

Development of Variable Mowing System (VMS)

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ABSTRACT

要 旨

The HRX217 lawnmower was developed for general consumer use based on the key concept of maximizing performance in both the bagging and mulching modes of operation. Performance has been increased by the development of a variable mowing system (VMS). The variable mowing system allows the customer to select either the bagging or mulching configuration for their lawnmower by easily rotating a lever. This gives the customer a never before achieved control on the performance of his/her lawnmower. Notably, this is done without the customer having to remove or replace any parts, or use any tools. The VMS technology was also achieved without an increase in cost to the customer over existing mulch plug technology. Lastly, the VMS significantly reduced the overall quantity of grass clippings collected in the bagging mode, therefore reducing the environmental impact of grass clipping disposal.

芝刈り性能(収納モード及びマルチングモード)の向上をねらいとして、一般消費者向けの芝刈り機 HRX217 を開発した。芝刈り性能向上は、可変型芝刈りシステム(VMS)の開発で達成できた。従来の芝刈り機は、部品の取り外し無しでは芝刈りモードの変更が出来なかったが、本システムの採用によって、お客様が、VMSレバーを操作するだけで手軽に芝刈りモードの選択をできるようになった。また、本システムは、既存のマルチプラグ機種と同等のコストを達成できた。最後に、本システムは、収納モードで収集される刈り芝を大幅に削減でき、刈り芝の廃棄処理が環境に及ぼす影響も削減できた。

1. Introduction

Approximately 5 million lawnmowers are purchased in the USA each year. As part of our lawnmower developments, we strive to provide new and innovative features to improve the lawn mowing experience for our customers. It was during interviews with customers that we noticed an increasing number of lawnmower users that want to be able to bag a portion of their lawn and mulch the remaining (Fig. 1). The existing models can accommodate this situation, but the customer is required to remove parts from the mower and store them. Many times these parts are lost or inconvenient when the customer is ready to change modes.^{(1), (2)} From this customer demand, the variable mowing system (VMS) (Fig. 2) was developed, and this report will detail the background of this development.

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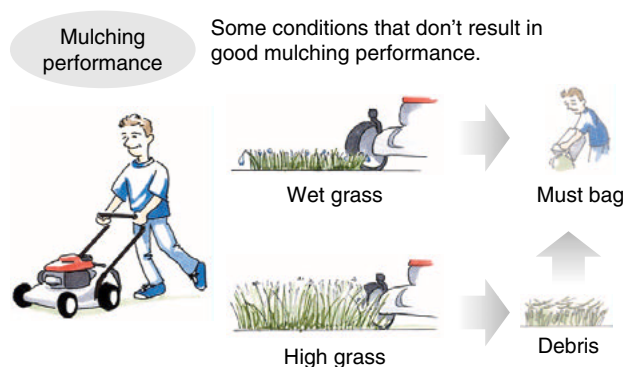


Fig. 1 Mulching performance

Development Goals

The development concept for this product was defined as a high-performance lawnmower that anyone can easily operate. In specific terms, the goals were as follows:

- (1) Attain best in class performance in both mulching and bagging modes (this normally requires two separate models each designed for their respective purpose)
- (2) Increase the convenience for the customer to convert between mulching and bagging modes. Achieving this ability without the use of any tools was also a goal of the development.
- (3) Provide new functionality by allowing a partial mulch/bag operation that allows the customer to choose what

- percentage of grass clippings were mulched or bagged.
- (4) Improve bagging performance by increasing the distance which the customer can mow between bag clearings, while maintaining the high appearance standards expected by the bagging customer.

2. Basic Configuration

Table 1 lists the major specifications of the HRX217 lawnmower shown in Fig. 3.

The HRX217 distinguishes itself from other lawnmowers by its main new technology, the VMS. The VMS is exclusive to the Honda HRX, and this is the first machine in the world to use such a technology. The VMS itself consists of several components which replace the conventional mower mulch plug (Fig. 4).

