

FSK658D

Engine Electronic Governor Controls

Operation Instruction

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Foreword

This operation instruction mainly introduces right methods for installation calibration, regulation, operation and maintenance of the electronic governor. It is suitable for personnel who perform installation, wiring, operation and routine maintenance of the electronic governor. It is recommended that this manual would be placed on the field of production. When use this product, should follow the operation method submitted by this manual.

User Notice

- Don't completely rely on electronic governor to prevent from engine over speed. For prevent from over speed due to fuel rack deactivation or man-made wrong operation and more, the independent over speed protective device should be installed on the engine.
- Don't share the speed sensor of this speed governing system with other system.
- Before starting engine, should confirm that fuel rack of the injection pump is located on the fuel cutoff position.

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1 Overview

FSK658D controller offers such functions as precise and fast governing, maximum current restriction and protection, adjustable steady state speed droop, wider setting range for high and low speed, start fuel quantity restriction, raising speed time control, over speed protection, start-up rotate speed signal out-put, automatic parallel operation and so on. Its working principle is to made-up a close control loop which combined the controller with proportion electromagnetic actuator and magneto electric sensor, for achieving wide range of speed control to the engine. In contrast to other controllers, it features of good governing performance, complete function, installation and maintenance convenience, high reliability. This series product adapts to control every kilowatts engine.

2 Main Technical Parameters

Supply voltage	12V or 24V DC
Power consumption	< 80 mA (static State)
Current output	< 8A
Pulsating rate of revolution	± 0.25 %
Steady state speed droop	0 ~ 5 %
High speed setting range	1 k~7.5 KHz
Speed fine-tune	Rated speed ± 200 Hz
Over speed value setting range	2KHz ~ 7KHz
Rotate speed out-put value setting range	0.4K ~ 6.5 KHz
Temperature drift	< ± 0.5 %
Rotate speed display	4 bit LED
Battery voltage display	10 lever (3V/lever)
Speed signal	0.5 ~ 120 V RMS
Vibration	<100 Hz
Shock	2 G
Relative humidity	< 95 %
Environmental temperature	- 30 °C~ + 70 °C

3 Composition and work principle

Composition of the controller is shown in fig.1.

Its principle of work is that: first it receives speed signal from magneto electric sensor. After processing and transform, it compares with reference signal and then generate error signal. After PID operation on this error signal, regulation voltage is formed. After being amplified, this regulation voltage is used to drive actuator for

achieving control.

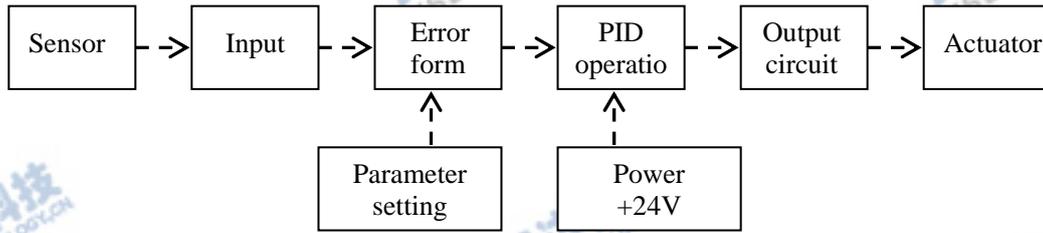


Figure 1 Controller composition

4 Fundamental Function

● Speed Adjusting Control

Speed adjusting control adopts closed loop mode for accurate regulation of the engine speed. Stability of speed can be selected by condition switch, and dynamic indication can be adjusted by built-in gain and stabilization potentiometers.

● High & Low Speed Switch and Speed Fine-tune

High and low speed switches are designed to low speed control and switching for rated speed control. External speed inching potentiometer can subtly adjust speed deviation.

● Automatic Stopping Protection

When speed sensor is with wrong, speed feedback signal vanishes or power supply cuts-down. This function can make engine automatic stop.

● Adjustable Steady State Speed Droop (decrease speed)

Steady state speed droop of the controller can be set as adjustable and non-tunable as required. When terminal 10 and 11 placed in circuit, the speed droop is for adjustable. Clockwise rotate the speed decrease potentiometer, steady state speed droop increases. At this moment, engine rated speed need to be reset.

