ZESZYTY PROBLEMOWE POSTĘPÓW NAUK ROLNICZYCH 1978 z. 203

METHODS FOR DETERMINING THE PHYSICO-MECHANICAL PROPERTIES OF AGRICULTURAL PRODUCTS

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Increasing mechanization of production processes has a negative influence on agricultural products in many cases. The destructive action of machines is particularly visible in the case of mechanical PROCESSING of high water percentage products.

Intensification of agricultural production involves the necessity of modern working and harvest technologies. This process aparat from doubtless advantages (high productivity, fast and punctual harvest) has some disadvantages, because it causes injuries. In order to decrease losses of agricultural crops it is necessary to introduce a new (from the point of view of resistance against deformation) criteria of management values of varieties.

Different measuring devices enabling determination of different physical-mechanical properties of agricultural crops constructed or adapted in the Institute of Agricultural Mechanization of the Agricultural Academy in Lublin are presented below. They make determinations of reactions of the investigated materials under static and dynamic loading possible. Presented devices were practically checked in experiments (1-8).

STATICAL SPRING PENETROMETER

The statical spring penetrometer (Fig. 1) makes it possible to determine the relationship between the force pushing punch F and the depth of deformation ε ($F = f(\varepsilon)$) in the condition of quasistatic loading. The measuring stand was assembled on basic plate *1* in which two guides *3* connected by beam *2* were fixed to lead the damaging element.

The measure stand is composed of a damaging device and measuring system. The damaging device possesses: a plate with a nut *4*, a bottom plate with a punch *5*, a pressing spring *8*, a beam connecting screws *13*, a power screw *6*. Power is transmitted by a handwheel *14* and power

