Current Aspects of the Primary Insufficiency of the Motor Functions of the Reticulum and Rumen

Prof. Dr. G. Dirksen
II Medizinische Tierklinik,
University of Munich,
Republic of West Germany

Until the middle of this century the diagnosis "hypotony" or "atony" of the rumen was one of the most frequent diagnoses in veterinary practice. Rumen atony was considered as a primary disease and its removal was considered as the definitive therapeutic task. Subsequently it has been demonstrated that a great number of digestive disorders as well as other organic or general diseases can inhibit reticulo-ruminal motility. On the basis of our present knowledge the following disorders of the rumen and reticulum can be coordinated to the definition (term) *Indigestion.* (Table 1) At first primary and secondary indigestions have to be distinguished. The primary indigestions can be subgrouped into motor dysfunctions and disorders of the microbial-biochemical digestion. Table 2 shows the primary disorders of the motor functions of the rumen and reticulum,which can be differentiated presently. Today the question arises whether a primary, a genuine ruminal stasis, really exists or at least whether conditions exist in which the inhibition of the motility of the forestomachs can be considered as the definitive finding.

To attempt to answer this question necessitates a short review of the physiology of reticulo-ruminal motility and its mechanisms of regulation. Movements of the forestomachs are automatic in nature and are regulated by a complicated control system via the vagus nerve and the sympathetic nervous system. The main center controlling the forestomachs is localised in the medulla oblongata presumably in the dorsal vagus knot, whilst switch points for the sympathetic nerve are thought to be in the spinal cord. Besides, a superior center seems to exist in the subcortical area of the brain. The centers receive the impulses via the afferent nerves from the peripheral receptors in the pharynx, in the stomach wall, as well as from other parts of the central nervous system and by the composition of the blood.

Today there is no doubt, that a **coordinated motor cycle of the different compartments of the forestomachs** exists, in which **reticulum and rumen form one unit.** (fig. one) The **cycle starts** with a bi-phasic contraction of the reticulum. Already during the second contraction of the reticulum the anterior ruminal fold is contracting strongly and forming a high barrier between rumen and atrium. The contraction wave extends to the dorsal sac caudally, pressing the ingesta backwards and downwards into the relaxed ventral sac. The subsequent contraction of the ventral sac progesses cranially squeezing the ingesta into the relaxing dorsal sac. This primary contraction generally is followed by a secondary contraction of the dorsal and ventral ruminal sacs, commonly accompanied by the eructation of ruminal gas. That ends the regular reticulo-ruminal cycle. Under special conditions, for example in case of high gas pressure, the dorsal sac can contract alone to induce eructation. Besides, single contractions of the reticulum can be observed before rumination.

In former times scientific opinion considered that reticulo-ruminal movements had the single purpose of thoroughly mixing the ingested feed with the other ingesta and the ruminal fluid. Today the main task of the forestomach movements is seen as a sorting out or separation of the contents. By so doing, the fermentation products of the fibrous layer are washed out and the volatile fatty acids are buffered by the bicarbonate and phosphate content of the saliva. The reticulum and rumen induce the

