

Tramp Iron in Chopped Hay

electronic device detects and removes bits of iron from chopped hay pneumatically conveyed at high speeds

John B. Dobie, Frederic C. Jacob and Leroy C. Kleist

An experimental tramp-iron remover successfully ejected 99% of the wire and nails in chopped hay during tests with pneumatic conveyors at hay and air speeds up to 6,000' per minute.

In a laboratory test—when adjustment was optimum—400 potentially dangerous iron pieces were passed through the electronic device and all 400 pieces were removed.

In a field test 34 pieces of miscellaneous nails and wire were removed from about three tons of hay that had been condemned as cattle feed because of the tramp iron it contained. The smallest piece removed was a shingle nail, the largest a coiled bale wire. A second run of the hay through the iron remover produced no rejections, and subsequent feeding of the hay did not produce any more trouble.

In a second field test the equipment was exposed to rain and fog and operated for a day every ten days over a five-month period. An estimated 200 tons of hay were processed, and 472 pieces of wire, nails, and miscellaneous iron pieces ranging from 1/2" to 12" in length, were removed.

The prevalence of tramp iron in hay and feed causes significant losses to dairymen every year because of hardware sickness—traumatic gastritis—among their cattle. Hardware sickness is the result of some foreign object, usually a piece of iron, penetrating the wall of



Wire and nail removed from one cow by veterinarian's operation. Paper match at lower right is for size comparison.

the animal's stomach. Because of their feeding and digestive habits, cattle are particularly susceptible to hardware sickness.

Problem of Tramp Iron

The growing incidence of baling wire in hay and grass silage is a result of the increase in field baling and chopping. Careless operation of wire-tie field balers may result in short ends or whole bale ties being deposited in the bales or left in the field to be picked up in a subsequent cutting. Chopping hay from contaminated fields or chopping baled hay are common ways of introducing bite-size wire into the cow's ration.

Incidence of hardware sickness varies with locality, but the problem exists wherever hay is fed to cows. In areas where twine-tie balers are used exclusively or where no baling is done, tramp iron still finds its way into the feed as pieces of fence wire, nails, staples, broken machinery parts, or pieces from hay-wired machinery. Barnyard manure spread onto hay land may be contaminated with tramp iron.

The most serious problem in removing

tramp iron from feeds arises with stemmy materials such as hay and silage. Plate magnets, magnetic pulleys, duct magnets, and the air-flotation process may all be used to advantage for removal of iron from liquid, ground, or granular feeds. In the case of hay and silage, however, the duct magnet alone has gained a common place in farm installations, but only with partial success.

A type of tangential-outlet chopper-blower, commonly used on farms, cannot be properly protected against tramp iron with a duct magnet. Duct magnets are often used on top-outlet chopper-blowers, but tramp iron continues to slip by and cause losses in cattle.

Another approach to the problem would use a metal detector which could operate a rejecting device to kick out the iron and the hay surrounding it.

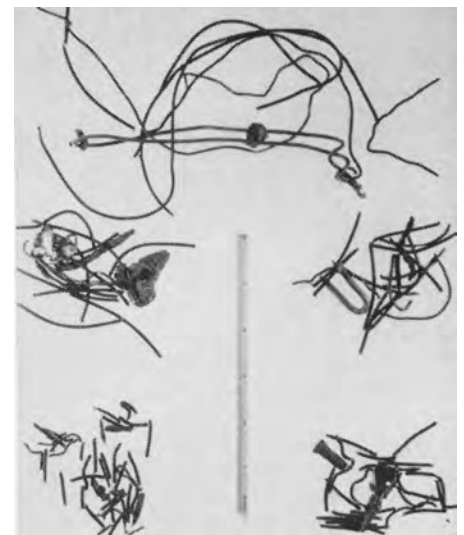
Experimental Detector

The successful experimental iron detector—intended for high conveyor speeds—is not sensitive to moisture or nonferrous metals. The iron is rejected along with about one pound of hay when an electrical signal from a detector coil operates a solenoid-controlled door in the conveyor pipe.

