April 4, 1967 J. K. MACOMBER 3,311,998

SPEED CONTROL FOR READING PACER

Filed Feb. 7, 1966 3 Sheets-Sheet 1

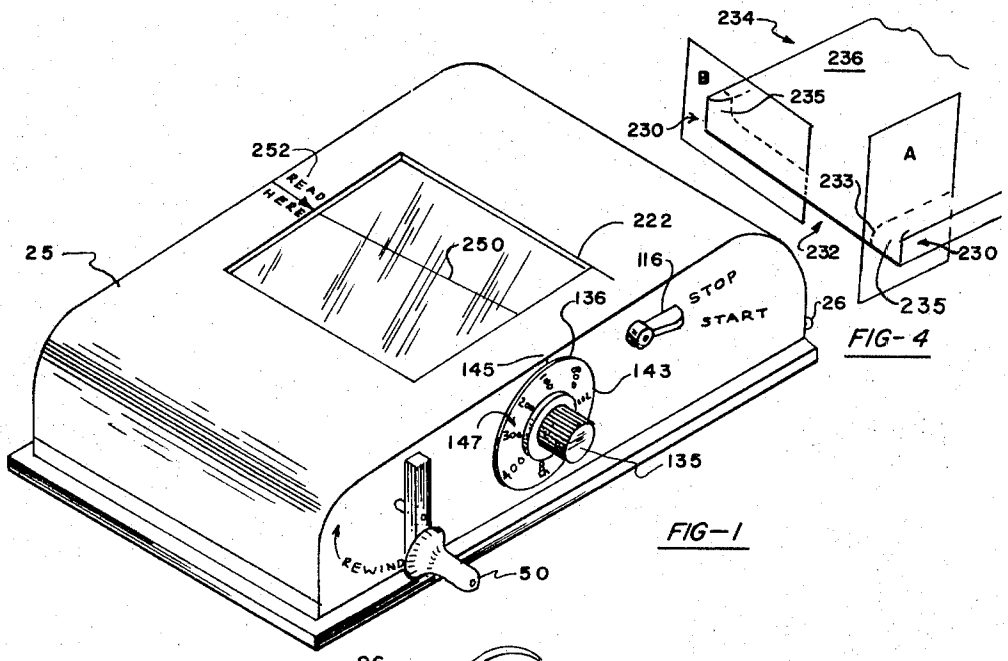


FIG-4

FIG-1

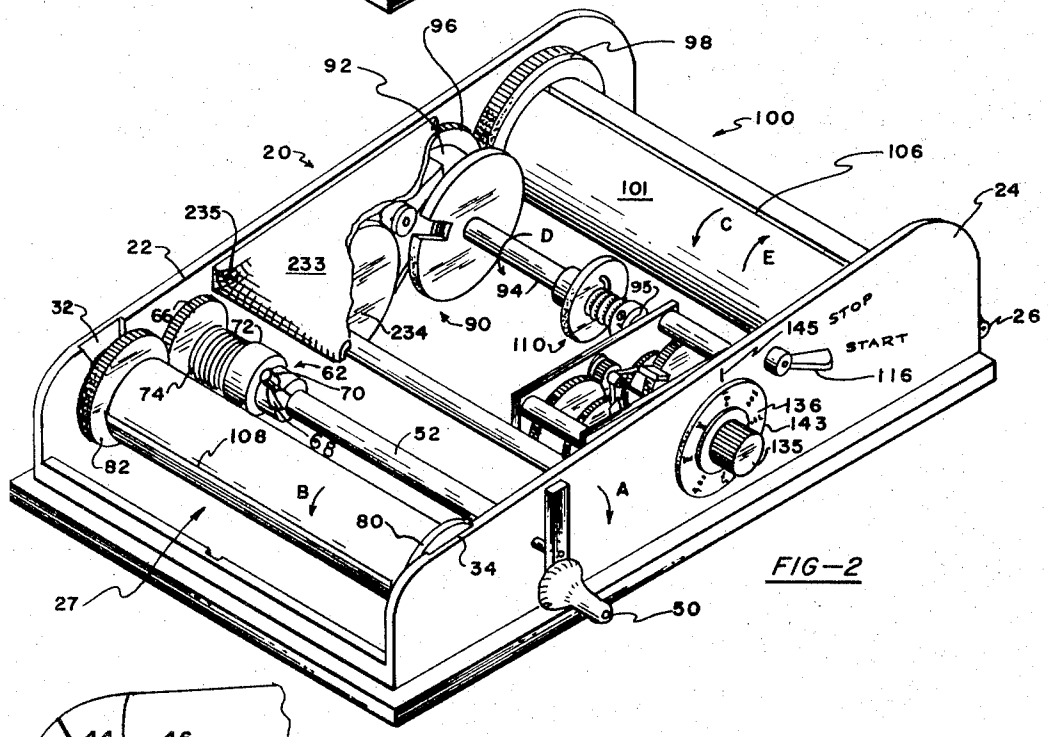


FIG-2

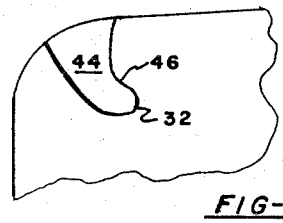


FIG-3

INVENTOR.
JAMES KEITH MACOMBER
BY
Edward Halle
ATTORNEY

April 4, 1967 J. K. MACOMBER 3,311,998

SPEED CONTROL FOR READING PACER

Filed Feb. 7, 1966 3 Sheets-Sheet 2

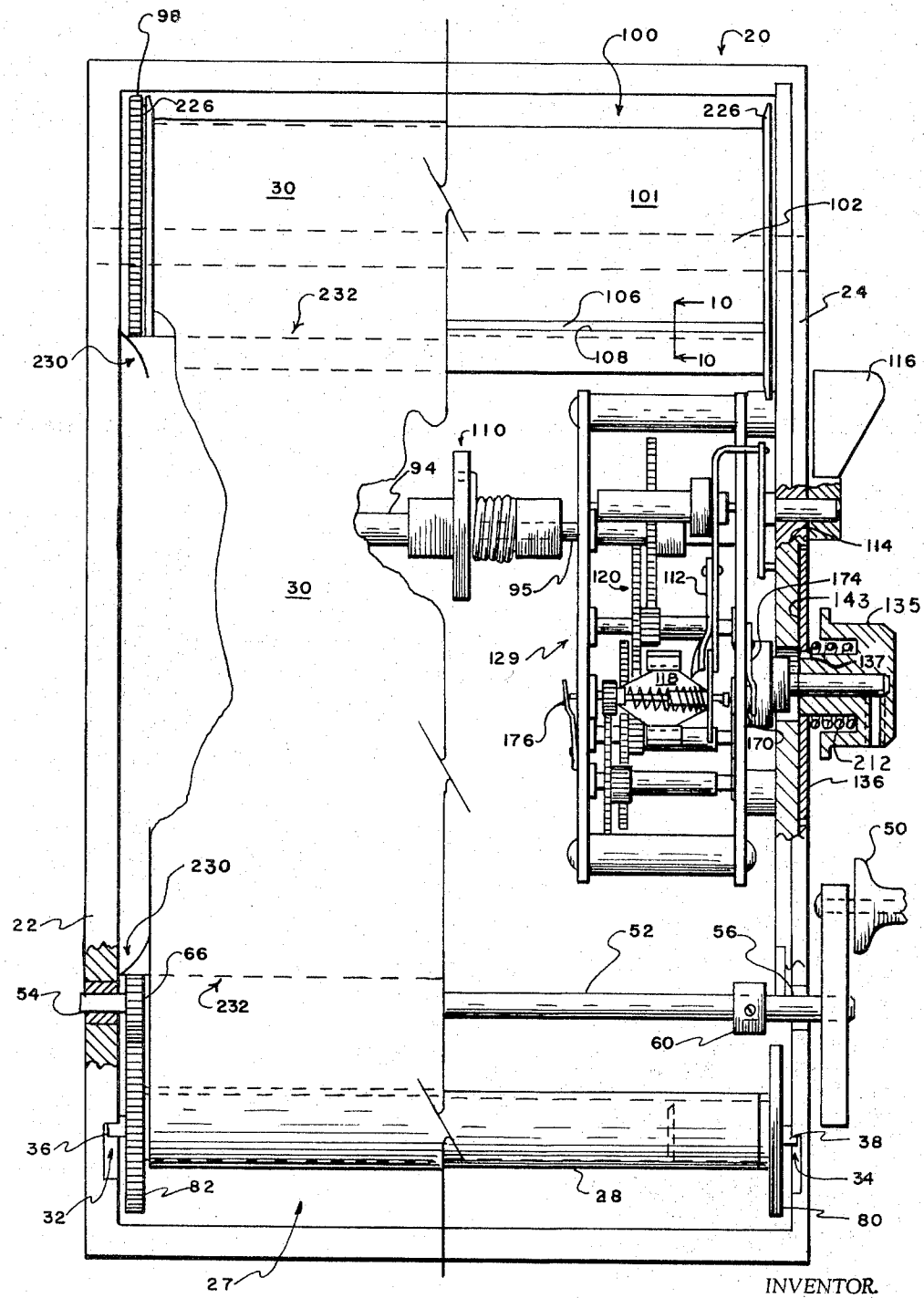


FIG-5

INVENTOR.
JAMES KEITH MACOMBER
BY Edward Halle
ATTORNEY

April 4, 1967 J. K. MACOMBER 3,311,998

SPEED CONTROL FOR READING PACER

