Tablet Compression operation

Lecture 5

Industrial pharmacy

5th class

1st semester

Tablet Compression Machines

Tablets are made by compressing a formulation containing a drug or drugs with excipients on stamping machines called presses.

- **Tablet compression machines or tablet presses are designed with the following basic components:**

1. Hopper(s) for holding and feeding granulation to be compressed.
2. Dies that define the size and shape of the tablet.
3. Punches for compressing the granulation within the dies.
4. Cam tracks for guiding the movement of the punches.
5. A feeding mechanism for moving granulation from the hopper into the dies.

Tablet presses are classified as either single punch or multi-station rotary presses:

1. **All of the compression is applied by the upper punch, making the single punch machine a "stamping press".**

2. **Multi-station presses are termed *rotary* because the head of the tablet machine that holds the upper punches, dies, and lower punches in place rotates.**

Notes:

i. As the head rotates, the punches are guided up and down by fixed cam tracks (control the sequence of filling, compression, and ejection).

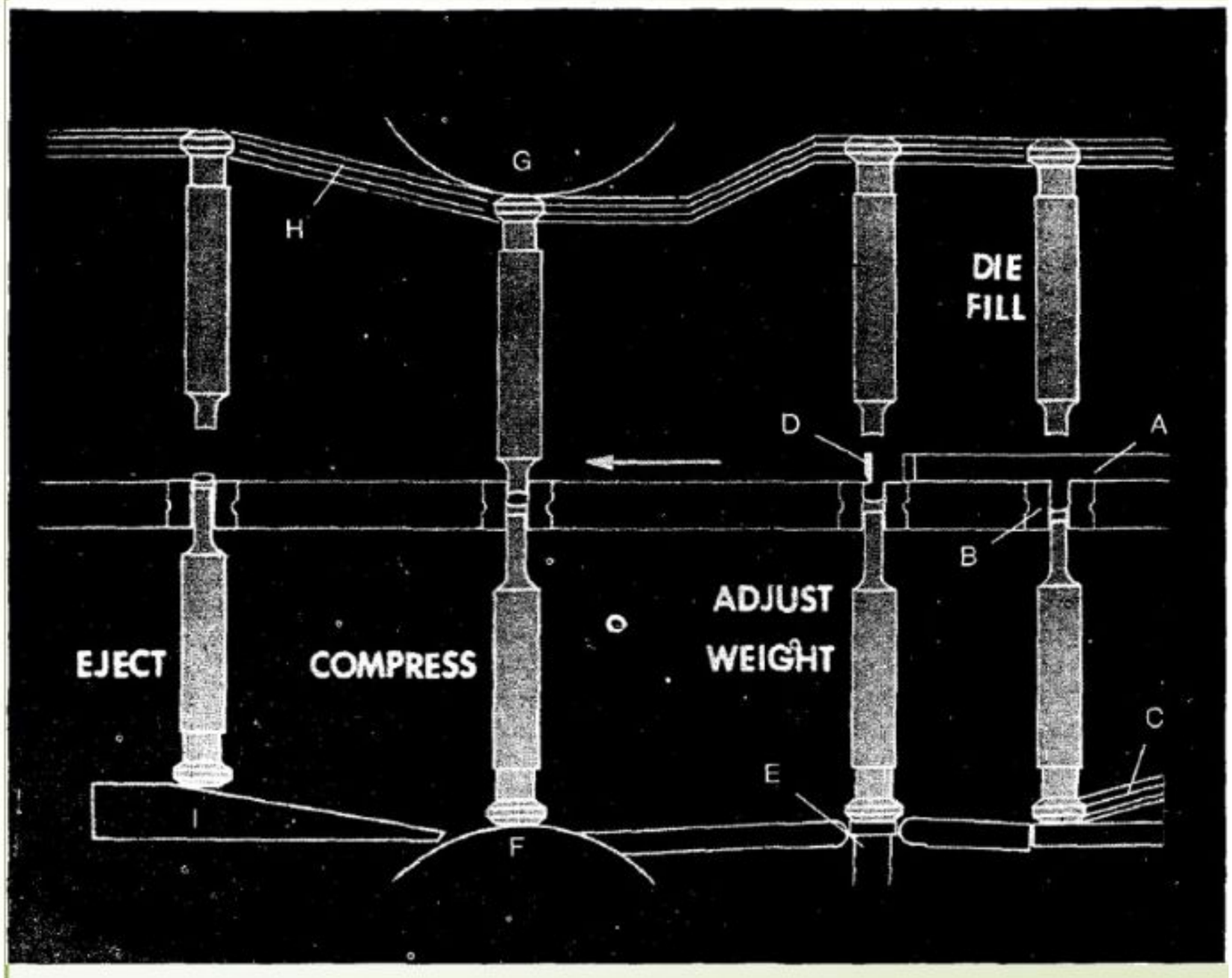
ii. The portions of the head that hold the upper and lower punches are called the upper and lower turrets respectively.

