

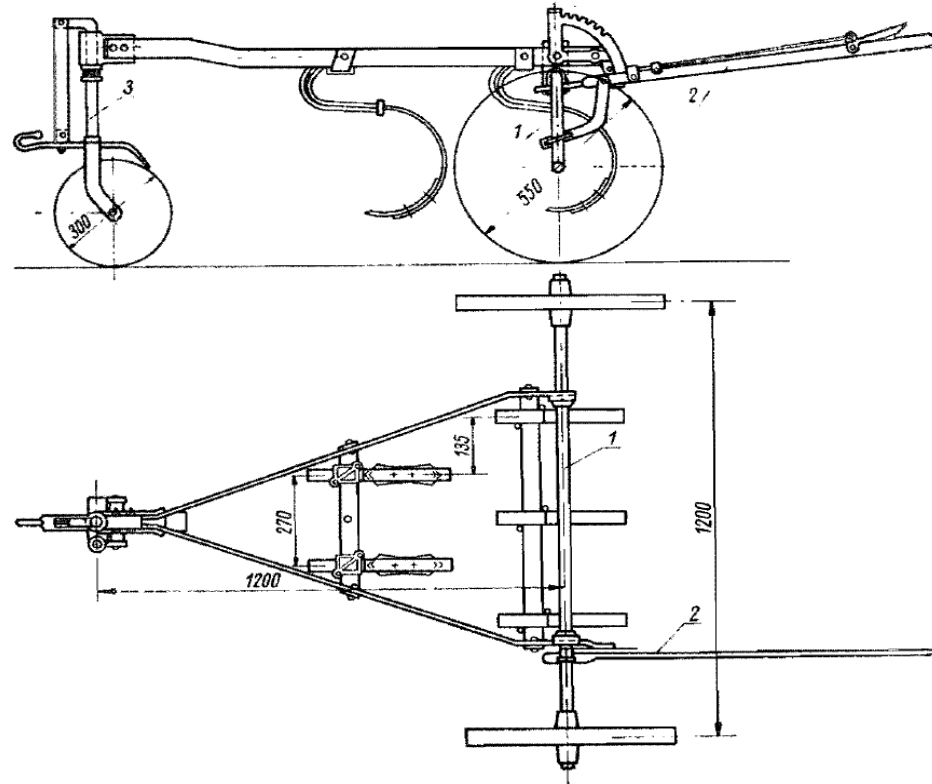
Cultivator

Introduction

- Cultivator pulverises and partly crushes the tilled and musty soil beds.
- Types of cultivator
 - I. Horse drawn cultivator
 - II. Semimounted tractor cultivator
 - III. Mounted cultivator

Types of cultivator

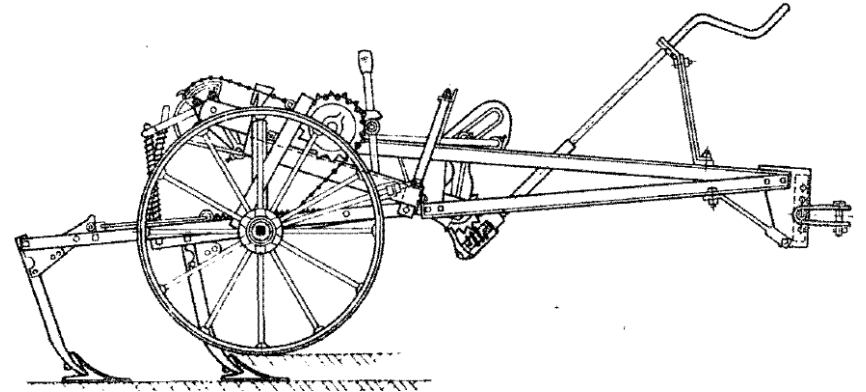
- Horse drawn cultivator



- 1- Rear wheel axle; 2- Lever for control of wheel setting;
3- One wheel forecarriage