Filed Feb. 7, 1966 3 Sheets-Sheet 3

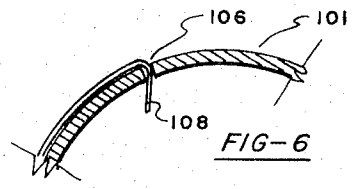


FIG-6

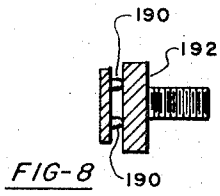


FIG-8

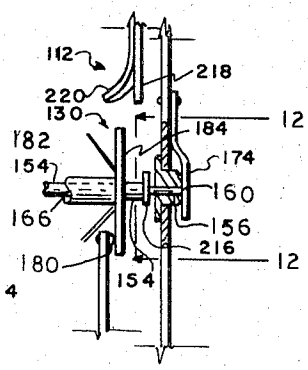


FIG-9

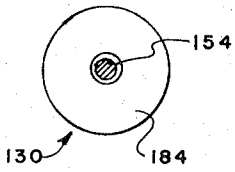


FIG-12

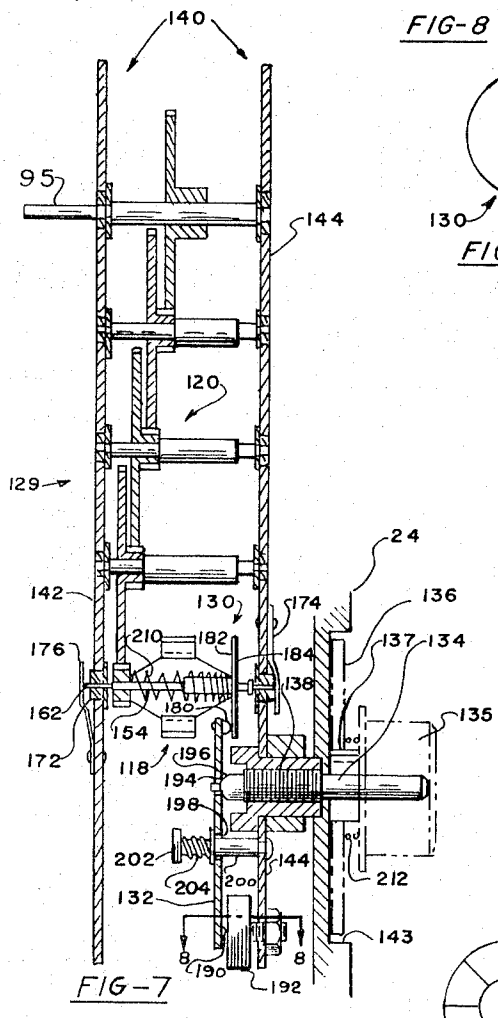


FIG-7

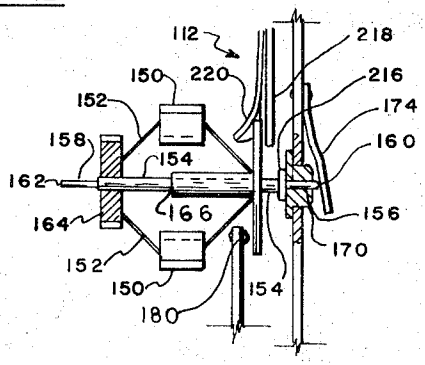


FIG-10

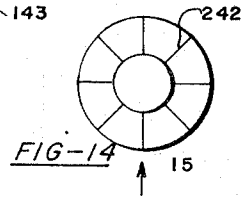


FIG-14

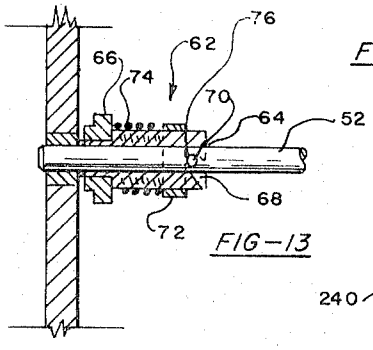


FIG-13

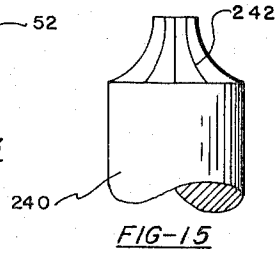


FIG-15

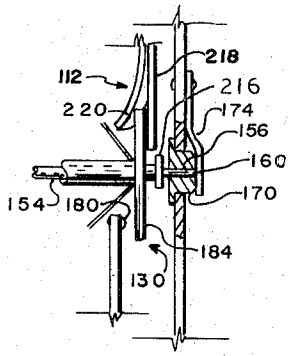


FIG-11

INVENTOR.
JAMES KEITH MACOMBER
BY Edward Halle
ATTY.