Table 1 Major specifications of HRX217

Item	Specification
Model name	HRX217
Engine model name	GCV190
Engine type	Air cooled single cylinder OHC 4-stroke
Engine displacement	187 cm ³
Maximum power	6.5 HP
Dry weight	43 kg (95lbs)
Blade diameter	530mm / 21"
T/M speeds	3
Maximum speed	1.75m/s (4mph)
Height adjust range	19 – 100 mm (3/4" - 4")
Wheel diameter	228mm (9")



Fig. 3 HRX217 PP1 Machine

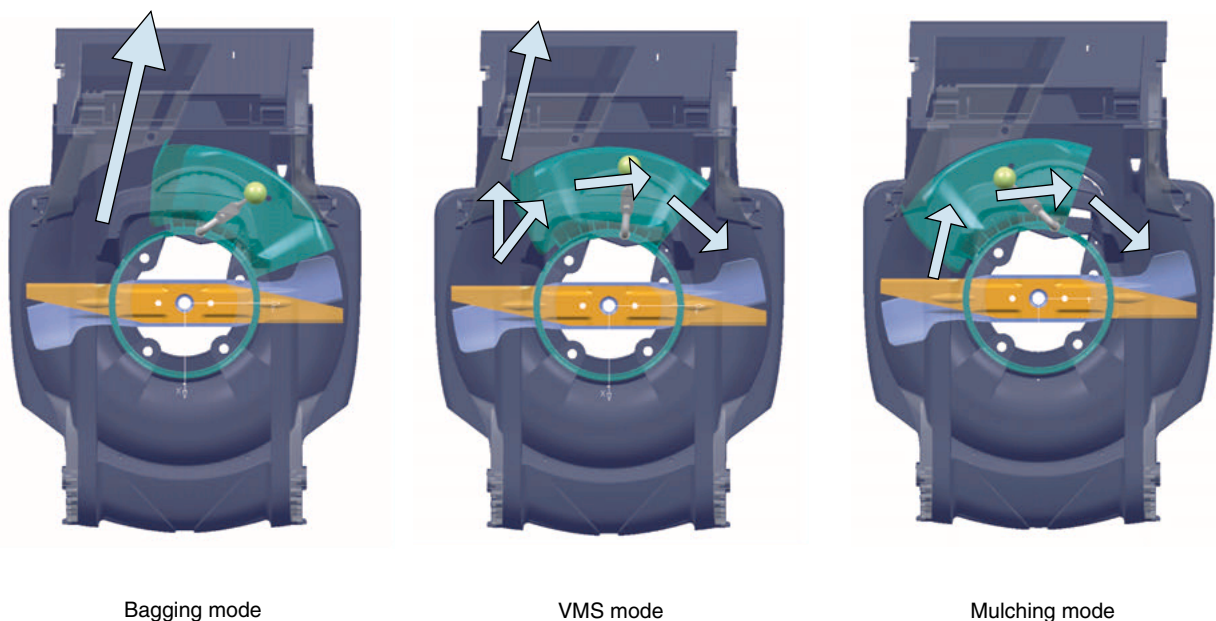


Fig. 2 Clipping path in various modes of VMS

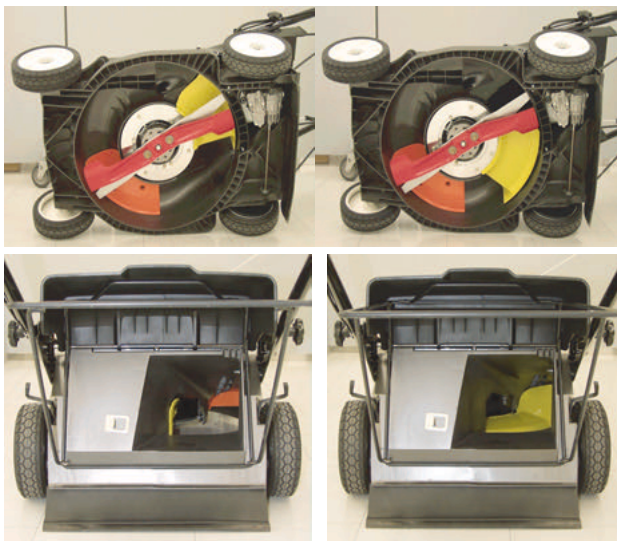


Fig. 4 Mulch plug part from previous model

The grass flow with the VMS can be controlled by merely rotating a lever behind the engine to place the mower in either mulch mode, bag mode, or somewhere in between. This allows the customer to select their lawnmower's mode at any time, on the fly, without the need for additional parts or the use of hand tools. The direction of the grass clippings is controlled by means of a rotating shutter scroll located under the housing and