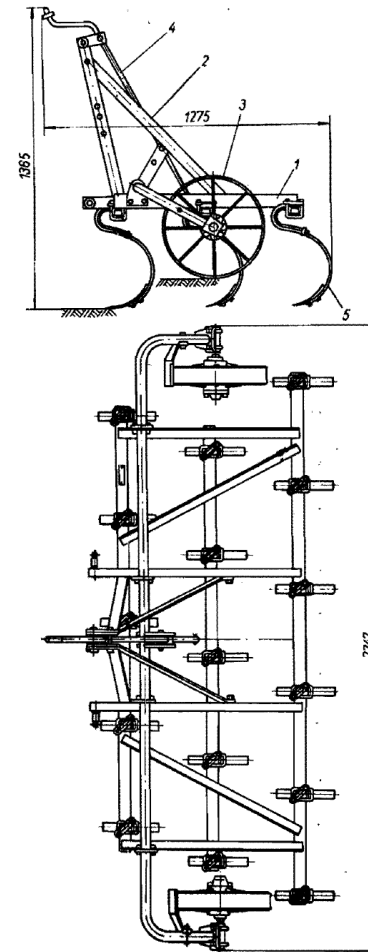
Types of cultivator

- Semimounted tractor cultivator

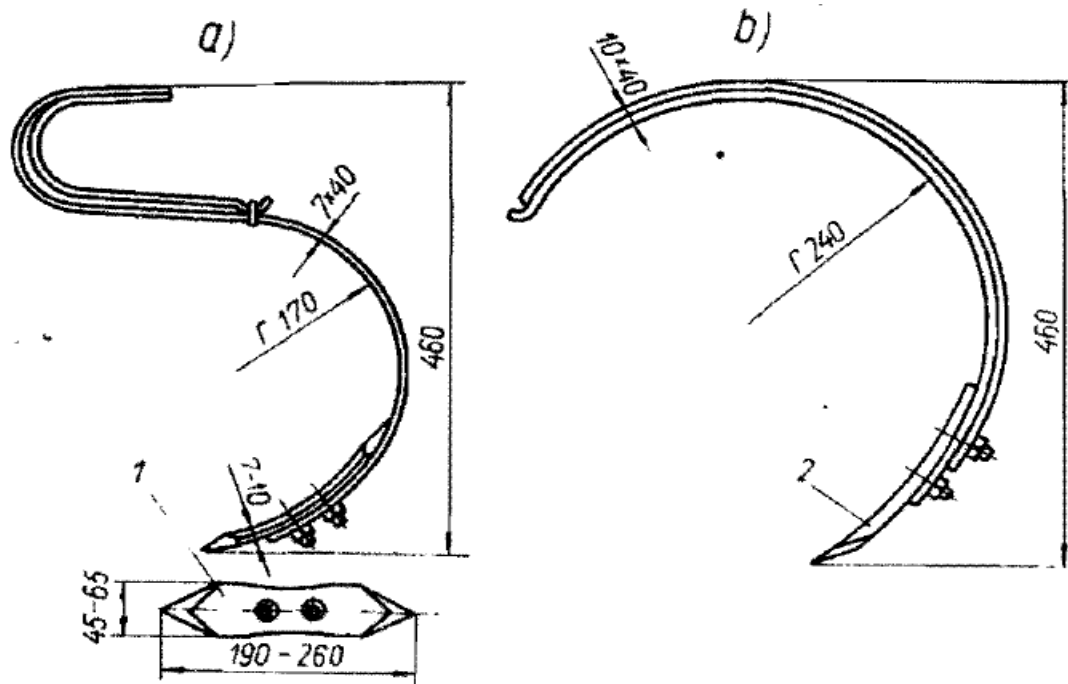


- Mounted cultivator

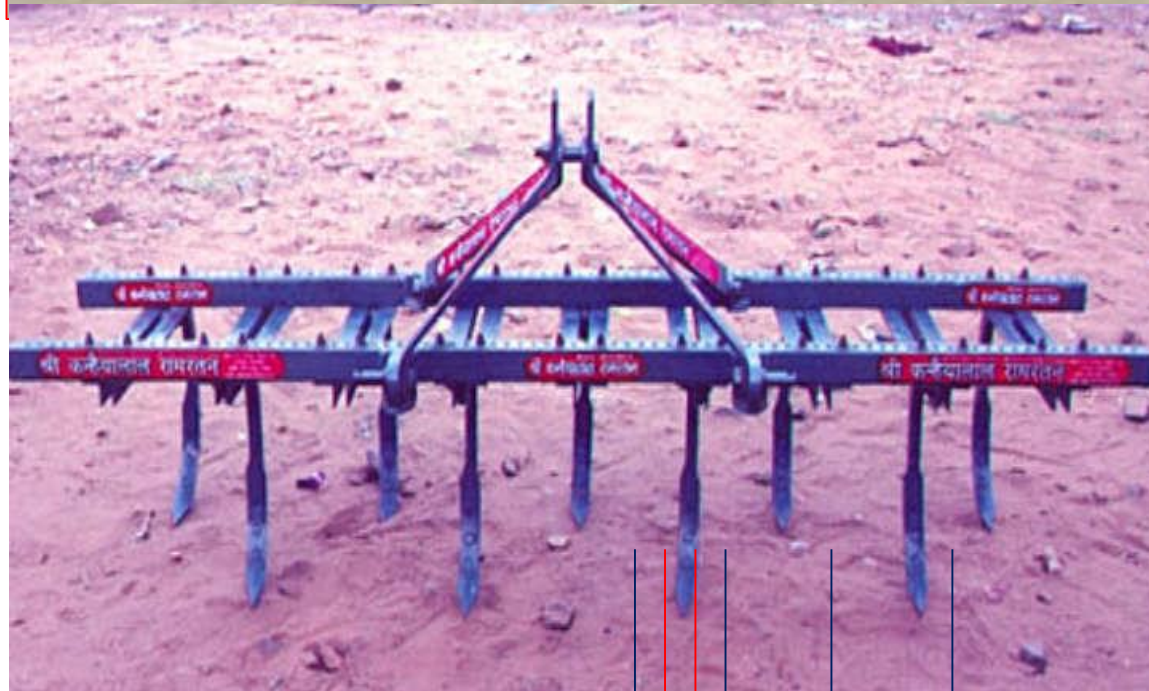
Mounted cultivator with spring tines: 1- frame; 2- mounting column; 3- gauge wheel; 4- spindle for controlling gauge-wheel setting; 5- spring tine.



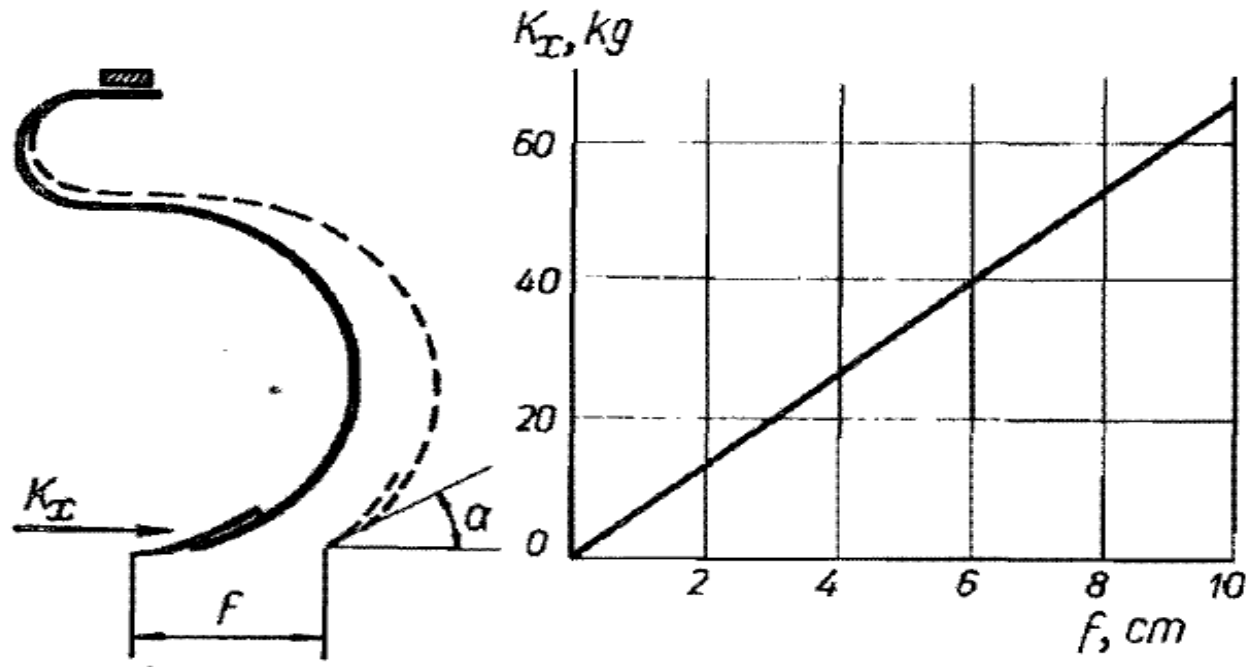
Cultivator teeth



Cultivator spring teeth: a) “S”-shape; b) circular;
1- two-sided shovel; 2- one-sided shovel