United States Patent Office 3,311,998
Patented Apr. 4, 1967

3,311,998

SPEED CONTROL FOR READING PACER

James Keith Macomber, Rockville Centre, N.Y., assignor to Consolidated Lithographing Corporation, Long Island, N.Y.

Filed Feb. 7, 1966, Ser. No. 525,637
22 Claims. (Cl. 35—35)

This invention relates to readers or reading pacers, and more particularly to devices designed to aid in teaching or helping a person to improve reading speed. Essentially, the device comprises a mechanism to run a web of printed material past a particular position, at controlled speeds, so that a person using the device may begin at a slow speed and work his way up to higher speeds to improve his reading speed.

It is an object of this invention to provide a reader in which the mechanism for transporting the web is spring wound, and in which the spring is rewound by the same manual operation required to reroll the web of material, thus eliminating a separate operation for rewinding the spring and rerolling the web.

It is also an object of this invention to provide a positive stop and start device which respectively stops and starts the web immediately.

It is a further object of this invention to provide a speed control comprising an indicator dial and control knob which operate in the direction of the increasing and decreasing speed.

It is another object of this invention to provide an observation station or window with a guide line medially located to aid the reader in maintaining his line of vision at a particular position while the web moves past.

Another object of this invention is to provide such a reading guide line at a fixed angle which will serve as a proper guide for all speeds at which the reader is run.

It is also an object of this invention to provide guides and other means in the mechanism to assure proper alignment of the web.

It is also an object of this invention to provide a web having program material arranged in such a manner that it will compensate for the increasing speed of the web due to the increasing size of the advance roll by reason of the increasing thickness of the web as it is rolled thereon.

Other objects and advantages will appear from the specification hereinbelow, and these objects and advantages are achieved with the device illustrated in the accompanying drawings in which:

FIG. 1 is a perspective view of the invention;

FIG. 2 is a perspective view of the invention with the cover removed and parts cut away to show the mechanism;

FIG. 3 is an elevational detail of a portion of a bearing wall of the invention;

FIG. 4 is a diagrammatic perspective view of the platen of the invention having imaginary planes intersecting the same to show the curvature of the edges of the said platen;

FIG. 5 is an enlarged top plan view of the device with the cover removed and parts cut away, parts in section and parts in phantom;

FIG. 6 is a detail in section of a portion of the drum cylinder of the advance roll of the invention;

FIG. 7 is a stretchout, partially in plan, partially in section and partially in phantom, of the speed control means of the invention;

FIG. 8 is a sectional view along the lines 8—8 in FIG. 7;

FIG. 9 is a detail, partly in section and partly broken away, of the start and stop brake unit, the governor, partly broken away, and associated parts of the invention

with the brake portion rotated into the plane of the drawing sheet for purposes of clarity, and showing the start-stop brake in first or running position;

FIG. 10 is a view similar to FIG. 9 (except that the governor portion has not been partly cut away) showing the brake in an intermediate position between the first or running position and the second or stop position;

FIG. 11 is a view similar to FIG. 9 showing the start-stop brake in second or stop position;

FIG. 12 is a sectional view along the lines 12—12 in FIG. 9;

FIG. 13 is a top view detail, partly in section, of the rewind clutch means;

FIG. 14 is the end of a cutting tool which is used to form the edges of the platen; and

FIG. 15 is an end elevation of the tool of FIG. 14 as seen from arrow 15 in FIG. 14.

Similar numerals refer to similar parts throughout the several views.

The reader mechanism consists of a spring motor, a speed control unit, a supply roll containing the web of paper upon which the program is printed, and the advance roll which transports the web past an observation station, or window. The controls, which are located on the side of the reader case, are the start-stop lever, the speed setting knob and dial, and the rewind handle.

The spring motor is equipped with stops to protect the mechanism and is connected to the speed control unit through a one-way over-running clutch. The purpose of the over-running clutch is to disconnect the speed control unit during remind so that the operator may be able to rewind the web and the spring motor rapidly with a minimum of torque. The act of rewinding the program web onto the supply roll automatically rewinds the spring motor. This is accomplished because the advance roll is reversed when the web is rewound from it to the supply roll; and since the advance roll is permanently geared to the spring motor, the spring motor is rewound by the reverse motion of the advance roll.

The case and the web transporting means

The invention is provided with frame means such as the frame, case, or housing **20** which comprises mechanism bearing means such as the bearing walls **22** and **24**. The case **20** comprises a cover **25** mounted on hinges **26**. The frame or housing and the cover may be made of any suitable material such as metal or plastic.

A supply roll **27** having a spindle **28** on which the web **30** is rolled, is fitted into supply roll bearings **32** and **34**, and rests on its hubs **36** and **38** within the bearings **32** and **34**. Bearings **32** and **34** are constructed in opposing relationship in the bearing walls **22** and **24** respectively, and comprise angled entry passages as designated by reference numeral **44** in FIG. 3 of the drawings. The purpose of the angled entry passages is to provide upper bearing points **46** to prevent the rolls **27** from being dislodged from the bearings **32** and **34** by varying the resultant forces of the mechanism and gravity in rolling and unrolling the web **30**. Gravity pulls down, but the web is under tension from the operation of the device, and this tension provides an upward component of force. The upper bearing points **46** will keep the rolls **27** in position against the resultant force.

The device also comprises a winding crank **50** which comprises a shaft **52** appropriately mounted on bearings **54** and **56** in the bearing walls **22** and **24** respectively. The shaft or rod **52**, which has a crank handle **50** fixed to an end thereof, is both rotatably mounted and permitted to slide axially to provide for a clutch mechanism. There is a collar **60** which prevents the shaft **52** from being dislodged. Freely mounted at one end of the shaft **52** is a rewind clutch means in the form of a cammed

coupling **62**. The cammed coupling **62** has a central through bore **64** and a pinion **66** at one end, and engaging slots **68** at the other end which are adapted to cooperate with an engaging pin **70** which is mounted transversely through the shaft **52**.

There is a sleeve **72** mounted on the coupling **62** and a spring **74** seated against the pinion **66** and the sleeve **72** exerting pressure against the sleeve which pushes the sleeve against the engaging pin **70**, and normally urges the engaging pin **70** away from the coupling **62**. The engaging slots **68** are provided with recesses **76**. The sides of the recesses **76** have a camming angle so that they may be disengaged from the engaging pin **70** by action of sleeve **72** and the spring **74**. When manual pressure is removed from the winding crank **50**, this disengages the crank shaft **52** from the coupling **62**. This comprises the clutch means.

It is to be understood that when a person winds the crank **50** in the direction of the arrow A in FIG. 2 of the drawings, he must first push the crank axially, inwardly, to engage the recesses **76** with the engaging pin **70**, and so long as the crank **50** is being wound, the recesses **76** will serve to hold the engaging pin **70** for a positive connection. When finger pressure is removed, the engaging pin **70** will be pushed away to break the connection.

The supply roll **27** may have a plain flange **80** at one end, and a gear wheel flange **82** at the other end. The gear wheel flange **82** is designed to mesh with the pinion **66** so that when the supply roll **27** is properly fitted into its bearings **32** and **34**, winding the crank **50** will rotate supply roll **27** in the direction of the arrow B shown in FIG. 2 of the drawings. This will serve to rewind or reroll the web **30** onto the supply roll **27**, and will also serve to rewind the spring mechanism of the device as will be more fully explained hereinbelow.