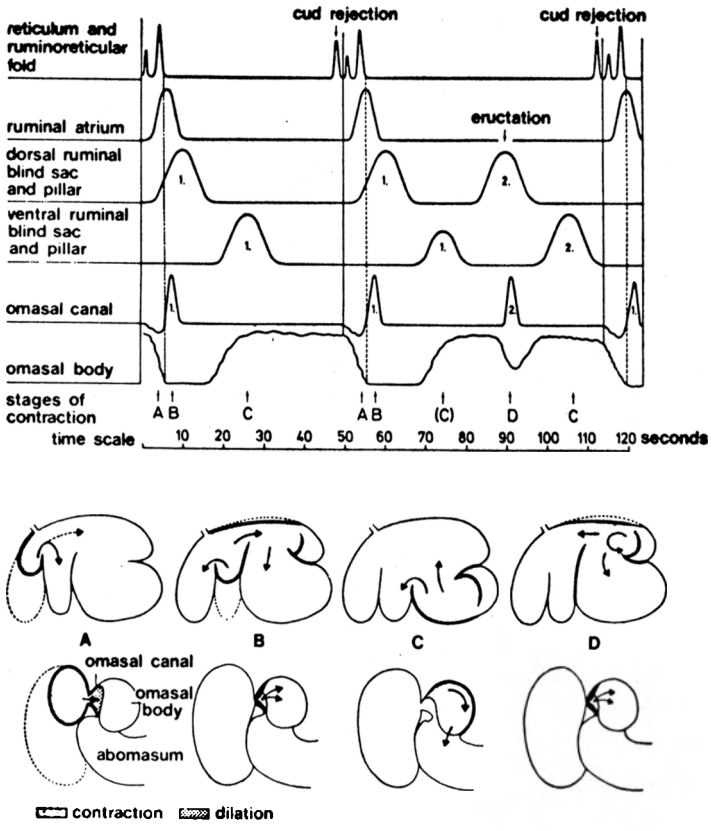
Table I

Indigestion
(Diseases of the rumen and reticulum)

	Primary Indigestion (Idiopathic disorders of rumen + retic.)	*Secondary Indigestion* (Rum. + retic. secondarily involved)
Motor dysfunctions	Disorders of microbial-biochemical digestion	Secondary motor insufficiency of rumen and reticulum
Diseases of the rumino reticular wall	—accompanied by high pH of rumen fluid	Secondary simple (biochemical insufficiency of the ruminal flora and fauna
Disorders of nervous regulation of forestomach motility	—accompanied by low pH of rumen fluid	Latent hyperacidity of rumen ingesta due to abomasal reflux
Mechanical obstruction to passage of ingesta	—accompanied by normal or lowered pH of rumen fluid	

Paper presented during a guest professorship at the Ontario Veterinary College, University of Guelph, Canada, February, 1982.

Figure 1: Forestomach motility in diagrammatic form.



separation of the contents sufficiently broken down, for transport to the omasum and they support the outflow.

Normal motor functions of the ruminant stomach depend upon the following preconditions:

1) Undisturbed general health, in particular an intact nervous system,

2) physiological status of the blood,

3) physiological composition of the rumen contents and

4) the absence of special inhibitory influences.

With regard to the rumen contents the following factors play a role in normal ruminal movements:

1) the degree of rumen fill

2) the water content

3) the physical form, that is the structure of rumen contents and

4) the chemical composition, that is the quantity and composition of organic acids of the rumen contents.

Disturbances of the mechanical function of the reticulo-rumen appear if those physiological conditions are not met.

Disorders of the mechanical functions of reticulum and rumen are now discussed, in which the disturbance of rumen motility seems to be primary or at least seems to be definitive for the status of the animal.

1) *Rumen hypotony at calving:* MOODIE AND ROBERTSON showed in 1962 by means of ruminographical examinations as well as by auscultation that rumen movements are reduced on the day of calving and to some extent on subsequent days. By means of a tracer method PAYNE stated that an increase of the passage of ingesta occurred just before calving followed by a phase of inactivity of the whole digestive tract during the following 18 hours. Other authors, who used a incomparable and unusual technique found that the frequency of rumen movements decreased from the 8th week before calving until delivery and regained the normal frequency 5 weeks later.

Because of this discrepancy, ruminal motility at the time around calving was investigated by us in 5 cows with permanent ruminal fistulae during 8 calvings. By means of a rubber balloon filled with water and placed inside the dorsal sac of the rumen and connected with a manometer via the ruminal fistula the rumen contractions as well as the pressure inside the rumen were measured. In the majority of the examinations the measurements began between 41 and 21 days pre partum and were continued until the 7th or the 8th day post partum. At the same time feed intake was registered. The ration consisted of 6 to 7 kg of hay and a concentrate mixture ad libitum. The results can be summarized as follows: The number of rumen contractions per unit of time remained constant within the physiological range until the last day before calving. In the last hours before birth the frequency of rumen movements decreased distinctly but without reaching complete stasis. The minimum, measured by us at different times before and after calving, varied between 36 and 77% of the prepartum average values. After calving the precalving values were reached in 6 out of 8 measurements on the first day whilst in 2 animals the normalization process lasted 3-4 days.

In the majority of the experimental animals rumen pressure was moderately reduced already during the last two weeks before calving. At calving a steep decline of rumen pressure commonly coincided with the reduction of ruminal motility. The minimum measured by us varied between 35 and 80% of the average values before calving.