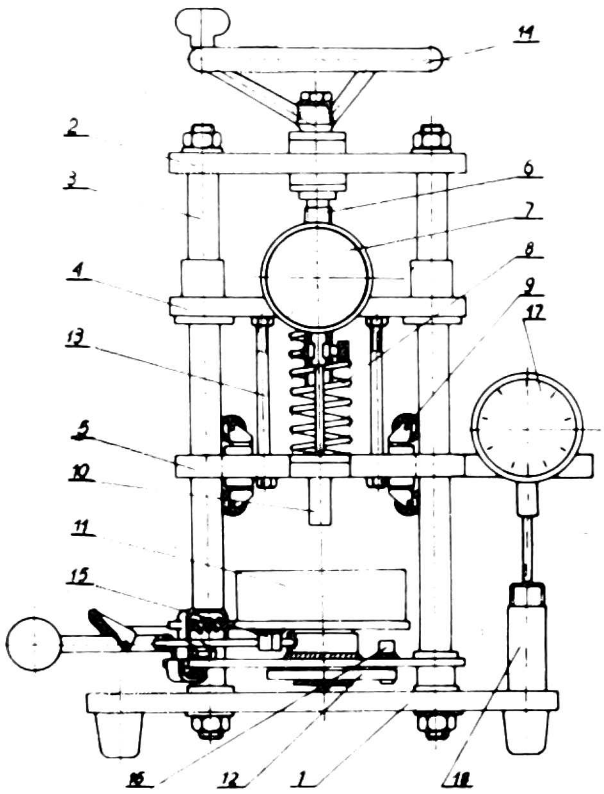


Fig. 1. Static spring penetrometer

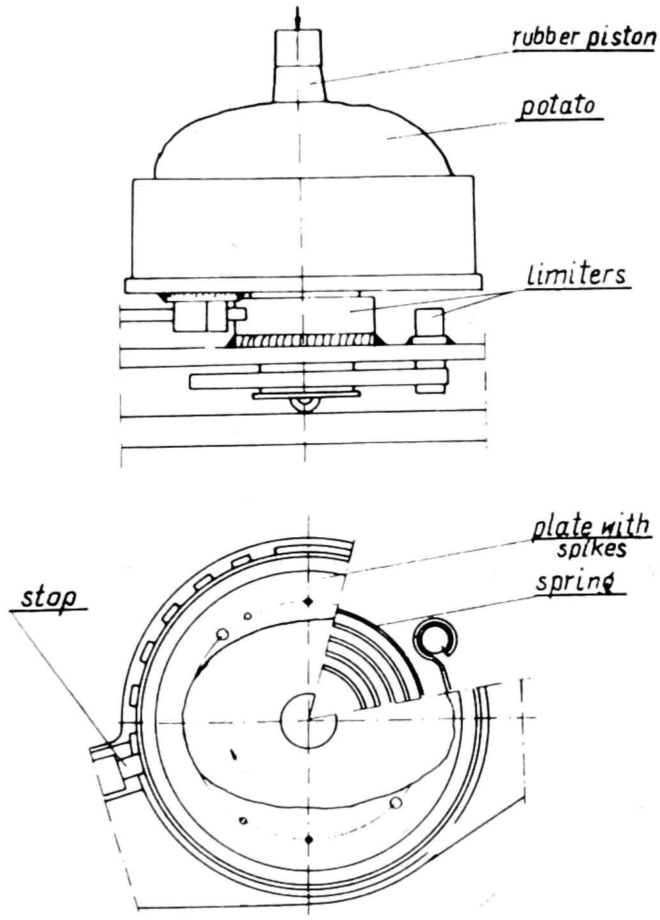


Fig. 2. Position of device during breaking skin

screw *6* to the beam with nut *4,* then by spring *8,* bottom beam *5* to punch *10.* The bottom beam stops, when contacting with the object investigated, whereas the beam with the nut being in continuous movement causes spring compression and increases its energy resulting in deformation.

The measuring device is composed of: sensor *7,* measuring the spring compression, i.e. acting force and sensor *17* for reading the depth of deformation.

DEVICE FOR MEASUREMENT OF BREAKING SKIN FORCE

Breaking skin forces were measured by the device (Fig. 2) fixed on the basis of the static spring penetrometer. A potato tuber is placed in seat *11* to make it immobile. The seat together with the potato can be turned through an angle of 140° and fastened by a catch in limiters *15.* A rubber piston *10* is pressed to the upper surface of the potato by turning the handwheel *14.* The catch is released after pressing the rubber piston to the potato surface and the seat returns to its initial position. The return movement is caused by the action of the spring *12.* During the seat turning through an angle of 140°, the skin is torn off.

SCHOB'S ELASTOMETER

The test of elastic properties of agricultural crops can be performed with Schob's method (Fig. 3 and 4). On the arm of case *1* made of cast iron pendulum *2* is hung with a weight *3* and spherical part *4* on its end. The potential energy of the pendulum *2* with the weight *3* equals 5 kpcm in position *5*, whereas it is 2.5 kpcm in position *5a*. There is an anvil *6* with two springs in the bottom part of the case to fix the sample. The catch *7* fastened on the arm of the pendulum, stopa the pointer *8* in the moment of rebounding of the pendulum from the sample, pushes it and sets it up in the position corresponding to the deflection of the pendulum after rebounding.

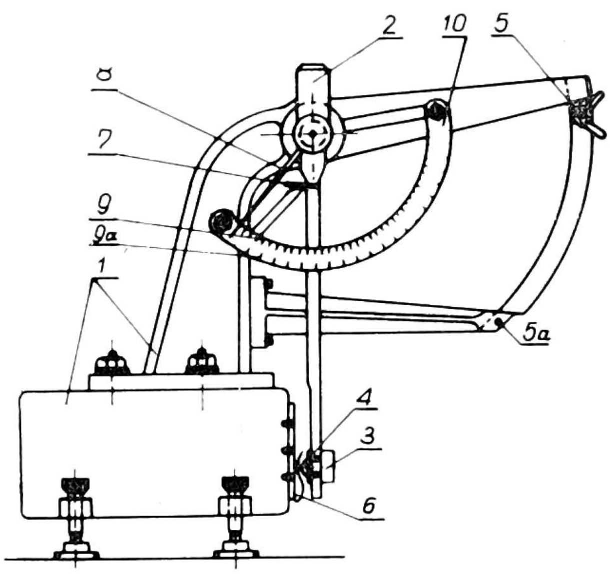
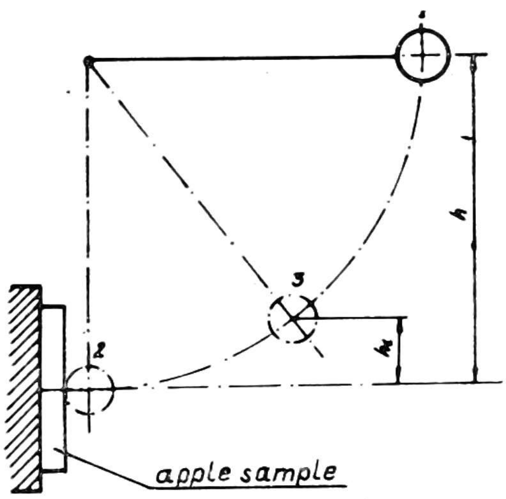