The spring mechanism and driving means

The device is driven by a potential energy motor **90** comprising a spiral spring **92** well known in the art, having stops to prevent it from being wound or unwound too much, which are also well known in the art. The spring mechanism is appropriately mounted on one of the bearing walls, such as wall **22**, or in any other suitable position in the frame **20**, and also comprises a drive shaft **94** and a driving gear **96** which meshes into a driven gear **98** of the advance roll **100**.

Advance roll **100** is in the form of a drum **101** which turns on a shaft **102** mounted in the walls **22** and **24**. The drum **101** and the driven gear **98** are meshed to rotate together to advance or transport the web **30** past the observation station or window **222**. The spring **92** is initially wound up with the palm of the hand by rotating advance roll **100** in a reverse direction such as that indicated by arrow C in FIG. 2 of the drawings, and when spring **92** unwinds, it causes drive shaft **94** and drive gear **96** to move in the direction of arrow D in FIG. 2 of the drawings, and causes drum **101** to rotate in the advance direction of arrow E. Drum **101** has one or more appropriate slotted means **106** within which to place leading edge **108** of web **30**. The spring **92** is initially wound by hand. After that, it is rewound by the crank **50** while rerolling the web **30**.

Speed control means

The speed control means **129**, which is connected to the motor **90** through drive shaft **94**, an overrunning clutch **110** and driven shaft **95**, comprises a governor **118**, a step-up gear train **120**, a speed control disc **130**, a speed control arm **132**, a speed setting member such as a shaft **134**, and a speed control knob **135** and speed setting dial **136**. The speed setting dial **136** is keyed at reference numeral **137** to the speed control knob **135** which in turn is fastened to the speed setting shaft **134** which has a mounting means such as the matched threads of the shaft

in a threaded mounting **138** in a frame element **144** of sub-assembly frame **140**.

The speed setting dial **136** is circular, and is fitted into a circular recess **143** in one of the bearing walls such as bearing wall **24** of the frame or housing **20**. Also, on bearing wall **24**, around recess **143**, there is a reference mark **145** which is used in conjunction with speed indicating means such as a speed setting scale **147** which is located on the dial **136**.

The governor **118**, which is a centrifugal flyweight type governor, is geared up by the gear step-up train **120** to run at a speed approximately 1200 times that of the potential energy, or spring, motor **90**. There are two flyweights **150** mounted on flyweight springs **152**. The governor **118** has a governor shaft **154** having journals **156** and **158**, the outer ends of which form pivot means **160** and **162**. The flyweight springs **152** are attached at one end to the governor shaft **154**, either directly or through a pinion or gear such as gear **164** attached to the shaft. Gear **164** is the connecting means between the governor and the step-up gear train **120**. The flyweight springs **152** may be attached to the governor shaft **154** by any other means. The other ends of the flyweight springs **152** are attached to the speed control disc **130** which has a central opening **166** which is positioned around the said governor shaft **154** for axial movement along the said governor shaft. For purposes of clarity, we shall define journal **156** and pivot means **160** as the disc end journal **156** and the disc end pivot means **160**. Journal **158** and pivot means **162** will be defined as the gear end journal **158** and the gear end pivot means **162**. It is to be understood that the terms "disc end" and "gear end" as used in connection with the journals and pivot means are for purpose of definition of location only since in another form of construction, the gear, which may be attached to the governor shaft, may be located in some other position than at the end of the shaft. This would be considered to be an equivalent construction however.

The journals **156** and **158** are mounted in radial bearings in the frame **140** of the speed control means **129**. Outside of the radial bearings **170** and **172**, flat springs **174** and **176** are mounted. The governor shaft **154** should be longer than the distance between the outsides of bearings **170** and **172**. In other words, pivot means **160** and **162** should be further apart than the outsides of the bearings, and as a result, if disc end pivot means **160** is maintained in the same plane as the outside opening of bearing **170** by means of flat spring **174** seating against both the pivot **160** and bearing **170**, then gear end pivot means **162** will protrude outside of bearing **172**. The spring **174** at the disc end of the governor is relatively the stronger of the two, and will normally rest against the outside of the radial bearing **170** with a more positive force than spring **176** which bears at the gear end of the governor, and said spring **176** will normally be pushed away from the outer face of radial bearing **172** of frame element **142** because gear end pivot means **162** will protrude by reason of the more positive force of spring **174** at the other end. This insures that the governor shaft **154** will be located with pivot means **160** held in contact with spring **174** which remains seated against the outer face of bearing **170** at all times except when the brake **112** is initially applied. This will be more fully described hereinbelow. The two flat springs **174** and **176** will, therefore, form pivot bearings together with the pivot means **162** and **160** of the shaft **154**, and spring **174** will be known as the normally fixed spring, and spring **176** may be called the normally floating spring.

The centrifugal governor **118** controls the rate of feed of the web of paper **30** while the reader is in operation, and the purpose of the two flat springs is to fix the position of the governor shaft **154** axially. During normal operation, pivot means **160** at the disc end of the governor shaft will continue to bear against the normally fixed flat spring **174** without lost motion. When the

reader is started, the torque of the spring motor 90 causes the governor 118 to accelerate. As the speed of the governor 118 increases, centrifugal force causes the flyweight spring combination to expand and causes the disc 130 to move along the governor shaft 154, toward the gear end. The governor 118 will continue to accelerate and the disc 130 will continue to move along the governor shaft 154 until it engages a contact means or point, such as speed control friction contact 180, at the end of the speed control arm 132. Upon engaging the friction contact 180, the governor 118 will accelerate slightly further until a speed is achieved where centrifugal force on the weights 150 will cause the disc 130 to bear on the friction contact 180 and cause a frictional braking torque on the governor 118 which is equal to the useful torque of the spring motor 90 exerted on the governor 118. At this point, the mechanism will cease to accelerate and will run at constant speed. Thus, the speed of the device is controlled by the position of speed control friction contact 180.

The speed control governor is a precision device. The change in axial position of the governor disc 130 for a speed difference of 500 words per minute is approximately .050 of an inch. It is thus apparent that a small error in the position of the governor disc 130 or in the friction contact 180 at the end of the control arm 132 would result in an appreciable error in the web speed in words per minute. It would be impractical to make the parts with a sufficient degree of accuracy to achieve the desired precision as the instrument is assembled by mass production methods. For this reason, a calibration method is provided, as follows:

The control arm 132 is provided with the speed control friction contact 180 at one end, as described, made of a brake material for engaging the governor disc 130. The engagement is normally at the gear end side 182 of the disc 130. The other side of the disc 130 may be called the disc journal side 184. At the other end of the speed control arm 132 are two raised points 190 which bear upon the head of a calibrating screw 192. Near the friction contact 180 end, there is a circular hole 194 which engages the spherical end 196 of the speed setting shaft 134 upon which the speed setting knob 135 and the speed setting dial 136 are mounted. Between this hole 194 and the calibration points 190, there is another hole 198 in the control arm 132. Through this hole 198 there extends a post 200 which is riveted to, or fastened to, or a part of the frame element 144 of the speed control sub-assembly frame 140, and this post 200 is provided with a head 202 and a spring 204 which holds the control arm 132 in place in the speed control assembly 140.