● Start Fuel Quantity Restriction

Start fuel quantity varies with environmental temperature of engine start. Through adjusting start fuel quantity potentiometer; exhaust smoke from the engine can be adjusted to the best state.

● Raising Speed Time Control

By tuning this potentiometer, rising speed time of the engine from idle speed to rated operating speed can be controlled. Clockwise rotation is for increase, and anticlockwise rotation is for decrease.

● Over speed protection

Through adjusting over speed setting potentiometer, over speed protection restriction point can be set. If engine speed exceeds this restriction point, controller out-put would be cutoff, actuator would be powered off and engine would stop. At the same time, red LED light on the controller panel bright. When

engine stop, push down the reset button on controller panel or cutoff the controller's power, controller will recover normal.

- **Wide range speed adjusting**

Through connecting a potentiometer between the terminal 7.9.10(11), the wide range speed adjustment will be achieved just as the fig.3 show. Clockwise rotate, speed will rise. Otherwise, speed droop. The rotate speed adjusting Range is decided by the resistance potentiometer. Just as the following table show. When using this function, high speed potentiometer should be in middle position .

Speed adjusting range	Resistance
900Hz	1k Ω
2400Hz	5k Ω
3000Hz	10k Ω
3500Hz	25k Ω
3700Hz	50k Ω

- **Battery voltage real time indication**

Voltage indicator of 10 lever can real time indicates battery's working voltage. Every lever expresses 3V. If there are 8 lever bright, this means the controller is in order.

- **High speed state starting up**

The controller can start engine directly at the high speed state. At this time, engine speed will increase to the rated rotate speed from low speed. The rising time can be adjusted by the rising potentiometer.

- **Actuator test**

After the controller system is connected, powered on the controller. Then push down the actuator test button on the controller panel, the actuator will work. This can test the connecting condition of the actuator.

- **Parallel Operation Function**

Terminal 13 receives input signal from load distribution device, automatic synchronizer device and other governor system auxiliary device. This device is directly connected with terminal 13 and its wiring harness should be shielded.

If exclusively use self-acting synchronizer without connect with load distribution module, a resistance of 3 MΩ should be connected between terminal 13 and 14. This is mainly for voltage matching between the control device and the synchronizer.

When auxiliary device is connected with terminal 13, rotate speed would droop. The engine speed must be reset.

5 Controller installation and debugging

5.1 Controller installation

Speed governor should be installed in the protective housing without sharp pounding vibration and/or EMI, and had has sufficient space for installation, maintenance and heat rejection. Its housing must be of reliable earth. Erect installation can prevent from too much moisture resident.

Installation dimension of speed governor is shown in fig. 2.

5.2 Controller Parameter Tuning

5.2.1 Controller wiring diagram

When using for generator set, the diagram of controller is shown in fig.2. Wide range speed adjusting diagram is shown in fig.3.accelerate

5.2.2 First time start-up

- **Inspect fuel rack for agility.** This inspection is very important. It is required that full stroke of the fuel rack would be no clamping stagnation. Heaviness of the fuel rack means depressing the controller's control performance. If it is serious, run wild will occur and it will bring about major failures such as engine speed unsteady, over speed and so on.
- Inspect whether the related electrical connections are correct according to fig. 2.
- Inspect actuator for movement flexibility. After confirmation of connection agility, recheck if the fuel rack's least position can make fuel(air) cutoff and if the fuel rack's maximum position can make fuel(air) quantity maximum.
- Inspect battery voltage. When no-load, it should be greater than 24 V. When engine starts, it should be not less than 18 V. When the controller was powered on, the red LED indicator light on the controller panel will be light.
- Inspect the parameter setting device's position compared with their factory set show in 5.2.5. If every parameter setting device's position is much different from their factory set before starting engine, user must reset them to factory set. This can avoid failures such as can not start-up or over speed etc.

5.2.3 Parameter adjusting

- **Factory adjusted control state of this Series controller:**

Idle speed: 1800 Hz; Rated speed: 3200 Hz

For the different type of flywheel tooth number, user should convert relevant RPM level and readjust high and low speed potentiometers according to equation $f = nz/60$, so as to reaching the required RPM level.