Fig. 3. Schob's penetrometer



ig. 4. Scheme of the elasticity test of apple

Scale *10* with graduations *9* and *9a* is fastened to the case. The elasticity of the investigated sample is determined by the value read on the upper graduation of the scale *10*. The ratio h_1 $(h = E_{p1})$ E_p in percents is read immediately after testing on the scale of the apparatus, where:

E_p — initial potential energy of the pendulum,
E_{p1} — final potential energy of the pendulum,
h — falling height of the pendulum,
h_1 — rebounding height of the pendulum.

DYNAMIC PENETROMETER

The purpose of the dynamic penetrometer (Fig. 5 and 6) is the dynamic measurement of the force when the percussive element *7* acts on the sample investigated. The result of percussion is sample damage. The leading tube *3* is the main part of the measuring device. The frame coil *4* is fitted to the lower part of the tube. The damaging piston *5* is placed inside the tube. This piston is made of brass and has a steel insert. The

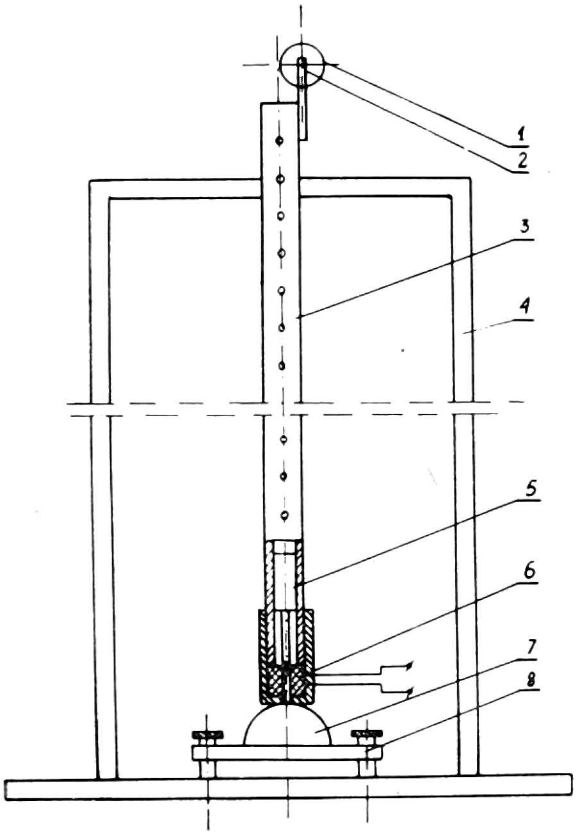


Fig. 5. Measurement stand for determining of influence of colouring intensity on damage depth

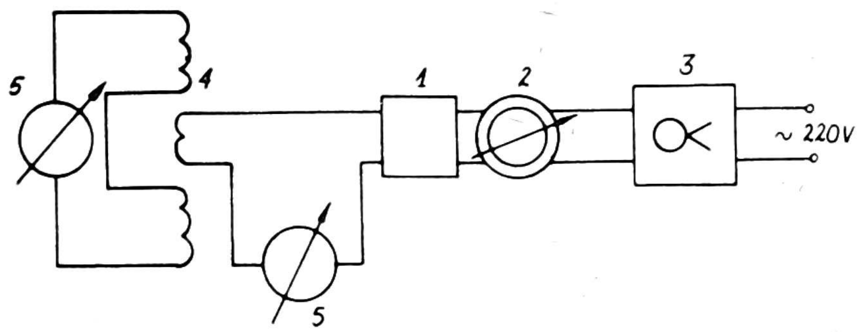


Fig. 6. Scheme of recording system

caving is measured by a difference transformer which indicates the position of the steel insert of the damaging piston. The change of the position of the steel insert in the coil of the difference transformer causes a change of coil inductance and in this way the current in the milliam-