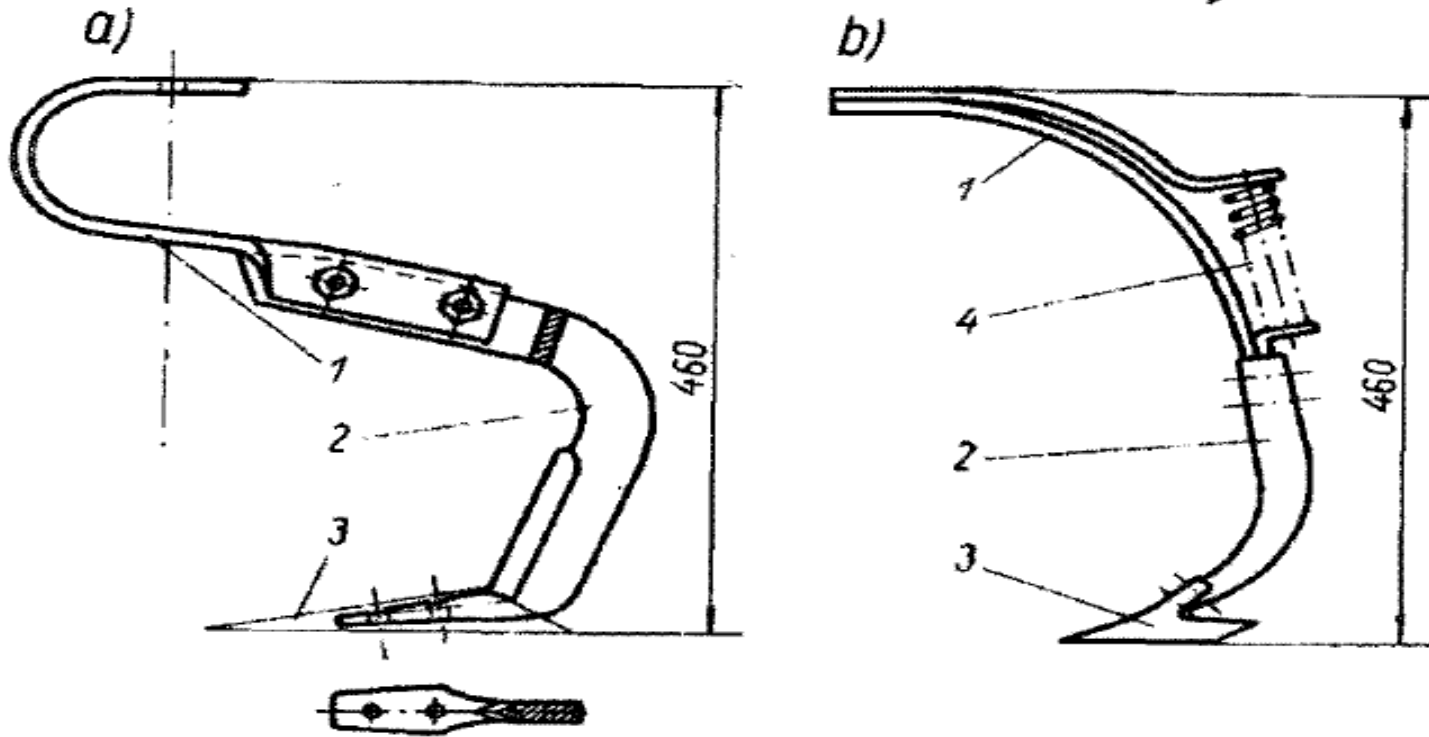


Cultivator teeth



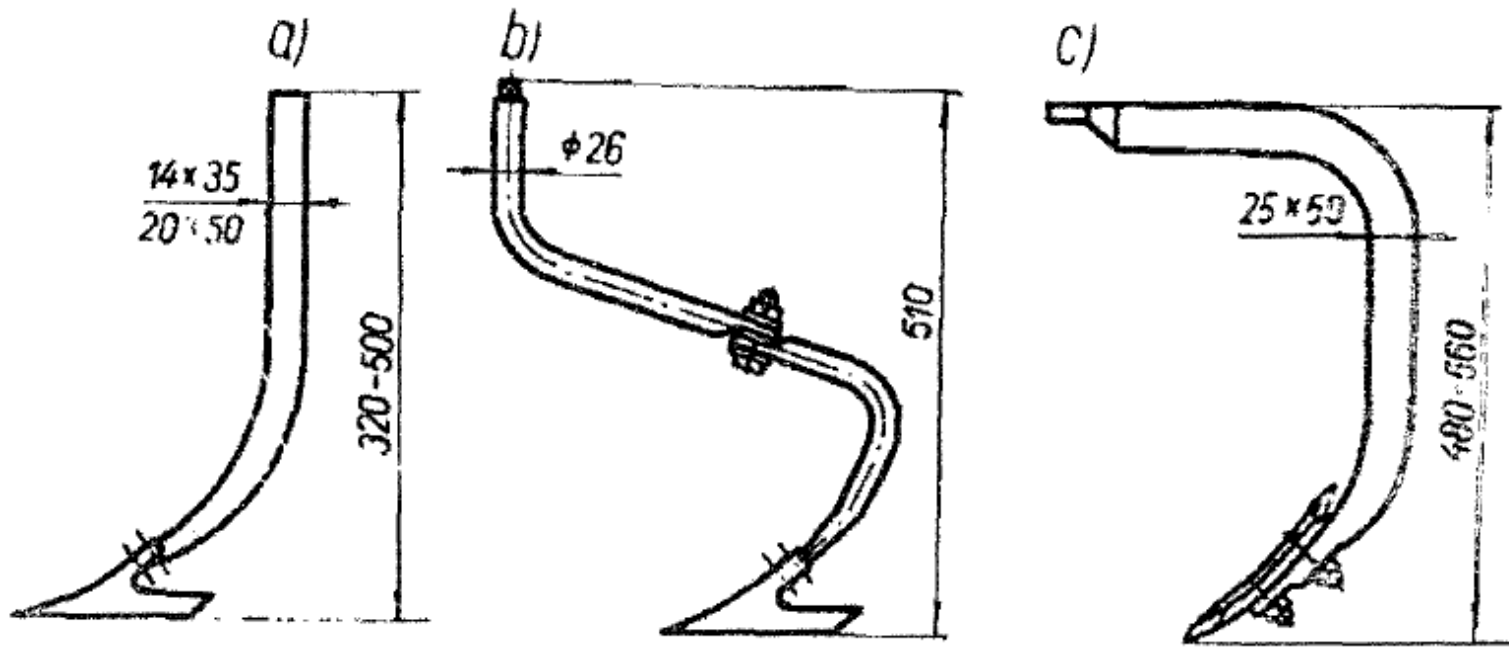
Spring tooth deflection

Spring teeth



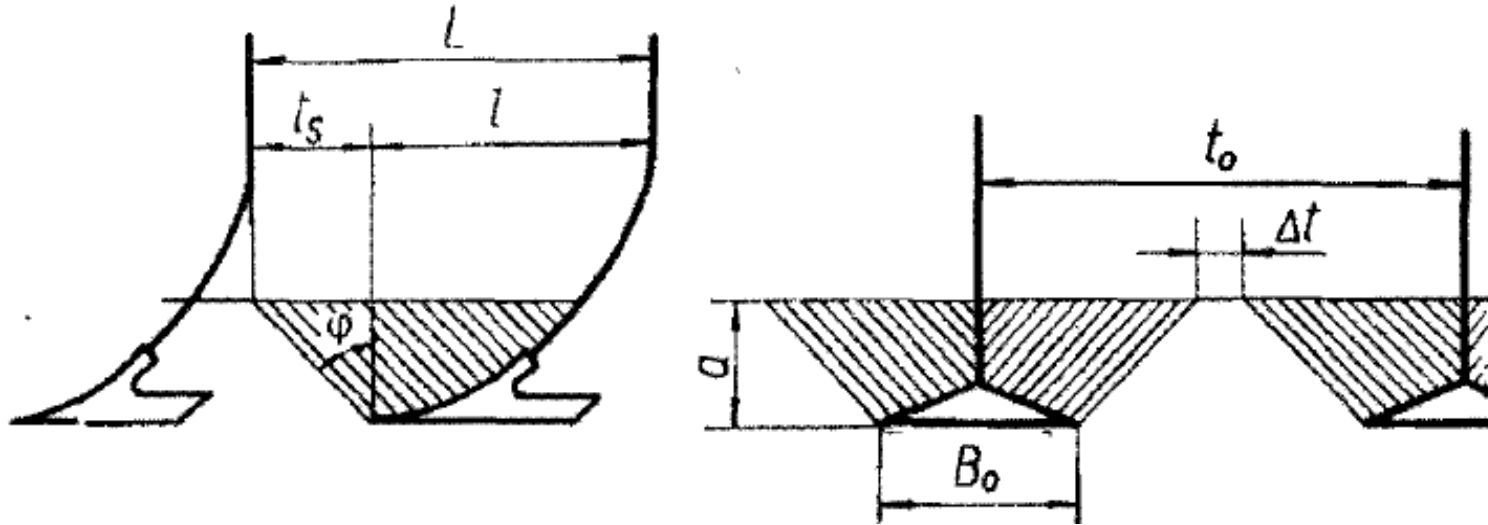
Semirigid cultivator teeth: a) with single plain spring; b) with additional helical spring (Arns); 1- plain spring; 2- shank; 3- sweep; 4- helical spring

Spring teeth



Rigid teeth of cultivator: a) with vertical shank; b) with sectional shank; c) chisel

Operating zones of cultivator teeth



B_0 - width of the shovel or of sweep