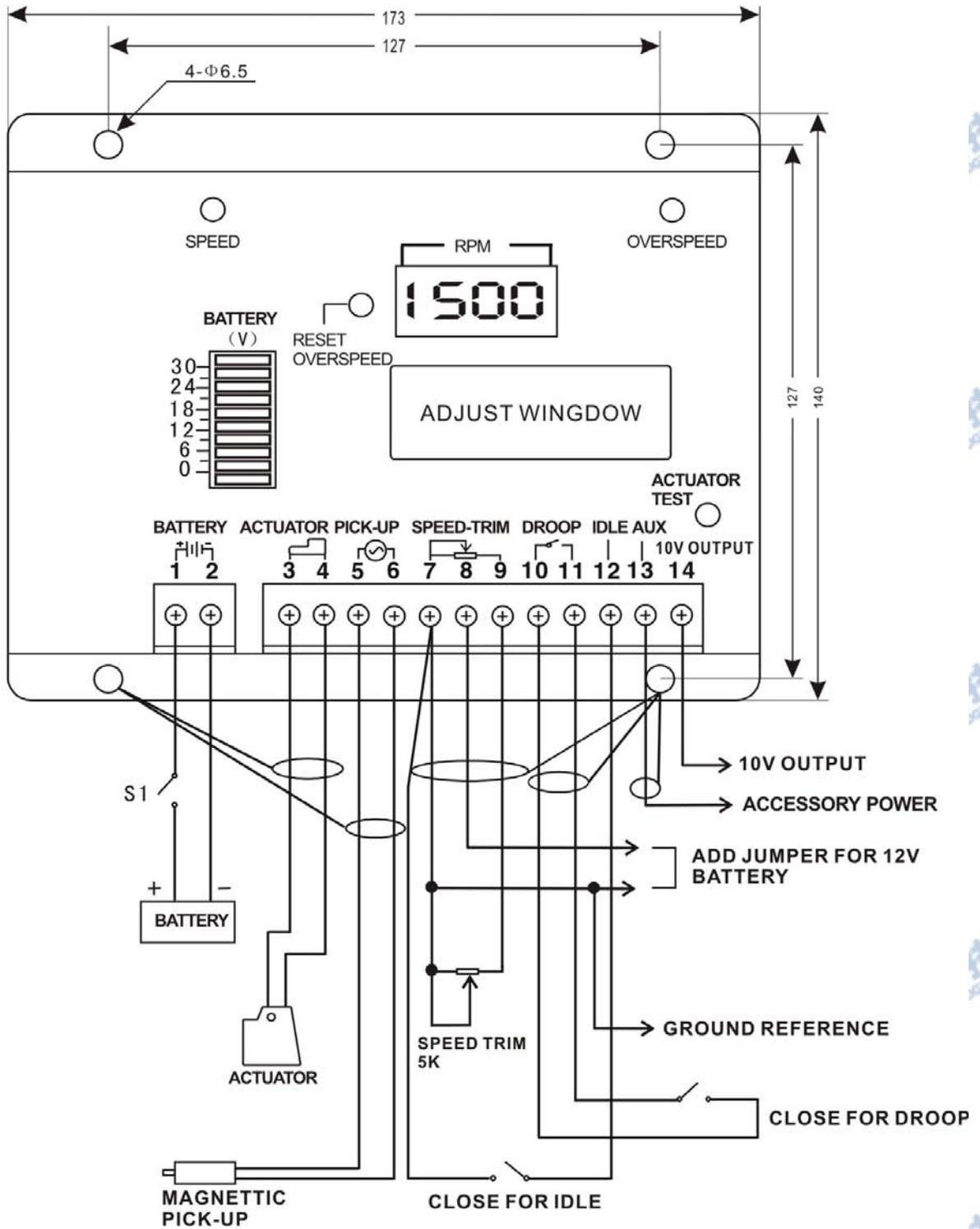


Fig.2 Electric connecting sketch map of the controller for normal generator

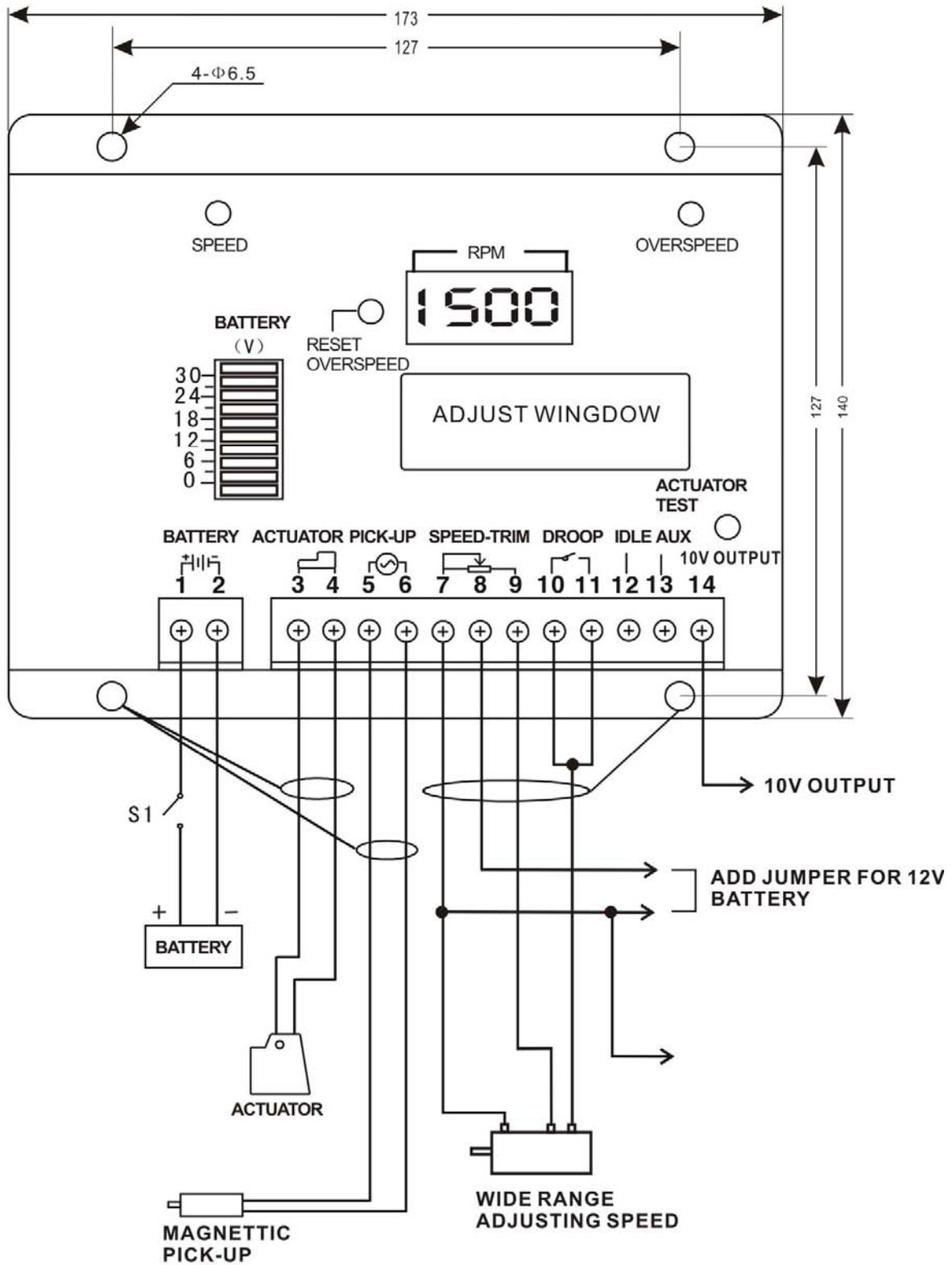


Fig.3 Electric connecting sketch map of the controller for a wide range of speed adjusting

Position of every adjusting components in window is shown in fig 4.