Fig. 5 Clip director (VMS) control area model



Bagging mode → Mulching mode

Fig. 6 Prototype in both positions

hidden from operator view. As the customer rotates the convenient lever on the top of the mower (Fig. 5), the shutter is placed to either allow clippings to escape through the back of the mower into the bag, or when the lever is placed in the mulch position, the shutter scroll closes off the bag chute and diverts grass clippings to the ground for mulching (Fig. 6).

This actuation is achieved by means of a lever that rotates on a boss molded into the polymer cutter housing of the lawnmower. This lever is held in its various positions by means of notches molded into the opening in the cutter housing which the lever is installed. These notches provide not only the full mulch and full bag positions, but also 8 positions between. These additional settings allow the customer to choose the amount of grass clippings which are bagged or mulched, depending on their own preference and lawn conditions.

Several different constructions were considered before arriving at the final shape seen in Fig. 7. Some ideas which the team evaluated included a shutter which closed across the bag chute in a linear path. This proved to be difficult to support in the outermost position and was abandoned in favor of the rotating type of shutter. Once the final shape and configuration was chosen as the rotary type (Fig. 7), the shape was modified numerous times in order to maximize the flow of grass clippings and minimize clogging of the opening to the bag chute. After showing this concept to customers in focus groups, the sales division decided to name this feature the "Clip Director" (Fig. 5). This name conveys the ability of the customer to direct the grass clippings



Fig. 7 VMS mechanism & components

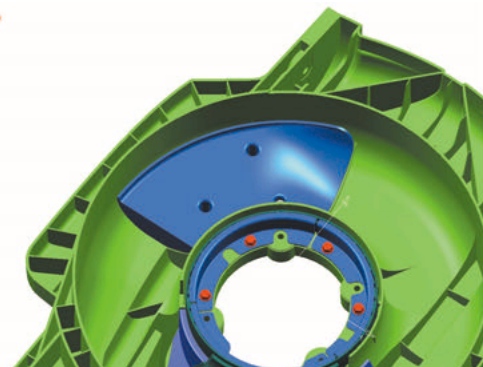


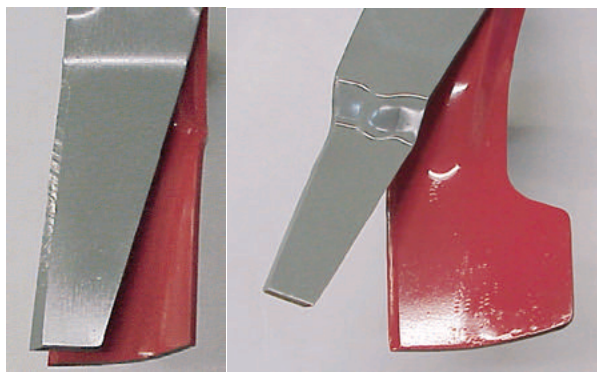
Fig. 8 Ramp scroll

as they want for their own conditions. It is also important to note that the Honda HRX217 is the first Honda mower to achieve the specification of “4 in 1” in the box. In other words, without purchasing any additional parts, the customer can mulch, bag, discharge, or leaf shred (four functions by one machine, also known as 4 in 1). This is a milestone achieved only by the introduction of this model.

The improved performance of the HRX217 lawnmower in the bagging mode was achieved by the use of ramp scroll (Fig. 8).

This scroll is added to the underside of the cutter housing slightly forward of the rotating shutter scroll. The ramp scroll provides a downward airflow just before the beginning of the bag chute. The airflow helps reduce the number of clippings directed into the bag, and forces some clippings into the blade to be cut into smaller sizes before being stored in the bag. The ramp scroll also decreases the cross sectional area of the cutter housing at the entry to the bag chute. This decreased area causes an increase in air velocity which helps prevent grass clogging during mulching and VMS operation, and helps fill the bag more efficiently during bagging. The ramp scroll is an integral part of the VMS system and helps improve its overall performance significantly.