The control arm 132 is thus provided with a three point mounting consisting of the spherical end 196 of the speed setting shaft 134 and the two points 190 which rest upon the head of the calibrating screw 192. The friction contact point 180, the center of the spherical surface 196 on the end of speed setting shaft 134, and the points 190 resting upon the calibration screwhead 192 are all located in the same plane. It is thus apparent that the linear motion of the speed control friction contact 180 in the axial direction of the governor is proportional to the angular motion of the speed setting dial 136. The spring 204 on the post 200 which locates and holds the arm 132 against the three point suspension system removes all lost motion in the speed setting part of the speed control means 129. Thus, after assembly at the factory, an adjustment of the fricion contact point 180, with relation to the governor disc 130, may be made by turning screw head 192, to insure that the web 30 speed will correspond to the scale 147 of the dial 136.

The two flat pivot springs 174 and 176 eliminate all lost motion in the governor 118. The effect of this relationship is that the speed control friction contact 180 will accurately repeat its position over and over for any given speed setting of the dial, and the disc 130 of the governor 118 will repeat its position exactly over and over for any given speed of its rotation. The combination of these qualities together with the calibrating screw 192 assures very accurate speed setting of the speed control unit.

In a flyweight governor 118, as described so far, the motion of the disc 130 will not be proportional to the speed of the governor. For example, assume that the flyweights 150 are spaced one-half of an inch apart and the angle of their supporting springs 152 with respect to the governor shaft is approximately 45°. Now, if an accelerating torque is applied to the governor 118 through the gear system 120, the governor 118 will pick up speed and the centrifugal force caused by the tendency of the weights 150 to fly outward will be proportional to the square of their linear velocity divided by the radial distance between the weights and the center of the governor shaft. Since the spring angles are approximately 45° to the governor shaft 154, and since the increase in radial distance due to the outward motion of the weights is proportionately small compared to the large increase in the speed of the governor, it follows that the axial motion of the disc 130 starting at its zero speed relaxed position will be roughly proportional to the square of the speed of the governor. Since, as stated before, the motion of the friction contact point 180 is proportional to the rotation of the speed setting knob 135 and dial 136, it follows that the speed control for a simple governor 118, as just described, would require a nonlinear speed setting dial 136 with a rapidly expanding scale. For instance, let us assume that the dial was graduated from zero to 500 words per minute, which would be equivalent to a governor speed varying from zero to 2,500 r.p.m. For this condition, the distance between the 400 and the 500 graduations might be nine times as great as the distance between the zero and the 100 graduations. This is undesirable because such a large proportion of the speed setting dial 136 is used up in the upper speed range that it is not possible to make accurate speed adjustments at the lower end of the speed range. To remedy this situation, a helical spring 210 is placed on the governor shaft between the governor drive gear 164 and the disc 130. This helical spring 210 is fitted so that when the governor 118 is relaxed in the zero speed position, the helical spring 210 is also relaxed and, therefore, is not under pressure. The helical spring is wound with a nonlinear pitch. The coils are wound very closely at one end, but not quite touching, and the distance between the coils gradually increases, as shown in the illustration FIG. 9. The action of this helical spring 210 is as follows:

When the governor 118 is relaxed, the coils are all active since none touches the other adjacent to it. When the governor accelerates in speed, the disc moves along the shaft of the governor and closes up the coils of the helical spring one by one until, at maximum operating speed, only a fraction of the coils are still active. As the helical spring 210 is compressed, its reactive force is not proportional to the distance it is compressed. Due to its nonlinear pitch, the reactive force builds up at an increasing rate as the spring is compressed. In the speed control unit described, the inventor has developed a combination of flyweight governor 118 and helical spring 210, which has caused the governor disc 130 to move from its relaxed position a distance which is closely proportional to the speed throughout the speed range as used in the reader. This has allowed the use of a speed setting dial 136 which is uniformly graduated throughout the useable speed range with negligible errors in speed indication. An expansion spring 212 is seated between the speed dial 136 and the manual speed setting knob 135. This will take up lost motion in this part of the system.

After a reading lesson on a web 30 is run through the machine, it is necessary to rewind it onto the supply roll before removing same and inserting the next lesson. Since, in many cases, the rewinding will be done by chil-

dren, it is desirable to have the rewind torque on the rewind handle **50** as low as practical. There is thus a practical limitation on the torque required to wind the potential energy, or spring motor, since the spring motor **90** is rewound at the same time that the paper web **30** is rewound onto the supply roll. Since the spring motor torque must be kept small in order that it may be rewound by a child, it follows that the bearing friction and the moment of inertia of the governor **118** about its axis, as well as the friction of the connecting gearing, must be kept as low as practical in order that the spring motor **90** will be able to accelerate the machine up to the set speed within a few seconds after the start lever **116** is pushed. To this end, the governor **118** has journal bearings and radial bearings of a very small diameter, and the ends **160** and **162** of the shaft **154** are rounded to form pivot bearings against the hardened steel flat springs referred to before as the normally fixed pivot spring **174** and the normally floating pivot spring **176**. The normally fixed pivot spring **174** constitutes a thrust bearing which is capable of withstanding the thrust caused by the pressure of the governor disc **130** against the speed control friction contact **180**. Except for a small component of gravity, this is the only force working against this bearing (components **160** and **174**) during the normal running of the machine.

The start-stop mechanism

The starting and stopping of the device is actuated by the start-stop lever **116** connected to a brake **112**, through means such as brake shaft **114**. It is most desirable to stop the machine in a fraction of a second, and a special braking means has been provided in the brake **112** for this purpose as follows:

The stopping action is caused by the disc **130** being engaged and held by the stop brake **112**. This is illustrated in FIGS. 9, 10 and 11 of the drawings. Stop brake **112** has a rigid finger **218** and a springy finger **220**. While the machine is running, the stop brake **112** is in a first position away from the said disc **130**. The rigid finger and the springy finger form a V shape with the outer ends of the fingers of the V shape at least as great a distance apart as the axial distance travelled by disc **130** along governor shaft **154** throughout the speed range of the device. Thus, when the stop brake **112** is moved from a first or running position to a second or stop position, the disc **130** will be grasped between the fingers **218** and **220**, and will be prevented from rotating. This will stop the governor and the device will stop instantly. The first or running position is illustrated in FIG. 9 of the drawings. The second or stop position is illustrated in FIG. 11 of the drawings. It will be seen that when the device is in the second or stop position, the disc journal side **184** of the disc **130** will lie against the rigid finger **218** and be held against the said rigid finger **218** by the springy finger **220**.

The stopping action, as described, causes a thrust on the normally fixed pivot spring **174** some ten times as great as the normal thrust of the speed control friction contact **180**. It is necessary to protect this pivot bearing (components **160** and **174**) against this abnormal thrust to prevent it from prematurely wearing out.