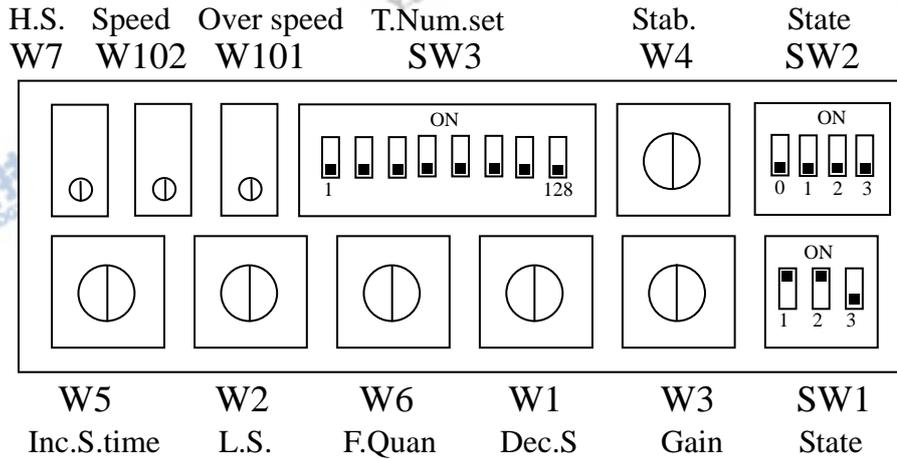
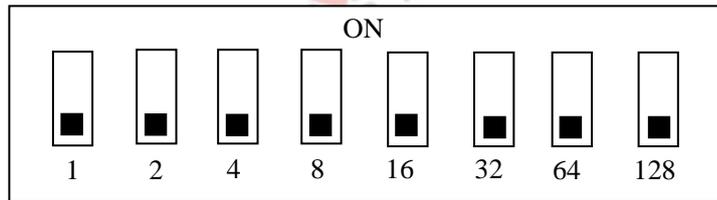
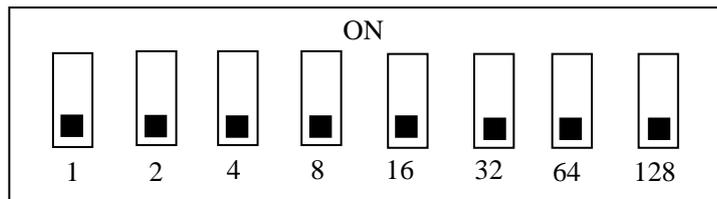


Fig.4 Debug window schematic diagram

● **Flywheel tooth number (SW3) setting**



As a 8 bit switch, SW3 is used for setting flywheel tooth number. When the switch is below, setting is effective. Number of every switch corresponding is shown in the before fig. Flywheel tooth number is the summation of every corresponding number below switch. For example:



$$\text{Flywheel tooth number} = 1+2+4+8+16+32+64+128=254$$

● **High and low speed adjustment**

Turn high and low speed switches to the low-speed position to start engine. After engine operating, if engine speed deviates from idle speed value, low speed setting potentiometer needs to be reset. Clockwise regulates, speed increase, and anti-clockwise regulates, speed decrease.

Turn high and low speed switches to speed up the engine from low speed to high speed. Look into tachometer indication at the same time adjust high speed potentiometer to speed the engine up to rated value. Clockwise regulation increases speed, and anti-clockwise regulation decreases speed.

After setting the idle and high speed value, inspect the rotate speed pulsating

rate, if it is over $\pm 0.25\%$ engine would be unstable. Adjust it to the demanded stable value by the following way.

High and low speed had been set when manufactured. Normally, this value is near from the user's engine working rotate speed value. In practice, after some adjustments, controller can achieve rated speed, and the stability would be very well.

- **Start-up fuel quantity (smoke intensity) tuning**

Turn high and low speed switches to low-speed positions until the engine could be placed in idle speed condition.

Adjust low speed potentiometer to demanded idle speed. Then anticlockwise adjust start fuel quantity potentiometer until engine speed begins dropping, then turn the potentiometer back forward until idle speed stability.

Let engine shutdown. Restart the engine. If it is difficult to start-up, increase the start-up fuel quantity.