t_s - Width of zones acting on both side of the tooth

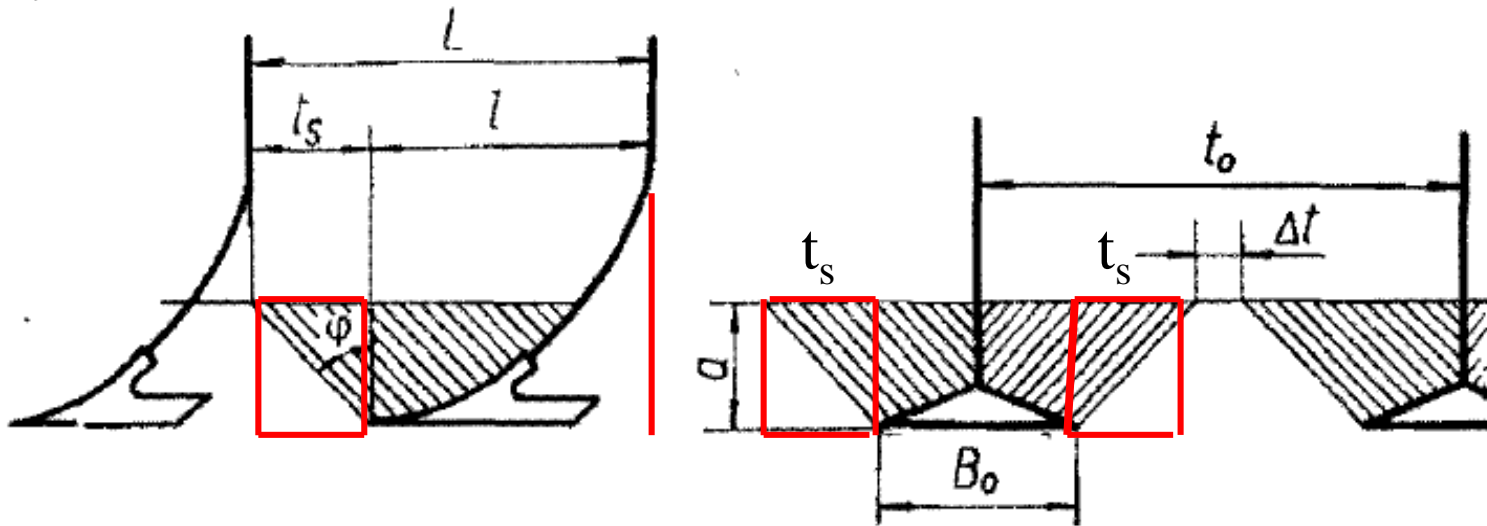
t_0 - transversal spacing; $\Delta t = 2-5$ cm of shovel and $0-5$ cm of sweep

a - working depth

l - distance of the blade point from the tooth shank

L - spacing of the rows of teeth

Operating zones of cultivator teeth



Transversal spacing of cultivator teeth should amount to

$$t_0 = 2a_{\max} + B_0 + \Delta t$$

where

$\Delta t = 2-5$ cm for the shovels,

$\Delta t = 0-5$ cm for the sweeps.