iii. The portion holding the dies is called the die table.

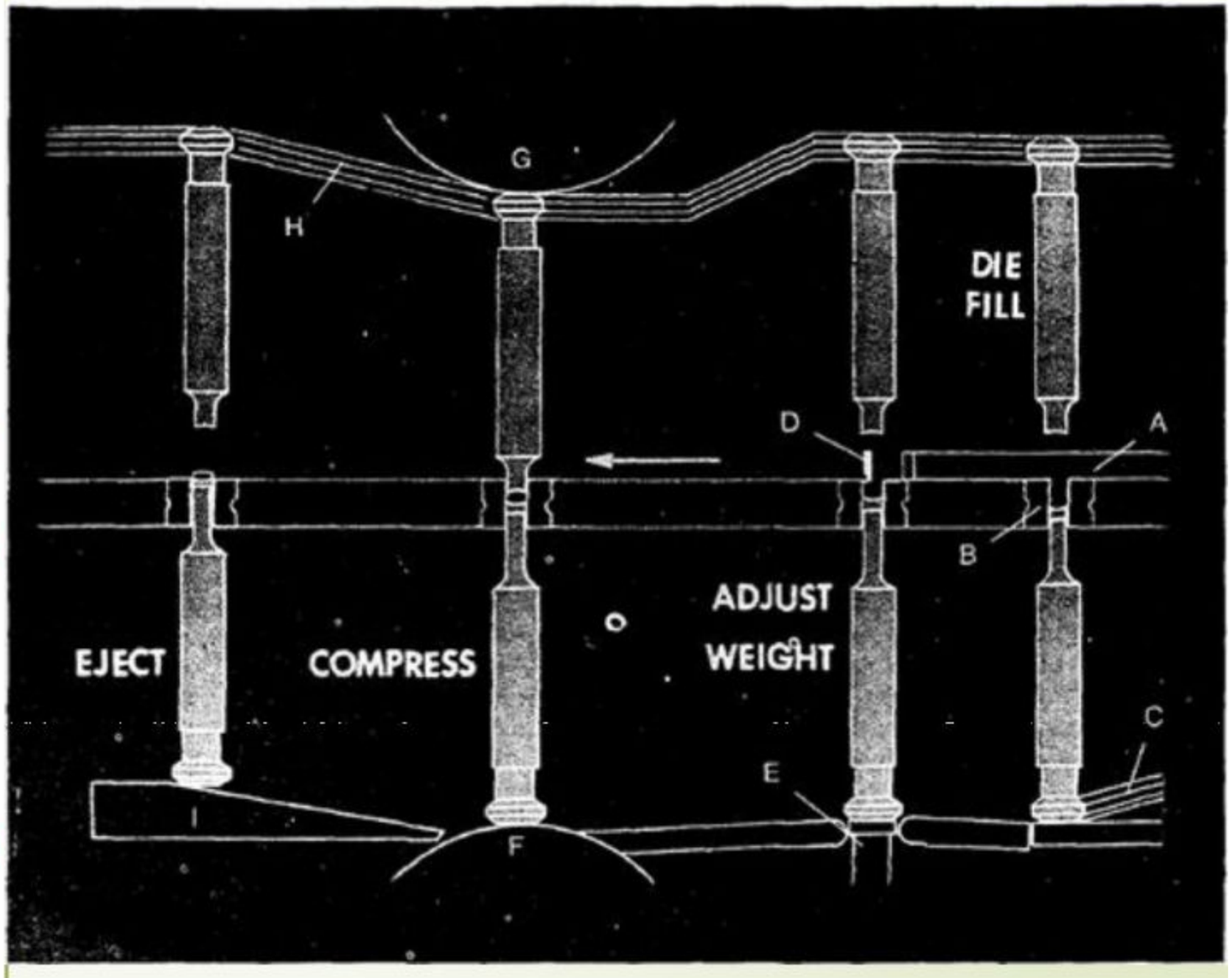
Cam

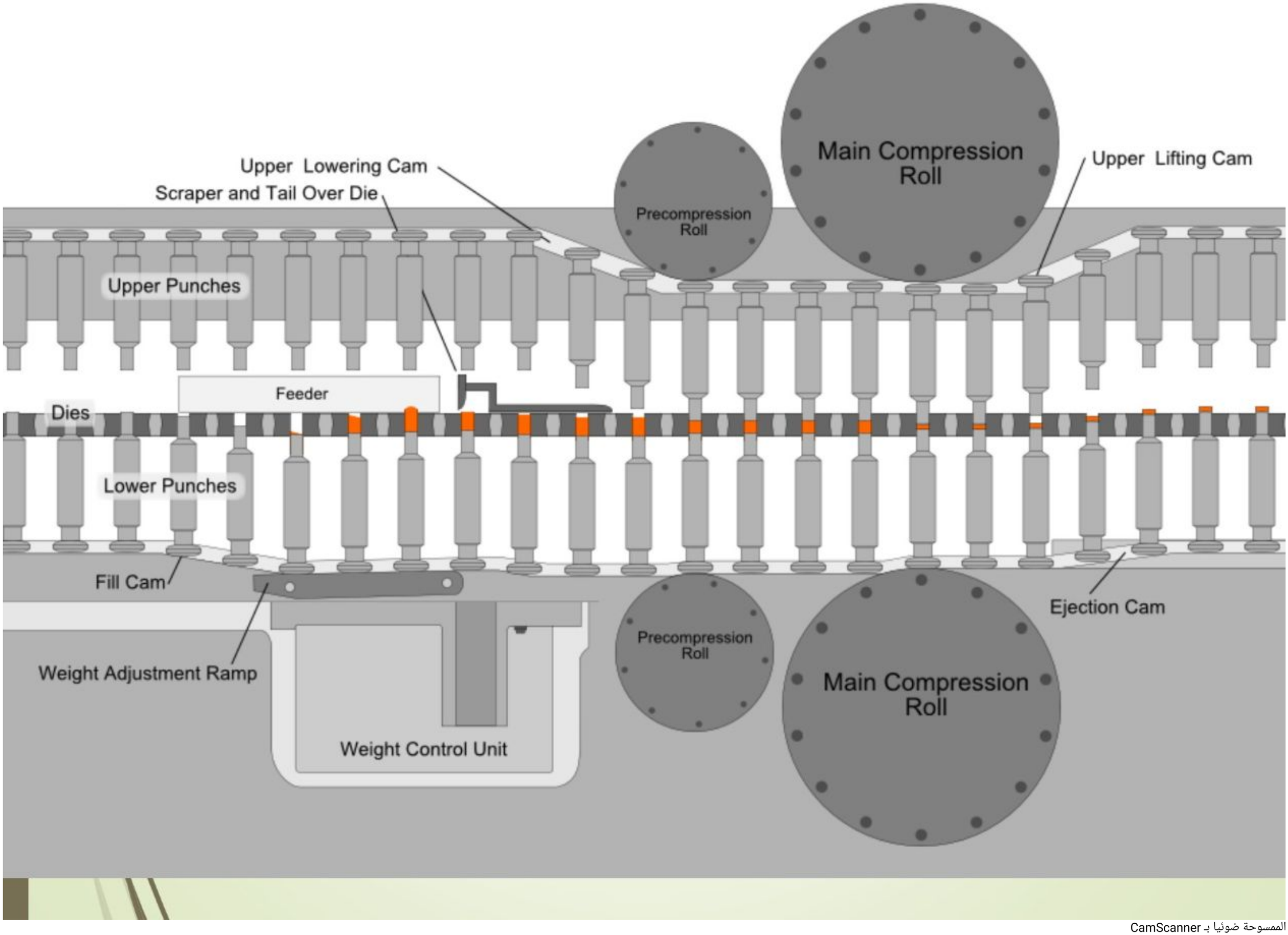
Compression cycle

- Granulation stored in a hopper that empties into **the feed-frame (A)** which has several interconnected compartments.
- These compartments spread the granulation over a wide area to provide time for **the dies (B)** to fill.
- **The pull-down cam (C)** guides the lower punches to the bottom of their vertical travel, allowing the dies to overfill.
- The punches then pass over a **weight control cam (E)**, which reduces the fill in the dies to the desired amount.
- **A wipe-off blade (D)** at the end of the feed-frame removes the excess granulation and directs it around the turret and back into the front of the feed-frame.