The normalization up to the precalving level occurred within 1-9 days, that means, that the normalization was faster than the decline but slower than the normalization of the contraction frequency. An example of the course of rumen contractions and the rumen pressure is illustrated by figure 2.

The feed intake, that means the intake of hay as well as of concentrates, decreased from the 4th day before calving and reached its minimum on the day of calving (fig. 3). After calving on the 4th day, values were recorded above the precalving level. By comparison, the hay intake even at the 5th day after calving was below the prepartum values. On the day of calving the total feed intake amounted to 53.1% of the precalving values.

These investigations confirmed the results of MOODIE and ROBERTSON concerning rumen motility and feed intake. The new finding is the demonstration of the decline of rumen pressure in the time around parturition. The cause of the hypomotility of th digestive tract at calving has not yet been clarified. It is probable that it depends on the hormonal changes within the organism in connection with parturition

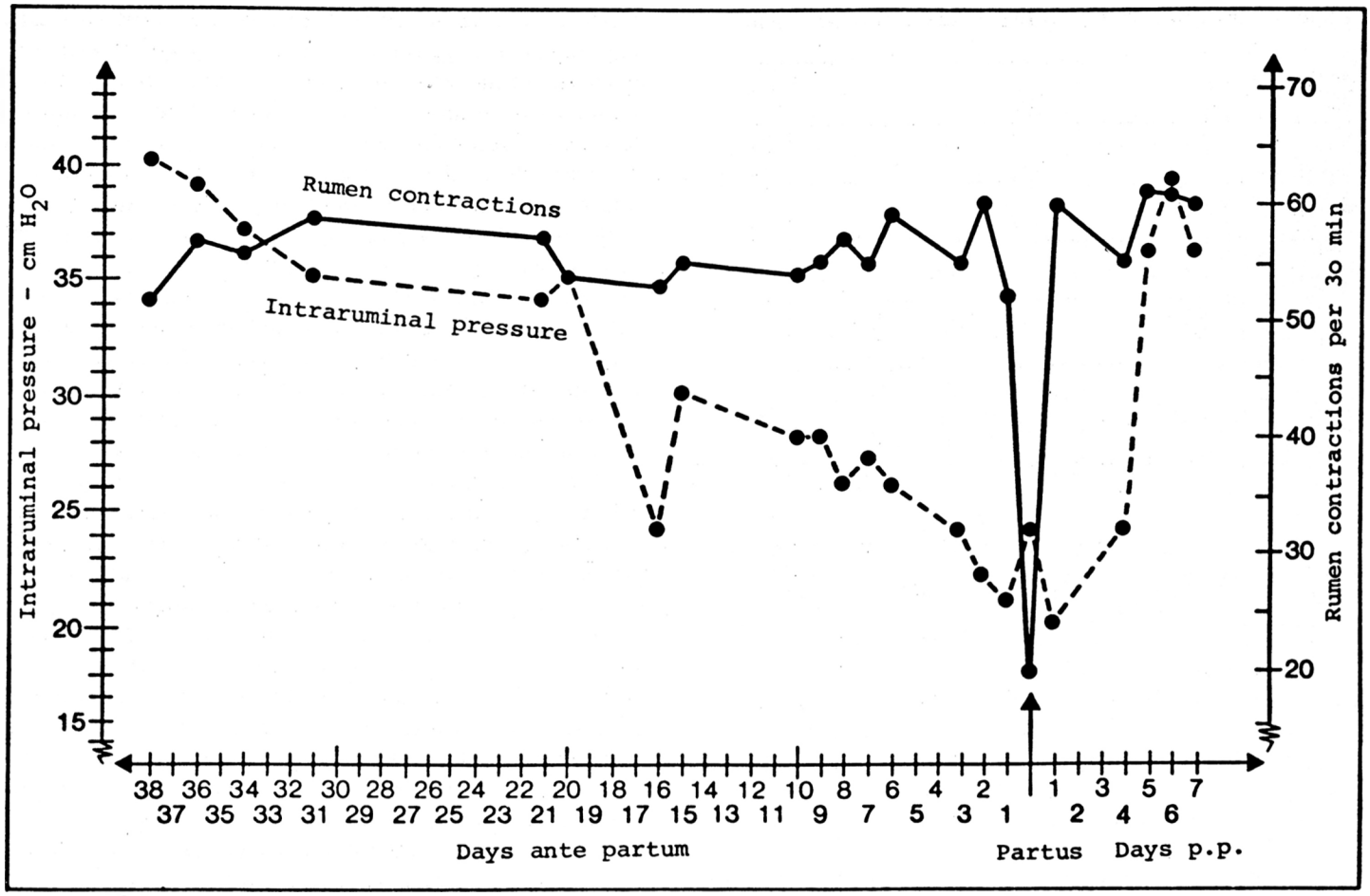


Figure 2

and subsequent lactation.