Zone of forward action of the cultivator amounts to

$$t_s = a \tan \gamma$$

It can be assumed that $\phi = 45^\circ$ and then spacing L of the rows of teeth should amount to

It can be assumed that $\varphi = 45^\circ$ and then spacing L of the rows of teeth should amount to

$$L \geq a_{\max} + l$$

where l is the distance of the blade point from the tooth shank.

Sweeps are spaced in cultivators most frequently in two rows, so that their tracks overlap on a width **C 2-3 cm**.

Sweeps of the second row can be wider than those of the first row.

The working width of the cultivator with sweeps amounts to

$$B_k = B_0 n - C(n - 1)$$

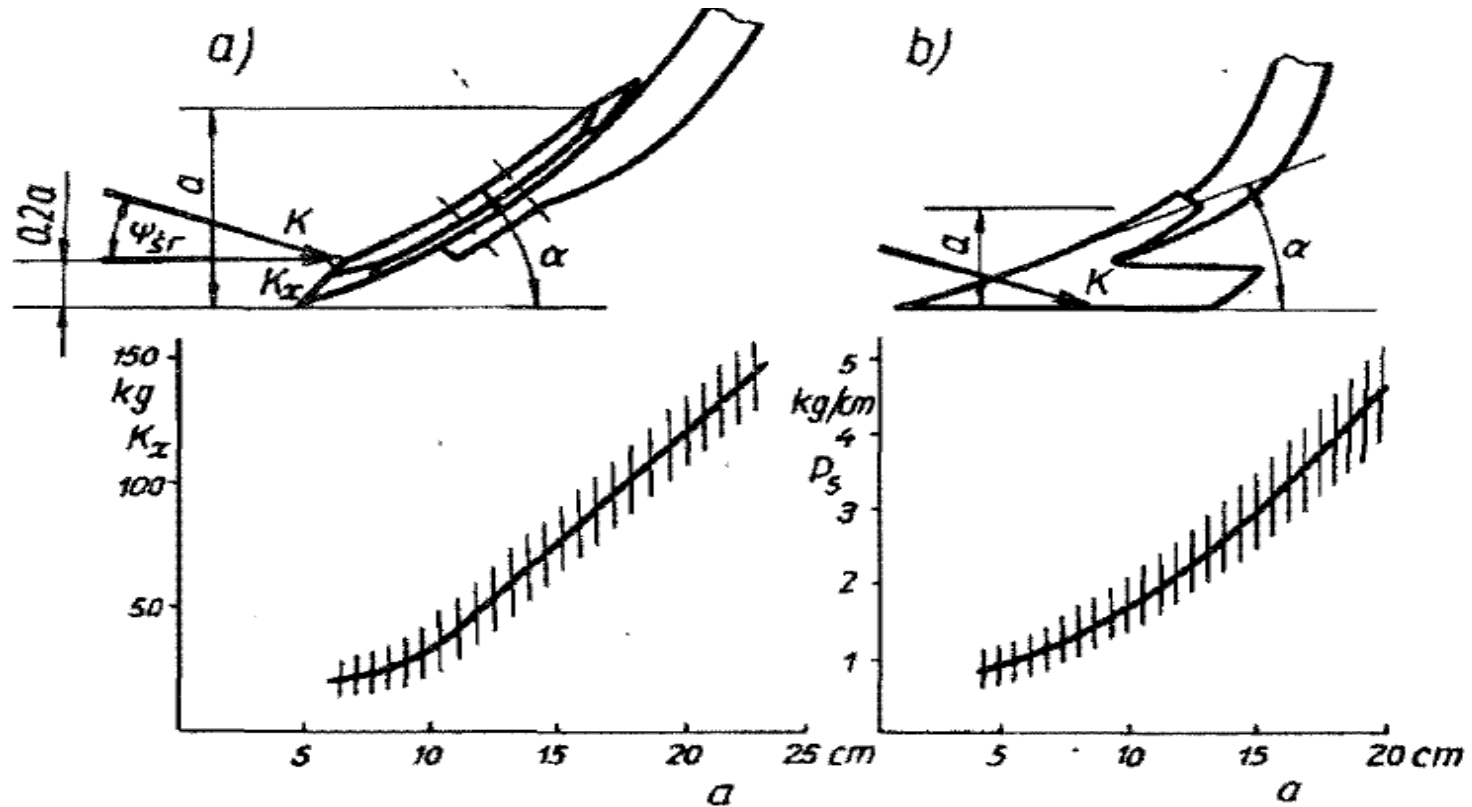
where

n - number of all sweeps,

B_0 - width of a sweep.