There is a stop means such as a collar, or shoulder **216**, on the governor shaft **154** which is normally spaced a few thousandths of an inch away from the inner face of the radial bearing **170** when the machine is running. The shoulder **216** is maintained in this position by the normally fixed pivot spring **174** which rests with a positive force against the outer face of the radial bearing **170**. This positive force of the spring **174** against the outer face of radial bearing **170** is of an order of magnitude of two to three times the normal force exercised by the speed control friction contact **180** against the governor disc **130**. So, during the normal running operation of the machine, the governor **118** is maintained very accurately in position, and the shoulder **216** of the governor shaft remains spaced slightly away from the inner face of the radial bearing **170**. The normally floating pivot spring **176** at the other end of the governor, being weaker than the normally fixed pivot spring **174**, maintains this relationship without lost motion.

When the start-stop lever **116** is raised, the stop brake **112** goes to second position to be applied to the governor disc **130**, and the thrust on the governor shaft **154** now becomes many times as great as the positive force of the normally fixed pivot spring **174** against the bearing **160**. This action thrusts the whole governor shaft **154** toward spring **174** as illustrated in FIG. 10 of the drawings. The pivot spring **174** is, therefore, deflected until the shoulder **216** on the governor shaft **154** comes in contact with the inner face of the radial bearing **170**. This is a contact of large area compared to that of the pivot bearing **160** against spring **174**, and is able to carry the load due to stopping the machine without damage to either the governor **118** or its bearings. While this stop action is going on, the normally floating pivot spring **176** follows up the axial motion of the governor shaft **154**. When the stopping action is finished, the axial load on the governor **118** is reduced and the normally fixed pivot spring **174** returns to its position in contact with the outer face of radial bearing **170**, and the shoulder **216** on the governor shaft moves out of contact with the inner face of the said radial bearing. The fingers **218** and **220** will then hold the governor disc **130** in a position where it is not touching the speed control friction contact **180** and where the governor shaft shoulder **216** is not in contact with the inner face of the radial bearing **170**. It is, therefore, in a position for easy starting when the start-stop lever is depressed to the start position. As a matter of fact, when the brake **112** is moved from second, or stop position, to first, or running position, the movement of the fingers away from the disc serves to give the disc **130** an initial rotational push to aid in starting.

Loading and running the device

To load the reader, a roll **27** containing the reading lesson is dropped into the slots **32** and **34** at the receiving end of the machine. The free end **108** of the paper web **30** is then threaded manually into a slot **106** in the drum **101** of the advance roll **100**, after checking to make sure that the spring motor **90** is fully wound. This check is made by turning the advance roll **100** backward with the palm of the hand until it causes the spring **92** to strike against a limit stop on the motor **90**.

The reader is started by pressing down on the start-stop lever **116**. The speed is set by turning the speed control knob **135** until the speed setting dial **136** reads the proper number of words per minute desired against the index mark on the case. The spring motor **90** will now drive the advance roll **100** through connecting gearing and cause the paper web **30** containing the reading lesson to be transported from the supply roll **27** to the advance roll **100**, passing all the while under the observation window **222** in the cover. After the lesson is completed, and it is desired to rewind the web **30** back onto the supply roll **27**, the student presses in the crank handle **50** in order to engage the crank through a clutch and connecting gearing to the supply roll **27** so that when the handle is turned, the supply roll **27** will turn backwards and, thereby, rewind the paper web on the supply roll **27**. This rewind action causes the advance roll **100** to turn backwards as the web so is pulled from it. The action of the advance roll **100** turning backwards rewinds the spring motor **90**.

It will be understood that the supply roll **27** is removable and replaceable with other supply rolls **27** having webs **30** with other program material. In addition to having replaceable rolls **27**, it may sometimes be desirable for a particular roll to be rerun at a particular point. For example, at some point on the roll, there may be an instruction to wind it back to a previous point so that the program material can be reread. Thus, the mechanism of the device is synchronized in the sense that winding the

roll 27 back a given length will partially rewind the spring 92 providing it with sufficient force to rerun the roll 27 for the length that it has been rewound.

Another feature of the device is that the overrunning clutch 110 permits the roll 27 to be rewound even when the device is running without applying brake 112. The overrunning clutch 110 will maintain a positive drive relationship with shaft when shaft 94 rotates in the direction of arrow D as shown in FIG. 2 of the drawings, as when the device is running and the web 30 is being advanced on the advance roll 100. On the other hand, when the advance roll 100 is being rotated in a direction to wind the spring 92, the shaft 94 will rotate in a direction opposite to arrow D, and the overrunning clutch will permit shaft 94 to slip freely. This feature is provided to insure that the spring 92 can be rewound easily and quickly without being obstructed by the speed control mechanism.

Web guide and alignment means

The paper web 30 is under considerable tension during the rewinding process so, in order to reduce the torque on the rewind handle, the rewind handle shaft 52 is geared down to the supply roll 27 by a two to one ratio. (Gears 82 and 66.) Paper webs 30 cut into strips twelve or fifteen feet long and five inches wide, which are preferably used with the device, are never straight. Paper webs 30 of this kind are always curved to a greater or less degree, sometimes as much as one-eighth of an inch to the foot or more. Sometimes the curvature runs in one direction for a few feet and then reverses to a curvature in the other direction. When a curved web is rewound onto the supply roll 27 under tension, as is the case in this reader, it tends to weave from side to side and wind unevenly. If it was under any considerable tension while being advanced to the advance roll during the next reading lesson, it would tend to wind unevenly even to a greater degree on the advance roll. The effect is cumulative and a repetition of this advance and rewind cycle several times under tension would cause the paper to wind so unevenly as to tear at the edges and destroy its usefulness. This is a serious problem in paper winding devices of this kind because the paper cannot be controlled by edge pressure if there is any considerable tension in the paper. Tension causes friction against the supporting surface which prevents the paper from being pushed sidewise without tearing the edges. This problem is solved in the present reader as follows:

The web is caused to advance onto the advance roll under practically no tension. This is accomplished by mounting the supply roll in free bearings 32 and 34 and by allowing the rewind handle 50 to be disengaged by spring 74 during the advancing part of the cycle. The advance roll 100 has flanges 226 at its ends which are about three-sixteenths larger in radius than the cylindrical part or drum 101 of the advance roll 100. That part of each flange extending away from the roll for the first eighth of an inch is perpendicular to the axis of the roll. From thereout the flanges have a slight taper by being rounded, flared or bevelled away from center. The paper is cut to a close tolerance in width, and is caused to fit closely between the flanges on the advance roll, allowing only enough tolerance to cover manufacturing errors.

Since the web 30 is advanced under practically no tension, it easily complies with the edge control exercised by the flanges on the advance roll 100, and is caused to wind on the advance roll 100 in an even manner. The total thickness of the roll of paper on the advance roll is approximately an eighth of an inch for about a fifteen foot length of paper. The rewind roll has a gear 82 at one end and a flange 80 at the other end. These both act as flanges but not as guides since the distance between them is about an eighth of an inch greater than the width of the paper. This situation allows room for the paper to wind unevenly on the rewind supply roll when it is under tension, as described above, and, therefore, cannot be guided by edge control.