- Next, the lower punches travel over **the lower compression roll (F).**



- while simultaneously the upper punches ride beneath **the upper compression roll (G)**. The upper punches enter a fixed distance into the dies, while the lower punches are raised to squeeze and compact the granulation within the dies.
- To regulate the upward movement of the lower punches, the height of the lower pressure roll is changed.
- After the moment of compression, the upper punches are withdrawn as they follow **the upper punch raising cam (H).**
- The lower punches ride up **the cam (I)**, which brings the tablets slightly above the surface of the dies. The exact position is determined by a threaded bolt called **the *ejector knob*.**
- The tablets strike **a sweep-off blade** affixed to the front of the feed-frame (A) and slide down a chute into a receptacle. At the same time, the lower punches re-enter the pulldown cam (C), and the cycle is repeated.





1. Hopper

Contains the granules that are to be compresses into tablets

Upper Punch

The upper punch moves vertically in and out of the die bore

2 - Feeder Housing

Hopper feeds material into the rotating die via the feeder housing

3 - Feed Paddles

Helps force feed the granules into dies especially during faster rotation

Lower Punch

The lower punch remains within the bore of the die during the entire cycle

4 - Lower Cam Track

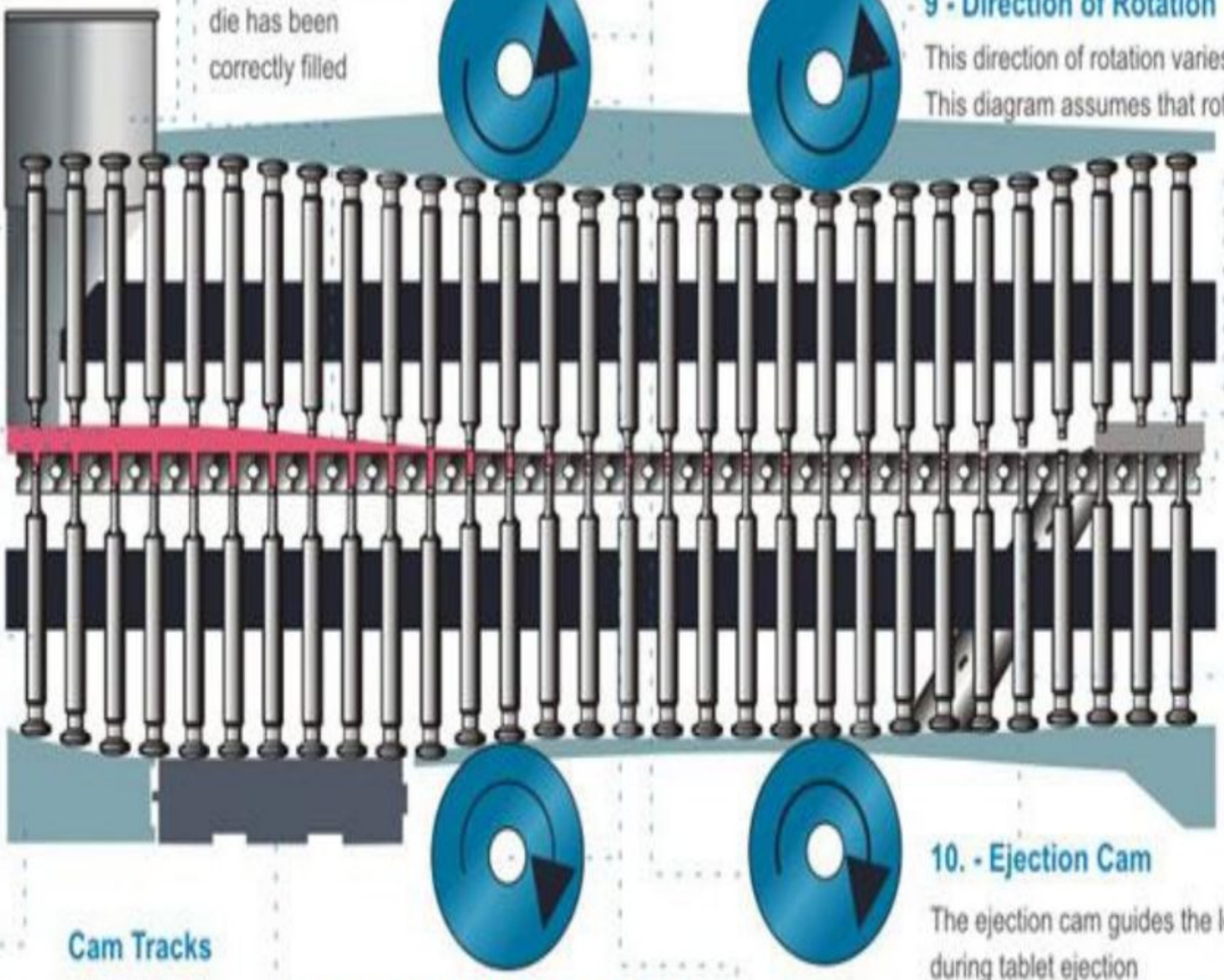
The lower cam track guides the lower punch during the filling stage so that the die bore is over filled to allow accurate adjustment