The improved performance in the mulching mode was achieved by several changes. New blade shapes were introduced with the primary design change being an increased offset between the upper and lower blades cutting edges (Fig. 9). This allows for a more efficient



Previous model → Newly developed

Fig. 9 Blade offset change

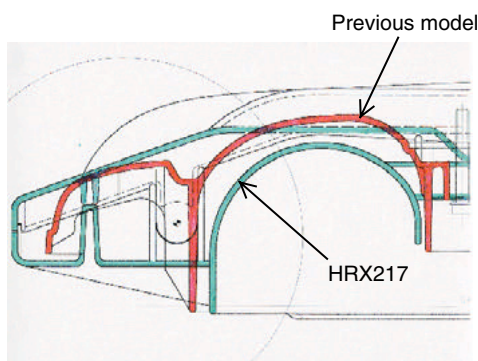


Fig. 10 Cutter housing shape change

cutting of the grass with less clogging of the cutter housing under severe conditions. The most significant effect on the mulching performance was achieved by optimizing the cutter housing shape itself (Fig. 10).

Allowing enough volume for the amount of grass clippings cut, while maintaining enough vacuum lift to pull the clippings up into the housing, is the key to a good housing shape. Also, the clearance between the tip of the blade and the cutter housing was reduced in order to improve the ability of the cutter housing to circulate clippings until they are cut to smaller size. Lastly, the scroll ramp (Fig. 8) improves mulching by diverting clippings from the upper portion of the housing back into the blade, resulting in smaller clippings as well.

3. Performance

The bagging performance of a lawnmower is based on two fundamental aspects. First is filling the grass catcher as full as possible between bag clearings. Second is traveling as far between bag clearings as possible to save time. The VMS system accomplishes both extended distance and fully filling the bag.

The VMS system's performance envelope is best illustrated in Fig. 11. The illustration is divided up into 3 zones: bagging, mulching and VMS. The performance zones are predominately defined by grass conditions (height, thickness, dampness) and distance to completely fill the grass bag. The bagging zones are divided up in four vertical zones. Each zone expands out as distance increases and grass severity decreases. Fundamentally, closing the VMS shutter cuts the grass into smaller pieces and places the smaller grass particles back into the lawn which ultimately increases the distance. As the condition becomes more severe, the VMS must be opened to achieve the same performance as in a dry condition. The horizontal zones are to define the traditional lawnmowers limitations when grass conditions become severe. The limitation of traditional

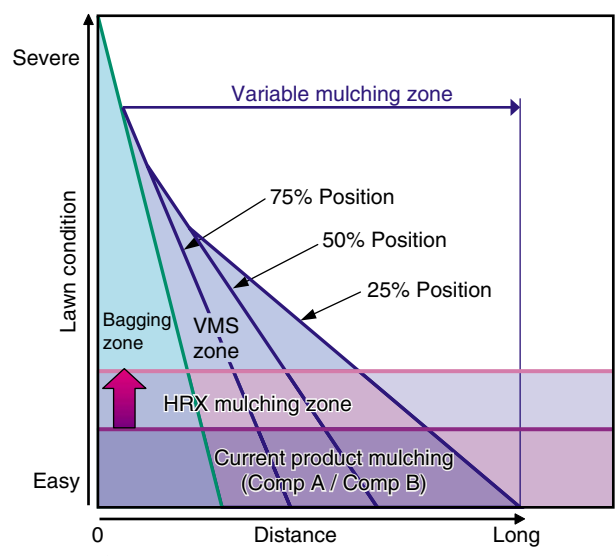


Fig. 11 VMS performance envelope

lawnmowers occurs due to dedicated modes; either 100% mulching, or 100% bagging. When the grass condition becomes more severe, the ability to use both modes (VMS mode) is instrumental in achieving the improved performance. As for the HRX217, the VMS expands the performance into a more severe condition because of the combination bagging / mulching of grass clippings.

Another way to illustrate mowing performance is by showing how it effects the customer's time and convenience. Many municipalities are restricting grass clippings to be placed in the landfills. This has caused an increase in the desire for mowers that produce less

yard waste. The VMS system is the answer to this environmental trend. The chart shown in Fig. 12, illustrates how opening the VMS shutter (35%, 50%, 75%, etc) decreases the amount of times the grass catcher fills up. In optimum conditions, bag emptying decreases by up to 66% when compared to a traditional lawn mower that has fixed operation modes. The shutter position (in column one) helps illustrate this function.