Currently great importance is attributed to atony of the digestive tract at calving in the pathogenesis of hypocalcemia. Furthermore these findings can explain the etiology of indigestions frequently observed in highly pregnant cows during the last days before calving. Moreover the findings have to be considered as a possible pathogenetic factor with regard to ketosis and to the left displacement of the abomasum.

2. *Inhibition of rumen motility by Xylazin = Rompun – Bayer:* As an other example of the inhibition of rumen motility—presumably by the inhibition of the relevant modullary centers—the investigations of WITTKE and coworkers on the influence of Xylazin should be noted. Xylazin, in the form of Rompun-Bayer, is widely used today in cattle practice. It is anticipated that many veterinarians who use Xylazin have seen bloat after application of this drug. WITTKE and coworkers stated that Xylazin mainly inhibits the primary cycle of the reticulum and rumen. The secondary contraction which is responsible for eructation is inhibited by a dosage of 0.1 mg per kg bodyweight or more. The duration of inhibition depends on the dosage and may last 3-4 hours.

As was shown, the undesired effects of Xylazine on rumen movements could be reversed (in sheep) by administration of Tolazoline. Another drug which is considered to possess similar effects, is Doxapram. Its antagonistic effect on Xylazin inhibition of rumen movements has to be tested.

Of the many other inhibitory factors acting via the blood only, the hyperglycemia and alkalosis should be mentioned.

3) *Lack of structure, lack of roughage:* In talking about motor dysfunctions on the basis of changes in the rumen contents, let us mention first the lack of ration structure, respectively the lack of roughage. It has been well known for a long time that the maintenance of normal rumen motility requires not only a sufficient fill of the forestomachs but also a sufficient physical structure of their contents; in short that means a certain fibrousness. This necessary for the stimulation of the receptors is in the ruminal wall mainly localized around the cardia, along the esophageal groove and around the reticulo-omasal orifice.

Recently this problem became apparent when attempts were made to improve the digestibility of hay by grinding. Because of the unfavorable consequences on the mechanical functions of the forestomachs these experiments were not continued. But the problem of the physical structure of the

feed still exists in our country with regard to the artificial drying of grass which is subsequently chopped and pressed into cobs or pellets. Also, corn silage is cut into small pieces to improve the fermentation. Physical structure also seems to play a role in animals which eat young grass in early spring and thereafter show a very substantial agglomeration of the rumen contents.

After ingestion of feed of low disgestibility and insufficient structure the following symptoms were observed: depression of rumen movements as well as of rumination and eructation, decrease of feed intake and simultaneously the animals showed the tendency to gnaw and to eat wood. Relatively often the animals became bloated and sometimes they developed an impaction of the omasum, a condition which in our country, has been known as "chopped fodder disease" for a long time. Animals on pasture showed decline of milkfat content, diarrhea, transient anorexia and via ruminotomy the mentioned agglomeration of the ingested feed could be found.

Unfortunately exact data for the minimum requirements with regard to roughness, hardness, size and elasticity of the feed to maintain a physiological motility of the forestomachs are lacking. RUCKEBUSCH communicated in 1970 that 1½ kg hay per day should be sufficient ensure normal stomach motility in the adult ruminant.

The structure of the feed however is not only of importance for rumen motility but also for the regulation of the pH value of the reticulo-ruminal contents.

4) *Drying out of the ruminal ingesta due to lack of water:* Another dysfunction of the forestomachs, the classification of which is doubtful, is the drying out of the ruminal ingesta due to lack of water. As has been pointed out by CLARK, in warm countries under such conditions the feed frequently is highly fibrous and therefore of low digestibility, this factor therefore contributes to the development of the disease. We saw this drying out of ruminal ingesta, when the automatic water bowl was damaged. In such cases, rumen motility and rumination are sharply depressed, the left flank appears deeply sunken and the rumen contents can be palpated from outside or via the rectum as a hard compact mass within the ventral sac. Coprostatis, sometimes diarrhea, highly reduced milk yield, ulceration and inflammatory changes of the ruminal mucosa are further findings in this type of indigestion.