Cam Tracks

These lift and lower both upper and lower punches as

6 - Fill Station

The point where the die has been correctly filled



5 - Depth of Fill (Weight Control)

The lower punch track during the later part of the fill stage, adjustable to ensure that as the punch rises the correct quantity of granule, remains within the die, and therefore the tablet weight is correct

8 - Main Compression Rollers

This rollers apply compression force to the punches for the final formation of the tablet

9 - Direction of Rotation

This direction of rotation varies from machine to machine
This diagram assumes that rotation is from left to right

11. Take - off Blade

Fitted in front of the feeder housing this deflects the tablet down the discharge chute

Die

Punch move within the die bore to compress the granules into tablets

12 - Discharge Chute

The Chute which the tablet passes through for collection

10. - Ejection Cam

The ejection cam guides the lower punch upwards during tablet ejection

7 - Pre - Compression Rollers

This roller gives the granule an initial compression force to remove excess air that might be entraped

Note:

Features such as capacity, speed, maximum weight and pressure vary with the design of the equipment but the basic elements remain essentially the same.

A tablet machine's output is regulated by three basic characteristics of its design:

1. **Number of tooling sets (dies, upper and lower punches)**
2. **Number of compression stations**
3. **Rotational speed of the press**

Purpose of using rotary tab. machines:

- **In general, all rotary presses are engineered for fast and economical production of all kinds of tablets.** (Larger machines can readily produce several million tablets each in a working day, and their performance can be geared to continuous low-maintenance operation).

- **Many modifications and options can be obtained from various manufacturers:**

(One modification, which is found on most modern high-speed tablet presses, **use of hydraulic or pneumatic pressure to control the pressure rolls in place of the older spring type pressure).**

- A smoother pressure or compressive load force over a longer period of time.
- More accurate and can be set with closer tolerances, which do not change with time or fatigue.

Compression Machine Tooling

The size and shape of a tablet as well as certain identification markings are determined by compression machine tooling set.

