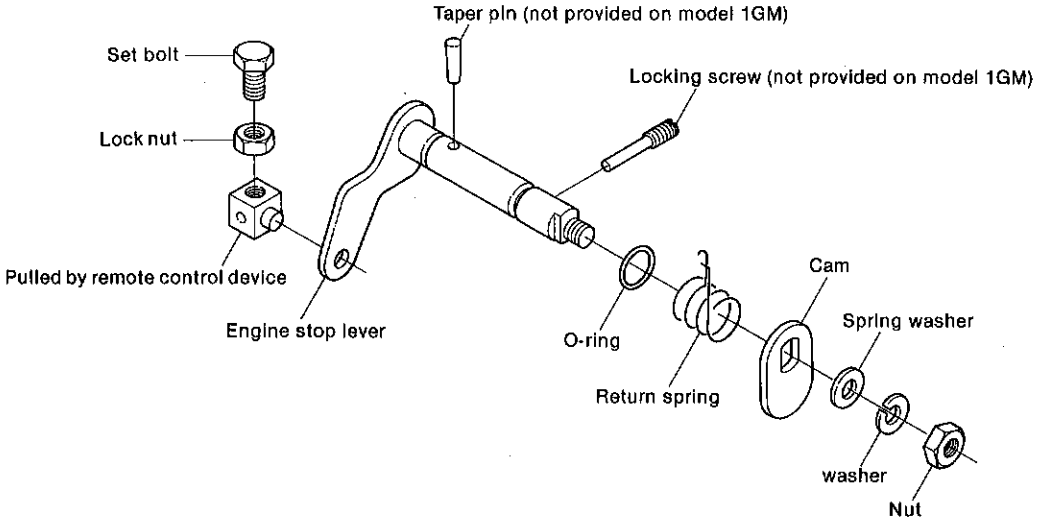
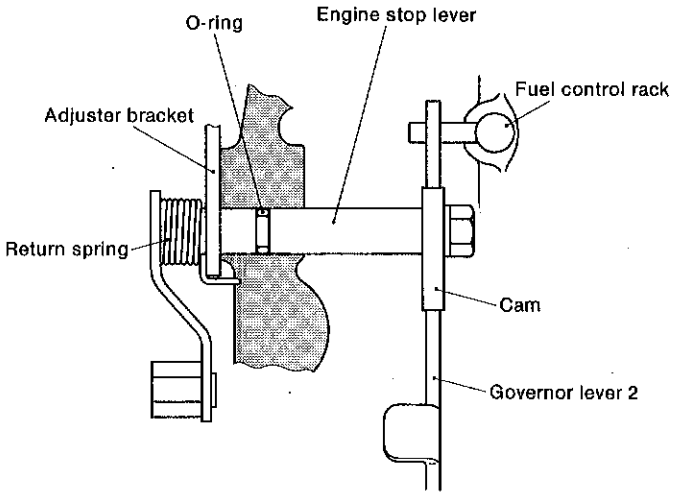
5. Engine Stop Lever

5-1 Construction

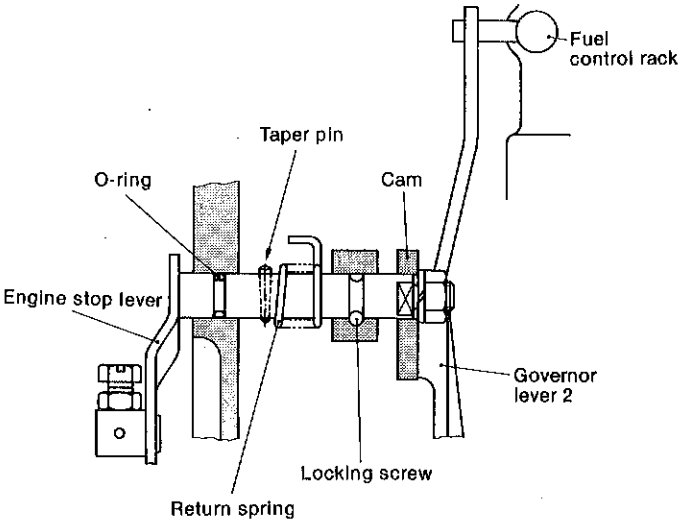
With this device, governor lever 2 is moved by the cam of the engine stop lever shaft, regardless of the position of the regulator lever, so as to adjust the fuel control rack and reduce the supply of fuel.
This device can be remote-controlled.



(1) 1GM10(C)



(2) 2GM20(F)(C), 3GM30(F)(C), 3HM35(F)(C)



5-2 Inspection

(1) Check for play in the Cam or Taper pin and the engine stop lever. If faulty, replace them as a set.
(2) Check for O-ring damage. Replace if faulty.
(3) Inspect the spring for coil damage and corrosion and replace if faulty.
(4) Inspect the contact between the governor lever 2 and the dam. Replace the cam if it is too damaged.

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