5) *Lack of low fatty acids in the rumen contents:* When we consider the motor disturbances due to lack of the chemical stimuli for rumen movements, again one has to ask whether this type of indigestion really should be classified as a primary motor disorder. In milk fed calves and lambs it could be demonstrated that the development of the ruminal movements is influenced not only by the quantity of the dry matter intake but also by the concentration of the volitile fatty acids in the rumen contents. This positive influence has been proved also in adult animals, in healthy ones as well as in sick cattle.

6) *Inhibitory substances in the feed:* Within the complex of motor dysfunctions, substances in the feed which possibly can inhibit rumen motility have to be mentioned. The inhibiting or paralizing action of atropine containing plants is well known. In such cases however, one has to consider that an absorptive intoxication probably will take place. Therefore it is questionable, whether such cases should be classified as genuine motor indigestion. A rumino-paralytic effect has been attributed by CLARK to the active substances of *Lippia rhemanni, Lantana camala* and *Tribulus terestris,* plants which grow in South Africa. Another substance under discussion is histamine. The effect of this compound, which can be released in the rumen contents as well as in the blood and also can be ingested with silages in remarkable quantities has not yet been elucidated.

According to JUHASZ, a high NH_3 concentration in the rumen fluid can depress rumen motility.

It seems possible to me that in the future more substances with inhibitory effects on rumen motility will be discovered, but our own practical experience favors the opinion that such toxic effects play a very limited role under conditions in our country.

7) *Other causes:* Finally it should be mentioned that besides the factors just elaborated upon additional influences may induce a depression of the motility of the prestomachs. If we follow exactly the previously given definition for primary indigestion we have to admit that in most cases the depression of motility actually must be considered as secondary. Such is the case, for example, when the rumen movements cease after enucleation of a corpus luteum in the ovary or after intraperitoneal injections of irritating drugs. Also in the case of sand accumulation in rumen and intestines it is debatable whether the depression of rumen motility has to be considered as the cause or the consequence.

Treatment: Sometime ago, the late Prof. DIERNHOFER from Vienna pointed out that rumen stasis generally can be considered as a protective mechanism of the animal. In this way toxic substances, released or synthezised within the rumen, will be prevented from being transported to the lower parts of the digestive tract, where they are more easily absorbed than in the rumen. In the case of reticuloperitonitis or ruminitis the ruminal stasis avoids the enlargement of the inflammatory processes. Considering the multiplicity of ruminal disorders known today, this understanding of rumen stasis can be accepted only partially, that is, with regard to these two disease complexes mentioned before. Without any restrictions, however, the therapeutic consequences drawn by DIERNHOFER fit into the modern concept of indigestions.

The conclusions were that the formerly used rather drastic ruminal stimulants like the various parasympathetic stimulants as well as strychnine, tartar emetic, Veratrin and many others must be considered today as contraindicated. On the contrary the target of the treatment must be to restore the physiological conditions in the rumen with regard to the physical and biochemical requirements (balance). As far as

inhibitory factors are known these have to be removed.

In case of lack of scabrous nutrients, a sufficiently structured feed has to be offered and in case of drying out of the rumen content large quantities of fluid have to be administered into the rumen. It is recommendable to give this fluid in the form of a very dilute mucous fluid such as a line seed mucus. For the adjustment of the pH, in cases of an elevation, acetic, lactic or propionic acid can be given in low concentrations or in the form of their salts. The best treatment for restoration of the biochemical digestion in the reticulo-rumen is the transfer of several liters of fresh ruminal fluid from healthy cattle to the sick ones. We combine this transfer of rumen fluid with simultaneous medication of Bykodigest or similar preparation. Rumen liquid and this drug are diluted by several liters of body warm water or some line seed mucus to achieve a good distribution within the rumen.

It seems self-evident that every treatment of an indigestion must be combined with a correction and adjustment of the diet. The animal should receive a mixed ration consisting of palatable, easily digestible feedstuffs taking into account the minimum needs for roughage. Appetite often can be stimulated by offering 200-300 grams of molasses or by offering grain or beets in small quantities.