The tooling must meet many requirements to:

1. Satisfy the needs of dosage uniformity
2. Production efficiency
3. Aesthetic appearance.

Tooling sets

- **BB tooling** (5.25 inches in length, nominal barrel diameter of 0.75 inches and 1-inch head diameter).
- **B tooling** (identical to the BB type except that the lower punch is only $3^{9}/_{16}$inches long).
- **D tooling** is popular for large tablets, (1-inch barrel diameter, $1^{1}/_{4}$-inch head diameter, and 5.25-inch length).

- **The dies that are used with the above punches are either:**

a) **0.945-inch outside diameter (OD) die capable of making a $^{7}/_{16}$-inch round tablet or $^{9}/_{16}$-inch capsule-shaped tablet.**

b) **1 $^{3}/_{16}$-inch OD die capable of handling a $^{9}/_{16}$-inch round or $^{3}/_{4}$ -inch capsule shaped tablet.**

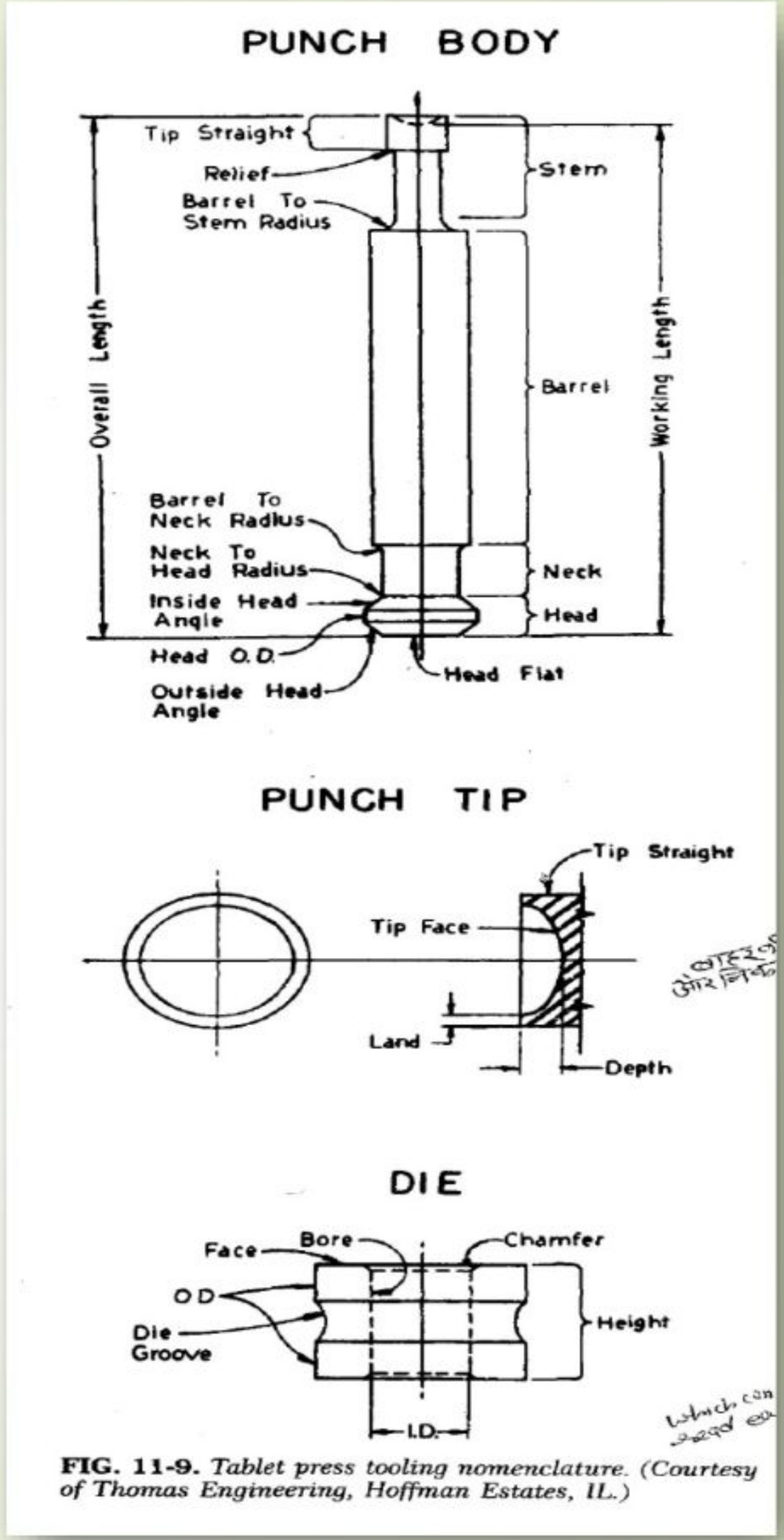


FIG. 11-9. *Tablet press tooling nomenclature. (Courtesy of Thomas Engineering, Hoffman Estates, IL.)*