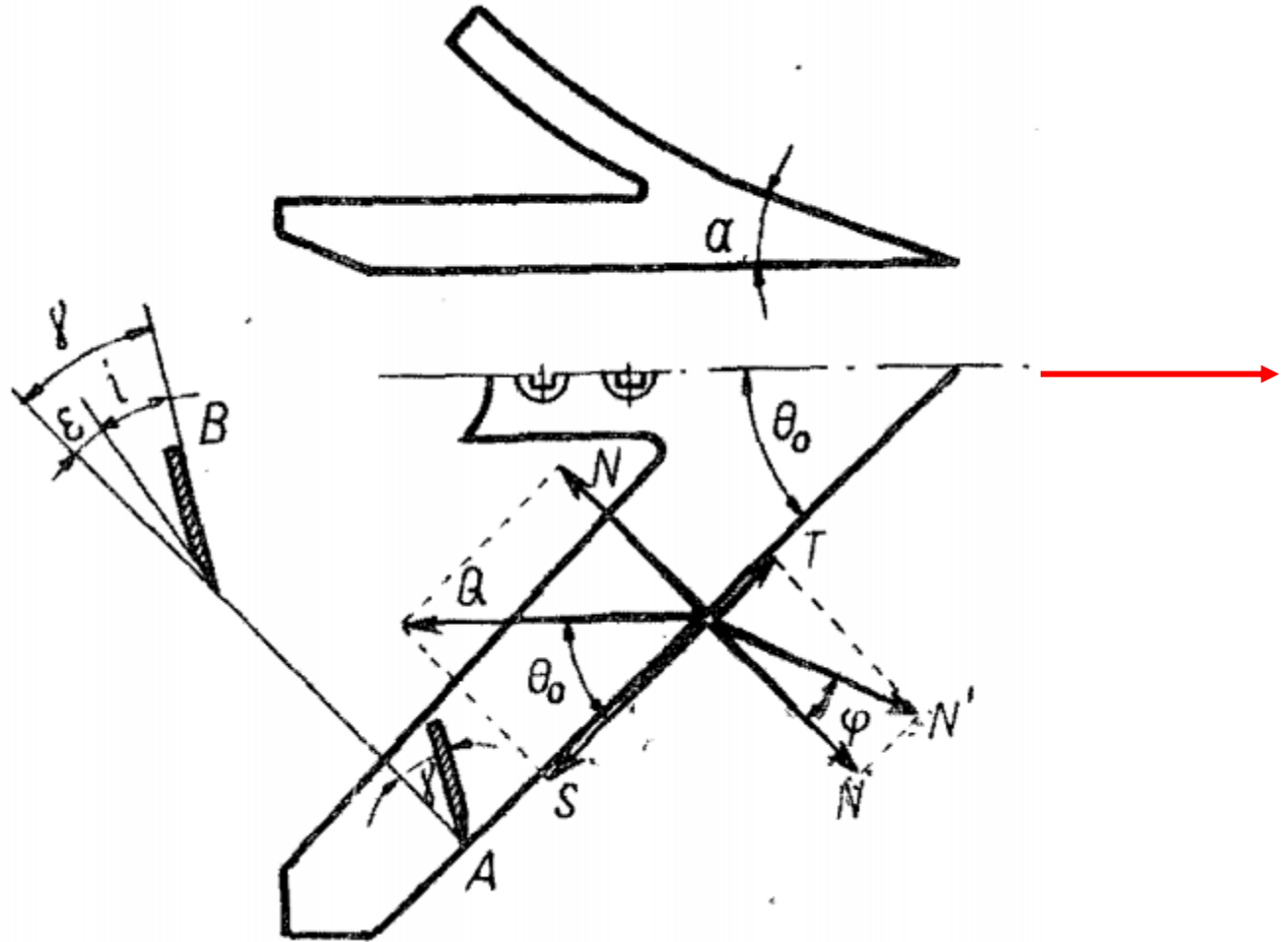
Shovel teeth are spaced most frequently in three rows.

Ground working parts of cultivators



Dependence of soil resistance on working depth: a) cultivator tooth with a shovel; b) with a sweep; p_s - specific resistance of working width

Ground working parts of cultivators



Distribution of forces during cutting of weed roots by the sweep:
A- sweep sharpened from above; B- sweep sharpened from below

Sweeps not only pulverize the soil but also serve for cutting roots of weeds. Therefore when selecting the apex angle $2\theta_0$, conditions for easy undercutting of roots of weeds by the sweep blades should be taken into account. While sweep is moving pressure Q on roots of weeds conforms to the direction of motion: This pressure is distributed on normal force N and tangential force S . Normal force produces friction $T = N \cdot \tan\phi$ of the root against the blade." The root is Cut through when the tangential force S becomes higher than the friction force T .

$$\tan \gamma = \frac{\tan \alpha}{\sin(\theta_0)}$$

$$T < S$$

$$N \tan \varphi < Q \cos \theta_0$$

$$N = Q \sin(\theta_0)$$

$$\tan \varphi < \cot \theta_0 = \tan(90 -$$

$$\varphi < 90 - \theta_0$$

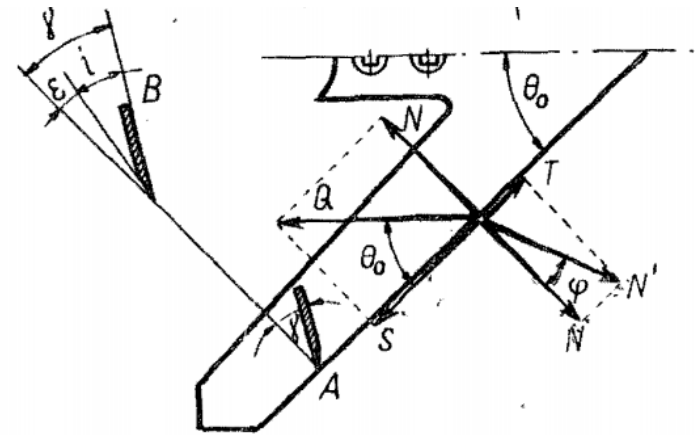
and then the angle of setting of the blade should amount to