As the depression of rumen motility sometimes is caused by a stasis of the contents in the lower gut the application of purgative such as 300-500 grams of sodium or magnesium sulfate or a mixture of both salts is recommendable in these cases, in which the faeces show a dry consistency. These laxatives shold be given by drench in order to stimulate the esophageal grove reflex so that the solution passes directly into the abomasum and the intestines.

Measures to avoid the depression of gastrointestinal motility at calving have still to be investigated. From the present status of knowledge the administration of a mixed ration, containing a high portion of roughage, is recommended during the last weeks prior to calving as well as the stabilization of the blood electrolytes.

Coming back to the question I put in my introduction, whether a primary ruminal stasis really exists, I think from the examples presented here it can be concluded that it is still justified to maintain the definition of a primary insufficiency of the motor functions of the reticulum and rumen.

References

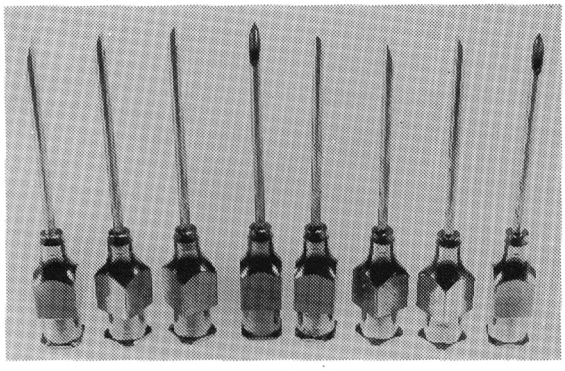
1. Asai, T. (1953): Development process of reticulo-rumen motility in calves. Jap. Veter. Sci. 35, 239-252. 2. Beghelli, W., A. Mavrulis, C.M., Caldera und R. Viviani (1967): Influenza degli acidi grassi volatili sulla motilità prestomacale in agnelli ad alimentazione lattea. Atti Soc. It. delle Sci. Vet. 21, 244-249. 3. Clark, R. (1950): A review of our present knowledge of factors and drugs influencing ruminal motility. J. South Afr. Vet. Med. Ass. 21, 49-57. 4. Clark, R. (1951): Studies on the alimentary tract of the Merino sheep in South Africa. XXII. The affect of the pH of the ruminal contents on ruminal motility. Onderstepoort J. Vet. Res. 25, 79-91. 5. Clark, R. (1956): The mechanics of the ruminant stomach. J. South Afr. Vet. Med. Ass. 27, 79-104. 6. Colvin, H.W. and L.B. Daniels (1965): Rumen motility as influenced by physical form of oat hay. J. Dairy Sci. 48, 935-941. 7. Diernhofer, K. (1959): Diagnose und Behandlungen der Indigestionen des Rindes, Probleme und Erfahrungen. Dtsch. Tierärztl. Wschr. 66, 141-149. 8. Dirksen, G. (1964): Die Motorik der Vormägen des Wiederkäuers. Zschr. Tierphys., Tierern., Futtermittelkde. 19, 13-24. 9. Dirksen, G. und W. Kaufmann (1978): Untersuchungen über die Pansenmotorik der Milchkuh im Zeitraum um die Kalbung. Fortschritte der Veterinärmedizin, H. 28 (12. Kongr. Ber., DVG), 144-152. Paul Parey, Berlin - Hamburg. 10. Ehrlein, H.-J. (1980): Vormagenmotorik bei Wiederkäuern. Publikation zum Film C 1328 des Institutes für den Wissenschaftl. Film, Göttingen. 11. Espinasse, J. (1969): Les indigestions des bovins adultes. Revue Méd. vèt. 120, 615-642; 121, 685-711 (1970); 122, 137-160 (1971). 12. Hoflund, Sv. (1955): Die Bedeutung des Rauhfutters für die Funktion der Wiederkäuermägen. Dtsch. Tierärztl. Wsch . 62, 403-408. 13. Hozenweger Dendi, J.A. und H.L. Parada (1981) Wirkùng von Doxapratn gegenüber Rompün beim Rind. Vet. Med. Nachr. H.1, G. 70-74. 14. Juhasz, B. und B. Szegedi (1980): Die Wirkung des Ammoniaks auf die Motilität der Vormägen. Arch. Tierernährung 30, 173-189. 15. Kurtze, H. (1969): Beitrag zum Problem der Vormagenerkrankungen und Stoffwechselstörungen von Milchkühen in Algerien. Tierärztl. Umschau 24, 381-385. 16. Lender, S.H. und W. Baumgart (1976): Verdauungsstörungen bei Rindern durch Knäuel-(Konglobat-) Bildung nach Aufnahme von Erntebindegarn. Mh. Vet.-Med. 31, 613-617. 17. Orth, A. und W. Kaufmann (1964): Über den EinfluB der Struktur des Futters auf die Verdauungsvorgänge im Pansen. Z. Tierphysiol., Tierernährg. Futtermittelkde. 19, 144-155. 18. Ruckebusch, Y. (1970): Der EinfluB der Nahrung auf das Wiederkauverhalten bei Rindern und Schafen. Mh. Vet.-Med. 26, 184-191. 19. Ruckebusch, Y. und R.N.B. Kay (1971): Etude critique de la motricitè gastrique chez les bovins. Ann. Rech. Vèterin., 2:1, 99-136. 20. Slanina, L. und L. Kralic (1967): The effect of some drugs (applied in the rumen and in the abomasum) on the motility of the rumen. Veterinàrni Med., Praha, 39, 119-126. 21. Wittke, G., A. Bayer und H. von Seefeld (1973): Wirkungen von Rompun (R) auf Kreislauf und Rumenomotorik des Rindes. Berl. Münch. Tierärztl. Wschr. 86, 181-200. 22. Zingoni, M.R., R. Gardia-Villar, P. 4. Toùtain (1982) La Tolazoline comme antagoniste de La Sedation par La Xylazine chez le moùton. Rev. Med. Vet. (in press). 23. Zumpt, I. (1971): Pansenanschoppung bei Rindern durch Aufnahme der Kokons der Molopo-Raupe Gonometa portica (Walker). J. South Afr. Vet. Med. Ass. 42, 315.