Important notes:

I. **Several types of steel are normally used in the manufacture of compression tooling that differ in:** (toughness to withstand the cyclic compacting forces, ductility (elasticity), and in wear resistance).

II. No single steel type has a high resistance to abrasive wear and a high ductility.

III. **Selection of the best steel for a specific application must be based on** Experience and an accumulated history of the product being tableted.

In the selection of the proper steel for a specific use, one should consider:

a. Shape of the punch tip, whether or not debossing is to be employed on the tooling.

b. The expected compression forces.

c. Materials to be processed are abrasive or corrosive.

IV. Tooling can be made with certain information (aid in producing a visibly unique tablet product).

Ex: Company names or symbols, trade names, dosage strength, or National Drug Code (NDC), numbers can be engraved into a punch face, or the punches may be scored, to produce uniquely embossed or engraved tablets.

V. Even though tooling design would appear to be limitless, certain practical aspects do limit design implementation.

Because of the movement of tooling during a compression operation, certain tablet shapes or configurations perform better than others.

Tools problems:

Because of its hard steel structure, tablet tooling may appear to be indestructible.

a. **During normal use, the punches and dies become worn, and the cyclic application of stress can cause the steel to fatigue and break.**

b. **Improper storage and handling can readily result in damage that necessitates discarding of an entire tooling set.**

c. **The punch tips are especially delicate and susceptible to damage if the tips make contact with each other, the dies, or the press turret upon insertion or removal of the tools from the tablet machine.**

Auxiliary Equipment

Problem 1: the speed of the die table is such that the dwell time of a die under the feed frame is too short to allow for adequate or consistent gravity filling of the die with granulation.

Causes: Improper filling of the dies with granulation results in unsatisfactory weight variation and content uniformity of the resulting tablets. A similar result can occur with a poorly flowing granulation.

Solution: mechanized feeders can be employed to force granulation into the dies

Problem 2: The high tablet output rates of modern presses demand that the granulation hoppers be refilled at frequent intervals; the larger the tablet is, the more frequently the hopper needs to be replenished.

Causes: Allowing a tablet machine to run "dry" results in a series of rapidly degenerating and unacceptable events:

1- low-weight tablets and tablets with poor weight variation are produced.

2- tooling is usually ruined, particularly with thin tablets, by the punches being forced together without any granulation between them. Because of the relatively low volume of press hoppers, the filling of hoppers by hand on high-speed presses is inefficient, increases the risk of-punch damage, and can contribute to weight variation problems.

Solution: mechanized equipment has been developed to load granulation into the press hoppers.

Problem 3: handling large quantities of materials into the hoppers.

Solution: place bulk granulation containers directly above tabletting machines to gravity-feed the granulation into hoppers.

1. Either by placing bulk granulation containers on floors and granulation can then be directed through openings into the hoppers.
2. Or granulation containers can be held above tablet machines.
3. Also granulation level sensors can be used to stop the press automatically when the granulation level drops to a critical level in the hopper.

Problem 4: The high rate of tablet output with modern presses calls for a higher frequency or even continuous monitoring of tablet weight.

Solution: Electronic monitoring devices, such as the Thomas Tablet Sentinel, Pharmakontroll, and the Kilian Control System-MC:

1. Monitor the force at each compression station, which correlates with tablet weight.
2. Monitors are also capable of initiating corrective actions, altering the amount of die fill to maintain a fixed force, ejecting tablets that are out of specification, counting and documenting the machine operation throughout the run.

Another auxiliary: In almost all cases, tablets coming off a tablet machine bear excess powder and are run through a tablet deduster to remove that excess.

Thomas tablet Sentinel