$$\theta_0 \leq 90 - \varphi \quad (7.18)$$

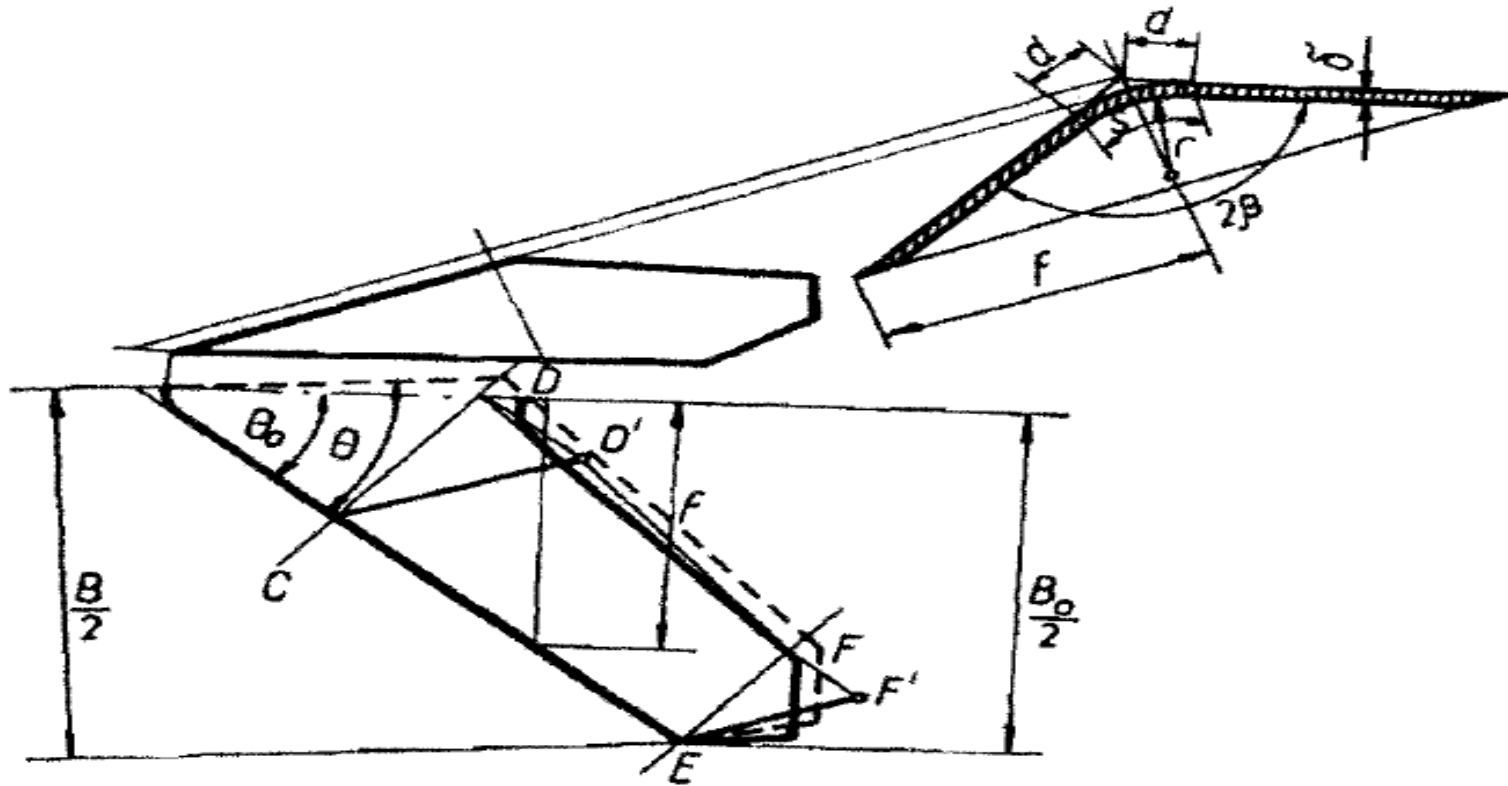
The friction angle of crushed roots and stalks of weeds does not exceed 45°. Assuming that $\varphi = 45^\circ$, we obtain

$$2\theta_0 \leq 90^\circ$$

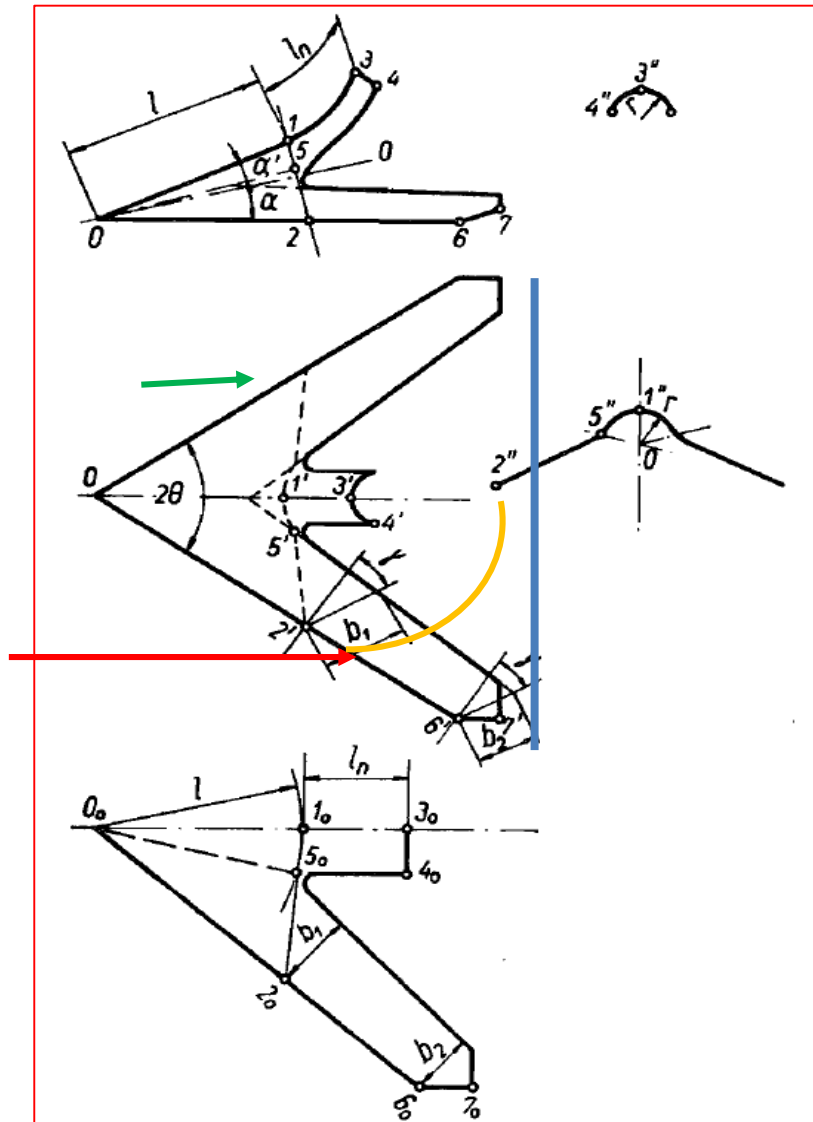
In practice, the apex angle of sweep ranges from $2\theta = 60^\circ$ to 90° , most frequently 70° .