F. W. Cislak Manufacturing & Engineering Company, Inc.

Designer & Manufacturer of the

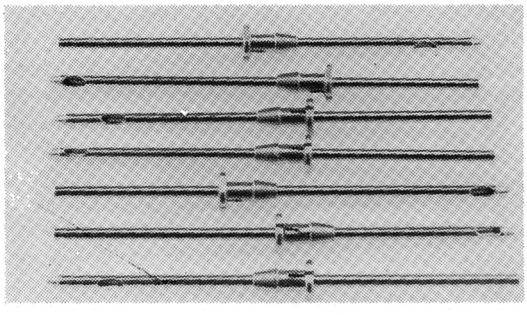
Unsurpassed

Smooth-point HUSKY® *Large Animal Needle*

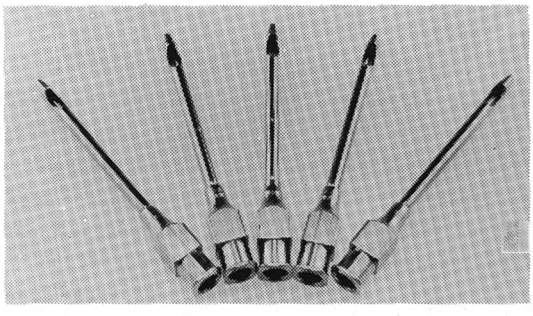


Proudly Announces the Addition to its Veterinary Line of the

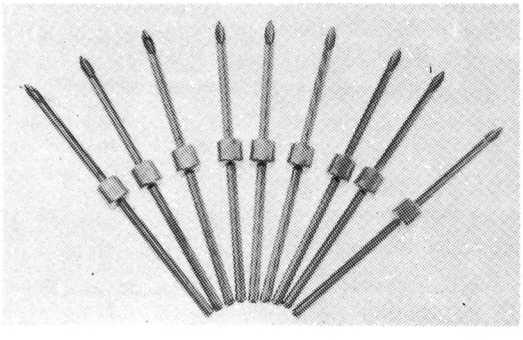
Cislak Milk Tube
(self-retaining)



Cislak Udder Infusion Tube
(single- or double-opening)



and the California Bleeding Needle



All in Popular Sizes

for further information and to order, contact
F. W. Cislak Mfg. & Eng. Co., Inc.
5768 West 77th Street
Burbank, Illinois 60459
312-585-2625