Start-up fuel quantity is influenced by the surrounding temperature. In order to make engine easy starting up in every kind of weather, fuel potentiometer should be set at the increased position.

- **Raising speed time adjustment**

User can tune raising speed time potentiometer as required to determining required raising time from low speed to rated speed. Anticlockwise rotate for time shorten; and clockwise rotate for time expanding. While working, this time can be annually adjusted between 1.5 to 40 seconds.

- **Over speed protection setting**

Commonly, over speed protection had been set by the engine's type user supplied. There is no need to adjust. If it is necessary, do as the following way:

First, clockwise rotate the over speed potentiometer 3~5 circle.

Second, make the engine operating at the rated speed (commonly it is 1500r/m).

Third, adjust the high speed potentiometer to 1.1 times of rated speed.

Forth, anticlockwise rotate over speed potentiometer slowly till the over speed indicator light bright. At the same time, engine stop and over speed protection would have been achieved.

Fifth, push the over speed button, anticlockwise rotate high speed potentiometer for one circle. Then, restart the engine.

Sixth, adjust the high speed potentiometer to the rated speed. Then adjusting is over.

If it's necessary to validate the over speed protection value, please adjust the high speed potentiometer to make the rated speed rise. Adjust until over speed protection occurred and then readjust the high speed potentiometer to the rated speed.

● **Stability Adjusting**

The order of stability adjusting is low speed, high speed and rated load, all these three state achieve stability.

Stability adjusting mainly through adjusting gain、differential(stability adjusting) potentiometer. Gain potentiometer is used for adjusting the sensitivity of system. Clockwise regulate for increasing flexibility and anticlockwise regulate for decreasing flexibility. Differential (stability adjusting) adjusting potentiometer is used to adjust the respond time of system. Clockwise regulate for increase velocity of respond time and anticlockwise regulate for decrease. After gain and differential(stability) adjusting, engine’s state can achieve best.

Note: Low and high speed as well as on load stability correlate one another in some way. When tuning, all of the three must be noted and system’s stability under each of the three state can achieve best. After it is stable, gain must be set as much as big to insure the dynamic character achieve the best state.

Set up procedure of stability adjusting is shown in fig 5.

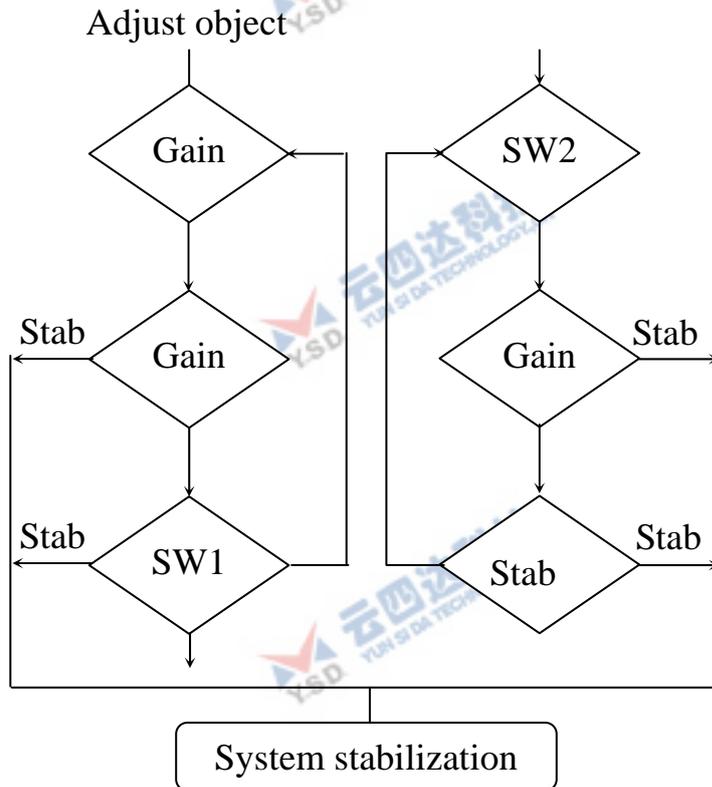


Fig. 5 Unsteadiness control procedure

Way of stability adjusting is: Start-up engine under factory condition, then inspect the stability state, if it is can't achieve requirement, adjust it as the following procedure.