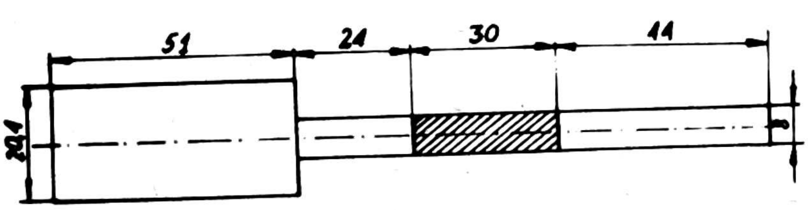


Fig. 7. Damaging piston

meter changes. The pointer of the milliammeter indicates the caving of the piston. The recording device consists of: transformer *1*, autotransformer *2*, stabilizer *3*, coil *4* and milliammeter *5*.

PENETROMETER MEASURING THE STRENGHT INDEXES AND THE INFLUENCE OF THE PERCUSSIVE ELEMENT VELOCITY ON DAMAGES

The purpose of the apparatus is measuring the force by which the percussive element acts on the object investigated as a function of time. The measuring device consists of the investigation stand (Fig. 8) and recording system (Fig. 9).

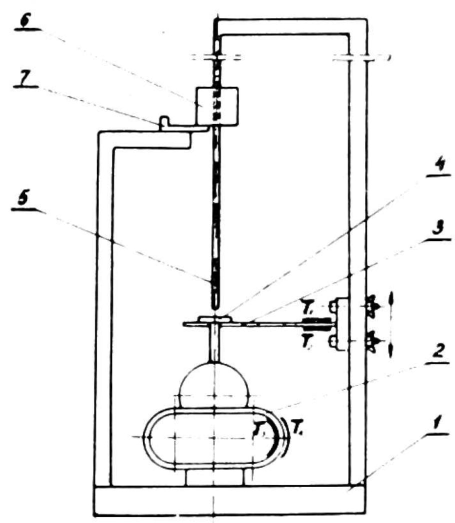


Fig. 8. Stand for measuring strenght indexes and influence of percussive element velocity on damages: *1* — frame, *2* — measuring ring, *3* — damaging piston, *4* — measuring plate, *5* — leading tube, *6* — weight, *7* — release

Measurements are performed on the frame *1* with the leading tube *5* and the weight *6*. The eliptical ring *2* is placed on the frame below the leading tube and damaging piston *3*. Two strain gauges T_3 and T_4 are stuck on to the ring in places where the strains appear to be maximum. The controlled holder *14* of the measuring plate is fixed on the frame. Strain gauges T_1 and T_2 are stick on to the measuring plate *3* in places of maximum strains. The measuring piston *4* is fitted to the measuring plate. The translating release *7* is placed on the frame to mobilize the weight. The measurement is made by releasing the weight and dropping on to the piston with known energy. The strain gauges on the measuring plate indicated the value of caving, whereas those on the eliptical ring — the force of piston caving.

In this way the apparatus makes registration of the empirical relation $F(\varepsilon)$ possible, where:

F — force of the piston action,

ε — depth of deformation.