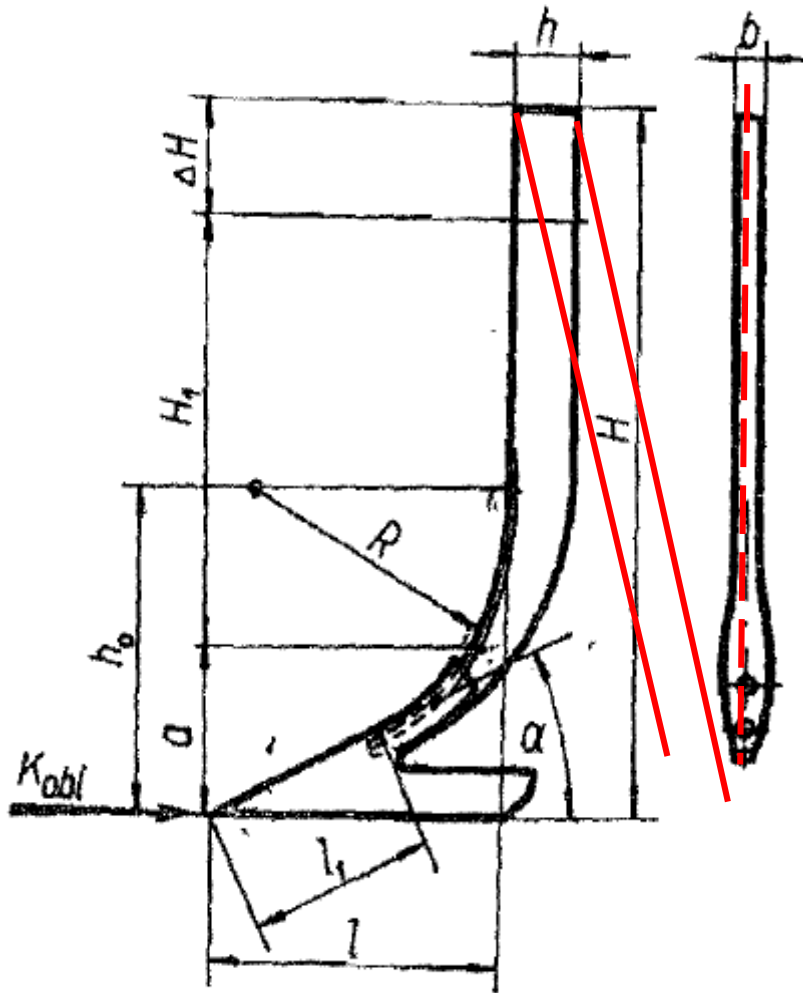
Spread view of straight sweep



Spread view of sweep with a nose



Shank of rigid teeth



$$R = \frac{h_0 - l_1 \sin \alpha}{\cos \alpha}$$

H = total height of shank

ΔH = length of the upper part of the shank serving for shank fastening

H_1 = minimum clearance between lower edge of the frame of lever and land surface

R = radius of curvature

l_1 = the length of the breast of the sweep.

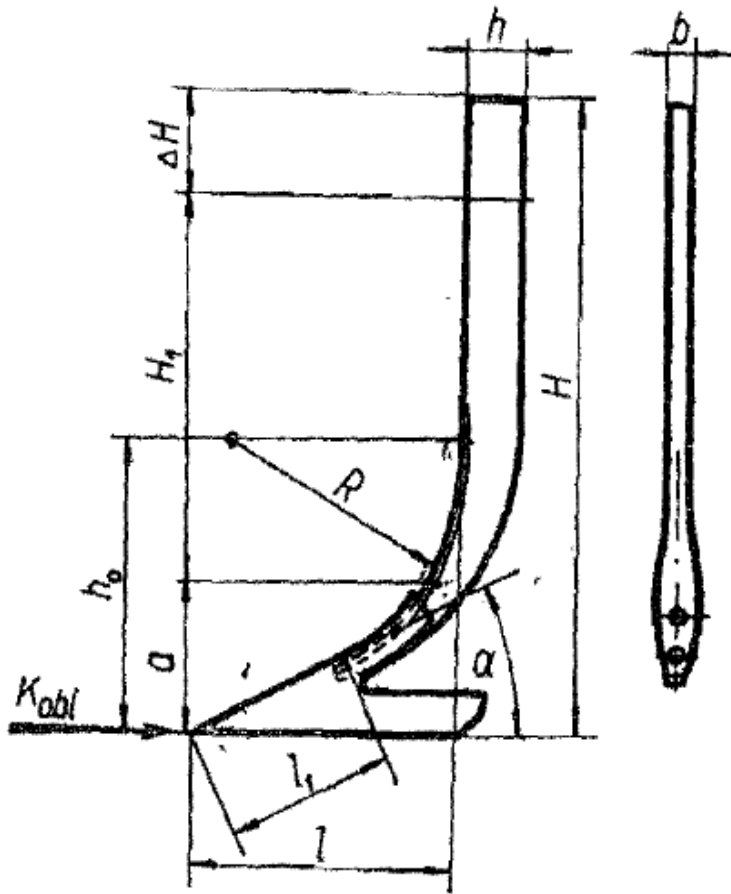
h = width of shank

b = thickness of shank

K_{obl} = Horizontal soil resistance

a = working depth

α = Load angle



$$H = \Delta H + H_1 + a_{\max}$$

Owing to the fact that the shank of the tooth is sinking into the soil, care is taken to keep its thickness b as small as possible. Most frequently it is assumed that $b : h = 1 : 3$. Shanks are manufactured of carbon steel with carbon content 0.45-0.65 percent.

$$K_x = a \frac{B_K}{n} p_K \text{ (kg)}$$

where

a — working depth (decim),

B_K — cultivator working width (decim),

n — number of cultivator teeth,

p_K — specific resistance of soil at cutting by means of a swe
(kg/sq decim).

Specific resistance of soil p_K when cultivating to a depth of 15 c
amounts to:

light soil	about 12 kg/sq decim,
medium soil	„ 15 „
heavy soil	„ 20 „
very heavy soil	„ 25 „

Average specific resistance of soil against a single shovel or sweep not cooperating with other shovels (this does not occur in the cultivator) can be 2–4 times higher than the above values. Shanks of shovels or sweeps in the first row are more heavily loaded than those of the second row. For calculation purposes they are assumed as being of the same value owing to the possibility of their interchanging.

Stress, causing the shank to bent amounts to

$$\sigma = \frac{M_{zg}}{W} = \frac{6K_{obl}(H_1 + a)}{bh^2}$$

Torsional stress is calculated according to the formula

$$\tau = \frac{M_{sk}}{W_0} = \frac{9K_{obl} \frac{B_0}{4}}{2hb^2}$$

$$\delta_{zr} = \sqrt{\sigma^2 + 4\tau^2}$$