First, tune the gain potentiometer. Clockwise rotate gain potentiometer. If instability increases, anticlockwise rotate gain potentiometer till stabilization appearance. If there is no stable point, rotate the potentiometer to a compared

stable position.

Second, adjust differential(stability) potentiometer. Clockwise rotate differential potentiometer. If instability increases, anticlockwise rotate differential potentiometer till stabilization appearance. If there is no stable point, rotate the potentiometer to a compared stable position.

After adjusting gain and differential potentiometer back and forth, normally, stabilization can appearance. If it is still instable, go on as the following procedure.

Third, adjust state switch. This part is shown in 5.2.4.

After adjusting state switch, go on the first and second adjusting procedure again. If it is still off within touch stabilization through the foregoing tuning, should inspect engine and fuel pump for service condition. And then, directly contact with manufacturer.

5.2.4 Condition tuning

The principle of condition tuning is different from that of gain and differential (stability) adjusting. The change of switch SW1's position will bring select frequency action. This action can decrease high frequency vibration in system while engine operating. Different position of state switch SW2 decides the differential function of governing system. This can improve and optimize the different engine system's dynamic character.

Commonly, if it is instability when there is no load, adjust SW1; if it's instability when there is on load, adjust SW2. Specially adjusting position is as follow:

- SW1 adjusting

Leave factory conditions of SW1 is , namely SW1-1, SW1-3 = OFF, SW1-2 = ON. This condition is suitable for the engine without fast wild effect.

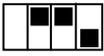
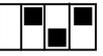
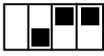
SW1-1, SW1-2 = ON, SW1-3 = OFF. This condition is suitable for the engine with fast wild effect.

So-called fast instability namely speed-rise, frequency instability increase quickly, vice versa slow down. Normally, through choose in these two conditions, diesel engine under medium can achieve ideal stable and dynamic character.

and SW1-1, SW1-2 = OFF, SW1-3 = ON and SW1-1, SW1-3 = ON, SW1-2 = OFF. This condition is suitable for fast precarious occasion owing to elastic fixing for engine and generator. It can match with diesel engines under medium.

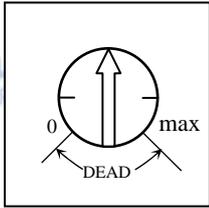
- SW2 adjusting

Leave factory condition of SW2 is , namely SW2-2. 3. 4 = OFF. This condition is suitable for small and medium type engine. As for other type engine, if instability occurred, especially when it is on load, dial the 3 switch of SW2 in turn to make the engine stable. The sequence is:

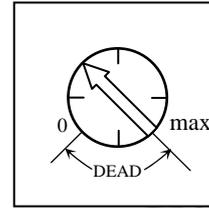
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5.2.5 Factory setting

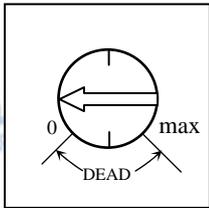
Start-up fuel quantity potentiometer



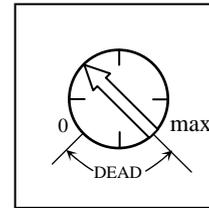
Rising time potentiometer



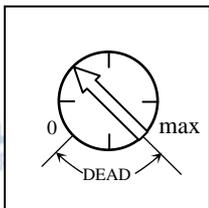
Gain potentiometer



Stability adjusting potentiometer



Low speed set potentiometer

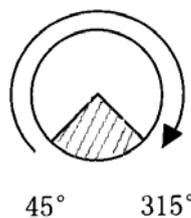


State switch 1、State switch 2



5.2.6 Caution Note for Tuning

The potentiometers for start fuel quantity, rising time, differential(stability), gain, decrease of speed and low speed regulation all are potentiometers which rotation angle is less than one turn. Their maximum action angle of adjustment is for 270 degree, as shown in following figure.





When user performs parameter tuning, must remember that cannot exceed this range to forcibly turn it, otherwise result in potentiometer breakage to cause malfunction such as engine shutdown, over speed, instability and more.