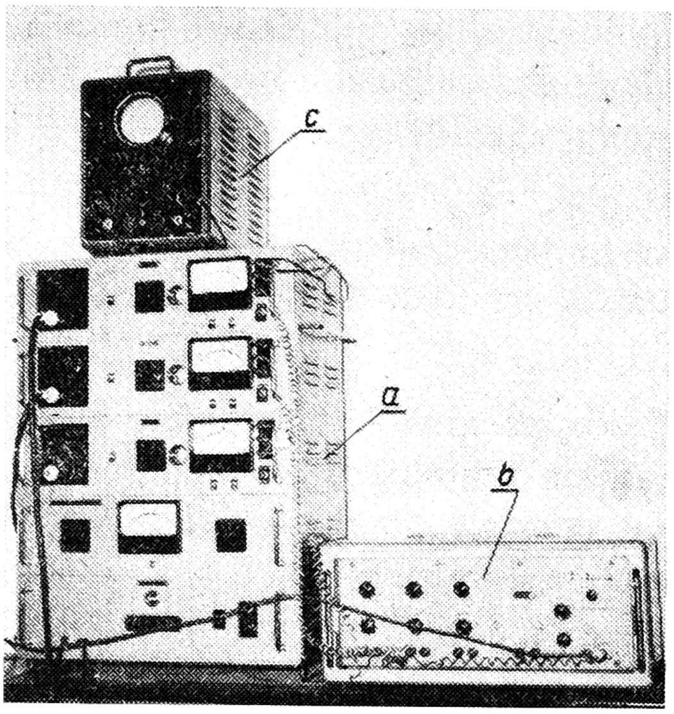


Fig. 9. Recording system

The recording stand (Fig. 9) consists of a three-channel strain gauge bridge and a three-loop oscillograph.

REFERENCES

1. Bieluga B.: Odporność ziemniaka na uszkodzenia podczas zbioru mechanicznego, Rocz. Nauk rol. s. C, t. 68, z. 1.
2. Bieluga B.: Określenie odporności ziemniaka na uszkodzenia mechaniczne. Rocz. Nauk rol. s. C, t. 68, z. 2.
3. Bieluga B.: Fizyko-mechaniczne właściwości odmian jabłek jako kryterium oceny ich dojrzałości technicznej. Rocz. Nauk rol. s. C, t. 70, z. 3.
4. Bieluga B., Gilewicz K.: Określenie wpływu czasu na zmianę wartości niektórych reologicznych cech jabłek. Rocz. Nauk rol. s. C, t. 69, z. 4.
5. Bieluga B.: Badania odporności odmian ziemniaków na uszkodzenia mechaniczne w warunkach polowych i laboratoryjnych. Biuletyn Instytutu Ziemniaka Nr 6. 1970 r.
6. Bieluga B., Gilewicz K.: Ocena przydatności badań niektórych fizyko-mechanicznych własności ziemniaków do określenia optymalnego terminu zbioru. Rocz. Nauk rol. s. C, t. 71, z. 3.
7. Bieluga B.: Nowe kryteria oceny wartości gospodarczych niektórych odmian jabłek w aspekcie wzrastającego poziomu mechanizacji. Zesz. prob. Post. Nauk rol. nr 112, 1971.
8. Bieluga B., Gilewicz K.: Laboratoryjne badania odporności odmian ziemniaka przy zastosowaniu dynamicznego czynnika uszkadzającego. Biuletyn Informacyjny IMER, nr 8/69/1970 r.

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METODY WŁASNE OKREŚLANIA WŁAŚCIWOŚCI FIZYKOMECHANICZNYCH PŁODÓW ROLNYCH

Streszczenie

Wzrostowi mechanizacji produkcji roślinnej towarzyszy wzrost kontaktów zachodzących między rośliną a maszyną. Fakt ten pociąga za sobą konieczność dokładniejszego poznania właściwości roślin ważnych z punktu widzenia warunków pracy maszyn rolniczych. W opracowaniu zobrazowano sześć różnych urządzeń pomiarowych pozwalających na określenie różnych cech mechanicznych płodów rolniczych skonstruowanych bądź zaadoptowanych przez autora.

Pozwalają one określić reakcje badanych surowców na czynniki statycznego oraz dynamicznego obciążenia.

Powyższe penetrometry sprawdzane były w badaniach.

Б. Белюга

СОБСТВЕННЫЕ МЕТОДЫ ОПРЕДЕЛЕНИЯ ФИЗИКО-МЕХАНИЧЕСКИХ СВОЙСТВ СЕЛЬСКОХОЗЯЙСТВЕННЫХ ПРОДУКТОВ

Резюме

Рост механизации растительного производства сопровождается учащением контактов, происходящих между растением и машиной. Ввиду того следует тщательнее исследовать свойства растений, важные с точки зрения условий работы сельскохозяйственных машин.

В работе представлены шесть различных измерительных приборов, сконструированных или приспособленных автором, позволяющих определить различные физико-механические свойства сельскохозяйственных продуктов.

Эти приборы позволяют определить реакции исследованного сырья на факторы статической и динамической нагрузки. Вышеуказанные пенетрометры были практически проверены в нескольких опытах.

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