When the same program, or supply roll 27, is used again and the paper web 30 is advanced during a reading lesson to the advance roll 100, it will be again under practically no tension and, therefore, can be guided by the flanges 226 on the advance roll to wind evenly on the advance roll 100. It is thus apparent that this cycle of advance and rewind can be repeated indefinitely without damage to the paper so long as the paper is wound accurately and evenly during the advancing part of the cycle, and so long as there is plenty of clearance for the roll to wind unevenly while under tension during the rewind part of the cycle. In other words, it tends to run wild during the rewind, but is corrected each time when wound on the advance roll during the reading lesson.

In order that the paper may not run too wild during the rewind, it is kept under partial control by means of rounding edges 232 downwardly and flaring the ends 230 of the edges 232 outwardly, at the advance end and at the rewind end of the platen 234.

The edges 232 of the platen are rounded by providing an arcuate shape along each edge 232 having downward roundings 233 except at the extreme ends 230 where there are outward flares 235. The flares 235 and the roundings 233 comprise true arcs of circles taken in proper vertical planes perpendicular to the face surface 236 of the platen 234. For the downward roundings 233, the vertical plane should be as illustrated in A in FIG. 4 of the drawings, that is, perpendicular to both the face and edge 232 of the platen. For the outward flares 235, the vertical plane should be parallel to the edge 232 and perpendicular to the face 236 as shown in B in FIG. 4 of the drawings. These flares and roundings are fabricated into the edges 232 of the platen 234 by means of a special rotary cutting tool 240 having a shape similar to a truncated cone, except that the sloping cutting edges 242 of the tool 240 are not straight lines, as would be the case with a truncated cone, but are arcs of a circle as illustrated in FIGS. 14 and 15 of the drawings.

During the rewind process when the paper web 30 is under tension and tends to weave left or right, it tends to climb up on the outward flares 235 thereby stretching its climbing edge, making it longer. For instance, if the right edge of the paper is shorter than the left, the web 30 will curve toward the right as viewed in the direction of rewind motion, and will tend to "steer" to the right when moving. As the web steers to the right, it will "climb" the flared portions 235 of the platen and, being under tension, the right edge of the web will stretch in order to follow the longer path. The right edge will continue to climb and stretch until it becomes long enough to cause the web to "steer" or weave in the other direction; e.g., to the left. Thus, the web weaves to a certain extent while being rewound under tension, but the errors are kept within plus or minus one-sixteenth of an inch so long as the web is corrected and wound evenly each time it is advanced under practically no tension, as described above.

Speed ratio compensation means for length of web

It will be understood that as a 15 foot web reels onto the advance roll 100, the diameter of the roll becomes thicker, and as a consequence, the web will be pulled faster. This increase in speed can be compensated for either by diminishing the length of each line of the web, or groups of lines, from the beginning to the end of the program material on the web, or by increasing the distance apart of the said lines from the beginning to the end of the said program material on the web 30. Thus, as the web 30 goes faster as it advances, by either diminishing the length of succeeding lines or increasing the distance between them, this increase in speed will be compensated for. In the preferred form of the inven-

tion, speed compensation is provided by diminishing the length of succeeding lines.

The guide line of the device

The device is provided with a guide line **250** which is next to an indicator such as the words "Read Here" together with an arrow **252**. Inasmuch as the eye travels on the guide line **250** from left to right in reading English, by the time the eye has completed this travel along one line of the program material of a web **30**, it will have advanced somewhat in the direction of the motion of the web **30**, relative to the window **222**. A guide line **250** has been provided for this device which will act to compensate for this advance of the web **30** as the eye travels along the line. The compensation is accomplished in a guide line **250** which may be located at a medial position in the observation station **222**. The guide line **250** should form an acute angle when viewed with relation to any single line of printed material on the web **30** when an end of such line of printed material is superimposed by a portion of the said guide line **250** when viewing the web **30** through the observation window **222**. The acute angle thus formed would have its apex toward the left when viewing the observation window **222** of the device. I have found that an angle in which the tangent of the angle is between 0.6 and 1.0 times the distance between the centers of the lines on the said printed program material on the said web **30**, diivded by the length of a line of the said printed material, will provide a satisfactory acute angle for the guide line, depending upon the aptitude of the one who is reading. The preferred angle is one in which the tangent of the angle is 0.8 times the distance between the centers of the lines on the said printed program material on the said web **30**, divided by the length of a line of the said printed material.

While I have described my invention in its preferred forms, there are many forms which it may take as equivalent structures without departing from the spirit and scope of the invention, and I, therefore, desire to be protected for all forms coming within the claims hereinbelow.

Wherefore I claim:

1. A speed control mechanism for a device actuated by a main drive through a rotary drive shaft comprising:

(a) a frame comprising a pair of bearings,

(b) a governor comprising a governor shaft with ends adapted to bear against the said bearings of the frame,

(c) a plurality of flyweights connected to flyweight spring means, said spring means being fixed with relation to said governor shaft at one end thereof, and fixed with relation to a disc at the other end thereof, said disc having a central opening positioned around the said governor shaft for axial movement along the said governor shaft,

(d) a speed setting member mounted through a portion of said frame on mounting means having means to provide for movement of said speed setting member with relation to said frame,

(e) a control member mounted on said frame including contact means contacting the said disc, calibration means in combination with said frame and in contact with said control member to calibrate the speed setting member, and engaging means to coact with the said speed setting member and with said control member, and

(f) means to connect the said speed control mechanism to the main drive of the device.

2. The speed control mechanism as defined in claim **1**, in which

(g) there is a pivot at the outermost end of the journal at the disc end of the governor shaft and a pivot bearing located on the frame outside of the bearing at the disc end of the governor shaft, said bearing at the disc end of the governor shaft being a radial bearing.

3. The speed control mechanism as defined in claim **2**, in which

(h) the said governor shaft has a shoulder facing the radial bearing at the disc end of the governor shaft, said shoulder being positioned between the said disc and the said radial bearing.

4. The speed control mechanism as defined in claim **3**,

(i) in combination with a start-stop lever comprising an end having a rigid finger and a springy finger together forming a V shape with the distance between the open ends of the V shape formed by the fingers being at least as great as the axial distance travelled by the disc during all speeds of the device, and with the open ends of said fingers being positioned to include the said range of positions of the said disc between them, said lever being adapted to move from a first position away from the said disc to a second position at which the said disc is grasped by the said fingers.

5. The speed control mechanism as defined in claim **4**, in which

(j) the said rigid finger of the start-stop lever is positioned with relation to the springy finger so that it will engage the disc journal side of the said disc when the start-stop lever is in the second position.

6. The speed control mechanism as defined in claim **2**, in which

(k) the said pivot bearing comprises spring means.

7. The speed control mechanism as defined in claim **2**, in which

(l) the said speed setting member and the said frame have means with matching threads to provide for axial movement of the said speed setting member with relation to the said frame when rotated,

(m) said speed setting member being provided with manual turning means having indicating means thereon, and said frame having indicating means thereon in combination to form a speed setting scale.

8. The speed control mechanism as defined in claim **7**, which includes

(n) a governor shaft spring, located around the said governor shaft, having helical coils of varying pitch, seated between the said disc and that portion of the governor shaft to which the said flyweight spring means are fixed, and in which

(o) the said speed setting scale comprises indicating marks spaced substantially equal distances apart with the distance between said marks representing substantially equal differences of the speed of the device.