- High speed Potentiometers are multi-circle potentiometers for rotating 25 turns. Clockwise rotation increase given RPM level, and anticlockwise rotation decrease given RPM level.
- The foregoing potentiometer all are precision electronic components. When tuning, should slowly regulate with special tool to prevent from man-made breakage.
- If engine still can't work normally(can't start-up or rotating instable) after user adjusting it, please reset the controller to factory position. If you don't remember the factory position, turn each regulator potentiometer to middle position. Then restart-up engine, adjust it by the way in 5.2.3. On the other hand, user can attach with manufacture and adjust it by the technologist's guideline.

6 Guideline for Controller Breakdown Maintenance

6.1 Routine trouble shooting

If System cannot normal working, generality can perform inspection according to following methods.

- After powered on, inspect if the power is normal. Measure the voltage at the controller's terminal5 and 6 , this value is the same to the battery out-put voltage value. At the same time, power indicator light bright.
- After powered off, cut-off the linkage between terminal 3 and 4. Inspect the sensor resistance value, this value should be 450Ω or so.
- Inspect assemblage gap of speed sensing governor whether within stated range of 0.4 -0.8 mm.
- After powered off, cut-off the linkage between terminal 1 and 2. Inspect the actuator resistance value, this value should be 4.5Ω or so.
- Manual check actuator whether movement agility, as well as injection pump rack whether movement agility. Insure linkage between the two can move agility and without clamping stagnation.

After Rummage Malfunction, in general with relevant processing can enable speed governing system get right.

6.2 Special fault diagnosis list

Phenomena	Probable cause	Processing method
Engine cannot start-up	1.Wiring wrong, unreliable.	Wring right and reliable.
	2.Air exists in fuel piping.	Drain air in pipe.
	3.No rotate speed feedback signal.	Inspect speed sensor and/or cable.
	4.Governor power is connected inversely or too low.	Inspect connection and/or replacing new battery.
	5.Rack deactivation.	Remount and troubleshoot.
	6.Start-up fuel quantity set value too low.	Properly increase in start-up fuel quantity.
	7. Speed set too low.	Clockwise rotate low speed potentiometer to upgrade to idle speed condition.
Engine start-up over speed	1.Fuel can't cut off after actuator setting on pump.	Inspect and reset as well as readjust the actuator.
	2.Speed set of speed governing system too high.	Tune again to arrive at rated set value.
	3.Gain of controller is set too low.	Increase the value of gain.
	4.Governor is breakage.	Change for another controller.
Engine speed unsteady	1.Governor parameter misalignments.	Readjust gain, settling and/or condition switch.
	2.Assemblage gap of speed sensor over size..	Inspect and remount and tuning.
	3.Clamping stagnation or large backlash of transmission linkage between actuator and rack.	Inspect and remount and tuning.
	4.Governor is not match with actuator.	Change for a actuator matched or attach with manufacture.
	5.Engine Overload	Reduce engine loading.
	6.Shrouding wire connection unsuitable, EMI occurs resulting in instability.	Inspect connection of shrouding wire whether right and reliable.
Engine automatic stop	1.Governor power interruption.	Inspect power supply and/or tie cable.
	2.Feedback signal of rotate speed interrupt.	Inspect sensor and/or tie cable.

Phenomena	Probable cause	Processing method
Engine automatic stop	3.Actuator cable turnout, short circuit.	Inspect actuator and/or cable.
	4.Engine fuel supply failure.	Fueling and remove air within pipeline.
Engine cannot shutdown	1.Wrong zero position between actuator and engine fuel pump rack	Inspect and remount and tuning.
	2.Regulating mechanism of rack deactivation.	Inspect and remount and tuning.
Cannot adjust steady state speed droop of the system.	1.Governor is placed in "constant frequency" condition.	connect terminal 10and 11
Rotate speed display wrong	1.Rotate speed is set wrong	Power off, reset the position of switch

If abnormality occurs during governor installation, troubleshoot and use, please processes refer to above list. If Malfunction is still not remove after inspection and processing refer to above list, and confirm that engine system no Problem, please contact with manufacturing plant. User who is without service qualification does not blindness overhauling in order to prevent malfunction expand.



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