The third column, distance, is the distance required to fill one typical grass bag. The added distance to fill the grass bag translates into less bags to dispose of. The fourth column, bag clearings, is the expected number of bags you might have over a typical 1/4 acre lawn.

The mowing distance is shown in Fig. 13. The actual data shows how the mowing distance varies between grass bag clearings. The grass is held within the housing for a longer period of time before passing through a narrower opening in the discharge chute. The added time in the deck will cause the particles of grass to become smaller, and in doing so, the mower is able to pack clippings tightly into the grass bag. This effect increases the distance between grass bag clearings.

4. Summary

The following achievements were made in the development of the variable mowing system for the HRX217 walk-behind lawnmower:

- (1) Along with normal mulching and bagging modes, the VMS system also provides new functionality allowing the customer to find an optimal mowing position in between mulching and bagging that recycles some of the grass to the ground, while still giving the clean look of bagging.
- (2) The customer's optimal VMS setting leads to less bags of grass collected over the entire lawn than the bagging mode by increasing the distance to fill the bag by partially mulching. This equals less bags of clippings at the curb, which will cost most customers less money for services to collect, and will be better for the environment.
- (3) Customer convenience was increased by allowing them to convert from bagging, to mulching, to anywhere in between with the ease of turning a lever. No extra mulch plugs or tools are required to do so as in conventional lawnmowers.
- (4) The shape and configuration of the cutter deck, blades, rotating scroll, and the deflection scroll developed for the VMS system resulted in the best pure mulching and pure bagging cut quality of any single Honda lawnmower.
- (5) A rotating shutter scroll was developed for the VMS system which rotates just above the blade in the path of the cut grass. Developing the shape and durability of this part was the key to the performance of the VMS system.
- (6) The VMS system, while adding convenience and excellent performance, does not add any extra cost to the customer over a conventional system.

Shutter position	Job type	Distance (/ Bag)	# of Dumping
100%	Bagging		12
75%	VMS		8
50%	VMS		6
25%	VMS		4
0%	Mulching		0

Fig. 12 VMS bag performance at different settings

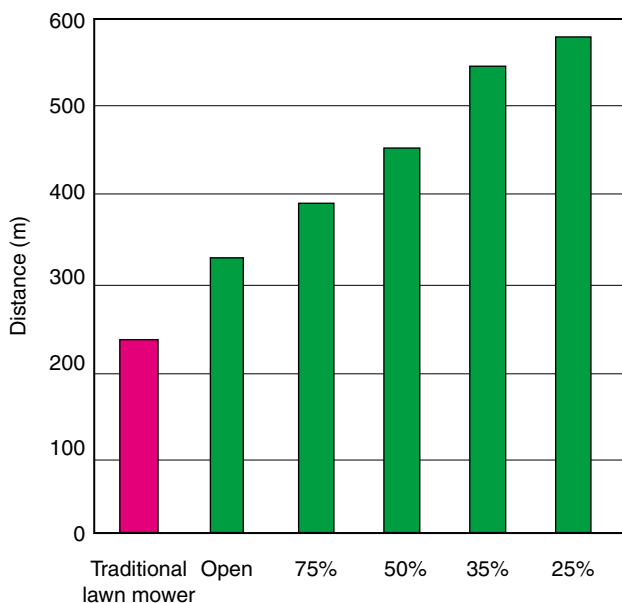


Fig. 13 VMS bagging distance at different settings

5. Conclusion

The variable mowing system on the HRX217 has achieved a new level of performance, convenience, and versatility for a walk-behind lawnmower. The concept for the variable mowing system came about from listening to customers needs for cutting performance and convenience, and from trying to add more value to our products by adding new features for the same price.

The variable mowing system will build new excitement around the HRX217 and the entire Honda lawnmower lineup. The development of the variable mowing system was made possible by the cooperation and dedication of Honda R&D Americas, Inc., Honda R&D Co., Ltd. and American Honda Motor Co., Inc. The authors would like to thank all the members of those departments that worked to make the HRX217 a reality.

6. References

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