9. A speed control mechanism for a device actuated by a main drive through a rotary drive shaft comprising,

(a) a frame comprising a pair of radial bearings,

(b) a governor comprising a governor shaft with journals on each end adapted to rotate within the said radial bearings of the frame, and said shaft having pivot means at the outer end of each of said journals,

(c) a plurality of flyweights connected to flyweight spring means, said spring means being fixed with relation to said governor shaft at one end thereof, and fixed with relation to a disc at the other end thereof, said disc having a central opening positioned around the said governor shaft for axial movement along the said governor shaft,

(d) a speed setting member mounted through a portion of said frame on mounting means having means to provide for movement of said speed setting member with relation to said frame,

(e) a control member mounted on said frame includ-

ing brake contact means contacting the said disc, calibration means in combination with said frame and in contact with said control member to calibrate the speed setting member, and engaging means to coact with the said speed setting member and with said control member, and

(f) means to connect the said speed control mechanism to the main drive of the device.

10. The speed control mechanism as defined in claim **9**, in which

(g) the outermost ends of the said pivots are further apart than the outermost ends of the said radial bearings, and a pair of springs of different relative strength are positioned on said frame and adapted to provide bearings for the outermost ends of the said pivots.

11. The speed control mechanism as defined in claim **10**, in which

(h) the said pair of pivot bearing springs comprises a first spring and a second spring in which the said first spring is of greater relative strength than the said second spring and is located on the frame outside of the radial bearing at the disc end of the governor shaft, and the second mentioned spring is located outside of the radial bearing at the other end of the governor shaft.

12. The speed control mechanism as defined in claim **11**, in which

(i) the said governor shaft has a shoulder facing the radial bearing at the disc end of the governor shaft, said shoulder being positioned between the said disc and the said radial bearing.

13. The speed control mechanism as defined in claim **12**,

(j) in combination with a start-stop lever pivoted to the said frame and comprising an end having a rigid finger and a springy finger together forming a V shape and positioned with the distance between the outer ends of the fingers of the V shape so formed at least as great as the axial distance travelled by the disc during all speeds of the device, and with the ends of said fingers being positioned relative to said range of positions of the said disc, said lever being adapted to pivot from a first position away from the said disc to a second position at which the said disc is grasped by the said fingers.

14. The speed control mechanism as defined in claim **13**, in which

(k) the said rigid finger of the start-stop lever is positioned with relation to the springy finger so that it will engage the journal side of the said disc when the start-stop lever is in the second position.

15. The speed control mechanism as defined in claim **11**,

(i) in which the said speed setting member and the said frame have means with matching threads to provide for axial movement of the said speed setting member with relation to the said frame when rotated,

(j) said speed setting member being provided with manual turning means having indicating means thereon, and said frame having indicating means thereon in combination to form a speed setting scale.

16. The speed control mechanism as defined in claim **15**, which includes

(k) a governor shaft spring, located around the said governor shaft, having helical coils of varying pitch, seated between the said disc and that portion of the governor shaft to which the said flyweight spring means are fixed, and in which

(l) the said speed setting scale comprises indicating marks spaced substantially equal distances apart with the distances between said marks representing substantially equal differences of the speed of the device.

17. A governor comprising:

(a) a governor shaft with journals at each end adapted to rotate within radial bearings in the frame, and said shaft having pivot means at the outer ends of said journals,

(b) a plurality of flyweights connected to flyweight spring means, said spring means being fixed with relation to said governor shaft at one end thereof, and fixed with relation to a disc at the other end thereof, said disc having a central opening positioned around the said governor shaft for axial movement along the said governor shaft,

(c) the outermost ends of the said pivot means being further apart than the outermost extremities of the said radial bearings, and a pair of pivot bearing springs of different relative strength being positioned on said frame and adapted to provide bearings for the outermost ends of the said pivot means.

18. The governor as defined in claim **17** which includes

(d) a second spring means adapted to be positioned around said shaft with its ends seated within the governor, comprising a helical spring having a plurality of turns of non-uniform pitch.

19. The governor as defined in claim **17**, in which the said

(d) governor shaft has a shoulder facing the radial bearing adapted to receive the journal at the disc end of the governor shaft, said shoulder being positioned between the said journal and the said disc.

20. A governor speed control device comprising

(a) a frame including a speed setting shaft mounted for axial movement with relation to the said frame,

(b) a control arm mounted on said frame including a contact means contacting a speed control means in a governor,

(c) calibration means in combination with said frame and in contact with said control arm to calibrate the speed setting shaft, and

(d) engaging means to coact with the said speed setting shaft and with said control arm.

21. A starting, stopping and braking device for a governor adapted to act on a governor disc having axial movement for positioning relative to the speed of the governor comprising

(a) a main frame with a start-stop lever mounted on the said frame and comprising

(b) an end having a rigid finger and a springy finger together forming a V shape and positoned with the distance between the outer ends of the fingers of the V shape so formed at least as great as the axial distance travelled by the disc during all speeds of the device, and with the ends of said fingers being positioned relative to said range of positions of the said disc,

(c) said lever being adapted to move from a first position away from the said disc to a second position at which the said disc is grasped by the said fingers.

22. A speed control device comprising

(a) a main frame including governor means: comprising

(b) a speed setting member mounted on said main frame connected to said speed indicator means,

(c) means for manually setting said speed indicator means and said speed setting member to selected speed positions,

(d) a speed control member mounted on said main frame including contact means for contacting the said governor means to control the speed of the governor,

(e) calibration means in combination with said frame and in contact with said control member to calibrate the speed indicator means, and

(f) engaging means to coact with the said speed setting member and with said control member.

(References on following page)

References Cited by the Examiner

UNITED STATES PATENTS

647,503	4/1900	MacDonald	188—187
676,463	6/1901	Hilton	188—187
841,819	1/1907	Rumely et al.	37—546 X
1,066,586	7/1913	Creech	188—187
1,352,419	9/1920	Herschede et al.	188—187
1,386,855	8/1921	Ewing	267—1

1,483,647	2/1924	Vasselli	188—187
1,976,304	10/1934	Stoiber	188—187

FOREIGN PATENTS

360,214	2/1906	France.

EUGENE R. CAPOZIO, *Primary Examiner.*

W. GRIEB, *Assistant Examiner.*

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,311,998 April 4, 1967

James Keith Macomber

It is certified that error appears in the above identified patent and that said Letters Patent are hereby corrected as shown below:

In the drawings, Sheet 2, the reference numeral 114 shown at Fig. 5 identifies the brake shaft where it passes through the housing. Column 1, line 6, "Filed" should read -- Continuation-in-Part of Application Serial No. 331,573, December 18, 1963. This application --. Column 2, line 31, "remind" should read -- rewind --. Column 9, line 8, after "shaft" insert -- 94 --; line 55, after "three-sixteenths" insert -- inch --. Column 11, line 29, "diivded" should read -- divided --. Column 13, line 72, "distances" should read -- distance --.

Signed and sealed this 25th day of August 1970.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

WILLIAM E. SCHUYLER, JR.
Commissioner of Patents