The search field of the detector is steady—similar to that produced by a



Section of a cow's reticulum—second stomach—showing embedded wire. Further penetration would be likely, and would normally cause infection or even death to the animal.



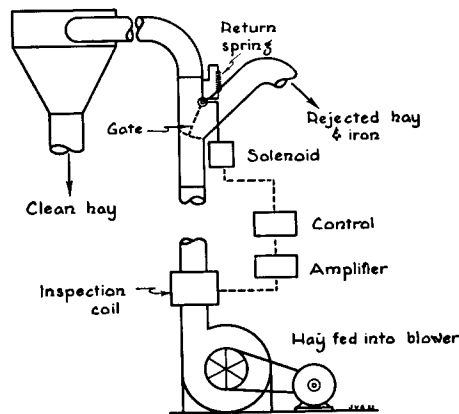
The tramp iron detector-rejector removed these 108 pieces of wire and nails from 25 tons of hay.

permanent magnet — rather than alternating, as commonly used for metal detectors. A ferro-magnetic material passing through the weak magnetic field causes a momentary disturbance in that field because of a change in reluctance of the magnetic path. This changing flux linking with the pickup winding generates a small voltage in that winding, which is then fed to the detector amplifier.

A fast-moving piece of iron produces a greater rate of change in the field and induces a higher voltage in the pickup winding than a slow-moving piece. Thus advantage is taken of the fact that iron pieces in hay handled pneumatically are traveling fast.

Timing of the detection and rejection operations must be controlled accurately because the iron-contaminated hay is moving at a rate of 100 to 160 feet per second through the blower pipe. In most installations the blower pipe enters the barn wall some 20' to 25' above the ground.

A suitable rejection device on a pneumatic chopped-hay conveyor—at maximum blowing velocity—must operate in 0.15 second or less, if the iron is to be rejected before entering the barn. The device must be positive in action, and have close-fitting parts so all the iron and surrounding hay are rejected when the device is in the reject position. It must not impede the normal flow of hay and air, and must be self-cleaning when oper-



Sketch of detector-rejector system. Tramp iron passing inspection coil generates a small voltage that is amplified and energizes gate solenoid. The minimum distance from coil to gate is determined by air speed and by speed of gate movement.

ated. Nothing can be used that might occasionally tend to clog the blower pipe. It must be built ruggedly to carry the weight of pipe attached to it and still maintain its close fit and ease of operation.

Sensitivity of Rejector

Veterinarians generally agree that pieces of iron shorter than $\frac{3}{4}$ " are not likely to cause hardware sickness so the electronic detector was designed to have a sensitivity sufficient to detect reliably a piece of baling wire one half inch long or longer.

The velocity of pieces of iron passing through the pipe may vary considerably. A specified hold time in the reject position is provided to insure rejection for the fastest and the slowest moving piece. Should a second piece of tramp iron pass the inspection coil before the first piece has been rejected and the reject gate closed, the hold-time circuit permits a new rejection cycle to be initiated—at any time—regardless of the position of the reject gate. Should the door be in the reject position at the time a second piece of iron is detected, it will be kept in that position for another normal hold period. Should the reject door be in its return stroke when an impulse is received, it would immediately be reenergized to return to the reject position.

In the experimental amplifier-controller an additional relay switch is incorporated to operate a buzzer in the event of a tube failure. An external light indicates power continuity.

John B. Dobie is Associate Specialist in Agricultural Engineering, University of California, Davis.

Frederic C. Jacob is Assistant Specialist in Agricultural Engineering, University of California, Davis.

Leroy C. Kleist was Junior Specialist in Agricultural Engineering, University of California, Davis, at the time of the experiments.

The above progress report is based on Research Project No. 400-N.

J. B. Powers, Agricultural Engineer, University of California, Davis; and the California Committee on Relation of Electricity to Agriculture, co-operated in the investigation.

The experimental tramp iron remover extracted 34 pieces of dangerous wire and nails from this haystack. Hay was put through a second time with no iron found.

